The Stock Market's Valuation of R&D and Market Concentration in Horizontal Mergers[1]

By

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Abstract

It is well documented that acquirers often pay a very large premium to acquire companies in related industries. There are many explanations as to the source of this premium. This study isolates two variables, R&D-intensity and market concentration, and correlates their value individually and jointly to the value of the acquired company. The results indicate that change in market concentration and R&D is positively correlated to the merger deal premium in a horizontal merger. Furthermore, deal premiums tend to follow an inverted U curve pattern relative to market concentration change. The study also shows that cost synergies and macro economic growth impact deal premium values.

Key words: mergers, R&D, market concentration, deal premium

JEL classification: L10, L40

1. Introduction

A large body of research has examined the effect of mergers on the stock prices of acquisition targets and acquiring firms. Study[2] results have consistently shown that acquisition candidates receive a large premium over market value to relinquish corporate control, while the market value of acquirers declines or remains the same. These papers also assess the source (s) of the deal premium, focusing on a variety of factors including cost synergies, management effectiveness, market power, financing, R&D, etc. While some authors, such as Higgins and Rodriguez (2006), have investigated the relationship between abnormal returns in a merger and R&D, there has been little research examining how change in market concentration and R&D intensity influence the perceived value of the merger.

The relationship between innovation and market concentration has been explored in a variety of studies and theories dating back to Joseph Schumpeter (1950) and John Kenneth Galbraith (1957). One hypothesis is that innovation increases with market concentration. It has also been posited that the relationship between innovation and market structure may not be linear over the total range of market concentration. A few researchers have promoted and sought to test the theory that innovation follows a U shape, with innovation reaching its apex at intermediate levels market of concentration with lower levels of innovation occurring at near monopoly and atomistic levels of competition (Wright, 2007). It has also been argued that larger firms have innovation advantages over small firms due to economies of scale and scope in research, financing advantages, and knowledge complementarities.

This paper examines whether acquirers pay more for acquisition candidates with higher levels of R&D. The hypothesis is that R&D activity of a rival is worth more to an acquirer than

[2] Examples includes Jensen and Ruback, 1983, Eckbo and Weir (1985), and Caves, 1991.

is indicated in the current value of the company. The essay also explores whether acquirers pay more for acquisition candidates as market concentration increases. This might be the case if companies are seeking to gain market share to increase pricing power and / or increase barriers to entry.

To investigate these issues, I construct a data set of 112 horizontal mergers that occurred from 1997 to 2007. These mergers were used as they all were issued 2nd requests by the Department of Justice or Federal Trade Commission for competition concerns[3], and 95 of these mergers were challenged by the government for concentration concerns. To analyze the data, a model was developed that correlates the deal premium paid for the acquisition candidate to R&D intensity, market concentration, cost synergies[4], and other factors relating to the merger.

The paper is organized as follows: A literature review section covers merger research relating to R&D and market value, innovation and market concentration, and deal premiums. The next section covers the data set and provides a descriptive analysis of the merger data and variables examined in this paper. A description of the models follows as well as an explanation of the econometric analysis employed to determine the effect of R&D, market concentration, and other covariates on the premiums paid for these mergers. The paper concludes with the results, an analysis of findings, and conclusions and potential policy implications.

2. Literature Review

There have been numerous studies[5] that examine the effect of R&D spending[6] and other intangibles (e.g. advertising) on market value. Researchers continually find that both

[3] See the Appendix for a list of mergers.

[4] These are claimed by the acquirers at the time of the merger announcement.

[5] For example, Chauvin and Hirschey (1993) and Ho, Key, and Ong (2005)

[6] R&D expenditures are expensed rather than capitalized per the 1974 FASB ruling, because, according to Lev and Sougiannis (2003), there is an assumed absence of a relation between R&D expenditures and value.

advertising and R&D expenditures have a consistent positive effect on the long term market value of the firm. They speculate that "spending on advertising and R&D can be viewed as a form of investment in intangible assets with predictable positive effects on future cash flows. However, the valuation effects of advertising and R&D investment are most uniformly apparent in the case of large firms." (Chauvin, 1993)

The first and most widely cited paper that examined the relationship between R&D and stock market performance was Griliches' 1981 study which found a positive correlation between the Tobin's q of a firm and the level of R&D spending and patents applied. Jaffe (1986) added to Griliches' approach in that he modeled the market value of the firm relative to the current R&D intensity and R&D stock. His regression results, which include factoring in spillover from R&D from other firms, indicated that investors placed a significantly larger emphasis on the value of R&D versus tangible assets. He also finds that firms whose R&D activity is in areas where there is a lot of research by other firms have a higher return on R&D, whether measured in terms of accounting profits or market value. Jaffe speculates that this result may be due to either a selection bias of studying only firms that report R&D or to the potential signaling that R&D spending conveys about long run returns. (Jaffe, 1986)

Connelly and Hirschey (1984) also contributed to the literature in examining the correlation between R&D, market concentration and the value of the firm. They theorize that a positive R&D-concentration interaction effect exists if R&D gives rise to sustainable proprietary advantage, while a negative R&D-concentration interaction effect would indicate that R&D may be especially difficult for joint profit maximizing oligopolistic firms to coordinate and thus undermine tendencies toward shared monopoly behavior. Connelly and Hirschey's findings

appeared to support the negative interaction effect although they suggest that the result could be due to other reasons (e.g. firms in more concentrated industries are more efficient researchers).

Hall (1988) performed a similar study when she correlated current and past R&D expenditures along with profits (as a proxy for market power) to a firm's market value. Her model included an R&D stock term, and an assumed depreciation rate of 15%. Her findings reject this hypothesis, as she finds current R&D, but not past R&D, to be a significant indicator of firm value. Hall (1993) later added to her analysis by examining the relative value of intangible versus tangible assets in firms over a 17 year period. She finds that the market valuation changed over time in its valuation of tangible versus intangible assets, with intangible assets declining by a factor of 3 or 4 to overall value. She provides a couple of explanations for this change to include the possibility that the returns to R&D declined or that R&D capital depreciated more rapidly in the later years studied. Finally, she considers the possibility that the reduced valuation of R&D in the 1980s was due to waves of mergers and leveraged buyouts, particularly in the consumer products industries, whereby these companies' market values were bid up. Thus, if the market value of R&D assets had been driven down in the 1980s and early 1990s, then it is possible that the increased premiums in this study that acquirers placed on R&D in horizontal mergers could be due to the depressed value of these R&D assets.

Johnson and Pazderka (1993) follow Hall and others in their 1993 study in which they correlated market value to R&D and R&D stock, as well as a market power term and a firm's book value. They hypothesize that the market places a positive value on R&D expenses as a sign of future growth and profitability. They develop a model that explains market value as a function of tangible assets, as measured by the firm's book value (BV), and intangible factors to include: 1) market power (E*/BV), 2) R&D intensity, which is measured as current R&D

expenditures divided by book value, and 3) investment (INV) over the last year. The market power term (E*) is defined as current profits minus a firm's cost of equity capital.[7] Their model is the following:

$$\ln MV = \beta_0 + \beta_1 \ln BV + \beta_2 \ln(E^*/BV) + \beta_3(R\&D/BV) + \beta_4(INV/BV) + \epsilon \quad (1)$$

Johnson and Pazderka chose not to use patents as an explanatory variable, like Griliches and others[8] did, because previous studies (e.g. Griliches, 1988 and Hall, 1990) did not find patents to be significant in explaining market value, and they deem measuring the number of patents to be of dubious value. Johnson and Pazderka found the coefficient of R&D intensity to be positive and significant to the 5% level. They found mixed results in their market power and investment terms.

