NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

THESIS

EXCESSIVE PROFITS OF GERMAN DEFENSE CONTRACTORS

by

Tom Neels

September 2014

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REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704–0188*
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.			
1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** September 2014	**3. REPORT TYPE AND DATES COVERED** Master's Thesis	
4. TITLE AND SUBTITLE EXCESSIVE PROFITS OF GERMAN DEFENSE CONTRACTORS			**5. FUNDING NUMBERS**
6. AUTHOR(S) Tom Neels			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			**8. PERFORMING ORGANIZATION REPORT NUMBER**
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB protocol number ____N/A____.			
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			**12b. DISTRIBUTION CODE** A

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14. SUBJECT TERMS defense contractor, defense industry, excessive profitability, Germany, industry-year-size match, profit, ROA, ROCE			**15. NUMBER OF PAGES** 85
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT Unclassified	**18. SECURITY CLASSIFICATION OF THIS PAGE** Unclassified	**19. SECURITY CLASSIFICATION OF ABSTRACT** Unclassified	**20. LIMITATION OF ABSTRACT** UU

NSN 7540–01-280-5500 Standard Form 298 (Rev. 2–89) Prescribed by ANSI Std. 239–18

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EXCESSIVE PROFITS OF GERMAN DEFENSE CONTRACTORS

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION

from the

NAVAL POSTGRADUATE SCHOOL
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LIST OF ACRONYMS AND ABBREVIATIONS

AG	Aktiengesellschaft; English translation: publically traded company
ARCADE	allied radiofrequency computer aided data exchange
BDSV	Bundesverband der Deutschen Sicherheits- und Verteidigungsindusrie e.V. English translation: federation of German security & defense industries
C4ISR	command, control, communications, computers, intelligence, surveillance, and reconnaissance
CAT	computer-aided testing
EBIT	earnings before interest and taxes
EC	European Commission
EU	European Union
FAR	Federal Acquisition Regulation (USA)
FASB	financial accounting standards board
GDP	gross domestic product
GmbH	Gesellschaft mit beschränkter Haftung English translation: limited liability company
GWB	Gesetz gegen Wettbewerbsbeschränkungen English translation: German act against restraints of competition
MR	size match ratio
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, and chemical
OMR	operating margin ratio
PMR	profit margin ratio
ROA	rate of return on assets
ROCE	rate of return on common shareholder's equity
SFAC	statement of financial accounting concepts of the FASB
SIC	standard industrial classification
VOL/A	Vergabe- und Vertragsordnung für Leistungen Teil A English translation: regulations on contract awards for public supplies and services-part A
WRDS	Wharton Research Database System at University of Pennsylvania

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ACKNOWLEDGMENTS

I thank my thesis advisor, Dr. Chong Wang, for his valuable work. He guided me through the process of writing this thesis, and used much of his time to provide helpful feedback. He was available any time I needed his advice and guidance. Without the effort and time he invested into our work, I would not have been able to do the research and writing of this thesis.

I also thank Dr. René Rendon, who was the second reader of this work. He provided valuable input for the research questions of this thesis. His suggestions helped to shape the direction of my work.

The faculty and staff of the Naval Postgraduate School, especially the Graduate School of Business and Public Policy, prepared me with the processes necessary to write this thesis in an exceptional way. I was impressed by the availability of every member of the faculty and staff, with whom I had the honor to work. Even on weekends and late at night I received answers to my requests. Thank You.

Special thanks go to my dear wife, Christine, who supported me throughout my time at NPS and during the process of writing this thesis. She was able to build up my confidence when I lost it, and kept me motivated at all times. By keeping burdens away from me, she created additional time for me to work on my thesis. Further, I could discuss my work with her and received constructive and valuable criticism.

Wharton Research Data Services (WRDS) was used in preparing this thesis. This service and the data available thereon constitute valuable intellectual property and trade secrets of WRDS and/or its third-party suppliers. No trade secrets or sensitive data, however, are revealed in this thesis.

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I. INTRODUCTION

Wang and San Miguel (2012) report that U.S. defense contractors earn excessive profits relative to their industry peers. This research focuses on investigating whether this major finding of Wang and San Miguel is generalizable in the international setting, or only unique to the United States. Specifically, this study assesses whether the German defense industry—one of the major competitors of the U.S. defense industry—makes excessive profits as their U.S. counterpart does.

The aforementioned research question is important for a few reasons. First, Germany is one of the major economies in the world. Measured by 2012 gross domestic product (GDP), Germany ranks the fourth in the world and the first in Europe. Specific to the defense industry, Germany is a major weapon producer. In 2012, the defense expenditure of Germany totaled €32 billion, ranking the third in Europe after UK and France.

The large-scale German economy and the material size of its defense industry warrant the significance, as well as the necessity, of this study. Additionally, a good understanding of the profitability of the German defense industry is critical for German decision makers to set up the export policy for the defense industry. Similar to the United States, the export of defense articles is heavily regulated by the German government. The goal of this regulation is to ensure that such exports do not undermine the basic interests of the country. For example, one such interest is to keep the state-of-the-art advanced technology within the control of the country, and off the hands of various enemies, including, but not limited to, hostile foreign countries, terrorists groups, and criminal organizations. Hence, it is natural to argue that strict export control is needed to protect national interest.

Overly strict export control, however, reduces the demand basis and increases per-unit production cost. The Federation of German Security and Defense Industries (BDSV), in representing the interests of all German security and defense industry businesses, has long argued that their industry needs exports in order to retain local jobs and maintain technological advantage. Therefore, it is essential for policy makers to understand profit levels the defense industry is making, and whether that level of profitability is sufficient to keep the industry sustainable. If defense industry businesses are earning excessive profits, then a tighter export control may be warranted. On the other hand, if defense industry profits are meager, then a less restrictive export control may become more suitable. To the author’s knowledge, little has been done regarding the profitability of the German defense industry. This research intends to fill this gap and provide useful implications to German tax payers and government. Finally, whether defense industry earns excessive profits is also an ethics issue. The excessive profits benefit defense contractors at the expense of taxpayers. Excessive profits are neither efficient nor ethical. Given the large magnitude of defense expenditure, the existence, as well as the scale of the excessive profits of defense contractors, should be brought to the attention of the public and the policy makers.

Using archived data from the Compustat database at the WRDS at University of Pennsylvania, we present scientific evidence to support the following main finding: similar to its U.S. counterpart, the German defense industry earns excessive profits relative to their German industry peers.

This thesis contributes to the literature in a few ways. First, this is the first study to extend the topic of excessive profits of defense contractors into a non-U.S. setting and hence presents the first piece of international evidence. Secondly, by documenting similar findings as Wang and San Miguel (2012), this study demonstrates that excessive profit of defense contractors is an international phenomena rather than an incident unique to the U.S. Finally, this study sheds some light on the similarities and differences between the U.S. and Germany on magnitudes and determinants of defense industry excessive profits.

The remainder of this thesis is organized as follows. Chapter II reviews literature and introduces the specific environments of German defense industry. Chapter III describes data and methodologies, and Chapter IV presents findings. Chapter V concludes.

II. LITERATURE REVIEW

A. PROFITABILITY AND EXCESSIVE PROFITS: DEFINITION AND MEASUREMENTS

This chapter reviews the literature about the definition and measurements of a firms' profitability and excessive profits that are essential to this study. Further, we discuss the research of Wang and San Miguel (2012), and introduce their major findings based on U.S. data.

1. Terms and Definitions

In order to achieve a better understanding of this thesis, some basic terms need to be defined. First, we define some statistical terms, which we use for our analysis. Next, the accounting terminology is explained.

The source for the definition of statistical methodology used for this thesis is the eighth edition of the textbook *Statistics for Management and Economics* by Gerald Keller (2009). This textbook provides an overview of statistical terms and methods that are especially useful for economic analyses, which are reported in this thesis. To explain the computation and interpretation of statistical data, the book uses many examples that are related to economical topics.

Statistics differentiate between data about a *population* and data from samples of this population. Keller defines a population as, "a group of all items of interest to a statistics practitioner. It is frequently very large and may, in fact, be infinitely large" (2009, p. 5). One goal of statistics is to come to an inference about the population using a descriptive measure called *parameter*. In our study, we use different parameters to describe excessive profits of defense contractors. Keller defines a sample parameter as, "a set of data drawn from a population" (2009, p. 5). In order to make an inference about a population, sample parameters are drawn from this population, because the examination of the population is usually very expensive or impossible.

To describe a population or a sample, measures of central location give a quick first impression about the data. We use the arithmetic mean and the median to describe the central location of our samples.

The terms *mean* and *arithmetic mean* are used interchangeably in this thesis. Keller provides Equation (1) to calculate the population mean (2009, p. 98).

$$\mu = \frac{\sum_{i=1}^{N} x_i}{N} \tag{1}$$

In Equation (1), μ is the mean of a parameter that describes the population, x_i is a single observation of this parameter, and N is the number of individuals, which make up the whole population. The calculation of the mean of a sample is very similar to the calculation of the population mean. Keller gives Equation (2) to calculate the sample mean (2009, p. 98).

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \tag{2}$$

In Equation (2), $\bar{x}$ is the mean of the sample, x_i are the single observations of the sample, and n is the number of observations in the sample. It is possible to infer from a sample mean to a population mean.

The second measure of central location used in this thesis is the *median*. Keller defines a median as, “calculated by placing all observations in order (ascending or descending). The observation that falls in the middle is the median” (2009, p. 99). The median is especially useful when single observations in a sample are extremely high or low, so that the mean gives a flawed impression of the central location of the sample.

In our analysis, we also use measures of variability. First, we use the minimum and the maximum of our observations. The *minimum* is the observation that has the smallest number. The *maximum* is the observation in the sample that has the highest number. Minimum and maximum give a good impression of the spread of our observations. Additionally, these numbers indicate whether we have to look for outriders, and determine their impact on our sample.

Another important measure of variability is the *standard deviation*. Keller defines the standard deviation as, "the positive square root of the variance" (2009, p. 110). To calculate the variance of a sample, Keller provides Equation (3) (2009, p. 107).

$$s^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1} \tag{3}$$

In Equation (3), s^2 is the variance of the sample, n is the sample size, x_i are the observed values of the sample, and $\bar{x}$ is the mean of the sample. Keller's definition of the standard deviation leads to Equation (4) for its calculation.

$$s = \sqrt{s^2} = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}} \tag{4}$$

In Equation (4), s, is the standard deviation of the sample.

