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A Quantitative Analysis of the Relationship Between DoD Contractors' Financial Health and Their Merger and Acquisitions Spending Using Panel Data Regression

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Abstract

This paper examines the relationship between a prime contractor's financial health and its mergers and acquisitions (M&A) spending in the defense industry. It aims to identify financial characteristics of prime contractors that are associated with M&A spending which can provide the Department of Defense (DoD) indications of future M&A activity. These indications can help decision makers better understand the competitiveness of the defense market and develop policies that benefit the overall health of the defense industrial base. The study uses panel data regression models on 40 companies between 1985 and 2021. The company's financial health is assessed using common financial ratios while controlling for key economic factors. The results show a significant relationship between efficiency and M&A spending, indicating that companies with lower efficiency tend to spend more on M&As. However, there was no significant relationship between M&A spending and a company's profitability or solvency. These results were consistent with previous research. However, the effect of liquidity was the opposite of the expected result, possibly due to the defense industry's different view on liquidity compared to previous research.

Keywords: Mergers, Acquisitions, Financial Ratios, Financial Health, Defense Industrial Base

Introduction

The U.S. Department of Defense (DoD) expected budget reductions at the end of the Cold War. This posed a significant problem for many defense contractors who relied heavily on DoD contracts to stay in business. For instance, Lockheed Martin regularly had up to 90% of its

annual revenue from defense contracts (Mahoney, 2021). The industry's feast-or-famine market was compounded by the fact that only a few large contractors could be financed simultaneously (Higgs, 1990). To address the challenges faced by the defense industrial base (DIB) during the budget drawdown, the DoD encouraged the consolidation of its contractors' assets through M&As.

The DIB is a vast set of more than 100,000 companies providing goods and services to support the DoD's mission (Defense Industrial Base Sector, n.d.; Peters, 2021). These companies include prime contractors, sub-contractors, suppliers, small businesses, and foreign and domestic contractors. Prime contractors in particular play a significant role in the defense industry. Prime contractors act as the primary system integrators for the DoD's complex weapon systems (Susman & O'Keefe, 1998) and can also be identified by the number or value of the contracts they receive from the DoD (Bernal, 2022). A recent report shows the top five contractors (all primes) securing 25%–50% of the annual defense contracts (Hartung, 2021). These primes often subcontract or collaborate with non-prime contractors to complete a project (U.S. Small Business Administration, n.d.). Thus, prime contractors have a central role in the structure of the DIB.

In 1993, DoD policymakers organized a meeting between defense industry leaders and government officials to encourage consolidation and reduce the assets the DoD needed to support and maintain (Deutch, 2001). The primary intent was reducing tangible assets like properties, plants, and equipment where savings would be split between the government and its partners. Consequently, the consolidation recommendation triggered a new wave of M&As. Tellingly, the top six contractors increased their share of total defense contract obligations by more than 20% between 1990 and 2014 (Ellman & Bell, 2014). This concentration is even more pronounced at the sector level with the top six contractors awarded nearly 70% of aircraft manufacturing contracts—up from roughly 30% in 1990 (Ellman & Bell, 2014)

The government promotion of M&As within the DIB in 1993 and its subsequent growth paralleled an expansion of M&A activity across the general economy (Institute of Mergers, Acquisitions, and Alliances, 2024). Businesses globally have used consolidation efforts to change ownership, increase product and service variety, add to their current asset mix, foster alliances, maximize shareholder value, and improve firm performance (Mboroto, 2013). Companies also resort to M&As in industries where circumstances prevent typical organic growth (Tikhomirov et al., 2019). While non-defense businesses conduct M&As for reasons similar to defense companies, the defense industry also has its unique considerations. For example, the DIB struggles with organic growth due to a monopsony with the DoD as the primary customer acting as a gatekeeper for access to other customers (Driessnack & King, 2004).

The multitude of reasons for consolidation is also reflected in how companies combine. While the terms merger and acquisition are often used interchangeably, they have subtle differences (Kovacic & Smallwood, 1994). A merger occurs when two businesses in similar lines of business combine their organizations with mutual consent, often under a new name to reflect the new partnership (Corporate Finance Institute Team, 2022). On the other hand, an acquisition happens when one company, usually larger, buys out another company, and the acquiring company completely takes over the target company's operations (Corporate Finance Institute Team, 2022). Acquisitions often involve hostile takeovers where the buyer purchases 51% or more of the target company's shares potentially leading to the dissolution of the target company (Inoti, 2014). In amicable cases, the target company may retain its name but operates under the new parent company's hierarchy—as in Lockheed Martin's acquisition of Sikorsky in 2015.