There has been a lot written correlating a firm's market value to its R&D activity, but few have studied the relationship between the abnormal returns in a merger and R&D activity. Higgins and Rodriguez (2006) examine acquisitions in the pharmaceutical industry from 1994 to 2001. They find evidence that acquirers realize significant positive returns on these acquisitions. They provide three explanations for their findings. First, deteriorating R&D productivity could be the motivation underlying the acquisition of research-intensive firms. The authors note that the late 1990s and early 2000s was a period in which drugs were very rapidly coming off patents. In response to their deteriorating patent-protected pipeline, pharmaceutical companies may have responded by making more acquisitions thus bidding up the acquisition prices. Second, biopharmaceutical firms supplement internal R&D efforts through acquisitions. This trend was particularly evident in the early 2000s as companies sought to fill drug pipelines and research gaps. This merger wave, they claim, has bid up acquisition prices. Third, acquirers can obtain

[7] E*=NI – (k X BV), with NI being net income, k the cost of equity and BV the book value.

[8] Johnson and Pazderka specifically refer to Zion (1984).

significant additional information through pre-acquisition alliances with the target firm or alliances with firms conducting research that is similar to that of the potential target firm. By obtaining this information, acquirers take out much of the risk inherent in an acquisition so they can more confidently offer a higher takeover price.

2.1 Relationship between Innovation and Market Concentration

The correlation of firm size to innovation and market concentration to innovation were first theorized by Schumpeter (1950) and Galbraith (1957). The rationale behind the innovation-firm size correlation, is 1) R&D projects involve large fixed costs that can only be covered if sales are sufficiently large (Syrneonidis, 1996), 2) Economies of scale and scope in the production of innovation are needed (Syrneonidis, 1996), 3) Capital market imperfections confer an advantage to large firms in securing financing for risky R&D projects (Cohen et al 1987), and 4) R&D is more productive in large firms due to complementarities between R&D and other non-manufacturing activities (e.g. finance and marketing) (Cohen et al 1987).

In addition, Syrneonidis (1996) argues that innovative activity may be higher in concentrated industries because firms with greater market power can more easily garner the returns from innovation and thus have more incentive to innovative. The argument is that patents become more valuable with greater market power. In addition, he states, other mechanisms assuring appropriability, such as the secrecy, investment in marketing, learning by doing, and control of distribution channel all play a role in a firm with market power benefiting from innovation.

The problems that Syrneonidis points out with the literature include: 1) assumptions that firm size and market structure are exogenous; recent work, he comments, points to "endogeneity of innovation and market structure", 2) lags between firm size and innovation, 3)

control of industry effects, and 4) the implicit assumption that market concentration equals market power.

2.2 Explanations of the Deal Premium

Explanations of the deal premium vary significantly and include 1) efficiency gains, 2) increased market power, 3) management improvement, 4) supply and demand for the stock, and 5) bidder's pay too much. Efficiency gains refer primarily to economies of scale, economies of scope, or other cost and/or marketing synergies. Efficiencies can be divided into static and dynamic efficiencies. Static efficiencies refer to improvements, such as economies of scale that occur once. Dynamic efficiencies, according to the Secretariat of the European Competition Commission, enhance the ability or incentive to innovate. "Learning by doing, eliminating redundant research and development expenditures, and economies of scale in R&D are examples of dynamic efficiencies." (OECD, 2007)

Market power refers to a firm's ability to influence price, quantity, and the nature of the product. In turn, market power may lead to excess returns. In related acquisitions, market power may be increased through product or market extension acquisitions (Montgomery, 1985).

Premiums for management improvement in a merger stem from shifting business assets into the hands of managers who can generate more value from them, thanks to a greater ability or stronger incentives to maximize value (Slusky and Caves, 1991).

In addition, deal premiums can arise simply because of the limited supply of stock in the company. If the buyer is demanding a large percent of the stock then the forces of supply and demand will raise the stock market value. According to Stout (1990), this has been an often overlooked factor, as most research has viewed the supply of stock to be perfectly elastic or that stock prices do not vary with the size of the transaction. She adds that this explanation is often

overlooked because it is contrary to the traditional capital asset pricing model. "From the perspective of the buyer, the supply function for outstanding shares is upward sloping. The takeover bidder who wishes to purchase the stock of a target firm from its current shareholders must offer a price that meets or exceeds the shareholders' varying subjective estimates of value. Thus, purchasing larger amounts requires the bidder to offer higher and higher prices." (Stout, 1990)

Finally, it has been argued that there is a winner's curse whereby bidders pay too much as evidenced by their below average post acquisition returns.

There are a number of empirical studies relating to the determination of merger premiums. The method employed in these studies is to regress certain factors, such as fit, financial leverage, management change, etc. against the deal premium One example is Slusky and Caves' (1991) study of 100 acquisitions in which they seek to identify the source of the acquisition premium using the following identity:

$$PR = (BRES[Xi]/MV)B(Zi) \quad (2)$$

PR in this equation refers to the one plus the deal premium or the ratio of the reservation price (BRES) paid by the successful acquirer divided by the market value of the firm. The reservation price depends on factors [Xi] that "predict the increase in cash flows due to combining the two firms' assets." (Slusky and Caves, 1991) Slusky and Caves further note that the B(*) is a bargaining function that "determines where the actual price falls between the reservation price of the would be acquirer (BRES) and the current owners (MV)." Zi are the determinants, such as the presence of competing bidders, affecting the bargaining function. The authors find in their study measures of synergy and managerial effectiveness as the primary factors influencing the reservation price.

3. The Data Set

The dataset for the dissertation includes 112 horizontal mergers that received second requests from the government per the Hart Scott Rodino (HSR) Act[9] from 1997 through 2007. 95 of these mergers were challenged by the FTC or DOJ for violation of the Clayton Act Section VII b for excess concentration, which per the recent merger guidelines is a change in HHI >50 and/or a new HHI level >1,800.

During this 11 year time period 742 2nd requests per the HSR Act were issued, and 440 proposed mergers were publicly challenged by the Department of Justice and FTC (208 were publicly challenged by the Department of Justice and 232 were challenged by the FTC). "Challenged mergers" refer to mergers that are publicly challenged by the government after a HSR 2nd request. I use this data set, since it represents horizontal mergers that the government has determined to involve significant increases in market concentration[10].

The following chart shows the number of 2nd requests and challenged mergers that occurred from 1997 to 2007[11] per the HSR Act.

Table 1: Breakdown of 2nd Requests and Merger Challenges

Insert Table 1 here

[9] The HSR Act requires specific filings for all mergers over a certain size threshold. This amount, which is adjusted annually based on the change in the gross national product, is $65.2 million as of February, 2009. After receiving the initial filings, the government then has 30 days to request additional information if the transaction appears to present anti competitive problems. The request for additional information is referred to as a 2nd request and typically extends the waiting period an additional 30 days. The government may then choose to allow the merger, seek injunctive relief, or negotiate a settlement that often involves disposition of key assets.

[10] Mergers involving private companies, product lines, or divisions of public companies could not be included because data was pulled from SEC filings. In addition, I needed mergers that occurred fairly recently, because SEC filings become harder to gather the further back in time one goes.

[11] The numbers in the chart were taken from public filing reports found on the DOJ and FTC web sites.

Typically, per the merger review process, approximately 1,750 to 2,000 mergers are reviewed a year. Roughly 95% of the mergers are cleared during the 30 day waiting period as detailed in the HSR act and subsequent merger guidelines. 2nd requests are issued by the FTC and DOJ for the other 5% of mergers if the government believes there is a strong possibility that the transaction may be in violation of antitrust laws. The parties then submit further documentation, and the government decides whether to challenge formally the merger. When a merger is publicly challenged a complaint and / or competitive impact statement is issued. These documents include evidence, such as market share, market concentration, and the definition of the contested market (See Appendix A for a list of challenged mergers used in this study).

Mergers were deemed to have been challenged by the Federal Trade Commission or the Department of Justice if a complaint was filed in court or a press release was issued by either agency announcing that the transaction had been abandoned or restructured in response to the Department's concerns.[12] In these cases a complaint and / or competitive impact statement is issued, which includes some of the evidence, such as market share, market concentration, and information concerning the relevant market behind the merger challenge.