The thirteenth edition of *Financial Accounting–An Introduction to Concepts, Methods, and Uses* by Clyde P. Stickney, Roman L. Weil, Kathrine Schipper, and Jennifer Francis (2010), is a useful source for the definitions of accounting terms and concepts. The textbook gives a brief overview of the basic principles of financial accounting, and helps the reader to understand and evaluate financial statements of publically-traded companies. Because this thesis primarily uses financial statement information to conduct analysis, many concepts used in this study are well defined in the book. According to Stickney et al. (2010), *profit* is defined as the difference between revenues and expenses to generate these revenues (p. 145). It is used interchangeably with the terms *net income* and *earnings*. According to Stickney et al. (2010, p. 145), the profit of a firm "reflects the change in net assets as a result of a firm's operating activities during an accounting period." Profit is measured over a defined period-of-time, known as the accounting period. This period-of-time is typically a quarter or a year. A publically-traded company reports its profit in the income statement.

"Revenues reflect the net assets (assets less liabilities) that a firm receives from its customers when it sells goods or renders services" (Stickney et al., 2010, p. 145). Revenues are measured for the same period-of-time as profit and are reported in the income statement of a company.

"Expenses reflect the net assets consumed in generating revenues" (Stickney et al., 2010, p. 145). As revenues and profit, expenses are reported in the income statement for a defined period-of-time.

Stickney et al. follows SFAC (statement of financial accounting concepts of the FASB) No. 6, and defines an asset as "probable future economic benefits obtained or controlled by a particular entity as a result of a past transaction" (2010, p. 841). Assets can be all types of tangible and intangible things that have an economic value, and there are current assets that can be transformed into cash within a short period-of-time. In contrast, fixed assets cannot be transformed into cash easily. Examples of fixed assets are a production plant or tools for the production. Assets are reported on the balance sheet, which reflects assets along with liabilities and shareholder's equity. Many ratios that are used to assess the profitability of companies relate profits to assets.

Common equity is defined as a common shareholder's equity on the balance sheet. In this thesis, the term *common equity* is used and defined in the same way as Stickney et al. (2010, p. 47). The stated value of common stock (i.e., book value) usually differs significantly from the price at which it is traded at the stock exchange (i.e., market value), but it is still often used to assess the profitability from common shareholders' perspective.

The term *profitability* is described as "a nontechnical term meaning the potential for, or actual earning of, net income" (Stickney et al., 2010, p. 897). Different measures of profitability are discussed in the following part of this thesis.

2. Measuring Profitability

For existing investors and owners of a company, it is of their interest to understand how much return they earn on their investments relative to alternative, forgone investment opportunities. Additionally, new investors want to know what companies are profitable candidates in which they can invest. Therefore, investors need to compare profitability across different companies. Financial ratios based on financial statements serve that purpose well, because they control the effects on magnitude of profits that stem from different company sizes. This study employs four different profitability ratios to compare the profitability of defense contractors with their non-defense contractor peers. Namely, these four ratios include Return on Assets (ROA), Return on Common Equity (ROCE), Profit Margin Ratio (PMR), and Operating Margin Ratio (OMR).

"The Rate of Return on Assets (ROA) measures a firm's performance in using assets to generate net income" (Stickney et al., 2010, p. 245).

In this study, Equation (5) is used to calculate ROA.

$$ROA = \frac{Net\_Income}{Total\_Assets} \tag{5}$$

As discussed previously, net income or profit is calculated for a period-of-time, while total assets are reported for a specific point in time. To calculate ROA, the total assets reported by the company at the end of the accounting period, for which the net income was reported, are used.

For shareholders who want to know how profitable their investment in a company is, the rate of return on common shareholder's equity (ROCE) is another interesting measure. In contrast to ROA, ROCE relates profit to common equity. In this study the ROCE is calculated using Equation (6). It "measures a firm's performance in using and financing assets to generate earnings" (Stickney et al., 2010, p. 257).

$$ROCE = \frac{Net\_Income}{Common\_Shareholder's\_Equity} \tag{6}$$

Because common shareholder's equity is reported on the balance sheet, it is only a snapshot at a point in time. Net income is reported for an accounting period. In the same way as discussed above for ROA, the common equity reported by the company at the end of the accounting period, for which the net income was reported, is used to calculate ROCE.

Another interesting measure for the profitability of a company is the profit margin ratio (PMR). This ratio indicates what percentage of the revenue (topline of the income statement) eventually becomes profit (bottom line of the income statement). Stickney et al. define the PMR as the “measures of a firm’s ability to control the level of expenses relative to sales, to increase the selling prices relative to the level of expenses incurred, or a combination of the two. By holding down expenses or increasing selling prices, a firm can increase the profits from a given amount of sales activity” (2010, p. 248). Equation (7) shows how the PMR is calculated in this thesis.

$$PMR = \frac{Net\_income}{Revenue} \tag{7}$$

The operating margin ratio (OMR) relates earnings before interest and tax (EBIT) to revenue. Stickney et al. define the *operating margin* as “revenues from sales minus cost of goods sold and operating expenses” (2010, p. 891). Compared to the PMR, the OMR is especially useful for the comparison of companies who pay different taxes and who have different methods to finance their assets. Equation (8) is used to calculate the OMR.

$$OMR = \frac{EBIT}{Revenue} \tag{8}$$

ROA, ROCE, PMR, and OMR are the ratios used in this study to compare German defense contractors with their non-defense contractor peers. Each ratio describes profitability from a different perspective. Additionally, ratios control for the size of the company because they relate absolute numbers to total assets or revenues, which are indicators of the size of a company.

3. Measuring Excessive Profitability of Defense Contractors: The Industry-Year-Size Matching Approach and Findings Based on U.S. Defense Contractors

Because this study uses the same methodology to measure excessive profitability as Wang and San Miguel (2012), this section discusses their paper. First, we describe the rationale, as well as the design of their industry-year-size matching approach to assess the defense contractors' excessive profitability. Next, we introduce their findings regarding excessive profitability of U.S. defense contractors.

Wang and San Miguel (2012) claim that some frequently used measures for defense contractors' excessive profitability are fundamentally flawed, because they often compare defense contractors' profitability with the profitability of a large group of firms often represented by popular indices like the S&P 500. They argue that, "it is meaningless to use a very broadly-defined index as the benchmark for inferring the defense contractors' normal profitability. The defense contractors (as a whole or as individual firms) and the broad market, are two different animals" (2012, p. 396). Further, they refer to earlier academic research (McGahan & Porter, 2002, pp. 834–851) that supports the following argument:

> Profitability is very industry-specific. Different industries have different risk exposures, competitions, and entry barriers, among many others. Therefore, given the wide industry representation of defense contractors, the correct benchmark for inferring defense contractors' normal profitability (and hence excessive profitability) must focus on the individual firm level. (Wang & San Miguel, 2012, p. 369)

Wang and San Miguel (2012) also cite McGahan & Porter 2002, pp. 834–851; Albuquerque, 2009, pp. 69–89; and Dechow, Hutton & Sloan, 1996, pp. 1–20, and argue that profitability varies across different years and depends on the size of a company. To reduce variation in profitability that is caused by effects from industry, firm year, and size, they introduced their new industry-year-size match to find benchmark firms for defense contractors. This method controls the three main reasons of differences in profitability and therefore, ensures that the remaining difference is very likely explained by the status of a company as defense contractor or non-defense contractor.

Another assumption of Wang and San Miguel is that a "significant contracting relationship continuity exists between the government and the defense contractors" (2012, pp. 396–397). This assumption allows the use of multiple years of data for the same defense contractor and hence, effectively increases the sample size. Using "fedspending.org" as the data source, Wang and San Miguel identified 112 publically traded companies from the 2008 list of "top 500 Department of Defense Contractors," and used their data for multiple years as a sample of defense contractors. Each company generates multiple firm-years depending on available financial accounting data. The Compustat database available from the WRDS at University of Pennsylvania is used to extract accounting data. Their search yielded 4,099 firm-years in a timeframe from 1950–2010. A benchmark firm-year for each sample firm-year was then identified.

> The benchmark firm-year is selected based on a three-dimension match on industry, year, and size. Specifically, we go to the same industry-year where industry membership is defined as four-digit SIC codes, and identify the non-defense (i.e., not on our 112-firm list) firm that has the best size match with our defense firm-year. The difference between the profit of the firm-year investigated and the profit of the benchmark firm-year will be the measure of "excessive profit." (Wang & San Miguel, 2012, p. 397)

Wang and San Miguel (2012) used statistical methods to show that U.S. defense contractors earn excessive profits relative to their industry peers. For their sample, they reported the mean of excessive ROA, ROCE, PMR, and OMR, respectively. Moreover, they conducted T-tests to demonstrate the statistical significance of their findings. The results based on ROA, ROCE, and PMR are statistically significant and show that profits of U.S. defense contractors are excessive. The findings based on OMR neither demonstrated higher nor lower profitability of defense contractors. A summary of Wang and San Miguel's findings is shown in Table 1.

Table 1. The excessive profitability of U.S. defense contractors (from Wang & San Miguel, 2012, p. 398, Table 5).

	N	Mean	Min	Max	Std Dev	t	P-value
Panel A: Size matched by Total Assets							
Excessive ROA (%)	3,809	1.12	-23.49	44.17	7.08	9.773	<0.0001
Excessive ROCE (%)	3,314	3.65	-143.64	175.57	25.73	8.083	<0.0001
Excessive PMR (%)	3,809	0.28	-31.82	74.56	7.87	2.223	0.03
Excessive OMR (%)	3,777	-0.09	-59.59	257.33	10.32	-0.52	0.60
Panel B: Size matched by Revenue							
Excessive ROA (%)	3,825	1.04	-21.89	44.37	7.29	8.803	<0.0001
Excessive ROCE (%)	3,246	3.71	-142.09	178.70	26.08	8.103	<0.0001
Excessive PMR (%)	3,825	0.45	-31.82	74.91	7.23	3.853	0.0001
Excessive OMR (%)	3,793	0.35	-48.23	69.29	7.80	2.772	0.0006

In addition to the investigation of the existence of excessive profits, Wang and San Miguel also found some determinants for their findings. First, they found that the magnitude of excessive profits increased after 1992 due to a consolidation of the defense industry beginning at that time. This consolidation led to a lower number of defense contractors in the United Stated and hence increased the bargaining power of the remaining companies. Second, they showed that “poorer quality of corporate governance measured by the duality of CEO and Chairman of the Board is positively associated with the excessive profits” (Wang & San Miguel, 2012, p. 402). Wang expanded his work in 2013 and demonstrated that, “in contrast to the prediction of ‘corruption hypothesis,’ the excessive profits are less (more) pronounced for those contractors with politically connected (non-connected) boards” (Wang, 2013, p. 426). Based on Wang’s and San Miguel’s findings, determinants for the magnitude of excessive profits are the bargaining power of defense contractors, corporate governance, and political connection of the board.