Furthermore, the Federal Trade Commission (2013) has identified different types of consolidation: two of which are horizontal and vertical M&As. A horizontal M&A occurs when two companies consolidate within the same line of business—i.e., two aircraft manufacturers; horizontal M&As usually involve a merger of primes rather than an acquisition (Deutsch, 2001). In contrast, vertical consolidation happens when a manufacturer combines with a supplier in its chain.

To justify M&A activity, acquirers often report synergies as the primary reason for consolidation to regulating agencies (Amano, 2022; Blonigen & Pierce, 2016; Tikhomirov et al., 2019). These synergies can lead to benefits such as rapid access to technology and products, an extended customer base, and enhanced market positions (Mboroto, 2013). Synergy can be further classified into operational and financial synergy (Dewi & Mustanda, 2021). Consolidations can cause a reduction in capability, capacity, and depth of competition that will severely affect national security (Freling & Hastings, 2022).

Due to the increased M&A activity over the last few decades and the government's interest in maintaining a healthy and competitive defense industry, understanding the financial circumstances of the defense companies involved in M&As is important. Financial ratio analysis has been applied to various industries, like randomly sampled markets (Amano, 2022; Gozali & Panggabean, 2019), banking (Rashid, 2021), fuel industries (Mboroto, 2013), and even households (DeVaney, 1994). These industries have utilized financial ratios to analyze company failures, acquisitions, and the results of post-consolidation synergy. However, little research has been conducted on the relationship between financial ratios and M&A spending within the U.S. defense sector. This research was undertaken to close that gap.

Monitoring top contractors' acquisition activities is crucial to ensure the fair allocation of defense contracts. Analyzing past M&A activity and company performance can inform future policy decisions that can promote industry health and competitiveness. Specifically, this research studies the relationship between financial ratios and the M&A spending of prime contractors over the period 1985–2021 using panel data models. The M&A activity includes both horizontal and vertical consolidation as prime-on-prime and prime-on-non-prime M&As are included.

Literature Review

Financial Ratios

Financial ratios are mathematical calculations that analyze the relationship between two or more financial variables using fractions or percentages (Suthar, 2018). Ratios provide insights into a company's financial health and allow for meaningful comparisons between companies of different sizes (Barnes, 1987). Financial ratios are commonly grouped into one of the following categories: profitability, efficiency, liquidity, and solvency (Budiantoro et al., 2022). Financial reporting practices are standardized for organizations through federal tax codes, the Federal Reserve System, and the Securities Exchange Commission (SEC) allowing for the calculation of financial ratios (Horrigan, 1968).

Profitability is the first measure of a company's financial health and reflects the effective management and productive use of resources (Burja, 2011). Profitability ratios can be further categorized as margin and return ratios. Margin ratios include gross or net profit, cash flow, and operating profit margin; while return ratios include return on assets (ROA), return on invested capital (ROIC), and return on equity (ROE).

The second category of financial ratios involves solvency (or leverage) ratios which measure a company's financial stability and ability to meet its long-term debts and financial obligations. Companies with assets that are greater than the sum of their liabilities are

considered solvent (U.S. Code, 2011); insolvency is an important indicator of company failure and often becomes an essential determinant in bankruptcy declaration (Ghosh & Chaudhuri, 2017). Common ratios used to study solvency include interest coverage, debt to assets, and debt to equity.

The next financial health category is efficiency which measures how effectively managers of a company utilize their assets to generate sales (Adedeji, 2014). Efficiency can be analyzed qualitatively or quantitatively. While qualitative measures focus more subjectively on company goals, quantitative measures can provide more objective data across companies using financial ratios (Zietlow et al., 2018). Some common examples of quantitative efficiency measurements include accounts receivable turnover, fixed asset turnover, and sales to inventory.

Finally, liquidity ratios measure a company's ability to meet its short-term financial obligations and is a vital indicator of its financial standing (Kritsonis, 2005; Tikhomirov et al., 2019). Investors and creditors assess the risk of lending money to or investing in the company (Beaver, 1966). Some common ratios used to measure liquidity include the current, quick, net working capital, and days sales outstanding.

Limitations of Financial Ratios

While valuable for analyzing a company's performance, financial ratios have several limitations. First, the numerical value of a ratio can vary depending on the specific values used from the financial statements. This discrepancy arises from multiple profit figures disclosed in income statements such as operating profit, net profit before interest and taxation, and net profit after taxation (Frecknall-Hughes et al., 2007). Thus, companies facing financial troubles may manipulate ratios to meet creditor and investor expectations, rendering them unreliable until a crisis occurs (Lev, 1969; Wilcox, 1971).