The data set also includes 17 mergers in which a 2nd request was issued, but the merger was not challenged. Presumably, the mergers that were challenged would have resulted in higher market concentration than mergers that were not challenged. However, some of the non-challenged mergers would have resulted in very high market concentration as well. Explanations as to why mergers with apparent high market concentration results were not challenged include 1) the failed firm argument, in which one of the companies is no longer a competitive threat. This argument was used in the merger of McDonnell Douglas and Boeing, when the FTC

[12] See http://www.ftc.gov/os/2003/12/mdp.pdf for the full explanation of challenged mergers.

decided that "McDonnell Douglas, looking to the future, no longer constitutes a meaningful competitive force in the commercial aircraft market."[13] A second argument is the efficiency defense, in which the government deems that the positive effects of merger specific cost savings outweighs the negative effects of potential price increases due to increased market concentration. This was a key reason why Whirlpool's acquisition of Maytag was approved.

The database is limited to mergers of standalone, public companies. I chose this data set since I wanted recent mergers across many industries in which I could test how market concentration is influencing the deal premium. Since these mergers were challenged, there is data available in the government merger impact statements regarding the levels of market concentration that result from the merger.

I recognize the selection bias in using this data set that primarily covers high levels of market concentration; however, there is a significant range of market concentration in the data. Another problem with testing the effect of market concentration is that most of the firms have multiple products. Therefore, I had to weight the change in concentration by the target company's product sales as a percent of their total sales.[14]

The following table details each variable used in this study to determine the effect of R&D, market concentration, and other factors on the deal premium.

[13] See http://www.ftc.gov/opa/1997/07/boeingsta.shtm

[14] A worksheet detailing the calculations of weighted change in HHI for each merger is available upon request.

Table 2: Variable Description

Insert Table 2 here

3.1 Sources

The merger announcement date, deal size, and claimed cost synergies were gathered from press releases. I then used the daily stock prices in the CRSP data base to determine the deal premium. R&D intensities and profit margins were gathered from company financial reports. The book value for Tobin's q was gathered from company reports and the Compustat database. Real economic growth rates were gathered from the Bureau of Economic Analysis report. Weighted change in HHI amounts were gathered from government complaint documents.

3.2 Deal Premiums

Per Slusky and Caves' (1991) technique, the premium is the difference between the adjusted deal price offered for the acquisition candidate and the market price, one month prior. The denominator is then the target's stock price one month before the announcement. The announcement date is the day in which the acquisition candidate received its first official bid.[15] The adjusted deal price is the amount offered for the acquisition premium multiplied by (1- % change in the S&P). By adjusting the deal price in this manner, the offer price is discounted to the 30 day prior level by the change in the S&P 500 index.

I used the offered share price versus the actual stock market price in order to capture the amount that the firm is worth to the acquirer. As such, this technique for calculating the deal premium does not take account investor reactions to the deal. Often the stock price is lower than the offered price in the days after the announcement as investors fear the deal may not occur due to regulatory or financial concerns.

In a few cases (e.g. Oracle-Peoplesoft and Boston Scientific-Guidant) the initial offer was rejected and later a second or third offer was accepted. In these cases I calculate the deal premium as the percent change in stock price from the market value 30 days prior to the initial offer to the final offer, and subtract out the change in the S&P 500 during that longer period. The window in which the deal premium was calculated was three months in the case of Boston Scientific and six months in the case of Oracle. I calculate the deal premium in this manner in order to capture the total amount the acquirer is paying for the deal.

[15] In a few cases (e.g. Oracle acquiring Peoplesoft) the first bid was rejected and subsequently a higher bid was accepted. For the purposes of this study only the premium reflected in the first bid is included.

The data set includes only acquisitions of one company by another. I did not include equal mergers of two companies (e.g. Smithline Beecham / Glaxo and Conoco / Philips) as there no outright purchase so one cannot correlate factors to a purchase price or premium.

3.3 Explanatory Variables

R&D intensity is often used as a proxy for knowledge potential. In this model, I use the average R&D intensity of the acquired firm for the two years prior to the merger. R&D intensities were obtained from company financial statements.

Deal size refers to the amount that is paid by the acquirer for the acquisition. It is used as a control variable and an interactive variable with R&D to test for part of the Schumpeterian hypothesis. A positive, significant coefficient for the interactive variable would support Schumpeter's argument that size improves a company's innovativeness.

Change in HHI refers to the weighted average change in HHI for the acquired firm. This amount was calculated by taking the percent of a firm's most recent annual sales that the product line (s) of concern for excess concentration represents and multiplying by the change in HHI as noted in the competitive impact statements or complaints.[16] In many cases the weighted average change in HHI included many product lines. Mergers are challenged based on change in HHI and HHI levels. I chose to use change in HHI as it more accurately reflects the incremental benefit that an acquirer might be gaining from the acquisition. In addition, change in HHI is more readily available in the public documents than HHI level.

Weighted average change in HHI in some of the mergers is difficult to calculate for a variety of reasons to include the following:

[16] These documents list either the change in HHI, which is the product of the firms' market shares, or the market shares of the firms of interest.

- Mergers were challenged for excess in concentration in the U.S., but the firm's sales are global. Thus, I assumed in some cases that the concentration levels in the U.S. applied globally as well. In other cases I weighted change in HHI by U.S. sales.
- In some cases (particularly with telecommunications mergers) the challenge was based on regional market shares and sales were not available for the region. In these cases I estimated regional sales on customer base or population level.
- Implicit in the weighted change in HHI technique is that the company's product line sales that were not challenged result in zero change in market concentration from the merger. Although this may often not be the case, the assumption is still valid because the government, who has supposedly sifted through the companies internal documents, has determined the other product lines do not constitute a threat to competition.

Change in HHI is a key variable in a structural analysis of a merger's impact on competition. In merger analysis the government examines the unilateral and coordinated effects that are likely to occur. Change in HHI is a key variable used to examine a merger's likely coordinated effects, which antitrust agencies describe as the probability that firms in the market will successfully coordinate their behavior or strengthen existing coordination causing significant harm to the competition. In conducting merger analysis, the agencies then examine both pre-market conditions and the impact of the merger on these conditions.[17] (Ray)

Net profit margins can indicate the target firm's ability to price above marginal cost and thus shows its pricing power. Large or increased net profit margins between the merger companies could indicate a firm's ability to harm competition unilaterally. Agencies look at the

[17] The descriptions of coordinated effects in this paragraph and unilateral effects in the succeeding paragraph were taken from the Merger Working Group co-chaired by the Department of Justice's (DOJ) Antitrust Division and the Irish Competition Authority as shown in Sheppard Mullin Richter & Hamilton LLP's July 9, 2009 Antitrust Blog found at http://www.jdsupra.com/documents/d4cf75da-0d3b-4934-ba8d-6b818fa2d1bd.pdf.

potential for a horizontal merger to result in anti-competitive unilateral effects, or the likelihood that a merger will harm competition "by creating or enhancing the merged firm's ability or incentives to exercise market power independently." (Ray)

Economic growth refers to the real U.S. annual GDP growth. This variable is used to control for macroeconomic effects under the assumption that the amount companies pay and perhaps more significantly the stock market value of the company are influenced by the macroeconomic environment, which is proxied by economic growth.

I use the actual growth rates in the year after the merger announcement. This variable then accounts for managers expectations of growth in the economy, which will influence the cash flows for the target company. The next year economic growth is also used because many of the mergers occurred mid or even late in the year.

I use Tobin's q as a measure of how much investors are willing to pay for a company's assets. Tobin's q relies on strict accounting of company book value and the market capitalization of the firm. However, book value (the denominator of Tobin's q) ignores the replacement costs of intangible assets, such as R&D and advertising (Carlton and Perloff, 1994). As such, one might expect a high correlation between Tobin's q and R&D intensity. However, these two variables do not appear to have significant correlation in the mergers examined in this study (See Appendix C for the correlation matrix of variables). A hypothesis regarding Tobin's q is that it will be positively correlated with merger premiums indicating that acquirers are willing to pay more than the market value for control over intangible assets. Alternatively, it might be negatively correlated with merger premiums suggesting that acquirers are seeking to purchase poorly managed companies. Higher Tobin's q amounts are often considered to indicate that investors have confidence in the management of the company.