To summarize, profitability of different companies can be compared by using various ratios. In addition, we introduce the industry-year-size matching method to measure excessive profitability, which will be applied to German defense contractors in this study.

B. GERMAN DEFENSE CONTRACTORS AND THE REGULATORY ENVIRONMENT

In order to assess the results of this study, it is important to understand the German defense industry, defense contractors, and the German regulatory environment in which defense procurement is conducted. In this chapter, we first have a brief overview of the German defense industry and defense contractors servicing German Armed Forces; then we move on to introduce the regulatory environment and explain how defense contracts are awarded in Germany. The final part of this chapter provides basic statistics of, and the regulatory environment for, German defense exports.

1. The German Defense Industry and German Defense Contractors

We distinguish between German defense industry and German defense contractors. German defense contractors are those companies that have contracts with the German Ministry of Defense or the German Armed Forces. The German defense industry consists of companies based in Germany that produce armament, weapons, as well as equipment for command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR). It is important to realize that most companies of the German defense industry are also contractors of the German Armed Forces, but some contractors provide goods or services that are not typically defense or security oriented.

Next, we will describe the German defense industry, based on the IHS Jane's overview of the German defense industry (2014). We will then demonstrate that there are defense contractors who do not belong to the German defense industry in a narrow sense.

In its overview of the German defense industry, IHS Jane's (2014) states:

> Germany's defense industry comprises around 200 companies, with eight major players. The German defense sector employs a workforce of some 98,000 people with a further 120,000 employed with the industry's

suppliers and contractors. In 2011, the volume of goods produced by the German defense sector was EUR21.3 billion.

The major organization of the defense industry is the Federation of German Security and Defense Industries. According to this organization, "small and medium-sized companies (Mittelstand) account for more than half of the value created by the German security and defense industry" (IHS Jane's, 2014). Consistent with this fact, most of the German defense contractors are privately owned or have the legal status of a Gesellschaft mit beschränkter Haftung (GmbH). These companies usually do not publish financial statements. Only very few companies are publically traded and provide financial statements. This data limitation sharply reduces our sample size.

The German defense industry provides a broad base of technology products, including but not limited to aerospace, naval capabilities, tactical vehicles, main battle tanks, small arms and ammunition, and various areas of C4ISR systems. "Exports play a major role in the success of the German defense companies" (IHS Jane's, 2014). Besides other European countries, German defense technology is exported to countries in the Middle East, Asia, and Latin America (IHS Jane's 2014).

Despite the fact that the German defense industry is a major contributor to the contracting business of the German Armed Forces; some major contractors are not German companies. One example is the Airbus Group (former EADS), which is best described as a European company with its headquarters in the Netherlands and subsidiaries in Germany. Some U.S. companies, like Northrop Grumman, also have subsidiaries in Germany and are defense contractors for the German armed forces.

Some German armed forces contractors operate outside the typical area of the defense industry. For example, the Deutsche Bahn AG operates the German railroad network for the transportation of people and goods. The company formed a joint venture with the German ministry of defense, the Bw Fuhrparkservice GmbH, which provides civil cars to the German armed forces (BwFuhrparkservice GmbH, n.d.).

We have shown the difference between the German Defense industry and German defense contractors. This study focuses exclusively on German defense contractors who have their headquarters in Germany.

2. The Regulatory Environment for German Defense Contractors

This section summarizes the regulatory environment for German defense contractors and describes the defense budget and how defense contracts are awarded in Germany. First, the legal system for awarding contracts is discussed. Second, the practice of determining a fair and reasonable price for defense contracts is explained. The final part describes the German defense budget and how it relates to different kinds of defense contracts.

Several laws and regulations govern the awarding of public contracts in Germany. In addition, directives of the European Union apply. There is no single set of rules in parallel to the U.S. Federal Acquisition Regulation (FAR, 2014) in Germany. Some general policies are laid out in the German act against restraints of competition (2011, §97). These policies state that contracts shall be awarded "through competition and by way of transparent award procedures." Further, "the participants in an award procedure shall be treated equally." Since the German industrial base consists primarily of small and medium-sized companies, "the interests of small and medium-sized undertakings shall primarily be taken into account in an award procedure." The law further demands "skilled, efficient, law abiding and reliable undertakings" for the award of contracts. When offers are compared, "the economically most advantageous tender shall be accepted."

The term "economically most advantageous" is further defined in the regulations on contract awards for public supplies and services-part A (2009). It states that, "in the contract evaluation, all contractual considerations must be taken into account (e.g., price, technical, functional, formal, aesthetic aspects; customer service; follow-on costs; life cycle costs)" ("Regulations on contract," 2009, p. 44). Further, "the most economically advantageous tender is the one with the most favorable price-performance ratio" ("Regulations on contract," 2009, p. 48).

German and European laws distinguish among public invitations to tender, restricted invitations to tender, single tendering ("Regulations on contract," 2009, Article 3), open procedure, "restricted procedure, negotiated procedure, or competitive dialogue" ("Regulations on contract," 2009, Article 3 EC) to award contracts. The type of award is determined by the expected value of the contract and by the type of product or service procured. When the value of a contract exceeds €134,000 for public supply and service contracts, €207,000 for public supply and service contracts awarded by specifically defined contracting agencies (among them is the German Federal Ministry of Defense), and €5,186,000 for public works contracts, European law, especially the DIRECTIVE 2004/18/EC on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts, is applied (DIRECTIVE 2004/18/EC, 2013, Article 7 and ANNEX IV). These limits were last changed in 2013. The main implication of the European law is that contracts have to be solicited throughout all members of the European Union. The DIRECTIVE 2004/18/EC is implemented in the German law by the Regulations on Contract Awards for Public Supplies and Services–Part A ("Regulations on contract," 2013), in Section 2.

In general, there is a preference toward using public invitations to tender for contracts below the threshold amount, and the open procedure for contracts above the threshold amount. Under these two procedures, the request for proposal is published, and an unlimited number of proposals will be accepted and evaluated. The German contracting authority can only use other types of awards when designated in the regulations on contract awards for public supplies and services-part A (2009). In the case of a restricted invitation to tender or a restricted procedure, those who are interested in the contract may contact the contracting authority, but only a few contractors are asked to submit a tender. The contracting authority is not allowed to negotiate with bidders when they apply the procedure invitations to tender, the open procedure, and for the restricted procedure ("regulations on contract," 2009, Articles 15 and 15 EC).

Single tendering means that the contracting authorities "generally approach several selected enterprises to negotiate with one or more on the contractual terms and conditions" ("regulations on contract," 2009, Article 3). The DIRECTIVE 2004/18/EC

(2013, Article 1–11.d) defines negotiated procedures as, "those procedures whereby the contracting authorities consult the economic operators of their choice and negotiate the terms of contract with one or more of these." Competitive dialogue is a procedure for complex and only vaguely known requirements. DIRECTIVE 2004/18/EC (2013, Article 1–11.c) defines it as "a procedure in which any economic operator may request to participate and whereby the contracting authority conducts a dialogue with the candidates admitted to that procedure, with the aim of developing one or more suitable alternatives capable of meeting its requirements, and on the basis of which the candidates chosen are invited to tender."

To recap, the German and European laws emphasize competition in a similar way as the U.S. FAR. In Germany, the request for proposal must be designed in a way that takes the needs of small and medium-sized companies into consideration; however, there are no contracts for these companies that are set aside. In contrast, FAR subpart 19.5 describes that U.S. contracting authorities can award contracts exclusively to small businesses. For German defense contractors, this means that they have to prepare competitive proposals for a competitive market to get business from the government. In many cases, they face competition from other German companies and from European companies, which have to be treated equally by law.

The German law defines market-based pricing and different kinds of cost-based pricing for public contracts. According to §5 of the *Verordnung PR Nr 30/53 über die Preise bei öffentlichen Aufträgen* (Regulation PR No 30/53 on prices of public contracts; Verordnung PR Nr 30/53, 2010), the German regulation on prices of public contracts, cost-based prices are only allowed when no market-based price is available. When cost-based prices are used, the proposal must include a cost-based price calculation, which follows the rules that are defined in the appendix of Verordnung PR Nr 30/53.

Cost-based prices are classified into fixed-cost prices, target-cost prices, and cost-reimbursement prices. Fixed-cost prices are calculated before or directly after conclusion of the contract (Verordnung PR Nr 30/53, 2010, §6 (2)). A target-cost price is used when a fixed-cost price cannot be determined at the conclusion of the contract. It has to be changed to a fixed-cost price as soon as a fixed price can be calculated (Verordnung PR

Nr 30/53, 2010, §6 (3)). Cost-reimbursement prices are only allowed when it is impossible to use any other method to determine the price (Verordnung PR Nr 30/53, 2010, §7 (1)). This leads to a hierarchy of acceptable mechanisms to find prices. Market prices are preferred over cost based prices. Fixed-cost prices are preferred over target-cost prices, and target-cost prices are preferred over cost reimbursement prices.

In cost-based prices, profit is paid to reimburse the contractor for the general business risk and for special achievements in economic, technical, or organizational terms ("Leitsätze für die Preisermittlung," 2003, Nr 51). Within the German Ministry of Defense, the general business risk is calculated via the "Bonner Equation" (German Federal Office of Defense Technology and Procurement, 1989), shown in Equation (9):

$$G = 0.05 \times (Q + 1.5\frac{BNAV}{BNV}) \times E + 0.01 \times F \qquad (9)$$

In Equation (9), G is the profit, and Q is a factor that varies with the type of contract, as shown in Table 2. BNAV is the value of fixed assets of the contractor. BNV is the value of total assets of the company. E is the cost of the primary contractor, and F is the cost of material and subcontracted work packages.