Furthermore, the choice of which ratios to analyze can be challenging due to the numerous ratios available; it is impractical to examine all of them in a single study (Murphy et al., 1996). Yet, it is important to note that not all ratios measure a company's performance equally well. To obtain a comprehensive understanding, it may be necessary to consider a combination of ratios alongside other economic factors (Gâdoiu, 2014). Moreover, the usefulness of financial ratios can vary depending on their application or the specific sample being analyzed, and researchers sometimes overuse ratios, leading to over-fitting and overstated predictability (Palepu, 1986)

Another limitation is that the importance of different financial ratios may vary across industries. Different industries prioritize certain categories of ratios based on their specific needs. For example, creditors may emphasize debt payment ratios more while managerial accounting practices focus more on profitability measures (Horrigan, 1968). Examining how financial institutions evaluated debt ratios for creditworthiness in industries reliant on debt financing, such as defense contractors in the 1990s, can provide valuable insights (Beaver, 1966; Deutch, 2001).

Despite these limitations, financial ratios remain valuable for assessing a company's health. Ensuring consistency in the calculation process can minimize variations caused by different financial statement values. Selecting the most relevant ratios for a specific industry or context is vital and combining them with other economic considerations can enhance their value. Financial ratios have been widely used for decades and have demonstrated their descriptive abilities in assessing companies across various industries. By avoiding known biases and building on previous studies, accurate modeling procedures can be developed to give interested parties a more accurate picture of a company's financial health over time.

Financial Ratios and Acquisition Activity

M&As occur for various reasons and the financial health of the companies involved provide insight into the possible reasons. Previous studies have indicated that some companies choose to be acquired strategically to avoid bankruptcy or other distress (Officer, 2007; Pastena & Ruland, 1986). Other researchers found that acquisitions caused by distress were less common (Camerlynck et al., 2005; Higson & Elliott, 1993).

Assuming struggling companies were the targets, successful companies would be the presumed acquirers. A company's profitability could be one measure of its health or success. The company may save its excess funds, pay debts, distribute dividends, or acquire businesses with these profits. However, according to research by Yang et al. (2019), successful companies with strong operating performances were less likely to pursue external acquisitions. Although, companies with higher growth opportunities may rely more on external investments to fund their expansion (Yang et al., 2019).

The relationship between liquidity and solvency concerning acquirers has been a subject of debate among researchers. Some argue that companies with excess cash prefer to utilize their funds instead of seeking external financing, while others contend that acquisitions financed with additional debt are more favorable, particularly in the defense industry (Bruner, 1988; Deutch, 2001; Myers, 1984). Since Myers' and Yang's studies, there has been a significant time gap, making it challenging to determine any potential shifts in the utilization of liquid assets for M&As. However, recent research suggests that higher liquidity tends to increase the likelihood of M&As (Erel et al., 2021; Shleifer & Vishny, 1992). Furthermore, a company's acquisition strategy may involve transitioning from internal assets to external debts and eventually equity financing, with variations based on the company's experience (Fourati & Affes, 2013). The free cash flow theory concept is also discussed, suggesting that companies with substantial liquidity may engage in self-interested, low-benefit acquisitions (Jensen, 1996; Yang et al., 2019).

Various ratios have been studied to determine the likelihood of a company becoming an acquisition target. Cudd and Duggal (2000) discovered that when there are imbalances between sales and resources within target firms, their acquirers can invest the excess resources more profitably in their projects or finance the acquired firms' projects at a lower cost of capital. Belkaoui (1978) found that non-liquid asset ratios best-predicted takeovers in Canadian industries. Additionally, comparing a company's ratio to the industry average has proven helpful in predicting failures and acquisitions (Barnes, 1990; Camerlynck et al., 2005).

Financial Ratios to Predict Failure

Revisiting the idea that targets may be in economic distress leads to two research efforts (Ghosh & Chaudhuri, 2017; Horrigan, 1968) which extensively outlined past studies (i.e., Altman & Hotchkiss, 2006; Beaver, 1966; Merwin, 1942; Smith & Winakor, 1935). These studies used financial ratios to predict company failure years before it occurred. Failure was defined as bankruptcy in these studies, not acquisitions. Bapat and Nagale (2014) compiled a list of 35 ratios used in these and other studies to evaluate three methodologies for bankruptcy prediction. They found that 24 of the ratios had statistical relevance in each of their three models predicting the failure of a company. At least one ratio fell into their performance categories of leverage, operating cash flow, liquidity, profitability, activity, and market ratios.

Many models and their included financial ratios have proven somewhat effective in predicting company failures. Successful models have seen anywhere from 60%–90% accuracy, depending on the analyzed periods and the financial ratios used (Bapat & Nagale, 2014; Ghosh & Chaudhuri, 2017). Although failure and target prediction models can provide valuable insight into a company's future status, not all researchers agree on their predictability or methodology. Palepu (1986) suggested that while these studies claimed high accuracy, they suffered

methodological flaws. The flaws in the results were caused by using non-random sampling and arbitrary cutoffs, which created biases and made it difficult to interpret the results. Palepu (1986) and Jensen and Ruback (1983) agree that it is difficult and perhaps impossible for the market to predict the fate of a company. These flaws were also addressed by Powell (2001), who studied several models reporting high accuracy in acquisition target detection. He made an interesting claim that companies targeting profitable investments should not use statistical models, but the same models could effectively predict future takeovers (Powell, 2001).

