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Merger Arbitrage: Analyzing Risk-Adjusted Returns and Profit Opportunities

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ABSTRACT

Merger arbitrage is an investment strategy that profits from price convergences resulting from corporate events, specifically mergers and acquisitions (M&A). This thesis explores the intricacies of merger arbitrage, focusing on its potential for achieving risk-adjusted returns in advanced financial markets. By examining the theoretical framework of merger arbitrage, this study seeks to explain the mechanics of the strategy and the factors that influence its profitability. A comprehensive empirical analysis of select companies is conducted to evaluate their financial performance following merger announcements. Furthermore, the study sheds light on the impact of M&A events on the stock prices and Cumulative Abnormal Returns (CARs) of target and acquiring firms, which were found through an event study. The analysis uncovers notable variations among target companies, further providing insights into market reactions following merger announcements. A detailed case study of Miromatrix Medical Inc. (MIRO) and Hawaiian Holdings Inc. (HA) provides an understanding of the dynamics of M&A transactions and their implications for involved stakeholders. Overall, this thesis seeks to contribute to the vast existing body of literature on merger arbitrage by offering empirical evidence and insightful analyses of real-world merger events.

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Chapter 1

Introduction

Merger arbitrage, or risk arbitrage, is an event-driven investment strategy that seeks to profit from price convergences resulting from corporate events. This strategy involves simultaneously purchasing and selling the respective shares of two merging companies, with the goal of profiting from the timely and successful completion of these transactions – thus creating “riskless” profits.

The announcement of a merger at an offer price higher than the market price tends to initially increase the value of the target’s shares, potentially allowing for profit through merger arbitrage, which occurs between the post-announcement market price and the deal (closing) price. However, there is an intrinsic risk of a merger transaction either being terminated or delayed. Thus, the target company typically trades at a discount to the offer price. By purchasing the target company at a discounted price in the open market, the arbitrageur is positioned to receive the difference between the offer price and the current share price when the deal closes, earning a spread. This discount, or deal spread, measures the potential returns for this strategy. Investors can either benefit from the announcement itself or the successful completion of the merger, depending on the time of investment. If the investor holds shares before the announcement, they stand to gain from the rise in prices following the announcement. Alternatively, should the investor opt to purchase the target company's shares after to the announcement, their profits will depend on the arbitrage spread. The larger the spread, the greater the potential reward for the investor, though it will be the largest if investments are made

prior to the announcement. As the deal moves towards a successful completion, the spread narrows, allowing the arbitrageur to earn a profit. The arbitrage spread is given as:

$$\text{Arbitrage spread} = \frac{P^{\text{Offer}} - P^T}{P^T}$$

where P^{Offer} is the offer price and P^T is the target company's stock price. This spread is known as the simple spread, calculated as the percentage difference between the current target stock price and the highest offer price in a takeover scenario. This "simple" figure is not annualized, which would require additional information such as the expected closing date. To compare arbitrage opportunities more accurately, an annualized spread may be more useful.

The merger arbitrage spread consists of the following components:

- a. Deal Risk Premium: This refers to the additional return that an investment is expected to provide beyond the risk-free rate. This implies that, because the risk-free rate can be obtained without bearing any risk, investors expect a higher potential rate of return for assuming that additional risk.
- b. Time to Close Premium: The time value of money significantly influences the calculation of the arbitrageur's return. The longer it takes a deal to finalize and reach completion, the lower the deal's annualized return will be.
- c. Risk-Free Rate: This refers to the interest rate investors expect from a risk-free investment within a defined timeframe. This includes short-term interest rates – typically U.S. Treasury Bills. A higher risk-free rate tends to correlate with wider deal spreads.

The main risk of merger arbitrage is the possibility of transactions being canceled or denied by regulatory bodies, potentially leading to substantial losses. As said by John Paulson, founder of Paulson & Co. hedge fund, "Risk arbitrage, generally, is investing in securities of corporations going through a corporate event where the return is not based on the stock going up and down,

but the success and completion of the event.” Thus, this strategy generally results in positive returns as the probability of a transaction's success increases with time. However, empirical studies have consistently shown that 70 to 90% of M&A deals fail, underscoring the inherent challenges that render M&A a risky undertaking. Primary causes of deal failure include regulatory issues/hurdles, financing conditions and agreements, shareholder vote(s), material adverse changes and termination clauses, and pending litigation risk. Therefore, an arbitrageur must examine the probability of a merger failing to close on time or at all. Other factors to consider when evaluating potential deals for merger arbitrage strategies include the likelihood of government scrutiny and subsequent enforcement measures related to antitrust regulations, which can estimate the probable outcomes of such events. Arbitrageurs should also analyze the company's public information in the transaction and the markets in which they operate, monitor litigation by government and private entities, and analyze target companies' anti-takeover defenses in hostile transactions.

In a standard acquisition, the acquirer offers cash, shares, or a combination of both, to the target's shareholders. In a stock-for-stock merger, the target company's shares are exchanged for shares of the acquirer. In a cash merger, the simplest arbitrage trade entails the purchase of the target firm's stock in cash, which is held until the completion of the deal. The manager then tenders the shares to the acquirer for cash, which "locks in" the difference between the price at which the shares were initially purchased and the price agreed upon in the acquisition deal. A stock-cash merger is a blend of the two, where the shareholders of the target company receive a mix of cash and stock from the acquiring company in exchange for their existing shares of the target company. The inclusion of the stock element introduces another variable into the deal, and the trader must consider the added risk of establishing a short position in the acquiring

company's stock according to the exchange ratio in order to lock in the value of the spread. Many studies have researched how payment methods and merger types affect merger completion.

Branch and Yang (2003) developed a prediction model for merger completion and found that takeover attempts offering cash are more likely to succeed than those that offer stock as payment. The authors also found that the uncertain equity values associated with stock payments account for the reduced success rate.

Unlike traditional investments, as opposed to market conditions, the performance of event-driven investments is largely dependent on a number of identifiable variables. Thus, arbitrageurs stand to make a potential return upon the successful closing of the deal, regardless of market fluctuations during the pendency of the transaction, because the value of the payment to be received is a fixed dollar amount. In essence, merger arbitrage offers a nuanced investment approach, providing an avenue for potential profits that are independent of broader market movements. This strategy can serve as an alternative for traditional stock and bond investors seeking to create a more efficient and diversified portfolio. It targets consistent gains while minimizing drawdowns through both up and down markets, offering returns that have a low correlation with other traditional assets such as stocks and bonds.

Background and Historical Context

Merger arbitrage has undergone significant expansion since the 1980s, transitioning from small operations within Wall Street firms to independent arbitrage funds directly accessible to the public. Merger arbitrage has been an important contributor to the success of some of Wall Street's most recognizable names. For example, during the early part of his career, Warren Buffett extensively practiced merger arbitrage. In the same vein, in the 1980s, the risk arbitrage desk at Goldman Sachs became renowned as the company brought in huge profits from the strategy.

An increased number of corporate takeovers has brought this strategy to the forefront of the hedge fund industry and financial markets. The first hedge fund is believed to have been started in 1949 by Alfred W. Jones, who pursued a simple equity strategy. There was a sharp surge in the number of hedge funds from the late 1980s through the 1990s, which entailed more specialized hedge fund classes with niche focuses. Since then, the number of hedge funds has increased dramatically, and as of 2023, there were 3,926 hedge fund businesses in the United States. Throughout the 1960s and 1970s, a similar rise of activity took place that spiked interest among investors – mergers and acquisitions, as seen in Figure 1. Consequently, a subset of specialized event-driven arbitrage hedge funds emerged, with an objective, among other things, to invest in risk arbitrage. Merger arbitrage strategies became increasingly refined as financial markets became more sophisticated and regulatory frameworks evolved, with investment decisions incorporating factors such as deal completion certainty, financing conditions, and regulatory approvals. By 2020, the yearly count of U.S. mergers and acquisitions, along with hedge fund capital, had risen substantially to approximately 24,000 and \$3.8 trillion, respectively. In the last 10 years, assets under management in merger arbitrage hedge funds have

quadrupled from \$22 billion to \$85 billion, according to data from Man Institute. Thus, merger arbitrage has become a fundamental component of many hedge funds and institutional investment portfolios, offering the potential for attractive risk-adjusted returns in a dynamic and ever-changing corporate landscape.