Cost synergies reflect anticipated cost reductions that are identified by the acquirer to be achieved as a result of the merger. This variable is self reported by the acquirer often as a justification for the merger. I am using this variable as a means to test directly for the efficiency rationale for a merger.

3.4 Merger Data by Industry

Table 3: Breakout of Mergers by Industry

Insert Table 3 here

The majority of the mergers covered were in the manufacturing sector, with roughly 20% to 25% of them being in the life sciences industry. After life sciences the industries covered are well spread out between petroleum, high tech, chemical processing, consumer goods, aerospace, and services, particularly the tele-communications industry.

There were merger waves in the petroleum (late 1990s) and life sciences (early 2000s) sectors that were included in this data set. These merger waves do not appear to have influenced the premiums paid, as I did not find any discernable difference in the merger premiums from the beginning to the end of the merger wave.

Table 4: Average Merger Premiums by Industry

Insert table 4 here

As shown in the chart, challenged mergers appear to have a higher premium than non challenged mergers in each industry, except for life sciences. However, since the data set included only a small number of mergers in which 2nd requests were issued, but the merger was not challenged, these differences are likely not to be statistically significant.

Table 5: Premiums, R&D Intensity and Market Concentration among Challenged Mergers[18]

Insert table 5 here

The high tech industry had the highest deal premium, R&D intensity and average weighted HHI. In addition, the average deal size in the high tech industry was the lowest. Life sciences had a below average deal premiums, high R&D intensity and lower HHI.

4. Methodology

The objective of this study is to investigate the relationship between innovation (as proxied by R&D), market concentration, and the acquisition deal premium. The primary hypothesis I am testing is whether R&D intensive acquisition candidates receive a larger deal premium. In addition, I am testing whether the deal premium is positively impacted by increased market concentration resulting from the merger. A positive answer to the first hypothesis supports the efficiency (static and dynamic) argument relative to R&D, while an affirmative answer to the second hypothesis provides evidence in support of the market power explanation for the deal premium

In considering these hypotheses, I plot an average of deal premiums in the data set versus the weighted change in HHI for three R&D categories.

[18] Only challenged mergers are included in this table, because data is not available for weighted change in HHI for the non-challenged merger.

Table 6: Average Deal Premiums versus Change in HHI by R&D Class

Insert graph here

The graph appears to indicate that for weighted average change in HHI above 50 and lower than 250, the deal premiums are higher with a higher R&D intensity class. Specifically, the deal premiums in the 50 to 250 change in HHI range are above the 34% average for challenged mergers in the R&D classes of 5% - 10% and >10%, but below the average deal premium in the R&D class <5%. Above 250 weighted change in HHI, the results are mixed.

4.1 Other Study Questions

In addition to testing for how R&D and market concentration influence the deal premium, I also examine whether 1) the combination of higher R&D intensity and market concentration or 2) deal size and R&D intensity result in a larger premium. In addition, I test whether the relationship between the two explanatory variables, R&D intensity and market concentration, and the deal premium differs depending on their level (e.g. low, medium, or high). If imperfect competition favors innovations, then one would expect a higher value to be placed on increased market concentration and R&D intensity. Similarly, if larger firms are more innovative, then acquirers might pay more as firm size and R&D intensity increases.

In addition, to these questions, I will examine whether the deal premiums vary significantly by industry. Significant deal premiums in a sector might indicate industry-specific factors (e.g. over capacity or new regulations) that are motivating firms to merge.

4.2 Models

My approach is to investigate these patterns using econometric models that integrate Griliches (1984) and Johnson and Pazderka's (1993) methods into Slusky and Caves' (1991) model. To do so, I will assess the effect of R&D intensity, weighted average market concentration, and profit margin (PM) on the deal premium (DP). I will also include terms for cost synergy (Cost), Tobin's q (Q), deal size (S), and economic growth (GRt+1). The analytical framework for the study is based on Slusky and Caves' structural equation presented earlier.

To answer the questions posed, I present a series of models as follows: 1) Base and Interactive Model, 2) Industry and Merger Challenge Fixed Effects Models, and 3) HHI and R&D Segment Models. The models were run for the 95 challenged mergers and all 112 mergers (challenged and non-challenged).

It should be noted that there are likely other variables, such as financial leverage, that affect the deal premium, but are not related to the questions of interest. The omission of these other variables is not likely to bias the other coefficients in the results as they do not appear to be correlated with the included explanatory variables.

Also, these models are reduced form equations. As such, I tested the models using a number of specifications[19] that are relevant to the study questions and chose equations 2.5 and 2.6 listed below as the primary models because they provided the best fit. I recognize that results may be sensitive to specifications. I investigated a number of specifications and found most of the results to be qualitatively similar to the ones reported.

[19] I tested a number of interaction terms including (profit*log ΔHHI), (profit*log deal size), (log ΔHHI*log deal size), and (log R&D*profit). None of the interactive terms were found to be significant. In addition, I tested a linear versus log specification for both the base and interactive models and found a better fit when transforming the dependent and independent variables to logarithms.

Model 1: Base Model

$$\ln DP_i = \beta_1 + \beta_2 \ln Cost_m + \beta_3 \ln S_i + \beta_4 PM_i + \beta \ln \Delta HHI_m + \beta_6 \ln R_i + \beta_7 \ln Q_i + \beta_8 \ln GR_{t+1} + \epsilon_i \quad (3)$$

In this equation, i refers to the acquisition candidate, and m indexes the merger. (See table 2 for a reference of variables) The variables were expressed in logs for all covariates except for profit margin to assess a non-linear relationship. Average profit margins were left in levels because approximately a third of the margins were negative.

Change in HHI variable is only available for challenged mergers. In order to compare results between challenged and all mergers, the base model was run both for challenged (95) and all mergers (112) without the change in HHI term. The results are presented in table 8.

To test the interaction between R&D intensity, change in market concentration, and deal size, I developed a second model that adds interactive terms (lnR*lnΔHHI) and (lnR*lnS) to Model 1. This model was run for the challenged merger sample and also for the full sample, with a challenge dummy included and change in HHI dropped.

Model 2: Interactive Model

$$\ln DP_i = \beta_1 + \beta_2 \ln Cost_m + \beta_3 \ln SIZE_i + \beta_4 PM_i + \beta_5 \ln \Delta HHI_m + \beta_6 \ln R_i + \beta_7 \ln Q_i + \beta_8 \ln GR_{t+1}$$
$$+ \beta_9 (\ln R^* \ln \Delta HHI) + \beta_{10} (\ln R^* \ln S) + \epsilon \quad (4)$$

Industry Models

Mergers in the data set were classified into 10 different industries. These industries may have specific characteristics during the time frame under consideration that would cause the deal premium to be higher or lower than average. As such, I ran a regression using fixed effects alone to determine the sign and significance of the industry on the deal premiums. I also ran a

second regression adding the fixed effects to model 2.5 to assess how the covariates along with the industry affect the deal premium.

In addition, I extended the base model to assess the effect of the merger challenge on the deal premium. I did this by running another regression using a dummy variable for the merger challenge, and an interactive term of the merger challenge dummy variable with R&D to see if the effect of R&D is any different in challenged versus non challenged mergers.

HHI and R&D Segments

The purpose of these models is to look at different segments (low, medium, and high concentration) of market concentration and R&D to assess the sign and significance of the effect of these segments on the deal premium. To do so, I classified weighted change in HHI and R&D-intensity into low, medium, and high ranges as follows:

Table 7: Change in HHI and R&D-Intensity Classes

Insert table 7 here

I then added dummy variables to equation 2.5 to assess the effect that each of the six segments has on the deal premium along with the other covariates. In addition, I ran a second regression to assess the impact of interacting each of the three R&D segments with each of the three changes in HHI segments. In the model I drop two of the segments; the coefficients for each of the variables are then compared to the dropped interactive terms.