Economic Factors

The economic conditions influencing a company's financial performance occur at different levels of the economy. Macroeconomics refers to the behavior of the overall, national economy. Microeconomics refers to the economic behavior of individual businesses. A third, intermediate level (also commonly included in microeconomics and less commonly referred to as mesoeconomics) refers to regional or organizational economics (Lambooy, 1990); a unique market structure (i.e., the defense industry) and its behavior would fall into this category.

M&As can be influenced by macroeconomic factors such as national productivity, inflation, and interest rates. Research has found that national productivity, measured by gross domestic product (GDP), can significantly impact M&As. Companies are more likely to engage in M&As during strong economic conditions and less likely to do so during weak economic conditions (Ji, 2016). Cordeiro (2014) observed that the number of M&As sharply declined in 2007 due to the subprime crisis and the subsequent recession in the United States, yet it rose globally in 2014 after the economy recovered. Additionally, Carbonara and Caiazza (2009) and Wang (2009) found that national productivity growth was the most significant economic factor influencing M&As in Italian and Chinese markets.

Previous studies have shown that financial ratio analysis is most effective when comparing companies within similar industries (Barnes, 1990; Beaver, 1966; Cudd & Duggal, 2000; Edmister, 1972). In this research, the sample only studies defense contractors, so this will not be an issue. By examining the mesoeconomic level, we can better understand how industry-specific disruptions can affect certain areas of the economy and individual businesses. This understanding can lead to shifts in M&A activity. For example, the government's budget drawdowns and pro-consolidation policy recommendations from 1993 to 1998 threatened contractor revenue, prompting some companies to seek M&As to secure DoD contracts. These conditions are unique to the defense sector and cannot be captured at a macroeconomic level.

Lastly, size was a prevalent microeconomic influence concerning company failure and M&A activity. There are various proxies for the size of a company, like market capitalization, sales, resources, or employees—each capturing different aspects of the firm. Market capitalization is market-oriented and forward-looking, while total sales are more related to the product market and not forward-looking, and total assets measure the firm's total resources (Dang et al., 2018). Nevertheless, the correlation among these proxies is high (Shalit & Sankar, 1977). The growth of a company demonstrated unusual findings in that while larger firms tend not to fail as frequently (Beaver, 1966), growth-to-asset imbalances can increase the likelihood of failure and becoming an acquisition target (Camerlynck et al., 2005; Cudd & Duggal, 2000; Palepu, 1986; Yang et al., 2019). Companies often became acquisition targets when their assets were insufficient to maintain their observed growth and acquirers typically had higher asset growth rates than their targets (Camerlynck et al., 2005).

In consideration of the existing literature linking a company's financial health (as measured by financial ratios) to failure and M&A activity, this research seeks to further explore the financial characteristics associated with M&A spending for DoD prime contractors. While there has been some previous research on this topic, little research has been done within the

defense sector. As the government has a vested interested in the health and competitiveness of defense contractors, this paper seeks to provide insight into M&A spending by analyzing its association with profitability, liquidity, solvency, and efficiency ratios.

Hypothesis Development

The observed relationship between profitability and liquidity ratios and M&A activity is varied. Camerlynck et al. (2005) found acquirers often had higher profitability than their industry peers, yet Yang et al. (2019) found that companies with higher profitability tended to rely on internal investments over M&As. Similar results were seen for liquidity. Some research found that cash-rich or liquid firms were more likely to attempt acquisitions (Bruner, 1988; Erel et al., 2021; Jensen, 1996; Myers, 1984) while Camerlynck et al. (2005) found acquirers often reported below industry-average liquidity and were highly leveraged.

For solvency and efficiency ratios, the relationship with M&A activity shows more consensus. Most researchers suggest that larger, less efficient firms seek to acquire smaller, more efficient firms to improve the acquiring company's efficiency (Inoti, 2014; Jensen & Ruback, 1983). Thus, efficiency and M&A activity appear to have an inverse relationship. Although an optimal size proxy has not been discovered (Lev & Sunder, 1979), this study utilized total sales to measure a contractor's size.