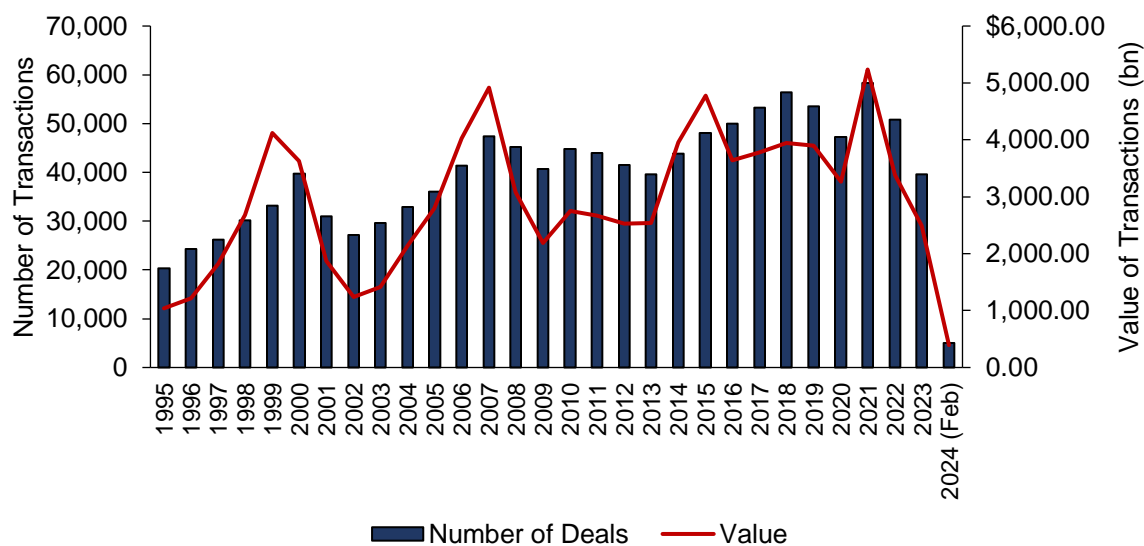


Figure 1: U.S. Merger & Acquisition Activity Since 1995

In a study by Mitchell and Pulvino (2001), they identified that relative to other hedge fund classes, event-driven arbitrage had an attractive historical performance. They found that from 1963 to 1998, risk arbitrage in the U.S. had annual abnormal returns of 9.25% when excluding transaction costs and 3.54% when including transaction costs. Similarly, Baker and Savasoglu (2002) found annual abnormal returns of 9.36% from 1981 to 1996 (excluding transaction costs). A U.S. study conducted by Getmankys et al. (2015) also found risk arbitrage to have intriguing performance characteristics, including a Sharpe ratio of 0.66 between 2004 and 2014 – the second highest amongst its peers of hedge fund classes.

Merger arbitrage strategies have yielded favorable returns across various market environments and conditions, offering notably reduced downside in bear markets. According to Morningstar Direct and Virtus Performance & Analytics, merger arbitrage strategies in bear markets had an average quarterly return of -1.71% from 2004 to 2023, compared to a -9.44% return of the S&P 500 Index. The increase in popularity of event-driven hedge funds, coupled with the attractiveness of risk arbitrage strategies, have paved the way for further extensive examination of this subject.

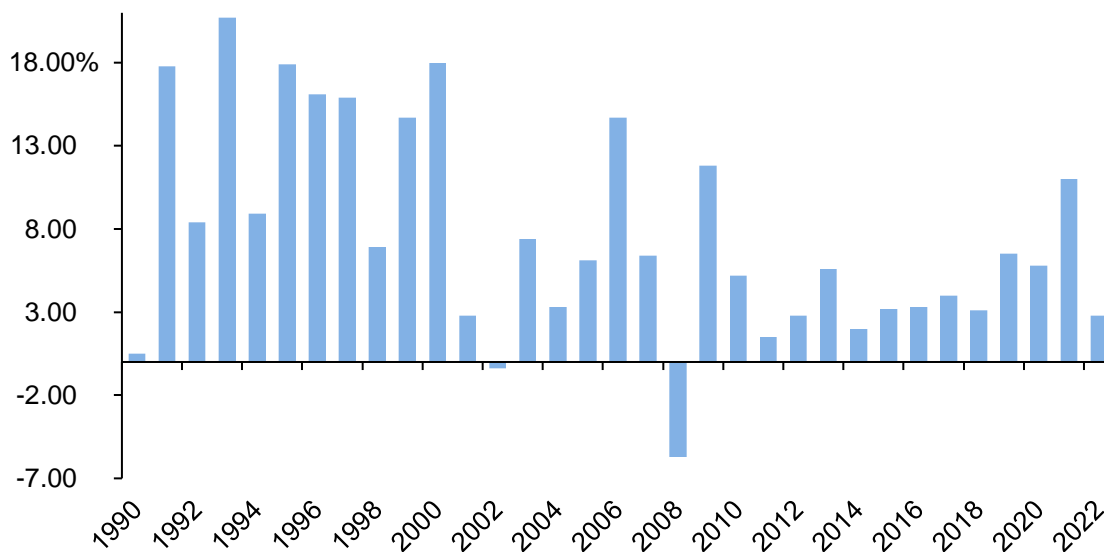


Figure 2: Calendar-Year Returns for Merger Arbitrage Strategies

Chapter 2

Existing Literature on Merger Arbitrage

Theoretical Framework and Efficiency

Arbitrage plays an important economic function because it enhances market efficiency. Thomas Kirchner's "Merger Arbitrage: How to Profit from Global Event-Driven Arbitrage" highlights the theoretical framework of merger arbitrage. The author reinforces that when a price discrepancy arises between two similar instruments or products – which can occur temporarily in any market – arbitrageurs capitalize on these discrepancies by purchasing in the cheaper market and selling in the expensive one. Thus, they effectively elevate prices in the lower market and reduce them in the more expensive market. Over time, the balance between the two markets is restored – ultimately benefiting all participants who rely on the expectation that prices will not significantly deviate from their true value. As stated by Xie (2023), the Efficient Market Hypothesis (EMH) claims that theoretically efficient markets, such as the United States and the United Kingdom, have minimum potential for investors to make excess profits through arbitrage. However, empirical evidence relating to merger arbitrage has challenged the assumptions of the EMH. The EMH does not necessarily preclude the existence of arbitrage opportunities; rather, it suggests that such opportunities should be rare and quickly arbitrated away. Yet, merger arbitrage is often considered a specialized form of arbitrage, involving unique risks, such as regulatory, financing, or execution risks, which may not be fully accounted for by the market. Thus, merger arbitrage has yielded significant returns and benefits for investors – challenging the traditional theory.

In Xie's analysis, the focus lies on determining whether the merger arbitrage strategy is truly profitable for investors in today's semi-strong and efficient market. This examination evaluates the strategy's effectiveness and profitability through an event study, centered around the case of IBM's acquisition of Red Hat in 2018. Statistical tests revealed significant fluctuations in both IBM and Red Hat's stock prices following the acquisition announcement. This indicates potential profits for arbitrageurs in the short term, with a calculated cumulative abnormal return of 40.57% during that period. The findings suggest that, in the short term, the merger is anticipated to have a more positive impact on Red Hat than IBM. However, the research underscores that profits may be constrained by a variety of factors such as taxes and institutional constraints, and that while the merger arbitrage strategy can yield advantages for arbitrageurs in the short term, this is only the ideal scenario. Long-term abnormal returns, as most academics have discovered, are fragile. These results provide guidance for emerging researchers in the field of merger arbitrage, while also indicating avenues for further investigation into this strategic approach.