Table 2. Factor Q for different types of contracts.

Type of contract	**Q**
Maintenance	0.70
Procurement of goods	1.05
Research and Development	1.10

The Bonner Equation shows how general business risk is compensated for contracts of the German Ministry of Defense. The contractor is allowed to mark up materials and subcontracted work by 1%, while the cost of its own work, risk adjusted for type of contracts, and the ratio of fixed assets to total assets, has a higher (5%) mark-up rate. Note that companies who invest more money into tangible assets get a higher compensation because a higher portion of fixed assets usually means a higher risk.

German laws do not allow any types of risk sharing between the contractor and the government. Profit is always calculated based on costs. Unless the price is calculated based on fixed costs before the contract is signed, the German government always bears the risk of rising costs. This leads to the implication that profits from contracts with the German government are pure savings for contractors.

Although Germany and the U.S. both have price-based and cost-based contracts, the methods differ significantly, especially for cost-based contracts. For example, the FAR allows several risk-sharing and incentive-driven tools, including, but not limited to, cost-plus-incentive fee and fixed-price incentive contracts, as described in FAR Part 16.4. These incentive contracts, which are not seen in current German practice, also motivate contractors to contain costs.

Next, we will discuss the German defense budget and its allocation toward German defense contracts. The German Defense Budget of 2013 was €33.26 Billion, about 11% of the total federal budget (German Ministry of Defense, 2012). Compared to 2012, it increased by €1.38 Billion. A major part of this budget was used for personnel, for example, €10.77 Billion was paid for active duty military and civilians, and €5.04 Billion was used to pay for retired soldiers and civil employees. Together, these two parts account for 47.5% of the defense budget. The operations and support budget contains €2.56 Billion for maintenance of materials, and €6.15 Billion for other expenses, which include fuel, rent, and the operating costs of military bases. €1.62 Billion was used for military services that are operated by external contractors or public private partnerships. Military investments account for €7.12 Billion or 21.4% of the budget. The German ministry of defense classifies the categories Research and Development (€0.93 Billion), military procurement (€5.12 Billion), military infrastructure (€0.93 Billion) and other investments (€0.15 Billion) as military investments. Expenditures for active duty and retired personnel are not available for defense contracts. These costs add up to €15.81 Billion. The rest of the German defense budget, €17.45 Billion, is available for different types of contracts. Figure 1 provides a graphical presentation of the German Defense Budget of 2013.

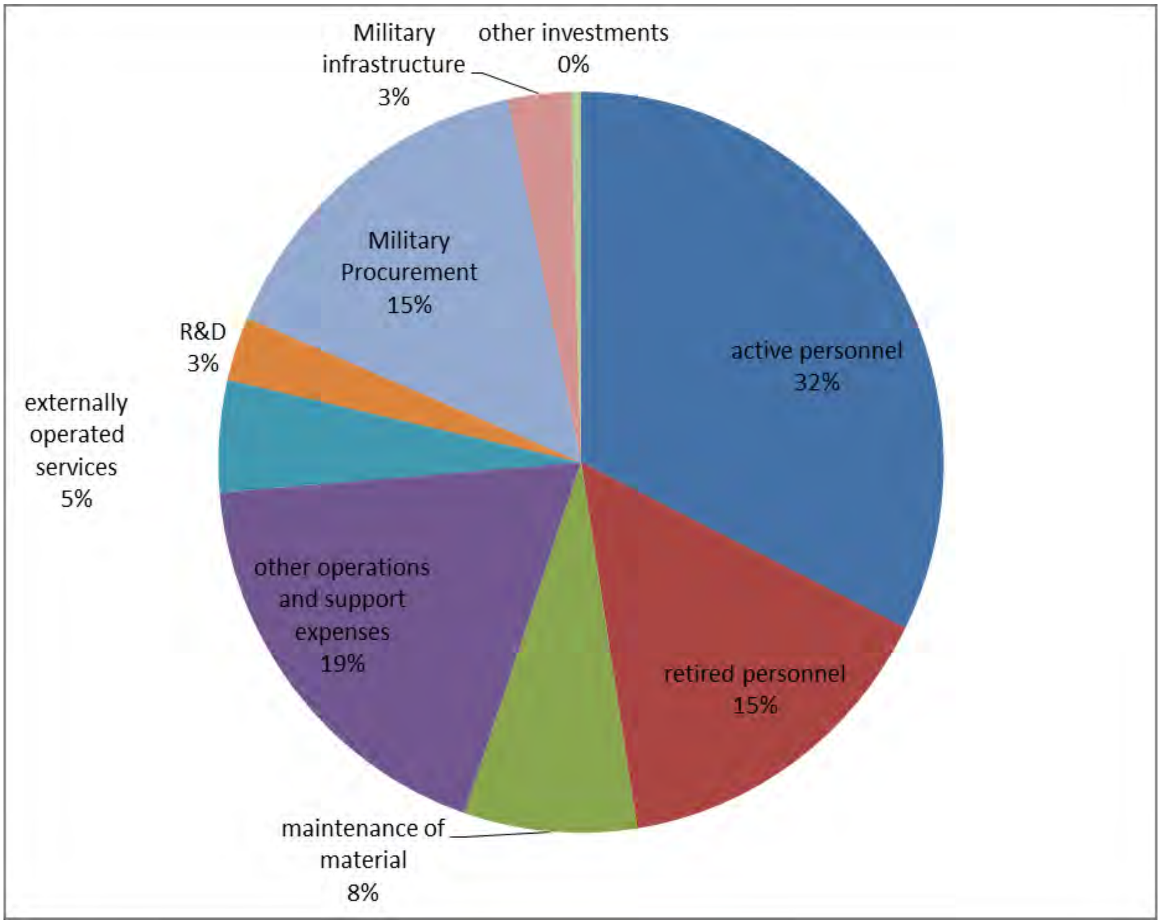

Figure 1. The German defense budget for 2013 (from German Ministry of Defense, 2012).

To summarize, German defense contractors face competition from the whole European Union, German defense contracting prices are determined through the hierarchy of acceptable mechanisms, and the German Defense Budget of 2013 included up to €17.46 Billion for defense contracts. This data provides a sufficient overview of the regulatory and business environment in which German defense contractors operate. The next section discusses regulations and statistics of German defense exports.

3. German Defense Exports

The German industry in general, and the German defense industry specifically, are both export oriented. According to the report on defense exports of the German federal government for FY 2013 (German Federal Ministry of Economic Affairs and

Energy, 2014), the German defense industry exported €933 Million of defense goods in 2013, a slight decrease from €946 Million in 2012. Moreover, the German government approved exports of defense goods worth €5.846 Billion, an increase from €4.704 Billion in 2012. The values of exported goods and approved exports differ because the time of the approval of the export and the time of departure of goods are not necessarily in the same year. Out of the total exports, only 33% went to EU, NATO, and allies, leaving 67% to other countries, of which the Republic of Korea (€274.7 Million), the United Arab Emirates (€102.3 Million), Algeria (€59.1 Million), and Singapore (€52.5 Million) were the major recipients. These numbers show that the German defense industry operates in a worldwide market. For instance, the €5.846 Billion of approved exports in 2013 was even more than the €5.12 Billion procurement budget of the 2013 defense budget. Hence, exports play a vital role in the German defense industry.

Regarding the approval process for defense exports, Article 26 (2) of the Basic Law for the Federal Republic of Germany (2010), the German constitution states that, "weapons designed for warfare may be manufactured, transported, or marketed only with the permission of the Federal Government. Details shall be regulated by a federal law." The Constitution deals with war weapons because it was written in the late 1940s, after World War II, and during the founding phase of West Germany. This is one of the precautions included in the Constitution to prevent the start of a new war from Germany. The spirit that guided the authors of the Constitution in the 1940s—to avoid another war like World War II—is still part of the German philosophy regarding defense. This philosophy exists in the German government, as well as in general public. The federal law, which regulates the details in Article 26 of the Basic Law, is the Gesetz über die Kontrolle von Kriegswaffen (2013) (English translation: war weapons control act). This law details what is meant by the term *war weapons*, and includes a list of those war weapons. In addition to this law, the foreign trade and payments act (2013) and the foreign trade and payments ordinance (2013) contain rules and regulations for the export of defense goods. The foreign trade and payments ordinance (2013) also includes a more detailed list of weapons, ammunition, and defense goods.

Defense exports are under tight political control in Germany. The first point of contact to apply for a permission to export war weapons is the federal foreign office. The application for the permission to export other armaments, which are mentioned in the foreign trade and payments act (2013), is submitted to the federal office of economics and export control. Depending upon the importance of the export and whether products that are legally classified as war weapons are involved, the application moves up the chain of command to the federal minister of economic affairs and energy or the federal minister for foreign affairs. Important deals—which are of high value or involve important technology—are decided by the Federal Security Council. The Federal Security Council is chaired by the Bundeskanzler, the head of the executive German government. In addition, members of the Federal Security Council include the ministers of the departments of foreign affairs, defense, economic affairs and energy, interior, justice, economic cooperation and development, and the head of the Federal Chancellery and Federal Minister for Special Tasks. This committee discusses the German security policy, its strategic direction, and approves defense exports. Meetings of this council are secret and happen unnoticed from the public (Behme, 2008).

To recap, exports of the German defense industry are subject to a high level of control and scrutiny, and are important to the sustainable growth of the German defense industry. Historically, the German government has been weighing national security interests against economic interests of the defense industry in decision making.

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III. DATA AND METHODOLOGY

A. DATA SOURCE

To conduct this research study, it was necessary to identify German defense contractors and analyze their financial statements. In this section, we will describe the process of identifying defense contractors as a sample, and then introduce how we obtain financial data for these contractors.

To be included in the sample, a company must be a publically-traded defense contractor that is headquartered in Germany. Publically-traded companies are obligated by law to publish financial reports, which make data readily available. In addition, public firms in the same country (i.e., Germany in this case) follow similar regulatory and legal environment, which makes data comparable. Limiting the sample to publicly traded firms—while desirable for reasons mentioned above—nevertheless significantly reduces the sample size. As shown in Chapter II, many German defense contractors are small and medium sized companies that are not publically traded and consequently are excluded.