5. Results

Table 8: Base and Interactive Model Results
(t statistics in parenthesis)

Insert table 8 here

The coefficient for change in HHI in logs is positive and significant at the 1% level in the base model. The coefficient (.15) of log change in HHI also explains a large amount of the deal premium. A positive, significant coefficient for log weighted change in HHI in the base model would appear to indicate that companies are paying more to gain market power via increased market concentration. This finding lends support to the structural method of evaluating mergers, as companies are motivated to acquire companies for gains in market share.

The coefficient for log cost synergy is positive and significant in each of the models. This finding supports the notion that companies consider the potential cost synergies in their acquisition price. This finding has important policy implications as it shows that acquirers engage in horizontal mergers not only to gain market share but also to take advantage of cost synergies.

The coefficient of growth one year in the future is significant and negative in both the base and interactive models. This finding might be due to lower market values of the acquisition candidates prior to the merger announcement as the economy slows. A possible explanation for the negative coefficient on growth is that acquirers have a longer term time horizon when considering the potential value of the firm than do investors.

I tested the macro growth rate for the current year and the next year and found only the next year to be significant. It is reasonable that the next period growth rate would be significant since stock prices supposedly are forward looking 3 to 6 months into the future.

The coefficient for log R&D is positive in all models and significant in the base model and the interactive model for both challenged and non-challenged mergers. The coefficient of log R&D also appears to be fairly large (.10 in the base and .15 in the second interactive model) relative to the other coefficients.

These findings are particularly relevant since these mergers are all horizontal mergers that received 2nd requests with the majority of the mergers being challenged for excess concentration. These results would seem to show that companies are paying higher premiums for firms with higher R&D intensity in concentrated industries. However, it is also noteworthy that the coefficient for log R&D in the first interactive model is insignificant and small. It appears from these findings that R&D intensity impacts the deal premium only when change in HHI or the deal size interacted with R&D intensity is considered.

The coefficient for the interactive term (lnR*lnS) is negative in the interactive model of challenged mergers and significant to the 10% level. The coefficient of the interactive term is also negative when including all mergers but not quite significant. It is surprising that the coefficient for (lnR*lnS) is negative since the coefficient for log R&D is positive and significant. It appears to contradict the hypothesis that an acquisition candidate is worth more the larger its size and R&D intensity. In fact, given that the term is significant and negative it would indicate the opposite. This result, however, is very likely skewed because high tech industries have a very large premium (average of 89%), high R&D-intensity, but small deal sizes. As such, some of the results do not appear to generalize outside of one or a few industries.

(lnR * lnΔHHI) is not significant, which appears to contradict the hypothesis that firms are paying more for the combination of R&D intensity and market concentration. We have to look at Table 2-10, which breaks down R&D and change in HHI in several classes to find both

the range of R&D intensity that is significant when combined with change in HHI and the range of HHI change that is significant when combined with R&D-intensity.

Finally, the coefficient for the challenge merger dummy is not significant in either the base or interactive models.

Table 9: Regression Results –Industry Effects
(t statistics)

Insert table 9 here

The first regression (Industry model) shows the results when regressing each of the industries to the deal premium, while the second regression (Industry 2) adds the other covariates from the base model. From the Industry model regression we see the effect of being in a specific industry if none of the other factors are considered. The results show the coefficient for the high tech industry to be positive, significant to the 1% level, and very large. The positive coefficient for the high tech industry may be due to the timing of the data set from 1997 to 2007, which includes the high tech bubble and bust. We also see the coefficients for general manufacturing industry to be positive in each of the models. This might indicate that market share is of greater value to an acquirer in the general manufacturing industry than other industries, perhaps due to barriers to entry from economies of scale. Finally, we see the coefficients for the aerospace, food, chemical, and health care industry positive and significant in the first model, but not significant when including R&D intensity, change in HHI, etc.

The fit is the best in the second regression. The results from this model indicate that R&D intensity and change in HHI are significant in their influence on the deal premium in addition to being in the high tech and general manufacturing industry.

The third model differs slightly from the second model in that it includes all mergers. The model has a dummy variable for the merger challenge and excludes change in HHI, since non-challenged mergers are included. The fit in the third regression is worse than the second one, most likely because change in HHI is not included. In the third regression, the coefficients for mining and aerospace become significant in addition to the coefficients for high tech and general manufacturing. It appears that as change in HHI is dropped from the model, acquirers primarily consider the industry and cost synergies in determining the deal premium.

HHI and R&D Segments

The next model examines the regions of R&D and change in HHI that are significant in determining the deal premium. In doing so, I break down the weighted change in HHI and R&D-intensity into three segments each (nine in total) to approximate low, medium, and high.

The following chart shows the average premiums by segment.

Table 10: Average Deal Premiums by Market Concentration and R&D Segments

Insert table 10 here

It is interesting to note that deal premiums are the highest in the middle and high range of market concentration irrespective of R&D intensity. The one outlier is 73% deal premium for high R&D intensity and medium levels of market concentration. The results from the following regressions show the sign and significance of separate R&D and ΔHHI segments as well as interacting R&D and ΔHHI segments.

Table 11: Regression Results – Fixed and Combination Segments
(t statistics in parenthesis)

Insert table 11 here

I find in the fixed segment model that the deal premium in the middle change in HHI range (100-250) is 48% higher than the high (>250) change in HHI range. The coefficient for the low (<100) change in HHI range is also positive but not significant. Therefore, the results show that not only does the change in HHI have a positive effect on the deal premium, and but also that companies will pay the most for acquisition candidates when the change in market concentration is in the middle range.

From the fixed segment model we also see that log R&D has a positive effect on the deal premium. However, it is unclear whether any R&D segment has a larger effect on the deal premium than another segment as neither of the R&D segment coefficients is significant.

In the combination segment model, I combine R&D segments with the range of change in HHI, and combine change in HHI segments with the range of R&D. I find the middle ΔHHI combined with R&D to have the highest deal premium (25% higher than the low segment), and the deal premium in the high ΔHHI combined with R&D to be positive but not quite significant in comparison to the low segment.

I also find significant differences in the R&D segments combined with change in HHI. Here, the middle R&D range and high R&D range each combined with change in HHI results in a 10% and 9% lower deal premium relative to the low R&D range combined with change in

HHI. This result again is counter to the notion that the deal premium is an increasing function of R&D intensity combined with change in market concentration.

6. Summary

There have been many studies that have found a positive correlation between R&D investment and market value. This study considers how an acquirer values a firm in a horizontal merger. In particular, I focus on the value acquirers place on R&D intensity and market concentration versus other factors. The study indicates that there is a high correlation between the amount acquirers pay in effectuating a horizontal acquisition and cost synergies, the R&D intensity of the acquired firm, and the resulting market concentration that ensues from the merger. R&D intensity, however, only impacts the deal premium when it is consider along with change in market concentration or is interacted with deal size. These results could be interpreted as lending support for the Schumpeterian theory[20] since if firms are paying more for R&D intensity and change in market concentration then there is incremental value to the acquirer when both factors exist. However, when R&D intensity is combined with market concentration the interactive term is not significant while R&D intensity when combined with deal size is negatively correlated to the deal premium. Both findings appear to counter the Schumpeterian hypothesis.

To further explore this issue, I separate the range of market concentration change and R&D-intensity into distinct segments. In doing so, I find significant positive correlation between mid and high levels of market concentration and the deal premium. In addition, I find that acquirers appear to value acquisition candidates the highest at mid levels of market concentration change when combined with R&D and slightly less at high levels of market concentration

[20] The study does not directly tie to Schumpeter's hypothesis because it tests for the significance of change in market concentration to the deal premium versus concentration levels.

change when combined with R&D. Deal premiums are the lowest at low levels of market concentration change when combined with R&D.