Empirical Evidence and Performance

Various academic studies consistently show that risk arbitrage generates significant excess returns. Cash tender offers have been particularly lucrative, with excess returns exceeding 100% in some cases. Studies by Dukes, Frohlich, and Ma (1992) and Jindra and Walkling (1999) highlight cash tender offers, showcasing excess annual returns surpassing 100%. These findings suggest systemic inefficiencies within financial markets, particularly in the pricing of firms involved in mergers and acquisitions. Mitchell and Pulvino (2001), present two explanations for the large excess returns documented in the previous studies: practical constraints and limitations and transaction costs that prohibit retail to mid-level investors from attaining these extraordinary

returns, alongside the risk premium that compensates arbitrageurs for the potential risk of deal failure. In their study analyzing 4,750 mergers from 1963-1998, Mitchell and Pulvino found that risk arbitrage generates excess returns of 4% per year, compared to estimates from other studies that range from 11% and 100+%. They also note that risk arbitrage returns are uncorrelated with market returns— as well as most traditional assets – in most market environments.

Baker and Savasoglu's (2001) study further sheds light on the persistently high returns associated with merger arbitrage, seeking to understand why these returns aren't simply eliminated through arbitrage activities. By constructing a model and testing its implications across various arbitrageurs, Baker and Savasoglu found that investors, especially those lacking diversification, often opt to sell to avoid the risk associated with merger completion. Thus, the remaining arbitrageurs, constrained by both capital and numbers, demand a premium for bearing this particular risk.

Market Reactions and Risk Considerations

Many empirical studies shed light on market reactions and stock movements that occur during merger announcements. Acquisition premiums are usually offered by bidding firms to incentivize the target's shareholders to sell. According to Redor (2019), the average premium is 30 to 50%. Consequently, upon such announcements, there is an observable increase in the target's stock price. In their research, Liu and Wu (2014) highlight the negative returns experienced by stock acquirers. They provide two explanations for this: one suggests that these companies may be overvalued (potentially leading companies to opt for stock as 'currency' for acquisitions rather than cash) while another proposes that traders betting against these stocks through short selling might be influencing prices. Their studies find that when acquiring

companies use their stock to buy other companies through stock mergers, there's a significant increase in short-selling activity, leading to big drops in stock prices around the announcement.

In theory, the key idea in arbitrage is the absence of risk. According to Kirchner, however, merger arbitrage trades involve considerable risk. The type of risk associated with merger arbitrage differs from beta -- the market risk that financial risk managers are familiar with and construct models around. Instead, merger arbitrage risk is about event risk, referring to the event that the merger is not completed -- which is not directly related to movements in the overall market. The risk caused by the incompleteness of the announced merger can be due to factors such as dried-up financing for the transaction, antitrust authorities, or changes in the economic environment.

According to Officer (2005), because deal completion risk is the primary risk merger arbitrageurs encounter, the unexpected failure of a tender offer or merger proposal can cause substantial losses for merger arbitrageurs as their long positions (target shares) fall significantly in price and their short positions (loans or bidder shares) are either fixed or rise in value. Although the main risk of merger arbitrage is event risk, that is not to say that merger arbitrage is completely independent of the market. However, market movements are not the principal determinant of the completion of a merger. As stated by Kirchner, event risk is very difficult to capture mathematically. In most statistical risk models, event risk falls into the 'unexplained' component. However, it is the job of the arbitrageur to weigh the risks with the potential for profit opportunities.

Spread Analysis and Trends

When considering the spread of a deal, arbitrageurs refer to the expected annualized spread. At the announcement date, because the closing date of a merger is not known with

certainty, the resulting annualized number is an estimate. Since the year 2000, average spreads of merger arbitrage have overall been undergoing a downtrend, though they have fluctuated widely. Gaurav and Ji (2010) provide research on the shrinking merger arbitrage spreads, uncovering notable and consistent decreases. The authors explain that part of the decline in the arbitrage spread may be explained by increased trading in the targets' stocks following the merger announcement, reduced transaction costs, and changes in risk related to merger arbitrage. For deals announced before 2001, the median first-day arbitrage spread ranged from 4.10 to 7.94%, whereas the median first-day arbitrage spread for the period after 2001 ranged from 1.74 to 2.63%. Nonetheless, speaking of a typical merger arbitrage spread at any time is not very meaningful, as it is better to refer to ranges for different categories. For example, safe mergers are priced for annualized returns of 2 to 5%, while mergers with antitrust risk have annualized spreads of 8 to 10%. Regardless, declines remained consistent when similar comparisons were made for periods extending to 90 trading days following the announcement. In a similar study, Redor explored the determinants influencing the arbitrage spread of S&P 500 firms between 2004 and 2014 within the context of M&A. A regression analysis found that hostile bids, larger target sizes relative to potential bidders, higher acquisition premiums, and lower proportions of cash in the offer were found to be associated with larger arbitrage spreads. Conversely, higher target termination fees were expected to result in smaller arbitrage spreads.

Conclusion and Future Directions

Merger arbitrage has emerged as an increasingly researched topic among academics and a sought-after investment strategy for many investors. This topic's existing body of research signifies the complexities and potential of this strategy, laying the groundwork for deeper exploration into its multifaceted dynamics. As scholars continue to explore the nuances of

merger arbitrage, the ongoing pursuit remains: understanding, implementing, and balancing risk, opportunity, and market efficiency.

Chapter 3

Methodology

This thesis aims to conduct a case study focusing on the financial performance of select companies, those of which have exhibited notable deviations from typical market behavior following the announcement of a merger. Through this approach, this study explores the complex factors that drive these abnormal returns. The primary methodology employed is an event study conducted through the comprehensive Wharton Research Data Service (WRDS) database. This database facilitates the retrieval and analysis of financial data of the selected companies, resulting in the computation of the Cumulative Abnormal Returns (CARs). The CARs outputted by the database serve as key indicators for evaluating the impact of merger announcements on the companies' stock prices and potentially highlight the underlying factors driving the observed market behavior.

The Zephyr database was used as a primary resource to create an appropriate sample for the study. In the process of sample selection for the event study, stringent criteria were applied to ensure the reliability and relevance of our findings. Drawing from an expansive repository of over 92,405 announced mergers and acquisitions accessible through Zephyr, the following criteria were utilized to delineate the selection:

- a. Deal types should be classified specifically as either mergers or acquisitions, facilitating a clear distinction in the analysis.
- b. Both the acquirer and target companies must be publicly listed entities, ensuring transparency and accessibility of relevant financial data.
- c. The timeframe for consideration is limited to the last 5 years, allowing for analysis of recent market dynamics and trends.

- d. Transactions outside of the United States will be excluded from the sample, ensuring that the deals are similar in terms of attributes and regulations. It is likely that different transaction standards or regulations in other geographies could change the results, but this is left for further research.
- e. Deal status encompasses announcements, pending, and completed deals, offering insights into different stages of the merger and acquisition process.
- f. Payment methods must be exclusively either 100% cash or 100% stock offers, ensuring consistency in financial structures across the selected transactions. This also simplifies the hedging positions required to set up the risk arbitrage strategy, as well as the data requirements. This decision follows Mitchell and Pulvino (2001).

Following the application of these criteria, the resulting dataset comprised 94 pairs of targets and acquirers. Specific estimation parameters were then employed to ensure a robust analysis within the event study. The estimation window of this study specifies the length of time, measured in trading days, and is used to estimate the expected return and residual return variance. A 100-day estimation window was used to capture a sufficient number of observations for estimating these metrics accurately. Additionally, a minimum threshold of 70 valid returns within the estimation window was set to ensure the statistical significance of our estimates. To mitigate the potential influence of event-induced return variance on risk model estimation, a gap of 50 trading days between the end of the estimation window and the start of the event window was introduced. This gap allowed for a sufficient buffer period. Further, a symmetric event window approach was adopted, with a span of 10 trading days before and after the event (announcement date). This approach ensured that the full impact of the merger or acquisition

event on stock prices was captured. By adhering to these parameters, the aim was to conduct a transparent and replicable analysis.