Because no official defense contractor's list is available from the German government, alternative sources have to be used to identify defense contractors. For the purpose of this thesis, a request for data to the Federal Office of Bundeswehr Equipment, Information Technology, and In-Service Support was rejected. The German government and its agencies are not allowed to publish names of companies that contract with the German government. This is proprietary information of the companies and protected by German law. The starting point for identifying German defense contractors was an article by Boris Hänßler (2013) in his Internet blog www.robotergesetze.com. In this article, Hänßler describes the German defense industry and its economic significance to Germany. This article includes a list of companies that are part of the German defense industry, along with a short description of their defense-related products. Each company on his list was investigated for the availability of financial reports in the Compustat data base. This database provides historical fundamental data of companies (i.e., data from financial reports) and market data in a standardized format, which allows convenient data analysis. It is maintained and marketed by Standard & Poors Capital IQ and was accessed via WRDS. The next step was to find additional evidence regarding whether a particular company was a defense contractor. Sources for this evidence include publications by the company or equipment that is used by the German armed forces and produced by that company. The next section shows such evidence for each sample company.

Once the German defense contractors were identified, we extracted accounting data from financial reports. This data was conveniently available in the Compustat data base, which was accessed through WRDS at the University of Pennsylvania. In contrast to U.S. data, which is available from 1950 until today, data for international companies is only available from June 1987 until today. For this research, we use annual report data. We use country code DEU to identify a German company. This data was received as MS Excel spreadsheets. We then programmed macros to conduct the analyses.

B. THE SAMPLE

This section describes our sample of German defense contractors. First, a general summary is given, followed by basic statistics. Next, each sample company is described and qualification evidence is presented.

1. Summary of the Sample

Ten German defense contractors were identified for our research. The data of these companies are summarized in Table 3, and a short description of each company and its contractual relationship with the German Ministry of Defense is presented in the next section. As described in research by Wang and San Miguel (2012), we assume that contracting continuity exists between the German government and the defense contractors, which provides the use of multiple firm years when a contracting relationship is displayed. Table 3. shows the years for which financial data is available for each company of the sample. In total, we have 171 sample firm years. To demonstrate the size of each company, we display the total assets and revenue for each company in 2012. In 2012, company size in terms of total assets ranged from €27.6 Million to €162.978 Billion, and the revenue of the same firms in 2012 ranged from €29.8 Million to €114.3

Billion. These numbers show that our sample covers a wide range of different-sized companies.

Table 3. Sample of German defense contractors.

Company Name	available data years	No of years	SIC	Total Assets 2012 in Million €	Revenue 2012 in Million €
THYSSENKRUPP AG	1989 -2013	24	3300	38,284.0	40,124.0
Tognum AG	2004 -2012	8	3510	2,929.5	3,014.5
Renk AG	1989 -2013	24	3560	553.9	476.0
Daimler AG	1989 -2013	24	3711	162,978.0	114,297.0
Rheinmetall AG	1989 -2013	24	3711	4,899.0	4,704.0
MTU Aero Engines AG	2001 -2013	12	3724	4,261.9	3,378.6
OHB AG	2000 -2013	13	3760	535.7	625.2
Draegerwerk AG	1989 -2013	24	3841	2,101.2	2,373.5
Conet Technologie AG	2007 -2012	5	7370	36.3	95.9
LS Telcom AG	2000 -2013	13	7372	27.6	29.8
Totals		**171**			

Table 4. presents some basic statistics of the sample. In particular, we show mean, median, minimum, maximum, and standard deviation of ROA, ROCE, OMR, PMR, total assets, and revenue. The mean of ROA is 2.71%, while the mean of ROCE is 11.65%. The means of OMR and PMR are 4.18% and 1.68%, respectively. The number of total assets and revenue show that the size of the companies varies widely. Specifically, the mean and median difference is big, as is the standard deviation.

Table 4. Basic statistics of the sample of German defense contractors.

	ROA	ROCE	OMR	PMR	Total Assets in Million €	Revenue in Million €
Mean	2.71%	11.65%	4.18%	1.68%	24,120.47	21,763.33
Median	3.63%	13.11%	4.70%	3.72%	2,190.81	2,373.83
Min	-36.23%	-131.16%	-118.05%	-104.21%	6.31	6.37
Max	13.76%	276.37%	18.70%	10.45%	207,410.00	162,384.00
StdDev	6.54%	32.35%	11.05%	12.99%	50,007.93	40,958.26

The sample covers different industries. The industry is identified by the four-digit Standard Industry Code (SIC). Table 5. summarizes the industries' information, using the website www.siccode.com to define the SIC codes. The SIC code has a hierarchical structure, and to find the SIC industry matches we use the first two digits to describe a general industry sector, the third digit to refine the industry to a group, and the fourth digit to specify the business area. Table 5. contains descriptions of the two-digit, three-digit, and four-digit SIC codes of the sample. When the third and fourth digit is zero, the industry cannot be specified in further detail than by the first two or three digits of the SIC code.

Table 5. Description of the industries covered by the sample from SICCODE at www.siccode.com.

SIC code	Description of the industry	Frequency in sample
3300	Primary Metal Industry	1
3500	Industrial and Commercial Machinery and Computer Equipment	3
3510	Engines and Turbines	1
3540	Metalworking, Machinery and Equipment	1
3560	General Industrial Machinery and Equipment	1
3600	Electronic and other Electrical Equipment and Components, except Computer Equipment	1
3670	Electronic Components and Accessories	1
3674	Semiconductors and Related Devices	1
3700	Transportation Equipment	4
3710	Motor Vehicles and Motor Vehicle Equipment	2
3711	Motor Vehicles and Passenger Car Bodies	2
3720	Aircraft and Parts	1
3724	Aircraft Engines and Engine Parts	1
3760	Guided Missiles and Space Vehicle Parts	1
3800	Measuring, Analyzing, and Controlling Instruments; Photographic, Medical and Optical Goods; Watches and Clocks	1
3840	Surgical, Medical, and Dental Instruments and Supplies	1
3841	Surgical and Medical Instruments and Apparatus	1
7300	Business Services	2
7370	Computer Programming, Data Processing, and other Computer Related Services	2
7372	Prepackaged Software	1

2. Description of the Defense Contractors

This section describes the companies of our sample. We will give a short introduction of the business of each company and proof that the company is a defense contractor. In all cases, we use publications of the companies that indicate contracts with the German ministry of defense.

(1) Thyssen Krupp AG

The Thyssen Krupp AG is a traditional German company with its roots in the German steel business, which broadened its business over time. Currently, Thyssen Krupp is known for different technologies, which range from heavy industries to elevators. Thyssen Krupp Marine Systems, which is its business unit that is part of the business area Industrial Solutions, has three ship yards in Germany. On its website https://www.thyssenkrupp-marinesystems.com/de/, it shows pictures of different warships. Thyssen Krupp Marine systems produced submarines, frigates, and corvettes for the German navy. The latest ships that were purchased from Thyssen Krupp Marine Systems include the new class 125 frigates. A press release of Thyssen Krupp Marine Systems states that, "one third of four 125 class frigates for the German Navy was laid down today at the Hamburg site of Thyssen Krupp Marine Systems, a company of ThyssenKrupp Industrial Solutions" (Thyssen Krupp Marine Systems, 2014). This shows that Thyssen Krupp, along with its business unit Thyssen Krupp Marine Systems, is a German defense contractor.

(2) Tognom AG

Tognum AG owned the MTU Friedrichshafen GmbH before it was renamed into Rolls Royce Power Systems, which is now owned by Rolls Royce and Daimler. Rolls Royce Power Systems was formed in 2012. MTU Friedrichshafen provided engines for many ships of the German Navy and for German battle tanks, such as the Leopard I and Leopard II. MTU refers to the use of its engines in these battle tanks on its website www.mtu-online.com, and the company offers propulsion engines for navy ships. This data demonstrates that Tognum AG, along with its subsidiary MTU, is a German defense contractor.

(3) Renk AG

Renk AG is a producer of gear sets for marine vessels and other propulsion systems. Along with the German Navy, the U.S. Navy also uses Renk gear sets in their new Littoral Combat Ships. In one of its 2012 press releases, Renk AG refers to the new 125 class frigates of the German Navy, and shows the gear set of the ships (Renk AG, 2012). This demonstrates that Renk AG is a contractor of the German Navy.

(4) Daimler AG

The Daimler AG is one of the world's leading producers of cars, busses, and trucks. According to its website www.daimler.com, Daimler owns different brand names under which they distribute their products across the world. Besides Mercedes-Benz, Daimler also owns the brands Smart, Freightliner, Western Star, and Thomas Build Busses. The German Armed Forces use trucks produced by the Daimler AG in specialized military versions as well as civil versions. In 2012, Daimler received a contract to deliver 110 trucks to the German Armed Forces (Daimler Communications, 2012).

(5) Rheinmetall AG

Rheinmetall is one of the traditional producers of armored vehicles, large guns, and ammunition. Further, Rheinmetall is also a supplier of automotive parts to car producers. The German armed forces purchased several products from this company, the latest purchase being that of the infantry fighting vehicle Puma. In a press release, Rheinmetall stated that "by the end of 2020, the Bundeswehr will have taken delivery of 350—between 40 and 60 every year—of these armored vehicles to replace the MARDER" (Rheinmetall AG, n.d.).

(6) MTU Aero Engines AG

MTU Aero Engines maintains and produces engines for civil and military aircraft. Besides its own engines, the company also maintains engines produced by Rolls Royce and General Electrics for customers all over the world. In a 2012 press release, the celebration of 10 years of cooperation with the German Air Force is described. It is stated that MTU maintains the engines of the Eurofighter and the Tornado fighting jets for the German armed forces (MTU Aero Engines AG, 2012). This demonstrates that MTU Aero Engines is a German defense contractor.

(7) OHB AG

OHB is a producer of space systems and aeronautical products. On its www.ohb.de website, the company states that it is the largest German supplier for the European Ariane 5 rocket that is frequently used to carry cargo to an orbit around the earth. For the German armed forces, OHB develops satellites and other space technology. In a press release of 2013, the company states that it "signed a contract with the Federal Office of Equipment, Information Technology and In-Service Support of the Bundeswehr (BAAINBw) for the development and integration of the 'SARah satellite-based radar reconnaissance system" (OHB System AG, 2013). Hence, OHB is a German defense contractor.