Economic factors have been shown to be associated M&A activity and thus should be controlled. National productivity is a proxy for an economy's overall health. Increases in national productivity, or GDP, have been associated with increased M&A activity in American, Chinese, and Italian markets (Carbonara & Caiazza, 2009; Wang, 2009). Industry-specific factors have also influenced M&A activity (Cordeiro, 2014; Palepu, 1986). The U.S. defense budget can be used as a proxy for the strength of the defense industry; the theory is that as budgets decrease, as they did in the 1990s, M&A activity will increase (Office of the Under Secretary of Defense [OUSD] for Acquisition and Sustainment, 2022). Finally, a firm's size is used to represent an individual company's potential for M&A activity. Research has shown that as a company grows, its acquisition spending increases (Dang et al., 2018; Shalit & Sankar, 1977). These macro and microeconomic variables are used as controls in studying four hypotheses on the relationship between M&A spending and a company's financial health:

Hypothesis 1 (H1): Defense contractors with higher profitability are associated with increased spending on M&As.

Hypothesis 2 (H2): Defense contractors with greater liquidity are associated with increased spending on M&As.

Hypothesis 3 (H3): Defense contractors that are highly leveraged are associated with increased spending on M&As.

Hypothesis 4 (H4): Companies with lower efficiency are associated with increased spending on M&As.

Table 1. Summary of Expected Results

Increase in	M&A Spending
Profitability	Increases (+)
Solvency	Increases (+)
Efficiency	Decreases (-)
Liquidity	Increases (+)

National Productivity	Increases (+)
Defense Budget	Decreases (-)
Contractor Size	Increases (+)

Methodology

This analysis required the identification of prime contractors as well as the collection of their annual 10-K reported financial data and M&A activity. The financial data was used to calculate the financial health ratios. At the same time, M&A activity was used as the response variable for the models. This study used various databases, and this section will define the processes used to build the final dataset. The collected data was used to develop the independent variables (IVs) to test the hypotheses. A panel data model was utilized since the experiment studies M&A activity on a cross-section of contractors over several years.

Sample

Several reports were critical in identifying whom the DoD classified as prime contractors within its weapons categories (OUSD for Acquisition and Sustainment, 2022; U.S. General Accounting Office, 1998a, 1998b). Between these reports, 42 prime contractors were identified for 1990, 1998, and 2020. The 42 initial contractors fall into the "DoD Identified Contractors" category in Table 2. Although the DoD provided the initial foundation for prime contractor identification, several contractors have entered or exited their market through M&A activity. The entry and exit of contractors required additional contractors to be added as primes or removed from the analysis. Additionally, some data could not be obtained due to financial reporting requirements and database limitations.

Several M&As transpired between the release of the GAO (1998a, 1998b) and the OUSD for Acquisition and Sustainment (2022) reports causing some primes to be absent in either report. It is assumed that if a company acquired a prime contractor, the acquirer becomes a prime themselves, as indicated by "M&A of DoD Prime." Models with and without the acquirer were assessed to ensure the acquirer's data did not influence the results. M&As also spurred two spin-off companies that still serviced their previous sectors within the industry. All defense industry spin-offs identified in this research were acquired or no longer considered primes by the OUSD (OUSD Acquisition and Sustainment, 2022). However, they still needed to be tracked in this analysis due to their strong influence within their sectors.

Nine DoD-identified prime contractors were subsidiaries of a larger parent company. Since financial data for a parent company is rarely reported at the subsidiary level, limited financial data could be found. Therefore, eight parent companies were added to the analysis as a proxy for the prime contractor they represent. Similarly, private companies' financial data is rarely made public. Although databases like Techsalerator, Mattermark, Crunchbase, and PitchBook provide private company financials, seven private prime contractors were omitted from this study due to database access limitations. Finally, most of the databases used in this study have limited financial data for companies that merged before 1995. Since Northrop merged with Grumman in 1994, Grumman's financial data could not be obtained.

The dataset became unbalanced due to contractors being acquired, merging into new companies, or companies being generated via spin-offs. M&A activity can cause contractors to come and go, making it hard to balance the dataset. The *plm* package from the statistical modeling software R was used for this analysis and was capable of using unbalanced data. Balancing the dataset would reduce the sample size to only seven contractors.

Table 2 summarizes the data inclusion and exclusion process for this research. The final sample includes 40 companies from 1985 to 2021, totaling 683 observations[1].

Table 2. Contractor Sample

Contractor Inclusion / Exclusion Criteria	# of Contractors	Observations
DoD Identified Contractors	42 Initial	419*
M&A of DoD Prime	5 Added	120
Spin-Off Companies	2 Added	29
Parent of Subsidiary	8 Added	115
Subsidiary	9 Removed	0
Private Companies	7 Removed	0
Missing Financials	1 Removed	0
Total	**40 Contractors**	**683**

*Refers to the observations of the 25/42 initial DoD-identified contractors. The remaining 17 were removed per the table.