Table 1: Sample Selection Criteria

Selection Criteria	Number of Transactions
Target (and acquirer in stock deals) must be publicly listed	92,421
Deal type classified as merger or acquisition	6,380
Payment must be 100% cash or 100% stock	2,952
Transactions must be classified as announced, completed, or pending	1,888
Transactions only within the last five years between 2019-2024	656
Transactions only in the U.S.	94

As for the risk model employed in this study, a Market-Adjusted Model was utilized. In event studies, this model is a widely used method to estimate the expected returns of a stock and calculate its abnormal returns during a specified event window. By utilizing a simple linear regression framework, the model captures the correlation between a stock's return and the return of a selected market index. The Market-Adjusted Model accounts for the systematic risk inherent in the overall market by adjusting the observed returns of the target and acquirer firms with respect to the returns of a relevant market index. By incorporating this adjustment, the Market-Adjusted Model enables us to isolate the idiosyncratic risk specific to the individual firms involved in the mergers and acquisitions under examination. This approach is particularly suited for our analysis, as it enables the discernment any abnormal returns attributable to the merger events themselves, beyond what would be expected based on general market movements. Table

2 offers insights into the size, valuation, and pricing dynamics of the mergers and acquisitions considered in the research. The "current premium" refers to the percentage difference between the market price of the target company's shares after the merger announcement and the offer price per share stated in the merger or acquisition deal. It is important to note that this premium is not annualized as it reflects the current status of the deals in the sample, which may include transactions that are pending and have not yet been completed. Since the premium is based on the current market prices, it does not consider any potential changes or adjustments that may occur over time until the deal is finalized. Therefore, while other metrics in the table, such as the annualized premium, provide insights into the expected returns over a certain period, the current premium simply reflects the instantaneous difference in prices at the time of observation.

Table 2: Sample Selection Characteristics

	Deal Size (mm)	Announced Premium (%)	Offer Price Per Share	Target Price Per Share	Current Premium (%)	Spread	Annualized Premium (%)
Average	\$4,893.981	38.84%	\$37.66	\$39.49	13.06%	\$3.49	112.73%
Median	\$942.61	26.50%	\$17.37	\$18.86	3.27%	\$0.45	10.00%
Minimum	\$28.43	-14.36%	\$0.32	\$0.34	-80.19%	-\$3.36	-5.40%
Maximum	\$67,995.45	298.10%	\$500.00	\$343.32	100.40%	\$57.15	2,478.29%
Standard Deviation	\$10,809.30	42.27%	\$72.35	\$58.65	30.02%	\$9.14	443.89%

Chapter 4

Statistical Analysis and Empirical Results

In reviewing the findings of the event study, the average cumulative abnormal return for the sample of target firms was 29.11% and the maximum was 203.24%. The average CAR of 29.1% indicates that, on average, target firms experienced positive abnormal returns during the event window. The maximum CAR of 203.2% suggests that one target firm experienced exceptionally high abnormal returns, possibly indicating significant market reactions to the merger or acquisition event.

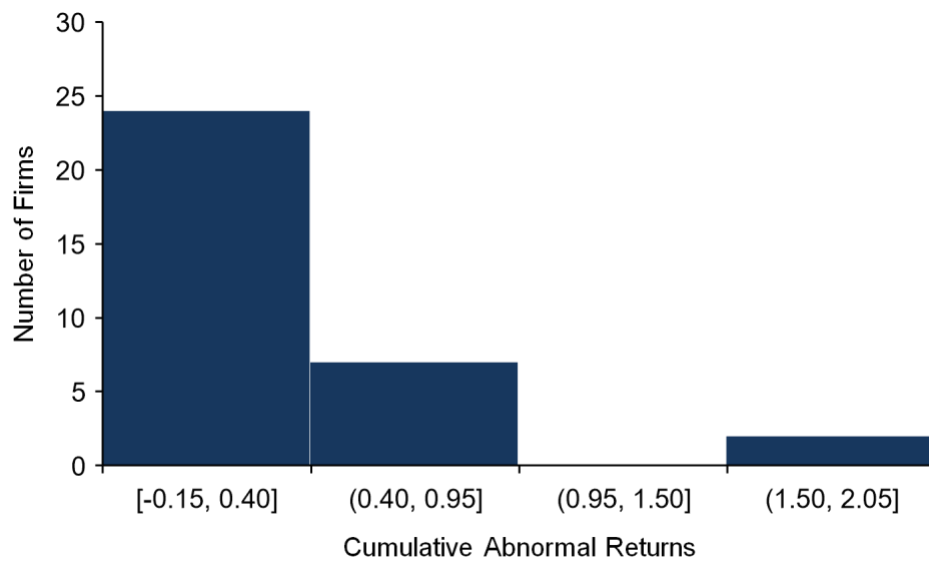


Figure 3: Cumulative Abnormal Returns (CARs) of Target Sample

Chapter 5

Case Study: Miromatrix Medical Inc. (MIRO) and Hawaiian Holdings, Inc. (HA)

When analyzing the CARs of the sample target firms, there were two potential outliers with above-average CARs: Miromatrix Medical Inc. (MIRO) and Hawaiian Holdings Inc. (HA). On October 30, 2023, United Therapeutics Corporation (UTHR) announced its intention to acquire Miromatrix Medical Inc. (MIRO). As per financial news reports, Miromatrix Medical Inc.'s stock surged 230% in premarket trading following its agreement to be acquired by United Therapeutics Corporation. This substantial increase in stock value underscores the significant market reaction to the acquisition news and raises questions regarding the factors driving this response. Similarly, on December 3, 2023, Alaska Air Group Inc. (ALK) announced its acquisition plans for Hawaiian Holdings Inc. (HA). The announcement of this acquisition stirred considerable interest among investors, with HA stock jumping 194% after the announcement.

Analysis of Miromatrix Medical Inc. (MIRO)

Company Overview

Miromatrix Medical Inc. is a life sciences company pioneering a proprietary perfusion technology for the bioengineering of entirely transplantable human organs. Its innovative technology has developed methods that allow it to turn discarded pig organs into human organs. Founded in 2009, Miromatrix is one of a small group of companies at the forefront of developing alternatives to human-donor organ transplants. The company has raised millions in funding rounds since its founding in 2009, partnering with institutions such as the Mayo Clinic, Mount Sinai Health System, and the Texas Heart Institute to further its efforts.

The company went public on June 24, 2021, with the common stock of Miromatrix listed on the Nasdaq Capital Market under the ticker “MIRO.” Ahead of its IPO, MIRO set the price of its public offering at \$9 per share with 5,520,000 shares on the table – which led the company to receive gross proceeds of approximately \$49.7 million, before deducting underwriting discounts and commissions. The company also gave its underwriter, Craig-Hallum Capital Group, the option to purchase another 720,000 shares within 30 days of the IPO – an extra \$6.5 million to Miromatrix’s earnings. Within the first few hours of its trading debut on June 24, its share price had reached a high of \$13.20.

Terms of the Agreement

On December 13, 2023, United Therapeutics Corporation (UTHR) and Miromatrix announced that United Therapeutics, through its wholly-owned subsidiary Morpheus Subsidiary Inc. (“Merger Sub”), had successfully completed the previously announced tender offer to acquire all 27,310,553 outstanding shares of Miromatrix. The acquisition was structured with a

payment of \$3.25 per share in cash upon closing, along with an additional \$1.75 per share in cash contingent upon the achievement of a clinical development milestone associated with Miromatrix's mirokidney™, a fully implantable manufactured kidney product, by December 31, 2025. The transaction included the sale of Miromatrix Medical's patents. The merger's completion comes just two months after United Therapeutics announced a definitive agreement for the company to acquire Miromatrix on October 30, 2023.