(8) Drägerwerk AG

Dräger is a producer of protection and medical equipment for civil and military applications. They offer test sets for the police to detect driving under the influence of alcohol or drugs, protection equipment for individuals and groups against chemical and biological threats, equipment for divers, and equipment to monitor medical treatments of people. The German armed forces purchased their standard equipment for the protection of soldiers against nuclear, biological, and chemical (NBC) threats from Dräger. In a 2011 brochure, Dräger also shows other equipment that is used by the German armed forces (Drägerwerk AG, 2011).

(9) CONET Technologies AG

CONET Technologies provides consulting services, IT solutions, software engineering, and IT staffing services. According to a 2013 press release, CONET provides a Computer-Aided Testing (CAT) system to the German armed forces. This system is used for "the running of various psychological testing procedures and is currently in use at the German Armed Forces Bundeswehr" (CONET Technologies AG, 2013).

(10) LS telcom AG

LS telcom is a specialist of frequency management technology in ground-based and satellite communications. In 2006, the German armed forces awarded a contract to implement German systems into the NATO ARCADE system (LS telcom AG, 2006). Since LS Telcom still offers products for military applications, the assumption that this company is still a German defense contractor is justified.

C. STATISTICAL ANALYSIS

This section describes the statistical methodology used for data analysis. After extracting the accounting data from the Compustat database, we used the software Microsoft Excel 2010 to analyze them. To automate the process, we programmed macros with Microsoft Excel using Microsoft Visual Basic for Applications. The three steps used to analyze the data include: (1) extracting all data sets of the same industry from the raw data; (2) matching year and size to find industry-year-size matches for each sample year; and (3) comparing the profitability of each sample year with its match. The following subsections describe each step.

1. Matching the Industry

The first step is to group companies of the same industry. We use SIC to identify the industry. In different experiments, we use two-digit, three-digit, and four-digit SIC, respectively.

Naturally, the number of same-industry matches decreased when more digits were used because a higher digit SIC represents a more narrowly defined industry group. This decrease is even more pronounced in Germany, because many German companies are small and medium-sized firms, hence, are not publically traded. Additionally, Germany's economy is smaller compared to the United States. This leaves even fewer publically-traded companies in our sample, and the number of available matches decreases significantly once we pass two-digit SIC.

We extracted all companies that had the same SIC as the defense contractor, which was examined, to a new MS Excel spreadsheet. This new spreadsheet contained only companies of the same industry and was used for further analysis. To ensure that the benchmark firms were non-defense contractors, we manually deleted other defense contractors from the resulting spreadsheet. The first step of our analysis, to match the industry, was complete.

2. Matching Year and Size

To identify a match between the two companies—one is our sample firm that is a defense contractor, and the other is the benchmark firm that is used to infer our sample firm's normal profit in the absence of defense contracts—the fiscal years that are compared must be the same. In addition, the size measure of both companies must be as close as possible. Hence, the next step is to sort the data in the spreadsheet generated in the first step by fiscal year and size measure.

Size measures were either total assets or total revenues. These were the same measures that were used by Wang and San Miguel (2012). We analyzed the results for companies matched by total assets and revenues separately. In addition, different methods to identify the closest match in size were used. We used the next smaller, the next bigger, the absolute difference, or a ratio to identify the closest match.

To identify the next smaller company as our sample firm's benchmark firm, we used the company that had the next smaller number in total assets or revenues, depending on the actual size measure. When there was no smaller company in the fiscal year, no match was found for the sample firm, and the data set of that fiscal year of the sample firm was not used for further analysis.

Similarly, the next bigger company was identified. The company that had the next bigger number in terms of revenue or total assets was used for further analysis. When no bigger company existed for the fiscal year, the data set of the sample firm was not used for further analysis.

The absolute difference criterion refers to the comparison of the size difference between the next bigger company and the sample firm with the size difference of the next smaller company to the sample firm. The company that yielded the smallest absolute number for this difference was chosen to conduct further analysis. When only a bigger company but no smaller existed for the fiscal year, the bigger company was chosen. Similarly, the smaller company was chosen as the best size match when only a smaller but no bigger company was identified for a fiscal year. When neither a smaller nor a bigger company existed, the data set of the sample firm for that fiscal year was not used for further analysis.

The ratio comparison of company size compares the relative size of two companies. The two ratios of size measures that are compared to each other are shown in Equation (10) and Equation (11). Note that the bigger company is always in the numerator and the smaller company goes to the denominator.

$$Ratio\_1 = \frac{Size\_Measure\_next\_bigger\_company}{Size\_Measure\_sample\_firm} \tag{10}$$

$$Ratio\_2 = \frac{Size\_Measure\_sample\_firm}{Size\_Measure\_next\_smaller\_company} \tag{11}$$

The benchmark company is the one that yields the smaller ratio. When only a smaller or only a bigger company existed for one fiscal year, this company was automatically chosen as the best size match. When neither a bigger nor a smaller company existed, the data of the sample firm for that fiscal year was not used for further analysis.

The ratio measure is especially useful when there are huge size differences between companies. Consider the case where a sample firm has total assets of €100 Million, while the next bigger company reports total assets of €250 Million, and the next smaller company reports total assets of €2 Million. Using the minimum absolute difference matching would yield a €98 Million difference for the next smaller company and €150 Million difference for the next bigger company. Hence, the next smaller company (i.e., €2 Million firm) would be chosen as the best size match, while common sense would indicate that the €250 Million company should be a better choice. Using the lower ratio approach would avoid this problem because the sample firm was 50 times as big as the next smaller firm, while the next bigger firm was only 2.5 times as big as the sample firm. Hence, the next bigger firm would be used as the best size match because its size ratio was smaller compared to the size ratio of the next smaller company. Therefore, the ratio is a better method for the comparison of size when huge differences in size are present, which was the case for the German setting.

In order to assess the quality of the size match, we introduce the size match ratio MR, which indicates the relative size of the next bigger company to the next smaller company, as defined by Equation (8). A smaller MR indicates a better size match, while a higher MR indicates a poorer size match. MR is always larger than 1.0 because the bigger number is divided by the smaller number.

$$MR = \frac{size\_measure\_bigger\_company}{size\_measure\_smaller\_company} \tag{12}$$

Once the industry-year-size matches for a sample firm were identified for each available fiscal year, the data sets of the sample firm were combined with the chosen match and copied to a new spreadsheet. Next, the profitability measures ROA, ROCE, PMR, and OMR were calculated for the sample firm and the matching firm.

3. Comparison of Profitability

To calculate the excessive profits for each sample firm-year, the profitability measures of the matching firm-year was subtracted from the same profitability measure of the sample firm-year. A positive value for this difference means that the sample firm achieved a better profitability in the fiscal year compared to the matching firm. A negative value is interpreted as a better performance by the matching firm.

When all available industry-year-size matches for all sample firms were identified, the next step was to consolidate the data of all sample firm-years. These consolidated data were analyzed statistically by calculating the mean, median, standard deviation, minimum, and maximum of the difference between the profitability measures.

As described in Keller (2009, pp. 382–391), t-tests were used to explore the statistical significance of our findings. We used a one-tailed t-test to investigate whether the population mean μ of the excessive profits based on each profitability measure was zero, which indicated that German defense contractors did not earn excessive profits, or larger than zero, which indicated that German defense contractors did earn excessive profits. The null hypothesis H0 and the alternative hypothesis H1 are shown in Equations (13) and (14).

$$H_0 : \mu_0 = 0 \tag{13}$$

$$H_1 : \mu_1 > 0 \tag{14}$$

Equation (15) displays the calculation of the t value for the t-test (Keller, 2009, p. 383).

$$t = \frac{\bar{x} - \mu}{s / \sqrt{n}} \tag{15}$$

In Equation (15), $\bar{x}$ is the arithmetic mean of the sample, μ is the population mean as defined by the null hypothesis shown in Equation (13), s is the standard deviation of the sample, and n is the sample size. When t was calculated, the p-value was identified as the area right to t under the curve of the student t-distribution. We used ν = n-1 degrees of freedom for that purpose. Keller defines "the p-value is the probability of observing a test statistic at least as extreme as the one computed given that the null hypothesis is true" (2009, p. 353). When this definition is applied to the object of this thesis, a high p-value would indicate that the null hypothesis H0 cannot be rejected, which does not mean that it is accepted. When the p-value is low, the null hypothesis H0 has to be rejected in favor of the alternative hypothesis H1, which means that there is statistical evidence that German defense contractors earn excessive profits. The p-value was identified using the MS Excel 2010 spreadsheet function T.DIST.RT (t, ν). The statistical significance of our findings was determined by interpreting the p-value as shown in Table 6.

Table 6. Interpretation of the p-value (from Keller, 2009, p. 355, Figure 11.6.)

p-value	**Statistical Interpretation**
$p > 0.1$	there is **no statistical evidence** for a better performance by German defense contractors
$0.05 < p < 0.1$	there is **weak statistical evidence** for a better performance by German defense contractors
$0.01 < p < 0.05$	there is **strong statistical evidence** for a better performance by German defense contractors
$p < 0.01$	there is **overwhelming statistical evidence** for a better performance by German defense contractors

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IV. FINDINGS

The methodology that was applied for this research was described in Chapter III. This chapter presents the findings. First, the numerical results are shown in Section A. Section B gives the statistical interpretation of the numbers presented in the first section. Section C evaluates the economic significance of our findings. The final Section D compares the findings for German defense contractors with Wang and San Miguel's (2012) findings for U.S. defense contractors.

A. NUMERIC RESULTS

This section presents the numeric results of our experiments. The findings based on two various profitability measures (i.e., ROA, and ROCE) are reported in subsequent subsections, respectively. For each of the two individual profitability measures, we have three specifications for the industry matching method (i.e., two-digit, three-digit, and four-digit SIC code), two size measures, (i.e., revenue and total assets), and four criteria to determine the best size match as described in Chapter III.C.2. We use tables to show the numeric results.