Data

To conduct this research, two areas of analysis were required. The first involved gathering financial data from each company, which must be disclosed in an annual 10-K report for publicly traded companies. In priority order, the sources for 10-K data were Mergent, Yahoo Finance, Compustat, SEC's EDGAR, and S&P Capital IQ[2]. Missing values were cross-checked with another source for consistency. The financial data gathered from these sources were used to calculate a company's financial health via ratios. These ratios were implemented as IVs to test the hypotheses. The second area of research required collecting each company's M&A activity from Yahoo Finance, SEC's EDGAR Archive, Mergr, and Mergent Online. M&A spending was analyzed as the dependent variable (DV) for this study.

Modeling Considerations

Panel data models were used to test the relationship between financial ratios and annual M&A spending. While pooled ordinary least squares (POLS) models can be used for a cross-section of entities over time multiple periods, it pools the data into one large cross-section ignoring the fact that some observations came from the same entity. Conversely, fixed and random effects models can often improve upon the pooled cross-section parameter estimates by controlling for the unobserved heterogeneity.

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[1] These values reflect the entire dataset used for this assessment. The most stringent model tested 22 companies, over 27 years, totaling 352 observations. The model removed one or more of the following: parent companies, years, or non-GAO identified prime contractors. The final model was robust to these changes. Therefore, the entire dataset was utilized.

[2] Yahoo Finance, Compustat, and EDGAR were only used when Mergent was missing information in a handful of cases. S&P Capital was used to confirm a company's private status. The Mergent database has several different storage mechanisms, such as Archive, Horizon, and Online. Mergent Online was used exclusively for this study.

Heterogeneity refers to the differences amongst the contractors in the sample which can be either observed or unobserved. Observed characteristics can be directly modeled by including independent variables; conversely, unobserved heterogeneity comes from unobserved group characteristics (Armstrong, 2021). Unobserved heterogeneity can include characteristics such as company culture, management styles, and employee attitude. Additionally, unobserved heterogeneity can be time-invariant (i.e., the unobserved characteristics of a company that do not change over time) or time-variant (i.e., the unobserved characteristics that do change over time). Both fixed and random effect models attempt to account for the time-invariant unobserved heterogeneity by exploiting the fact that the panel data includes multiple observations from the same entity and using a composite error term of time-invariant and idiosyncratic components. The underlying assumptions regarding the unobserved heterogeneity is different between the two models. Fixed effects (FE) modeling assumes that time-invariant, unobserved heterogeneity is correlated with one or more of the IVs. FE demeans each variable across time for each entity effectively removing the unobserved time-invariant heterogeneity and leaving only the idiosyncratic error. Thus, the net effect of the IVs on the DV can be explored. Conversely, random effects (RE) assumes that the time-invariant unobserved heterogeneity is uncorrelated with the IVs. While RE also demeans the data, it does so in such a way that does not completely remove the time-invariant unobserved heterogeneity.

The distinction between fixed and random effects is whether the time-invariant unobserved entity effect embodies elements correlated with the regressors in the model—not whether these effects are stochastic (Greene, 2008). Choosing between fixed or random effects often depends on the assumptions of the research and the nature of the data. Fixed effects models are almost exclusively used in econometric research since the time-invariant component of the error term is often correlated with one or more IVs (Hilmer & Hilmer, 2014).

Without an extensive deep dive into each contractor's management structures, processes, and other company-specific characteristics that are generally constant over the period of time studied, it is hard to rule out that the time-invariant unobserved heterogeneity has zero correlation with any predictor variables—meaning fixed effects models would be preferred. Additionally, fixed effect models are often preferred for small (Borenstein, 2009) and non-random samples (Dougherty, 2011)—both of which were used in this study. The sample size was 40 contractors manually selected due to their status as defense contractors. Due to this, both fixed and random effects models were considered, and a Hausman test was used to determine the best-fit model.

Additionally, time fixed effects were assessed for inclusion in the model. These are the effects that remain constant across the entities for a given time period but have may have a different effect in different time periods (e.g., the attitude of a government regulatory body may change from year to year but is the same for each entity in a given year). Modeling time fixed effects is similar to controlling for unobserved heterogeneity in fixed and random effects models; but instead it focuses on demeaning the data across the time dimension instead of the contractor dimension. Controlling for time-fixed effects may correct potential biasedness in the estimates of the model parameters. A Breusch-Pagan Lagrange Multiplier (LM) test was used to determine the need for time-fixed effects.

It is important to test model assumptions to support the quality of the model. First, the presence of unit roots is considered. A dataset is considered stationary if its statistical properties remain constant over time. However, in a time-series dataset, some variables may have upward or downward trends over time, indicating a unit root's presence. To evaluate unit effects, the Dickey-Fuller test is utilized.