United Therapeutics is an American biotechnology company that develops novel, life-extending technologies for patients in the areas of lung disease and organ manufacturing. Incorporated in 1996, the company is headquartered in Silver Spring, Maryland. According to Martine Rothblatt, Ph.D., Chairperson and Chief Executive Officer of United Therapeutics, the company and Miromatrix share a common dedication to solving the chronic shortage of transplantable organs. She stated, "We expect that Miromatrix will help us in this mission, bringing a number of new approaches, highly-skilled personnel, and state-of-the-art facilities as additional shots on goal to complement our existing organ manufacturing programs."

The merger was not subject to any financing condition, and all conditions of the tender offer were satisfied or waived. Further, all shares validly tendered and not validly withdrawn were accepted for payment. As indicated by the depositary and paying agent for the tender offer, Continental Stock Transfer & Trust Company, as of the expiration, 22,876,102 shares of Miromatrix common stock (not including 39,582 shares tendered but not received pursuant to guaranteed delivery procedures as of the expiration) were validly tendered, and not validly withdrawn, representing approximately 83% of the issued and outstanding shares of Miromatrix common stock.

In M&A documents, a “Merger Sub” is the term given to a new shell company formed by the acquirer to complete its acquisition of the target company. Therefore, the Merger Sub enters into a merger agreement with the acquired company and the acquired company is no longer an independent company but is owned by Merger Sub, which in turn is owned by the acquirer. Thus, following the transaction, the acquired company is effectively owned by the acquirer. In the specific case mentioned, following the closure of the tender offer, Merger Sub merged with and into Miromatrix, making it a wholly-owned subsidiary of United Therapeutics. Any remaining shares of Miromatrix common stock not tendered were converted into the right to receive the tender offer’s consideration. As a result, shares of Miromatrix common stock ceased trading on the Nasdaq.

Based on the Miromatrix shares closing price of \$1.07 on the day prior to the announcement and the offered price of \$3.25, the deal value came out to be \$137 million, which includes immediate cash payment of \$88.76 million and \$47.79 million to be paid entirely in cash as an earn-out. As per the closing share price of \$1.07 on October 27, 2023, the offered price reflects a bid premium of 212.5% on the announcement date.

Table 3: MIRO/UTHR Deal Summary

Announcement	10/30/2023
Completion	12/14/2023
Status/ Duration	Completion; 45 Days
Nature of Bid	Friendly
Structure	Patent Sale; Tender Offer
Percent Sought	Acquisition 100%
Payment Type	Cash \$88,765,000; Earn-Out \$47,793,000
Deal Attributes	Tender Offer, Company Takeover
Total Deal Value	\$136,553,000.00

Post Announcement Performance

On Monday, October 30, 2023, MIRO stock surged by 230% in premarket trading following the company's agreement to be acquired. The announcement triggered a burst of activity, with MIRO stock experiencing heavy trading, surpassing 582,000 shares traded on that Monday alone. This volume far exceeded its daily average trading volume of about 19,000 shares. As of October 30, United Therapeutic's stock was down 21% so far in 2023, compared to a 20.8% rise by the Nasdaq Composite. For a merger arbitrage strategy implemented post-announcement and held until the deal's closing, the potential profit would have been approximately 51.67%. This calculation considers the acquisition's structure, including a payment of \$3.25 per share in cash upon closing and an additional \$1.75 per share.

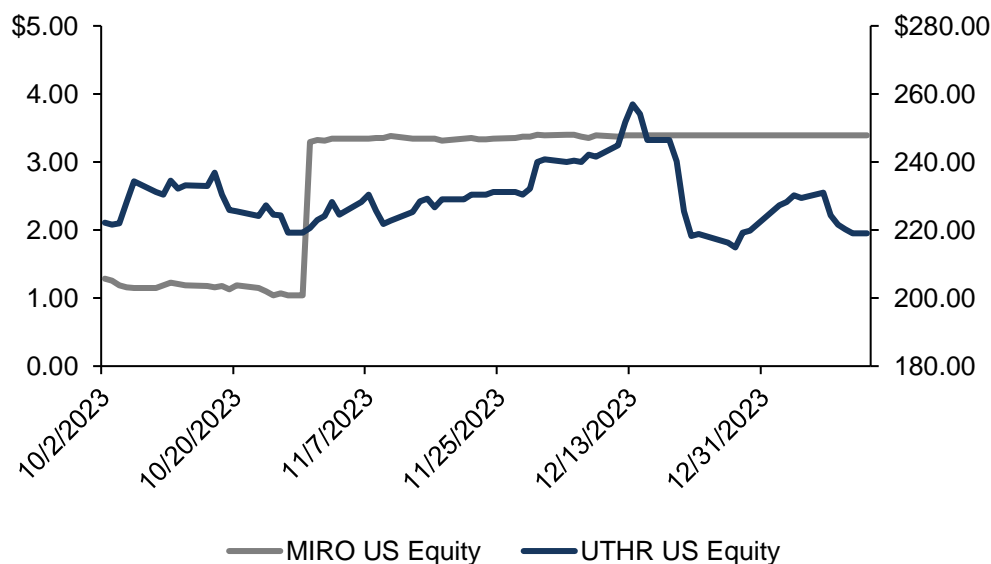


Figure 4: Miromatrix and United Therapeutics Price Chart

Analysis of Hawaiian Holdings Inc. (HA)

Hawaiian Holdings, Inc. is a holding company whose main asset consists of all the issued and outstanding shares of common stock of Hawaiian Airlines, Inc. Through its subsidiary, Hawaiian Airlines, Inc., Hawaiian Holdings operates scheduled air transportation services for passengers and cargo within the Hawaiian Islands, as well as between the Hawaiian Islands and select cities in the United States, the South Pacific, Australia, New Zealand, and Asia. Hawaiian Airlines is the oldest continuously operating airline and the largest airline based in Hawaii. It is ranked the 11th largest domestic airline in the United States by revenue passenger miles (RPMs), according to data from the Research and Innovative Technology Administration Bureau of Transportation Services, as of October 2022, the most recent data available. Incorporated in 1929, the company is headquartered in Honolulu, Hawaii. Hawaiian Holdings Inc. had its initial public offering (IPO) on March 17, 2003. On June 30, 2008, the company announced that it had been added to the Russell 3000 Index. As of February 3, 2023, there were 51,451,449 shares of Hawaiian Holdings common stock outstanding.

Terms of the Agreement

On December 3, 2023, Alaska Air Group Inc. announced that it had entered into a definitive agreement to acquire Hawaiian Airlines Inc., for a total deal value of approximately \$1.9 billion in cash, which includes \$900 million of debt. Alaska Airlines has offered \$18 per share for all outstanding shares of Hawaiian Airlines. This offer represents a bid premium of 270.374% based on the closing price of \$4.86 per share on December 1, 2023, the last trading day before the announcement. The boards of directors of both companies have approved the acquisition. In February of this year, Hawaiian Holdings announced that its stockholders voted to

adopt the merger agreement, which is an important milestone toward closing the deal. The deal is expected to close within 12 to 18 months, on or before June 4, 2025, subject to regulatory approvals and fulfillment of other customary closing conditions. Upon closure, the deal would retain both Alaska Airlines and Hawaiian Airlines as separate brands.

Alaska Air Group Inc., headquartered in Seattle, Washington, is a prominent provider of air transportation services in the United States. Founded in 1985, Alaska Air Group is a leading aviation holding company for Alaska Airlines, Inc. and Horizon Air Industries, Inc., both of which operate as airlines. The company offers large-scale service within the western U.S., Canada, and Mexico, and passenger and cargo services to and within Alaska. It also provides long-haul east/west service to Hawaii and 17 cities in the mid-continental and eastern U.S.