The results also show that macro economic conditions effect the deal premium as higher premiums are paid in times of expected future low economic growth. In addition, I find in some cases the industry affects the value of the deal premium. In particular, deal premiums are higher in the high tech industry and the general manufacturing industry.

There are a few policy implications to consider from this study. First, it does appear that change in HHI is relevant in viewing the potential pricing power that can result from a merger since firms will pay a larger premium for mergers that result in higher changes in HHI. Second, R&D-intensity is also a very important factor to consider, particularly when combined with mid to high levels of market concentration. Acquirers appear especially interested in acquiring companies that provide a unique mix of R&D intensity and increased market share in order to gain monopoly positions. It is this mix, I believe, that facilitates the acquirer's ability to monetize R&D efforts and, therefore, gain a sustainable competitive advantage.

While this paper has provided evidence of the significant role that market concentration and R&D intensity play in affecting the values placed on horizontal merger candidates, it does not explain the effect on innovation that results from these mergers. It is left to future research to assess the impact of R&D intensity that results from horizontal mergers.

APPENDIX A

LISTING OF CHALLENGED MERGERS – ANALYSIS OF PREMIUMS

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Chevron – Texaco	Petroleum	25%	1.2	3.3	45.0	79	.4%
CEMEX - RMC	General Industry	39%	.2	3.9	5.8	1150	.1%
Shell - Pennzoil	Petroleum	42%	.070	2.3	1.8	350	.9%
Amgen - Immunex	Life Sciences	44%	.200	17.0	16.0	163.50	25.6%
Allergan-Inamed	Life Sciences	27%	.350	7.4	3.3	186.2	7%
Cephalon - Cima	Life Sciences	25%	0	2.9	.514	187.4	27.5%
Genzyme-ILex	Life Sciences	22%	0	4.5	1.0	123	20%
Boston Sc. - Guidant	Life Sciences	40%	.325	5.7	27	689	20.8%
Nestle – Ralston Purina	Food / Consumer	36%	.260	23.5	10.3	39.61	8.0%
Pfizer - Pharmacia	Life Sciences	36%	2.2	4.8	60	27.7	17.74%
Sanofi-Aventis	Life Sciences	30%	2.0	4.7	58	109.29	18%
Teva-IVAX	Life Sciences	20%	.1	5.0	7.4	180	8.9%
Procter& Gamble-Gillette	Food / Consumer	18%	1.0	24.8	57	13	2.08%
Valero-Premcor	Petroleum	20%	.350	8.6	8.0	12	.9%
Cytyc-Digene	Life Sciences	13%	0	13.6	.5537	48	24.2%

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Exxon-Mobil	Petroleum	32%	3.0	3.9	73.7	50	.44%
BP-Amoco	Petroleum	25%	2.0	3.5	48.5	21	.6%
BP Amoco - Arco	Petroleum	26%	1.0	2.9	26.8	505	.31%
Whirlpool-Maytag	General Industry	43%	.40	1.9	2.6	4,792	1.46%
Valero-Ultramar	Petroleum	30%	.20	3.6	6.0	116	1.11%
Pfizer-Warner L	Life Sciences	30%	2.100	13.8	112.5	38	8.59%
Valspar - Lilly	Chemical	65%	.095	3.8	.762	625	3%
JDSU-Etek	High Tech	56%	.200	38.2	13.5	288	10%
Dow-Sentrachem	Chemical	33%	.060	3.3	.745	2800	8%
Precision Cast Gordon Wyman	General Industries	42.9%	.030	1.2	.721	2400	4.87%
Novartis Eon Labs sub	Life Sciences	23%	.2	11.5	5.1	84	31.1%
Smith Kline - Beecham	Life Sciences	7.4%	1.2	10.9	70	40.43	11.3%
Hoechst/ Rhone-Poulenc	Chemical	3%	0.4	3.7	22	920	8.74%
Penn-Argosy	Services	16%	0.0	5.1	2.2	410	0%
GE-Invision	Life Sciences	21%	0.0	2.5	.9	161	2.00
Philips-Conoco	Petroleum	07%	0.8	2.0	35	907	0%
Dow –Union Carbide	Chemical	22%	0.5	4.5	13.5	141	6.3%
Oracle-Peoplesoft	High Tech	53%	0.0	2.4	10.3	626	13.0%
Tyco-Mallinkrodt	General Industry	39%	0.0	2.6	4.2	11.98	0.79%
Alcan-Pechiney	General Industry	28%	0.3	1.0	3.9	64.17	0%

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Compuware-Viasoft	High Tech	42%	0.0	1.3	.18	3,070	0
General Dyn. - Newport News	Aerospace	13%	0.0	8.3	2.6	3470	1.87%
United Health - Pacificare	Service	10%	.0143	3.82	9.2	159.7	0.0
3D Systems - DTM	General Industry	38%	0	1.81	.045	8800	8.0
Alcan - Reynolds	General Industry	20%	.02	1.87	5.6	1137	1.0
Alcoa-Alumax	General Industry	28%	0	1.77	3.8	93	0.0
Allied Signal-Honeywell	Aerospace	10%	.01	4.60	14	29	6.0
Computer Associates-Platinum Technology	High Tech.	51%	0	5.52	3.5	382	34.0
GE - Instrumentarium	High Tech.	45%	0	2.53	2	73	8.0
Haliburton-Dresser	Petroleum	15%	.026	1.53	7.7	73	2.0
Inco-Falconbridge	General Industry	11%	.029	2.47	13.2	108	1.0
Kimberly Clark-Scott Paper	General Industry	-2%	.053	4.15	7.4	261	1.0
SBC-Ameritech	Services	32%	.1285	5.52	62	106	1.0
SBC-AT&T	Services	3%	0	.38	16	37	0.0

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Suiza-Broughton	Food and consumer	4%	.113	3.4	.1	169	0.0
Case-New Holland	General Industry	39%	0	1.81	4.3	356	4.0
L'Orleal-Carson	General Industry	35%	0	.299	.1	3759	0.0
Monsanto-Dekalb Genetics	Chemical	22%	0	8.42	2.3	44	13.0
Food Lion-Hannaford	Service	14%	.025	5.15	3.6	300	0.0
Bell Atlantic-GTE	Service	4%	.039	6.33	52.8	102	1.0
Georgia Pacific-fort James	General Industry	55%	.070	6.43	11	836	1.0
Verizon-MCI	Service	9%	.18	1.74	8.5	48	0.2
Lafarge-Blue Circle	General Industry	21%	.09	1.80	4.7	522	0.2
Worldcom-Intermedia	Telecom	38%	0	9.53	6	68	1.1
Worldcom-Sprint	Telecom	28%	.0	7.34	129	48	0.0
Nestle-Dryers	Food and consumer	57%	.11	7.3	2.4	914	0.0
Allied Waste-Browning Ferris	General Industry	23%	.037	5.47	9.4	87	0.0
AT&T-TCI	Telecom	22%	.037	8.90	48	314	0.0
TRW-BDM	Aerospace/ Automotive	31%	.051	4.56	1	222	1.6

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Western Wireless-Alltel	Telecom	40%	.18	16.77	6.2	222	0.0
Cingular Wireless-AT&T	Telecom	17%	.056	1.22	41	239	0.0
ABB-Elsag Bailey	General Industry	58%	.181	6.43	2.1	174	8.7
Ge-InVision	Life Sciences	21%	.15	2.41	.9	162	7.4
Hospira-Mayne Pharma	Life Sciences	32%	.025	7.57	2	153	7.1
Abbitti-Bowater	General Industry	24%	.023	2.18	2.4	413	0.0
Barr-Pliva	Life Sciences	50%	.1	1.21	2.5	190	4.3
Monsanto – Pine Land	chemical	20%	0	7.32	1.5	1930	2.8
Excelon-PJM	Utility	16%	.333	1.79	12.0	1086	0
Watson-Andrx	Life Sciences	32%	.025	7.57	2.0	153	7.1
Marquee Holdings-LCE Holdings	Service	10%	.01	8.18	4.1	531	0.0
Linde-BOC	Chemical	39%	.04	2.55	14.4	157.75	1.6
Federal Mogul-T&N	General Industry	65%	-	-3.23	2.4	1508	2.4
McClatchy-Knight Ridder	General Industry	4%	.007	5.52	6.5	306	0.0
Clear Channel-AMFM	Service	27%	.004	3.31	23.8	447	0.0