Next, serial correlation and cross-sectional dependence within the errors were tested. These type of correlations may be a problem for macro-panels with long time series. While the distinction between micro and macro panels is subjective, Baltagi (2021) defines macro panels as having more than 10 to 20 years and a moderate number of entities, 7–200, which this assessment satisfies. Serial correlation refers to the dependence between observations over time within the same unit was assessed using a Breusch-Godfrey/Wooldridge. Cross-sectional dependence is the simultaneous dependence between observations across different units (Armstrong, 2021). When the errors of multiple observations within a certain period are correlated, it can lead to biases and inefficient estimates of the model parameters. Breusch-Pagan LM and Pesaran Cross-Sectional Dependence tests were used to assess the model for cross-sectional dependence.

Finally, heteroscedasticity occurs when the error term's variance in the model is not constant across all IV levels resulting in inefficient estimates of the model parameters; heteroscedasticity was assessed using a Breusch-Pagan test. If heteroscedasticity exists, robust covariance matrix estimation can correct it. Different methods of correcting for assumption violations can depend on whether the model uses random or fixed effects. For example, White's heteroscedasticity-consistent covariance estimators are commonly used for random effects, and the Arellano method of clustered standard errors for fixed effects (Arellano, 2009; Greene, 2008).

Variables and Model

To avoid the issues surrounding statistical overfitting, the models in this study used one ratio per financial health category and economic level. The variables chosen for this study were selected based on the frequency and statistical relevance of the ratios in previous research. The variables and model structure are reported in Table 3.

Table 3. Variable Definitions and Model Structure

IVs:	**Definition**
Profitability (P)	ROA (%) measures a company's profitability by dividing net income by average total assets. Average total assets are calculated by averaging the current and previous year's total assets
Solvency (S)	The debt-to-equity ratio (%) measures a company's solvency by comparing its long-term debt to shareholder equity
Efficiency (E)	Total asset turnover (%) measures a company's efficiency by comparing its revenue to its average total assets
Liquidity (L)	The current ratio (%) measures a company's liquidity by comparing its current assets to its current liabilities
Control Variables:	
National Productivity (GDP)	Represents macroeconomic factors as measured by U.S. GDP in billions of dollars (Office of Management and Budget, n.d.-a)
Defense Budget (DB)	Represents defense industry factors as measured by the U.S. defense budget in billions of dollars (Office of Management and Budget, n.d.-b)
Size (Sz)	Represents the contractor's size measured by year-end sales in billions of dollars
DV:	
M&A Spending (MA)	Represents the millions of dollars a contractor spends on annual M&As
Model:	
$MA_{it} = \beta_0 + \beta_1 P_{it} + \beta_2 S_{it} + \beta_3 E_i + \beta_4 L_{it} + \beta_5 GDP_{it} + \beta_6 DB_{it} + \beta_7 Sz_{it} + \varepsilon_{it}$	

Empirical Results and Discussion

Initially, it was believed that a company's unobserved heterogeneity and IVs were correlated—e.g., its internal processes and company culture could be related to the company's observed financial ratios. Although fixed effects models are usually preferred in econometric research, the Hausman test frequently indicated that random effects models better fit the data. Random effects models may be better than fixed effects models in industries where market randomness affects the correlation between a company's unobserved characteristics and financial health. The fixed effects models still regularly outperformed Pooled (OLS) models until the most stringent criteria for prime classification was placed on the model. As the sample size decreased, this may have caused a lack of statistical power within the fixed and random effects models.

After running a series of increasingly more exclusive criteria on the contractor selection, it was noted that the general trends remained constant throughout each model. There were a few cases in which the signs of an estimate would change. However, the term was statistically insignificant in these cases and contained large standard error margins. Thus, the remainder of this research utilized the entire dataset, which includes the acquirers of primes, spin-off companies, and parent companies.

Table 4 reports the relationship between the contractor's financial health and M&A spending. The Hausman and F-tests reported that the best-fit model was the random effects, followed by fixed effects, and then the pooled OLS model. Although time-fixed effects were found via a Breusch-Pagan LM test, they were intentionally left off the results reported in Table 4 to assess the control variables' effects and provide easily interpretable results. While time-fixed effects can be used in fixed and random effects models, how they are reported differs. After demeaning for time-fixed effects that are constant for each contractor in a fixed effects model, the result of the variable is zero. In a random-effects model, the quasi-demeaned data remains and is not fully reduced to zero, making interpretation of the variables difficult. This difficulty in interpretation only applies to the national productivity and defense budget variables since they are constant for each contractor. The remaining variables are company specific.