Alaska Air Group has made commitments regarding the future operation of Hawaiian Airlines. The company intends to keep its headquarters in Seattle while maintaining a significant presence in Hawaii. Both the Alaska and Hawaiian Airlines brands will be retained under a unified operations and loyalty platform. According to Ben Minicucci, President and CEO of Alaska Airlines, “This combination is an exciting next step in our collective journey to provide a better travel experience for our guests and expand options for West Coast and Hawaii travelers. Our two airlines are powered by incredible employees, with 90+ years of legacies and values grounded in caring for the special places and people that we serve.” The Hawaiian market has an annual revenue of \$8 billion, a large part of what led Alaska Airlines to approach Hawaiian leadership about a transaction earlier last year.

The proposed acquisition involves several key financial terms. According to Minicucci, this deal represents an attractive transaction multiple of 0.7x revenue. The acquisition is expected to yield high single-digit accretion to earnings within the first two years, along with a mid-teen

return on invested capital (ROIC) by year three. There is no financing contingency for the deal; financing will be provided through cash on hand and new debt. The merger would reinforce Alaska Air's position as the fifth-largest air carrier in the U.S., which many speculate could raise some resistance from U.S. antitrust regulators in an industry undergoing its second notable merger in less than two years. U.S. regulators have resisted more airline consolidation out of concern it would lead to increased fares. Last month, a federal judge sided with the Biden administration and halted the \$3.8 billion merger between JetBlue and Spirit Airlines. Historically, mergers involving smaller airlines do not typically encounter significant legal opposition. Although Alaska Air Group's proposed acquisition would have easily been approved in the past, it's now vulnerable to the current wave of anti-merger government actions. Merger arbitrage specialists had originally given the deal a 70% chance of success, later trimming it to a 65% probability after the JetBlue-Spirit ruling, with Hawaiian shares dropping as much as 3.1% after the judge's decision.

Table 4: HA/ALK Deal Summary

Announcement	12/3/2023
Expected Completion	4/6/2025
Status	Announced/ Pending
Nature of Bid	Friendly
Structure Type	Unsolicited Bid
Percent Sought	Acquisition 100%
Payment Type	Cash \$1,000,000,000
	Liabilities \$900,000,000

Post Announcement Performance

On Monday, December 4, 2023, Hawaiian stock nearly tripled in pre-market trading after Alaska Air Group announced its plans to acquire the airline holdings company for \$1.9 billion. Hawaiian shares opened at \$13.40 on Monday morning and rose as high as \$14.20 throughout the day – a significant increase from the \$4.86 closing price on the previous Friday. A merger arbitrage strategy between the Hawaiian stock price of \$13.40 and the offer price of \$18 per share would yield a potential profit of approximately 34.33% if the deal closes at the proposed price. Despite this rise, the \$13.40 price still fell short of Alaska's offer of \$18 per share, which suggested that investors remain concerned that the deal may not clear regulatory hurdles.

According to analysts, Hawaiian shares had suffered in the months preceding the announcement, primarily due to the effects of the Maui wildfires, elevated fuel costs, and jet engine recall issues affecting certain Airbus SE aircrafts in its fleet. Prior to the announcement, its shares had fallen 52.6% year to date. Meanwhile, around 15 minutes before the start of the regular trading session, Alaska Air's shares had declined 17.6% from Friday's closing price, reaching \$34.19.

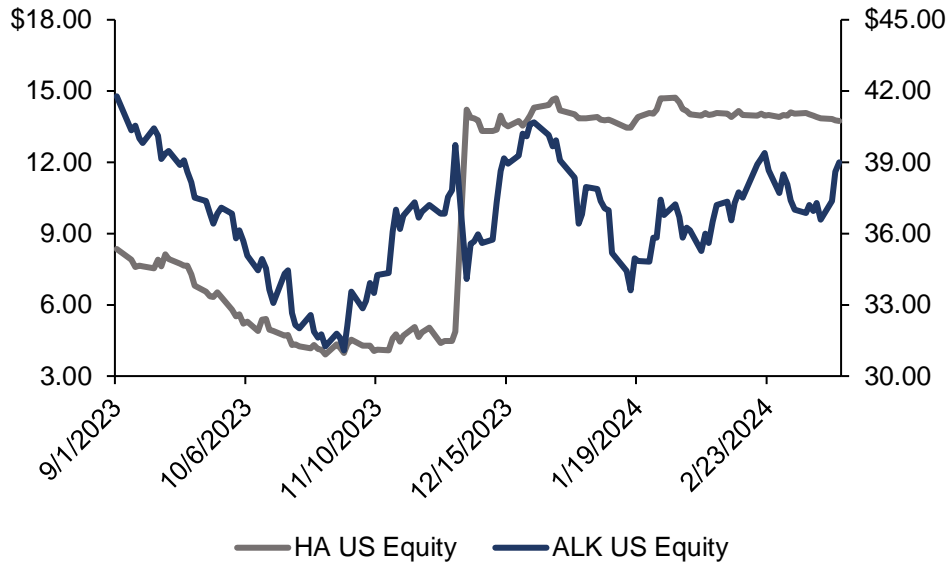


Figure 5: Hawaiian Holdings and Alaska Air Price Chart

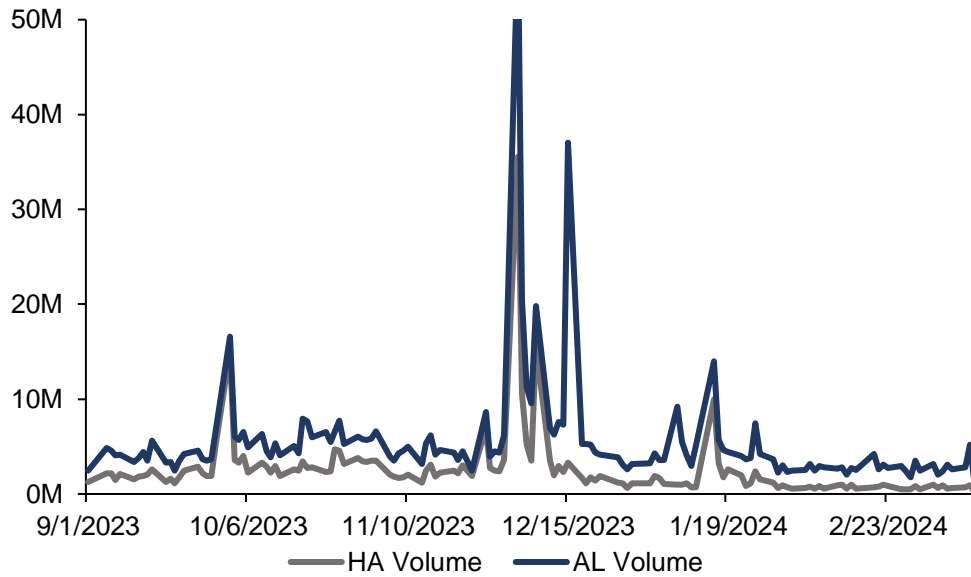


Figure 6: Hawaiian Holdings and Alaska Air Trading Volume

Chapter 6

Further Analysis and Results

To evaluate the stock returns of Alaska Air Group and Hawaiian Holdings surrounding the announcement of their merger, the Cumulative Abnormal Return (CARs) serves as a valuable metric for assessing performance. When analyzing the CARs of Hawaiian and Alaska stocks within a five-day event window surrounding the announcement date of December 3, 2023, the returns exceeded what would typically be expected considering the stocks' risk and the market's performance.

On the day of the event (Day 0, December 3, 2023), there was a significant negative CAR of -8.19% for ALK, which indicates that negative market reactions led the acquirer's stock to perform worse than expected following the news of the merger. This reinforces the hypothesis that, on the day of the event, the stock's performance is driven primarily by abnormal factors and events rather than general market movements. In the days leading up to the announcement (Days -5 to -1), a blend of positive and negative CARs was observed, with the day before the announcement (Day -1) standing out with a relatively high positive CAR of 5.60%. This can indicate that there may have been speculation or leaked information about the acquisition prior to the announcement, which can explain the elevated stock price. In the days following the event (Days 1 to 5), there was a mix of positive and negative CARs, with the stock slightly recovering in the days immediately following the announcement after the initial drop on the day of the announcement, though these positive CARs were still relatively small compared to the negative CAR on the announcement day.