1. Numeric Results for ROA

Our findings for the rate of return on assets (ROA) are shown in Tables 7, 8, and 9 (corresponding to two-digit, three-digit, and four-digit SIC code, respectively), with Panel A (Panel B) of each table presenting the results for the scenario where size is measured by total assets (revenues). Within each panel, there are four columns reporting the results for four different criteria to determine the best size match of a company. These four criteria are next smaller, next bigger, the closest in size, and the smaller ratio (please refer to Chapter III.C.2). Under each column, we report the basic statistics for excessive ROA across our sample, where the excessive ROA is defined as the difference in ROA between a sample defense contractor firm and its industry-year-size matched firm. Mean and median show the central tendency of the difference in ROA. The minimum, maximum, and standard deviation are used to present the spread of the data. The sample size n demonstrates how many matches were actually found, when the special method of determining the industry-year-size match was used. The p-value shows the statistical significance of the hypothesis test that is discussed in Chapter III.C.3.

Table 7 shows that, when the company size is determined by total assets, the mean of excessive ROA ranges from 1.44% to 3.80%, depending on the method used to determine the best size match. The p-value of the t-tests ranges from 0.0075 to 0.0967. When revenues are used to determine the company size, the mean of excessive ROA of the defense contractors ranges from -0.13% to 1.31%. The p-values for the t-tests range from 0.1962 to 0.5569.

Table 7. Numeric results for excessive ROA using the two-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Excessive ROA, company size is determined by Total Assets				
Mean	**2.36%**	**3.80%**	**1.92%**	**1.44%**
Median	0.08%	1.27%	0.32%	-0.005%
Minimum	-30.30%	-35.42%	-35.42%	-35.42%
Maximum	69.74%	43.46%	43.46%	43.46%
Standard deviation	13.31%	12.93%	11.74%	10.99%
sample size n	100	72	100	100
p-value	**0.0395****	**0.0075*****	**0.0525***	**0.0967***
Panel B: Excessive ROA, size is determined by Revenue				
Mean	-0.13%	1.31%	0.48%	-0.03%
Median	-0.13%	0.40%	-0.13%	-0.36%
Minimum	-34.83%	-33.55%	-27.75%	-27.75%
Maximum	23.22%	57.54%	26.18%	26.18%
Standard deviation	9.21%	12.90%	8.97%	9.06%
sample size n	98	72	99	99
p-value	0.5569	0.1962	0.2998	0.5146
* indicates 10% significance level; ** indicates 5% significance level; *** indicates 1% significance level				

For the size measure total assets, Table 8 displays values between 0.16% and 1.36% for the mean of excessive ROA, depending on the method used to determine the best size match. The p-values range from 0.0839 to 0.4497. When revenues is used to determine the company size, the mean of excessive ROA ranges from -0.07% to 1.54%. The p-values of the hypothesis test range from 0.2431 to 0.5294.

Table 8. Numeric results for excessive ROA using the three-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Excessive ROA, company Size is determined by Total Assets				
Mean	1.36%	**3.41%**	0.16%	0.32%
Median	-0.49%	0.11%	-0.19%	-0.19%
Minimum	-28.34%	-35.42%	-35.42%	-35.42%
Maximum	69.74%	50.75%	43.46%	43.46%
Standard deviation	14.30%	15.94%	10.83%	10.55%
sample size n	73	43	73	73
p-value	0.2096	**0.0839***	0.4497	0.3996
Panel B: Excessive ROA, company Size is determined by Revenue				
Mean	0.61%	1.54%	-0.07%	0.19%
Median	0.40%	14.59%	-0.13%	-0.15%
Minimum	-27.75%	-33.55%	-27.75%	-27.75%
Maximum	31.75%	50.75%	31.75%	34.86%
Standard deviation	7.68%	14.59%	7.95%	8.95%
sample size n	72	44	72	72
p-value	0.2527	0.2431	0.5294	0.4295
* indicates 10 % significance level				

As shown in Table 9, the difference between ROA ranges from -2.01% to 0.47% when the company size is determined by total assets. The p-values range from 0.4282 to 0.9381. The mean of excessive ROA ranges from -0.16% to 1.28% when revenues is used to determine the company size. The p-values range from 0.3144 to 0.5451.

Table 9. Numeric results for excessive ROA using the four-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Excessive ROA, company size is determined by Total Assets				
Mean	-0.56%	0.47%	-2.01%	-1.86%
Median	-0.80%	-0.95%	-0.87%	-1.10%
Minimum	-69.45%	-35.42%	-35.42%	-35.42%
Maximum	82.94%	50.75%	38.75%	38.75%
Standard deviation	16.54%	16.78%	11.04%	11.96%
sample size n	73	43	73	73
p-value	0.6125	0.4282	0.9381	0.9062
Panel B: Excessive ROA, company Size is determined by Revenue				
Mean	-0.16%	1.28%	0.13%	0.33%
Median	-0.13%	-1.00%	-0.13%	-0.73%
Minimum	-69.45%	-39.16%	-30.18%	-30.18%
Maximum	40.95%	67.32%	67.32%	67.32%
Standard deviation	12.34%	17.44%	11.66%	12.17%
sample size n	73	44	73	73
p-value	0.5451	0.3144	0.4608	0.4082

2. Numeric Results for ROCE

This subsection presents the numerical results of our analysis for return on common shareholder's equity (ROCE). Tables 10, 11, and 12 parallel Tables 7, 8, and 9, except that we change the profitability measure from ROA to ROCE.

Panel A of Table 10 shows that the mean of excessive ROCE ranges from -10.81% to 17.70% when the company size is determined by total assets. Depending on the method that was used to determine the best size match, the p-values range from 0.0007 to 0.0133. The mean of the difference between ROCE ranges from 6.72% to 31.84% when revenues is used to determine the company size. The p-values of the t-test range from 0.0924 to 0.1217. The maxima for the three size matching methods next bigger company, minimum absolute difference, and smallest ratio have an extreme value of 1668.09%. This value stems from the comparison of the defense contractor Renk AG with its peer company NORDEX SE in the fiscal year 2004. The size match ratio MR for this example is 1.031, which means that, in terms of revenue, NORDEX was only 3.1% larger than Renk. This is a good size match; but the profitability measure ROCE differs significantly.

Table 10. Numeric results for excessive ROCE using the two-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Excessive ROE, company size is determined by Total Assets				
Mean	**13.53%**	**17.70%**	**11.84%**	**10.81%**
Median	4.50%	6.96%	4.33%	3.46%
Minimum	-128.42%	-41.86%	-128.42%	-128.42%
Maximum	378.01%	263.20%	264.96%	264.96%
Standard deviation	60.11%	44.95%	46.85%	46.56%
sample size n	100	71	99	99
p-value	**0.0133****	**0.0007*****	**0.0068*****	**0.0115****
Panel B: Excessive ROCE, company size is determined by Revenue				
Mean	**6.72%**	**31.84%**	21.72%	20.34%
Median	4.01%	0.30%	3.46%	1.02%
Minimum	-152.71%	-39.99%	-152.71%	-152.71%
Maximum	264.96%	1668.09%	1668.09%	1668.09%
Standard deviation	49.84%	201.62%	172.40%	172.48%
sample size n	98	71	99	99
p-value	**0.0924***	**0.0938***	0.1065	0.1217
* indicates 10% significance level; ** indicates 5% significance level; *** indicates 1% significance level				

As shown in Table 11, the mean of the difference between ROCE ranges from 6.75% to 10.91% when the company size is determined by total assets. The p-values of the t-tests range from 0.0071 to 0.0646. When revenues are used to determine the company size, the mean of excessive ROCE ranges from 4.46% to 6.45%. The p-values range from 0.0959 to 0.1630.

Table 11. Numeric results for excessive ROCE using the three-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Excessive ROCE, company size is determined by Total Assets				
Mean	**9.76%**	**10.91%**	**5.72%**	**6.75%**
Median	2.90%	2.55%	3.05%	2.99%
Minimum	-102.04%	-41.86%	-46.10%	-41.86%
Maximum	378.01%	146.76%	112.77%	112.77%
Standard deviation	54.30%	36.56%	22.88%	22.79%
sample size n	73	42	72	72
p-value	**0.0646***	**0.0301****	**0.0187****	**0.0071*****
Panel B: Excessive ROCE, company size is determined by Revenue				
Mean	**6.03%**	5.52%	4.46%	**6.45%**
Median	4.32%	-0.01%	2.73%	2.73%
Minimum	-156.00%	-39.99%	-156.00%	-156.00%
Maximum	205.31%	146.76%	205.31%	205.31%
Standard deviation	39.36%	33.77%	39.82%	41.56%
sample size n	72	43	72	72
p-value	**0.0990***	0.1449	0.1630	**0.0959***
* indicates 10% significance level; ** indicates 5% significance level; *** indicates 1% significance level				

Table 12 demonstrates that the mean of the difference between ROCE ranges from 1.27% to 6.28% when the company size is determined by total assets. The p-values of the t-tests range from 0.0995 to 0.3470. The mean of excessive ROCE ranges from -2.84% to 5.43% when revenues are used to determine the company size. The p-values range from 0.1230 to 0.6179.

Table 12. Numeric results for excessive ROCE using the four-digit SIC code to match the industry.

Best match by	Next smaller company	Next bigger company	Minimum Absolute difference	Smaller Ratio
Panel A: Company Size is determined by Total Assets				
Mean	**6.28%**	4.36%	1.27%	2.71%
Median	1.24%	-2.09%	1.24%	1.24%
Minimum	-113.83%	-93.23%	-93.23%	-93.23%
Maximum	206.49%	146.76%	112.77%	116.44%
Standard deviation	41.09%	43.17%	27.49%	30.21%
sample size n	72	43	73	73
p-value	**0.0995***	0.2558	0.3470	0.2232
Panel B: Company Size is determined by Revenue				
Mean	5.00%	5.43%	-2.84%	5.81%
Median	2.09%	-1.84%	1.25%	0.30%
Minimum	-589.53%	-51.37%	-589.53%	-156.00%
Maximum	492.69%	146.76%	205.31%	205.31%
Standard deviation	101.22%	37.17%	80.55%	42.44%
sample size n	73	44	73	73
p-value	0.3370	0.1689	0.6179	0.1230
* indicates 10% significance level				

B. STATISTICAL SIGNIFICANCE

This section discusses the statistical significance of the numerical results, which were presented in Section A of this chapter. First, the quality of the sample and of the size match will be discussed. The following subsections show the statistical interpretation of the numerical results for ROA, ROCE, and other profitability measures. Last, our statistical interpretations are summarized.