Table 4. Empirical Results

		Models		
		Random-Effects	**Fixed-Effects**	**Pooled OLS**
IVs	**Pred.**	Coef. (Std. Error)	Coef. (Std. Error)	Coef. (Std. Error)
Intercept		**694.527** (239.487)**	--	**799.454*** (222.721)**
Profitability	+	4.847 (3.784)	1.792 (2.945)	**7.700* (3.907)**
Solvency	+	0.030 (0.101)	0.015 (0.126)	0.026 (0.100)
Efficiency	-	**-3.381** (1.057)**	**-2.826• (1.548)**	**-3.633*** (0.941)**
Liquidity	+	**-0.853** (0.265)**	-0.728 (0.671)	**-0.945*** (0.247)**
National Productivity (GDP)	+	0.039 (0.028)	0.037 (0.026)	0.036 (0.027)
Defense Budget	-	-1.093	-1.184	-1.103

		(0.839)	(0.934)	(0.027)
Size (Sales)	+	**11.402*** **	22.254	**10.682*** **
		(3.350)	(14.752)	**(2.747)**
	R^2	0.073	0.057	0.098
	Adjusted R^2	0.063	-0.013	0.088

Significant at: *** 0.001, ** 0.01, • 0.1

These results point to some interesting findings. First, M&A spending increases with increased profitability (H1), solvency (H3), GDP, and firm size match their respective hypotheses and economic theory. As predicted in the hypothesis development section, efficiency (H4) and defense budget increases negatively impact M&A spending. It can be seen that not all variables were significant. Also, several had large standard errors, suggesting that some coefficients are not statistically different from zero. This is seen in the case of solvency, which has a p-value of 0.77 or higher in all models. If the significance is ignored, all estimates' signs match the hypotheses across modeling techniques, except for liquidity (H2). It appears as if efficiency has the strongest relationship with M&A spending. Although, profitability and liquidity can also be contributors depending on the modeling processes used.

Interestingly, liquidity (H2) had one of the greatest effects on M&A spending, yet the sign was the opposite of the expected result. While financial ratios have been used to analyze various industries, not much ratio analysis has been conducted in the defense industry. The defense industry may not give as much significance to liquidity due to its relationship with the DoD. For example, the defense industry may choose to place less weight on liquidity due to its relationship with its primary customer—the DoD. Evidence shows that the DoD offers subsidies to troubled contractors through research and development contracts, loan guarantees, tax breaks, and possible strategic selection for new contracts (Higgs, 1990). Knowing a contractor may have a fail-safe in the event of a near collapse, liquid assets may not be viewed as they would have been in markets without these subsidies.

Conclusion

This research investigated the relationship between a company's financial health and M&A spending. The study utilized common industry ratios to assess a company's profitability, solvency, liquidity, and efficiency as measures of financial health. Panel data regression models were employed, revealing a significant association between a company's efficiency and M&A spending, supporting Hypothesis 3. Although the regression models did not indicate a significant relationship between M&A spending and a company's profitability or solvency, the signs of the parameter estimates aligned with prior research and Hypotheses 1 and 3. However, the unexpected opposite sign on liquidity contradicted Hypothesis 4. The defense industry may perceive liquidity differently than the industries examined in previous studies.

While the primary focus of this study was not predicting future consolidation activities, the model's findings can provide indicators or warnings to DoD policymakers. These indicators enable more precise targeting of policies to promote or discourage consolidation. Additionally, insights can be gained regarding the impact of specific actions, such as budget reductions or contract awards, on M&As within the industry. The control variables used in this research, namely national productivity, defense budgets, and firm size, exhibited signs consistent with economic theory. Increased national productivity and firm size, along with decreased defense budgets, could contribute to increased M&A activity.

Future research can further enhance the model's specification by conducting a more comprehensive analysis of a company and the factors influencing its unobserved heterogeneity. This would help determine whether a fixed or random effects model should be utilized. Although

this study did not rule out the assumptions of either model, additional investigations can contribute to this determination.

Expanding the observation frequency from annual to quarterly financial reports could enhance the model's power. Broadening the sample beyond the GAO-identified contractors investigated in this study can augment the model's statistical power. During the initial data collection, uncertainties arose concerning the number of contractors that needed to be excluded due to their private status, ownership by larger companies, or unobtainable financial information.

Lastly, while some researchers have examined the financial performance of companies before and after M&A in other markets, limited research has been conducted within the defense sector. Although previous studies have provided fragments of the puzzle, a comprehensive assessment of defense contractors' performance before and after M&As remains elusive. Further exploration of this area is warranted to gain a holistic understanding of the dynamics involved.

This research demonstrates that companies with higher profitability and solvency, along with lower efficiency and liquidity, are more likely to engage in M&A spending. The findings hold implications for DoD policymakers, enabling more targeted policies, and shedding light on the influence of various actions, such as national productivity, defense budgets, and firm size, on industry consolidation. However, future research should delve deeper into the model specification, increase observation frequency, expand the sample size, and explore the financial performance of defense contractors in the context of M&A.

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