The CARs of HA stock were also observed in the days prior to and following the announcement. On the day of the announcement (Day 0, December 3, 2023), the significant positive CAR of 189.47% indicates that the stock performed better than usual. In the days leading up to the event (Days -5 to -1), the stock underperformed relative to expectations, as seen in the negative CARs. However, Day -1 stood out with a less negative CAR of -3.54%, indicating a slight improvement in performance relative to the preceding days. The days following the announcement show positive CARs, as the stock continued to perform well after the initial jump on the announcement day. However, there was some level of correction in the stock price in the subsequent days as the positive CARs decrease gradually.

These results reinforce the underlying thesis of merger arbitrage and event-driven strategies. This specific example exhibits a significant potential arbitrage opportunity, as the large positive abnormal returns observed in HA following the announcement suggest an opportunity for investors to profit from the spread between the elevated market price and the ultimate acquisition price once the deal is completed. The analysis of these stock returns further highlights the existence of price inefficiencies in the market, upon which merger arbitrage as a strategy heavily relies, particularly when a merger or acquisition is announced. Initially, Hawaiian stock was underpriced relative to its true value, while negative abnormal returns for Alaska Airlines indicate an initial overvaluation of the stock, as seen in Figures 7 and 8. It is important to note that merger arbitrage does not entail predicting the 189% return; rather, it involves capitalizing on the price adjustments that occur in the days following the announcement, emphasizing a nuanced approach distinct from speculative forecasting.

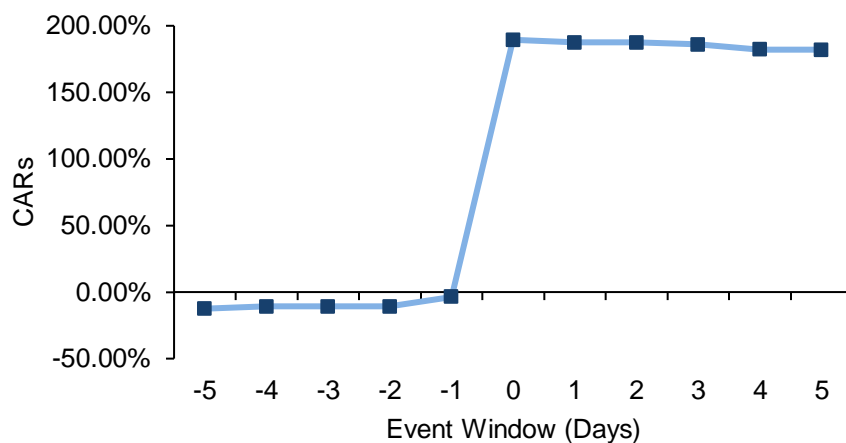


Figure 7: Hawaiian Holdings Cumulative Abnormal Returns

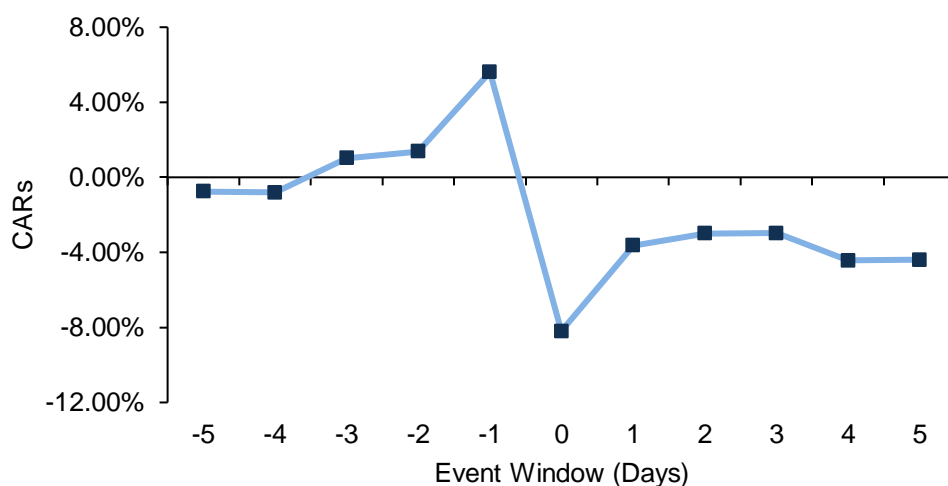


Figure 8: Alaska Air Group Cumulative Abnormal Returns

Similar results were found when conducting an event study to identify the CARs of Miromatrix (MIRO) and United Therapeutics Corporation (UTHR) stock, as seen in Figures 9 and 10. Following the merger announcement, there was a clear upward trend in the CAR for MIRO, which steadily increased from -3.15% five days before the event to 201.71% five days after the event. Conversely, for UTHR stock, CAR decreases from -0.36% five days before the

event to -1.91% five days after the event. Thus, in the case of merger arbitrage, investors would have been able to exploit these price inefficiencies by purchasing MIRO stock after the announcement and holding until the deal closed.

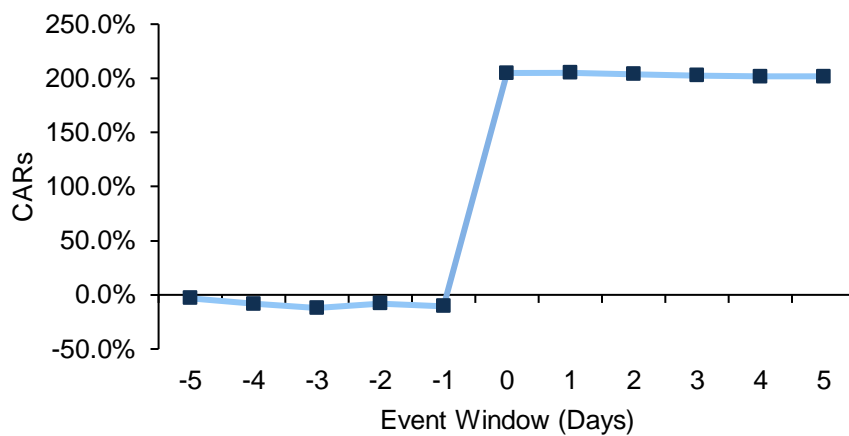


Figure 9: Miromatrix Cumulative Abnormal Returns

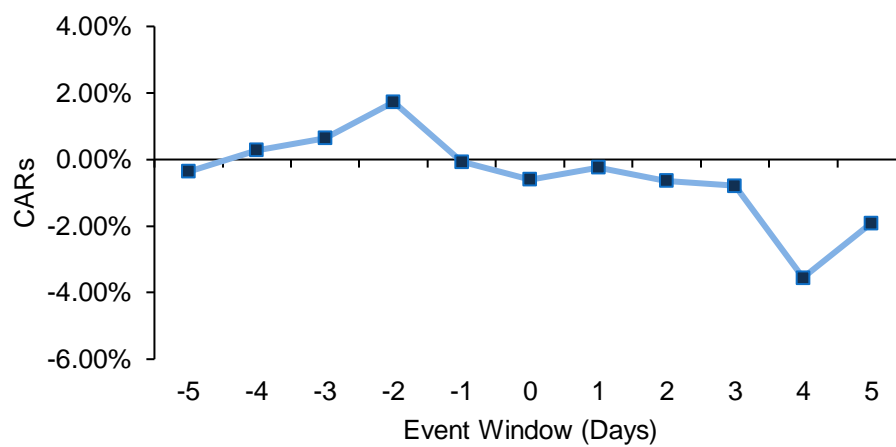


Figure 10: United Therapeutics Cumulative Abnormal Returns

Chapter 7

Conclusion and Future Areas for Research

Throughout this thesis and several other scholarly works, research has uncovered valuable insights into the evolving dynamics of merger arbitrage and the financial implications of M&A events for firms. However, merger arbitrage is still widely misunderstood by the public, as it has become synonymous with words like speculation, extraordinary profits, greed, and *spectacular company implosions*. Several avenues of research remain understudied and insufficiently explored, leaving ample opportunity for future researchers to explore and deepen the understanding of this field.