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
Quest - Unilab	Health care	26.7%	005	27.3	.87	107	0.0
CBS-American Radio	Service	19.9%	0	3.36	1.6	890	0.0
Cardinal - Bergen	Health care	46.8%	0	2.63	2.5	802	0.0
McKeeson-Amerisource	Health care	18.5%	0	135.7	2.25	629	0.0
Northwest-Continental	Service	23.6%	0	6.65	7.4	96	0.0
GE-Innoserve	Health care	26.5%	.02	2.36	.016	1912	0.0
Commscope - Andrew	Service	17.6%	0	1.44	2.6	322	5.2
Capital-Triathlon	Service	14.8%	.178	2.8	0.19	152	0.0
AT&T - Dobson	Telecom	16%	0	7.18	2.8	30.6	0.0
American Radio –EZ Systems	Telecom	66.4%	.0068	5.36	0.66	158	0.0
Thermo Electron-Fisher Scientific	Life Sciences	11.9%	.0138	2.5	12.8	5.25	0.9
Ricket & Coleman-Benkiser	General Industry	20.5%	.038	15.45	2.7	30.6	0.7
Provident-Unum	Service	22%	0	2.62	11.43	218	0.0
Medtronic - Avecor	Life Sciences	53.5%	0	1.53	.106	202	8.3
Medtronic – Physio Control	Life Sciences	21%	.155	7.48	.53	130	12.0

Acquirer / Acquired	**Category**	**Pre-mium**	**Annual Cost synergies** (In billions)	**Tobin's q**	**Deal size** (In billions)	**Change in HHI**	**R&D Intensity**
El Paso - Sonat	Service	36%	0	28.7	6	65	0.0
CSC - Mynd	High Tech	54%	.06	.816	.568	398	0.0
Agrium - UAP	Chemical	27%	.04	11.4	2.65	90	0.0

APPENDIX B

2nd REQUEST DEALS – NON CHALLENGED MERGERS – ANALYSIS OF PREMIUMS

Acquirer / Acquired	**Relevant Category**	**Pre-mium**	**Cost Synergies (Annual)** (In billions)	**Tobin's q**	**Deal size (In billions)**	**R&D of Acquired Company / Sales**
Anthem Wellpoint	Healthcare	35%	.239	3.02	14.2	0%
Sprint Nextel	Telecom	4.5%	.07	5.82	36	.1%
Boeing – McDonnell Douglas	Aerospace/ Automotive	13%	.075	3.57	13.3	2.7%
Daimler Benz - Chrysler	Aerospace/ Automotive	48%	.05	3.6	40	3.8%
Phelps Dodge - Inco	General Industry	23%	.02	2.96	41	2.0%
Tyco-Keystone	General Industry	52%	0	1.28	1.2	0.0%
Perkin Elmer – Bio-Perspective	Life Science	17%	0	3.82	0.4	16.0%
J&J Alza	Life Science	39%	0	7.17	21	6.1
Valero - premcor	Petroleum	23%	.044	8.6	8	.9%
Whirlpool - maytag	Industrial	43%	.219	1.33	2.6	1.5%
Arch wireless - Metrocall	Telecom	5%	.165	1.53	.3	0%
Worldcom MCI	Telecom	21%	.032	3.4	44	0%
Monsanto-DeKlab	Chemical	41.5%	0	4.88	2.3	13%

Acquirer / Acquired	**Category**	**Pre-mium**	**Cost Synergies (Annual)** (In billions)	**Tobin's q**	**Deal size (In billions)**	**R&D of Acquired Company / Sales**
Intelsat - Panamsat	Service	23%	.04	20.0	3.2	0%
Ebay - Paypal	Service	-11%	0	1.21	1.5	0%
Yellow - Roadway	General Industry	60%	.18	10.64	1.1	0%

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Tables and Figures

For

The Stock Market's Valuation of R&D and Market Concentration in Horizontal Mergers

Table 1: Breakdown of 2nd Requests and Merger Challenges

Type	DOJ	FTC	Total
Merger Challenges	232	208	440
2nd Requests	400	342	742

Table 2: Variable Description

Variable (s)	Symbol	Description	Purpose
Deal Premium	DP_i	$DP = \frac{(S_m*(1-\%\Delta S\&P)-MV)}{MV}$ S = deal value at time of merger announcement MV = market value 30 days prior to the merger	Shows the additional amount the acquirer will pay for the acquisition above market price
Deal size	S_m	Purchase price of target firm	Variable to calculate market value and create an interaction term with R&D
Average R&D intensity	R_i	R&D as a percent of sales of the acquisition candidate for recent year prior to merger	A measure of the knowledge potential of the firm
Weighted Average Change in Herfindahl Index	ΔHHI_m	Change in HHI multiplied by the percentage of the challenged product revenue by total company sales	Shows the increase in market concentration from the merger.
Profit margin	PM_i	Average of target firm's profit margin for previous two years	Measure of ability to price above marginal costs and earn abnormal profits
Tobin's q	q_i	Market value divided by the stockholder's equity of the acquisition candidate.	A measure of intrinsic value or the value of the company to the market. It is often viewed as a measure of managerial performance.
Cost Synergy divided by Market Value	$COST_i$	Claimed annual merger specific cost synergies. This variable is normalized by dividing by market value	Shows the expected efficiencies from the horizontal merger
Economic Growth	GR_{t+1}	Annual GDP growth one year after the deal is announced	Measure of expected economic growth, which is used to determine if premiums vary with economic growth

Table 3: Breakout of Mergers by Industry

Industry	Primary NAICS Code (s)	Frequency - Challenged Mergers	Frequency - Total Mergers
Petroleum	324110	7	8
General Manufacturing[21]	Various	10	15
Life sciences	325411,	22	24
Food and consumer	311111, 325611	6	6
High tech	334111, 334611	6	6
Mining, metals, and minerals	33111, 212111	4	5
Chemical processing	325110,	5	6
Aerospace / Defense	336411,	5	6
Telecommunications	517110	14	18
Health care	524111	10	10
Other services[22]	Various	5	8
Total		95	112

[21] General manufacturing includes automotive, appliances, paints, and building products.

[22] Other services include movie theaters, gaming, airlines, newspapers, financial processing, supermarkets, and utilities.

Table 4: Average Merger Premiums by Industry

Industry	Average Merger Premiums - All Mergers	Average Merger Premiums - Challenged Mergers	Average Merger Premiums - Non Challenged Mergers
Petroleum	27%	27%	23%
General manufacturing	50%	50%	48%
Life sciences	31%	30%	49%
Food and consumer	40%	40%	-
High tech	89%	89%	-
Mining, metals, and minerals	28%	29%	25%
Chemical processing	31%	33%	22%
Aerospace / Defense	35%	37%	22%
Telecommunications	28%	32%	18%
Health care	21%	21%	-
Other services	22%	27%	23%
Average	34%	35%	32%

Table 5: Premiums, R&D Intensity and Market Concentration among Challenged Mergers[23]

Industry	Average Merger Premiums - Challenged Mergers	Average Deal Size in Billions	Average R&D intensity	Average Weighted Change in HHI
Petroleum	27%	$27.2	0.8%	170
General manufacturing	50%	$7.0	1.8%	349
Life sciences	30%	$14.9	12.1%	250
Food and consumer	40%	$12.1	1.8%	188
High tech	89%	$4.7	14.4%	778
Mining, metals, and minerals	29%	$13.5	0.9%	200
Chemical processing	33%	$4.3	5.9%	532
Aerospace / Defense	37%	$7.2	2.7%	550
Telecommunications	32%	$26.8	0.8%	265
Health care	21%	$5.8	0.0%	239
Other services	27%	$5.9	0.0%	312
Average	35%	$13.4	4.4%	317

[23] Only challenged mergers are included in this table, because data is not available for weighted change in HHI for the non-challenged merger.

Table 6: Average Deal Premiums versus Change in HHI by R&D Class

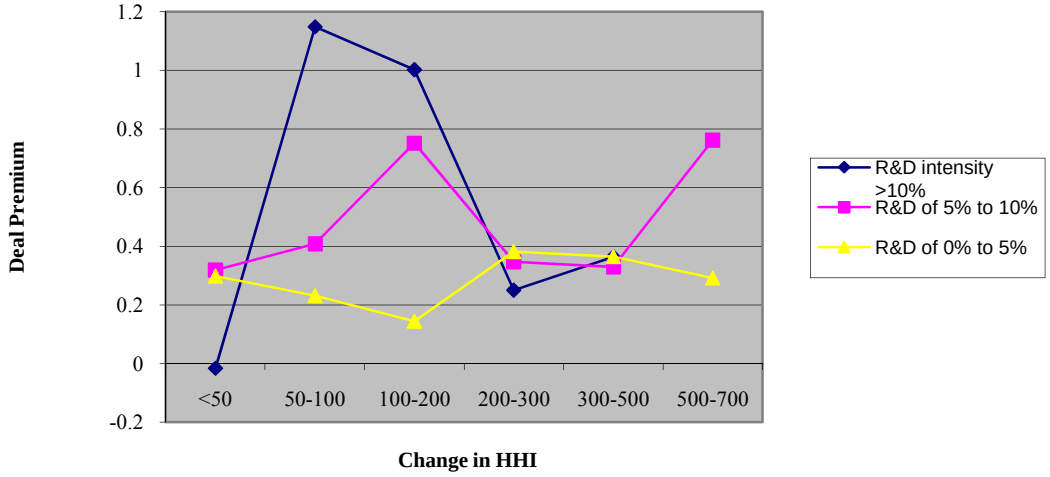

Table 7: Change in HHI and R&D-Intensity Classes

Category	Weighted Change in HHI	R&D-Intensity
Low	0 - 50	0% - 5%
Mid	51 - 250	5% - 10%
High	>250	>10%

Table 8: Base and Interactive Model Results
(t statistics in parenthesis)

Base Models				Interactive Models		
Log Deal Premium	**(Challenged Mergers)**	**(Challenged Mergers without change in HHI)**	**(All Mergers)**	**(Challenged Mergers)**	**(Challenged Mergers without change in HHI)**	**(All Mergers)**
Log R&D	**.10** **(2.01)**	.08 (1.53)	.05 (.86)	.11 (.47)	**.15** **(2.26)**	.10 (1.36)
Log ΔHHI	**.15*** (2.90)**	-	-	**.15** (2.43)**	-	-
Log Cost Synergy	**0.07* (1.70)**	**0.08** (2.08)**	**0.09** (2.17)**	0.07 (1.62)	**.08** (1.98)**	**0.08** (2.12)**
Log Deal Size	-.01 (-.08)	-.04 (-.92)	-.04 (-.89)	.02 (.50)	-.01 (-.04)	-.02 (-.34)
Average Profit Margin	-.001 (-.03)	-.001 (-.29)	-.004 (-.53)	-.01 (.46)	-.01 (-.59)	-.01 (-.56)
Growth $_{(t+1)}$	-.07 (-1.51)	**-.10** (-2.00)**	**-.10* (-1.80)**	**-.08* (-1.68)**	**-.11** (-2.19)**	**-.10* (-1.92)**
Log Tobin's q	-.02 (-.28)	.02 (.28)	.03 (.39)	-.01 (-.10)	.03 (.43)	.03 (.47)
Challenge			.15 (.67)			.15 (.66)
Log Size * log R&D	-	-	-	-.03 (-1.47)	**-.04* (-1.88)**	-.03 (-.89)
Log R&D * log ΔHHI	-	-	-	.01 (.29)	-	-
Constant	**-1.62*** (-4.28)**	**-.74*** (-3.84)**	**-.88*** (-2.89)**	**-1.72*** (-3.73)**	**-.80*** (-3.98)**	**-.79*** (-3.84)**
R2	.21	.14	.12	.23	.16	.13
N	95	95	112	95	95	112

Legend: * P <.1; ** P <.05; *** P <.01

Table 9: Regression Results –Industry Effects
(t statistics)

Log Deal Premium	Industry Model	Industry and Base Model	All Mergers
Petroleum	.9 (.84)	.38 (1.37)	.37 (1.39)
General Manufacturing	**.76***** **(3.05)**	**.65**** **(2.13)**	**.84***** **(3.01)**
Life sciences	.31 (1.59)	.72 (.10)	.06 (.23)
Food and Consumer	**.61**** **(2.08)**	.45 (1.45)	.48 (1.59)
High tech	**1.36***** **(4.92)**	**.72*** **(1.84)**	**.99**** **(2.79)**
Mining	.29 (1.31)	.31 (1.25)	**.41*** **(1.65)**
Chemical	**.64**** **(2.45)**	.24 (.93)	.36 (1.58)
Aerospace	**.35*** **(1.78)**	.27 (1.01)	**.36*** **(1.68)**
Telecommunications	.18 (.73)	.31 (1.15)	.24 (.96)
Health Care	**.43*** **(1.65)**	.21 (.88)	.33 (1.16)
Services	-.06 (-.32)	-.09 (-.38)	-.01 (-.06)
Log R&D	-	**.13*** **(1.70)**	.07 (.82)
Log HHI	-	**.11*** **(1.92)**	-
Growth $_{(t+1)}$		-.05 (-.94)	-.06 (-1.14)
Average Profit Margin	-	-.01 (-.33)	-.01 (-.75)
Log Deal Size	-	.01 (-.28)	-.03 (-.54)
Challenge	-	-	.21 (.99)
Constant	**-1.65***** **(-9.87)**	**-1.84***** **(-3.98)**	**-1.53***** **(-3.92)**
R2	.22	.33	.28

N	95	95	112

Table 10: Average Deal Premiums by Market Concentration and R&D Segments

Weighted Change in HHI	**R&D <5%** (Low)	**R&D 5% - 10%** (Mid)	**R&D > 10%** (High)	**Total**
0-50 (Low)	18%	15%	23%	19%
51-250 (Mid)	37%	35%	73%	39%
> 250 (High)	33%	43%	44%	37%
Total	33%	35%	44%	35%

Table 11: Regression Results – Fixed and Combination Segments
(t statistics in parenthesis)

Log Deal Premium	Fixed Segment Model	Combination Segment Model
Log R&D	**.26*** (2.93)**	.08 (.83)
Log ΔHHI	**.29** (2.38)**	**.16*** (2.80)**
Log Cost Synergy	.04 (1.24)	**.07* (1.66)**
Log Deal Size	-.01 (-.01)	.01 (.27)
Average Profit Margin	-.01 (-.54)	-.01 (-.38)
Growth $_{(t+1)}$	**-.09*** (-1.99)**	**-.26*** (-2.50)**
Log Tobin's q	-.05 (-.86)	-.02 (-.31)
Low R&D (<5%)	.42 (1.50)	-
Mid R&D (5% - 10%)	-.09 (-.42)	-
Low ΔHHI (<100)	.34 (.74)	-
Mid ΔHHI (100-250)	**.48** (2.09)**	-
Mid ΔHHI (100-250)* log R&D	-	**.25*** (2.34)**
High ΔHHI (>250)* log Δ R&D	-	.18 (1.62)
Mid R&D (5% - 10%) * log ΔHHI	-	**-.10*** (-2.48)**
High R&D (>10%) * log ΔHHI	-	**-.09* (-1.85)**
Constant	**-2.90*** (-3.61)**	**-1.60*** (-3.86)**
R2	.32	.28
N	95	95