This study focuses primarily on short-term abnormal returns following merger announcements. However, the depth of this study could be enhanced by researching the long-term performance of companies post-merger, examining factors such as financial performance and operational synergies. Additionally, conducting deeper research into the impact of the financing structure of a deal on market reactions would likely be a productive path to investigate further. Within this paper, the implications of payment methods, including cash versus stock offers, and their impact on stock price dynamics and returns are briefly discussed. However, to expand on this subject, future researchers can quantify CARs associated with different financing structures utilizing event study methodology, allowing for the isolation of the influence of financing structure by controlling for relevant variables such as deal size, industry, and market conditions. Along with this, collar offers are notably scarce in merger arbitrage literature, despite contributing to a large fraction of M&A transactions. Of the authors mentioned throughout this paper, Branch and Yang (2003) are the only to investigate collar offers. Branch and Yang found

that collar transactions yield higher abnormal returns compared to stock or cash deals – providing a rationale to further investigate why this is in fact the case.

New opportunities have been created out of evolved economic realities and risk factors. A potential element to explore is how the strategy reacts to these shifts in the market. For example, ESG is a newer risk factor that could impact merger arbitrage as a strategy. As the ESG evaluation frameworks mature, it is likely that ESG factors will play a bigger role in deals, as they already influence business decisions. In “Merger Arbitrage and ESG Impact Investing” from Versor Investments LP, new research suggests that there could be an ESG premium available through merger arbitrage. The paper looks at the impact of M&A on the ESG scores of companies and finds that merger arbitrage produced large increases in aggregate ESG scores for a given company in a portfolio in a relatively short time period. According to the research, from one year before the merger to one year after the completion of the merger, the ESG scores for target companies rose by about 57% compared to a group of peer companies. The paper further noted that acquirers typically have a higher score than their target companies, with the score going up post-close for both companies. These findings are significant as many ESG strategies are transitioning from divestment and towards approaches that evaluate companies’ ESG improvement over time. Thus, the integration of ESG risk factors into a merger arbitrage strategy’s decision-making could potentially demonstrate an improvement in ESG scores in a portfolio within a span of two years.

This thesis investigates the risk and return characteristics of merger arbitrage by analyzing a comprehensive sample of 94 cash and stock M&A deals in the United States from 2019-2024. Moreover, the case studies of Miromatrix Medical Inc. and Hawaiian Holdings Inc. highlight the significant market reactions often observed following merger announcements,

revealing substantial abnormal returns and emphasizing the complexities involved in evaluating such events. To conclude, merger arbitrage is a lucrative strategy that can offer significant opportunities to profit through the exploitation of market inefficiencies. When executed skillfully and in a timely matter, the strategy is an opportunity to capitalize on price fluctuations, though it requires meticulous analysis, careful risk management, and a comprehensive understanding of the underlying factors driving these reactions.

Appendix A

Increased Risk of Regulatory Intervention

In recent years, regulatory hurdles such as antitrust laws, tax policies, and trade agreements have had significant impacts on merger activity. These shifts in the regulatory environment have influenced investor behavior and deal-making strategies.

According to the Federal Trade Commission, it is a top priority to make sure the agency's "approach to merger enforcement is rigorous and keeping pace with new market realities." In a letter written by FTC Chair Lina Khan, she stated that the FTC has initiated actions against at least 38 mergers since she assumed leadership of the agency in June 2021. With Khan at the helm of the agency, large companies are struggling to close M&A deals that would present unique arbitrage opportunities. The FTC further affirmed its position against some of the world's most powerful companies through its move to block Amgen's \$27.8 billion acquisition of Horizon.

Hedge funds have had to alter their strategies as companies like Google, Meta, and Amazon are faced with mounting regulatory pressure. While certain funds have opted to liquidate and unwind underperforming positions, others have shifted their focus to trading the fluctuations in spreads as deal prospects vary. For high-risk tolerant investors, a widening arbitrage spread presents huge opportunities and potential profits, with some hedge funds taking advantage of the chance to exploit exaggerated spreads through merger arbitrage strategies. Moreover, with fewer investors willing to bet on deals closing, there are more lucrative opportunities for those confident enough to do so. However, for most funds, these regulatory roadblocks have caused losses and setbacks, with merger arbitrage traders having lost 2% on

average last year, according to data from Hedge Fund Research. This return places the sector among the worst-performing hedge fund strategies, which is indicative of how deal-making has become unpredictable as transaction volumes have declined to multiyear lows. In May of last year, TD Bank abandoned its plans to acquire First Horizon, blaming uncertainty on whether regulators would approve the deal. Initially, investors expressed a high deal of confidence that the deal would go through, sending First Horizon's stock up from less than \$18 per share to \$24.49 per share, nearly equivalent to TD's \$25-a-share offer. It subsequently plummeted to around \$10 a share.

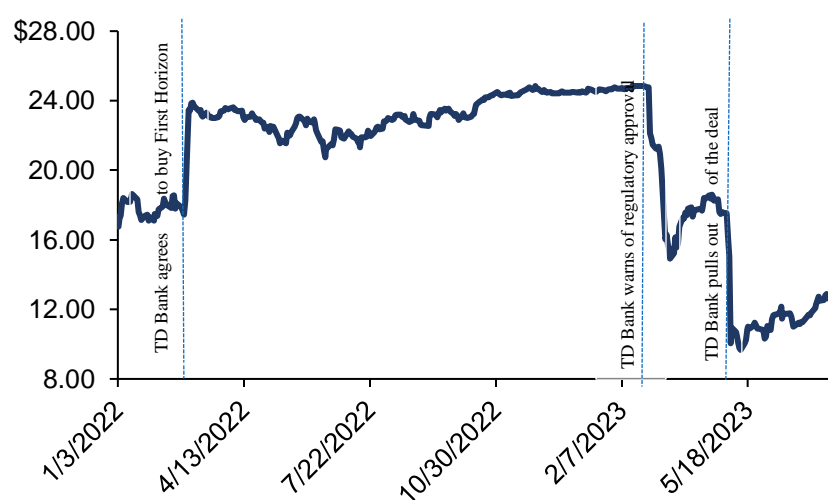


Figure 11: First Horizon Shares Fall After TD Bank Acquisition Collapses

Moreover, merger arbitrage strategy ETFs, such as The IQ Merger Arbitrage ETF (MNA), were highly profitable from 2010 to 2020 due to quick government approval of mergers and high M&A deal volumes. However, since 2020, M&A funds have

underperformed as the Biden Administration has blocked numerous large mergers, and overall deal volumes have declined.

Appendix B

Merger Arbitrage ETFs

With four ETFs traded on the U.S. markets, Merger Arbitrage ETFs have total assets under management of \$418.92M. The IQ Merger Arbitrage ETF MNA is the largest ETF with \$292.16M AUM. In the last trailing year, the best-performing ETF was MRGR at 8.21%.

Table 5: List of Merger Arbitrage ETFs

Ticker	Fund Name	Issuer	AUM (mm)	Expense Ratio
MNA	IQ Merger Arbitrage ETF	New York Life	\$292.16	0.77%
ARB	AltShares Merger Arbitrage ETF	Walter Island Capital Partners LP	\$69.31	0.77%
MARB	First Trust Merger Arbitrage ETF	AJM Ventures LLC	\$47.47	1.80%
MRGR	ProShares Merger ETF	ProShares	\$10.07	0.75%

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