1. Sample Size and Quality of the Size Matches

In this subsection, we demonstrate how the use of a four-digit, three-digit, or two-digit SIC to match the industry affected our sample size and the quality of the size match criterion.

The use of the three-digit and four-digit SIC to determine the industry match reduces the sample size significantly. Table 13 demonstrates that using three-digit or four-digit SIC sharply reduces sample size by 27 or 27%. This reduction of the sample size reduces the power of the hypothesis test significantly. The power of the test is defined as the ability to correctly reject the null-hypothesis. Less power means that it is less likely that the null-hypothesis is rejected even though the alternative hypothesis is true; so when we go to higher digits SIC, we lose samples, and the power of the test suffers accordingly.

Table 13. Number of identified matches by different industry matching methods.

Size determination method	**Number of found matches using**		
	two-digit SIC	**three-digit SIC**	**four-digit SIC**
Total Assets, absolute difference	100	73	73
Total Assets, ratio	100	73	73
Revenue, absolute difference	99	73	73
Revenue, ratio	99	73	73

In order to determine the quality of the size match in our sample, we used the Size Match Ratio MR as defined in Chapter II.A.3. We used the percentage of observations that fall into the defined ranges of MR to normalize the numbers and to neutralize effects from different sample sizes. Figures 2, 3, 4, and 5 show the distribution of the identified matches for different ranges of MR. For all industry matching methods; more than 50% of all identified matches are smaller than two. This means that the majority of the matches used for our study are good size matches. When more digits of the SIC are used to determine the industry match, the percentage of observation that have a MR that is larger than 10 increases significantly. This undermines the size dimension of the industry-year-size match for those matches.

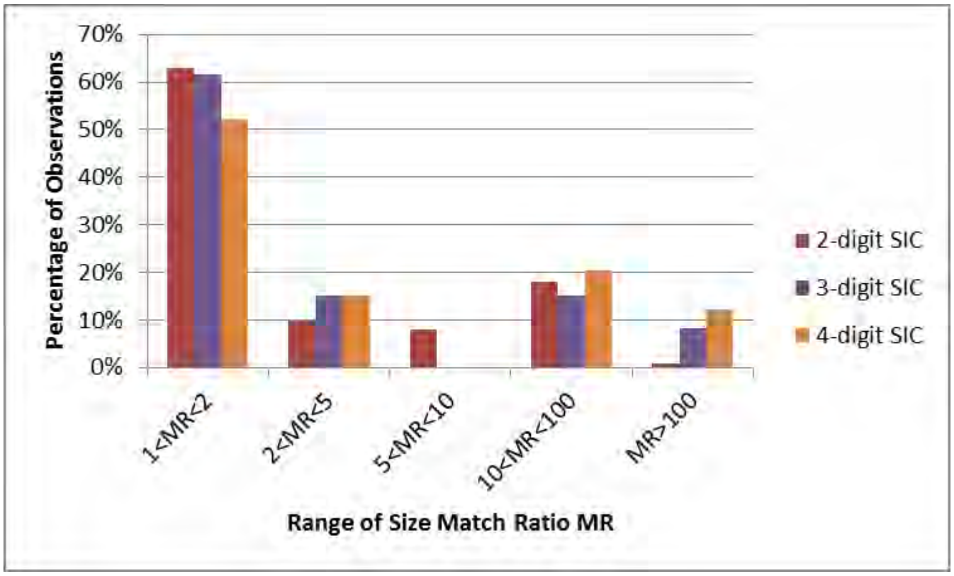

Figure 2. Size Match Ratio for the different industry matching methods, the company size was determined by Total assets using the absolute difference to determine the best size match.

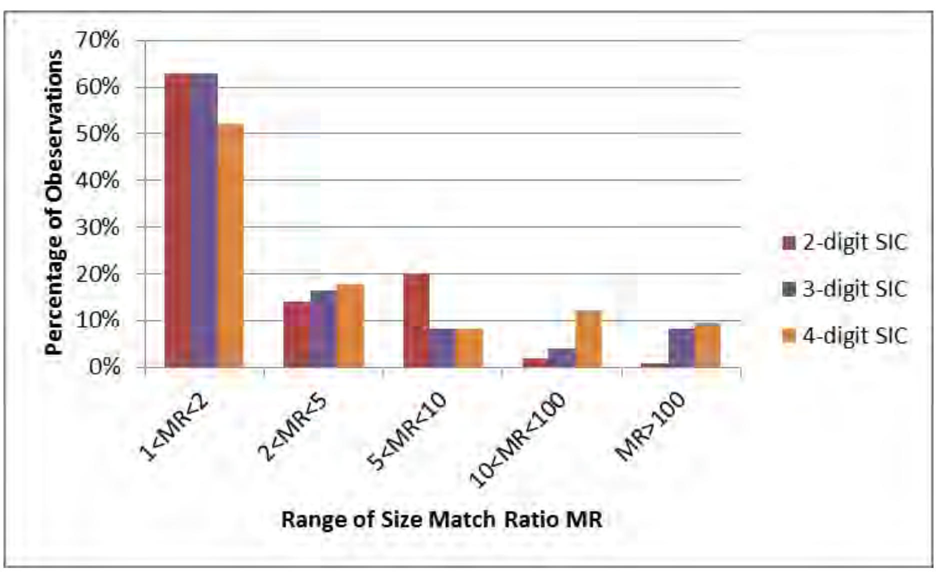

Figure 3. Size Match Ratio for the different industry matching methods, the company size was determined by Total assets using the ratio method to determine the best size match.

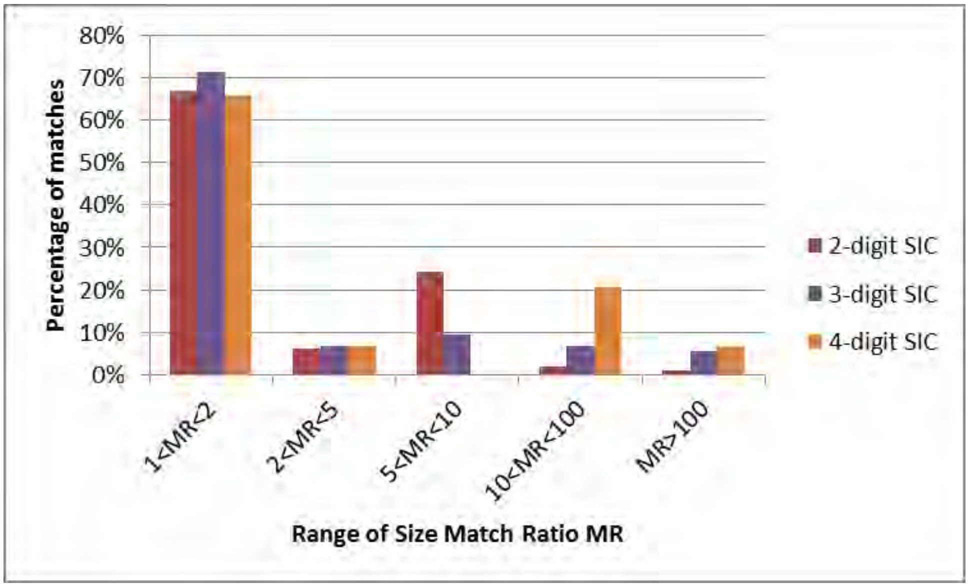

Figure 4. Size Match Ratio for the different industry matching methods, the company size was determined by revenue using the absolute difference to determine the best size match.

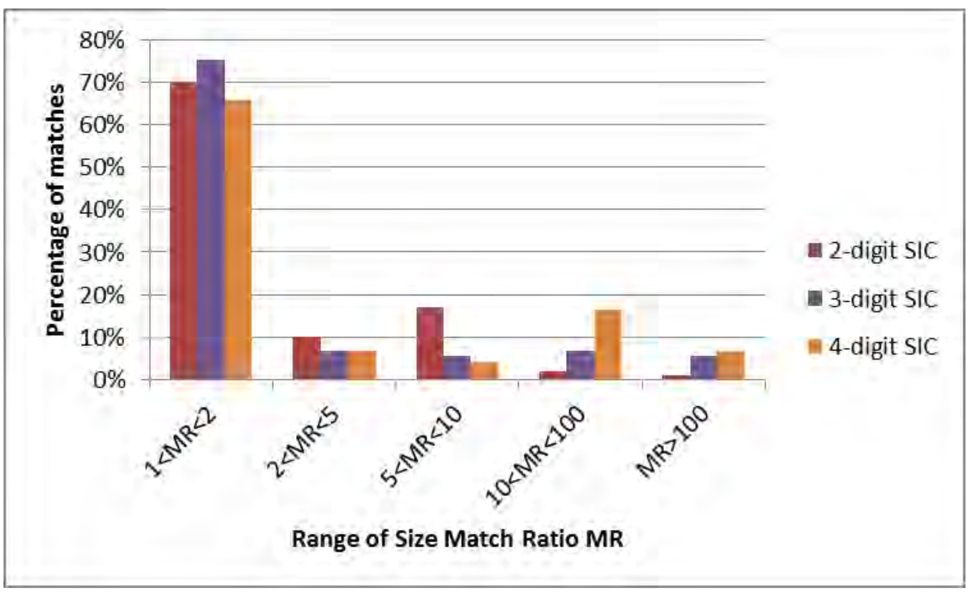

Figure 5. Size Match Ratio for the different industry matching methods, the company size was determined by revenue using the ratio method to determine the best size match.

For the German setting, the two-digit SIC code is the best method to determine the industry match dimension of the industry-year-size match because the sample size is bigger and the quality of company size matches is best. As shown above, the sample size significantly decreases when more than two digits of the SIC are used to determine the industry. In addition, a higher percentage of matches has a size match ratio that is larger than 10. Using more than two digits of the SIC to determine the industry match reduces the power of the hypothesis test and undermines the size match dimension of the industry-year-size match method to find benchmark firms for defense contractors.

2. Statistical Interpretation of the Numeric Results for ROA

This subsection statistically interprets the numeric results for ROA, which were presented in Section A.1 of this chapter. First, the findings for ROA when the first two digits of the SIC were used to define the industry match are shown. Next, the findings when the first three digits of the SIC were used are interpreted. Last, the numbers of the results when the four-digit SIC was used to define the industry are discussed. A short summary concludes this subsection.

As shown in panel A of Table 7, the mean for the difference between ROA of German defense contractors and their benchmark firms is larger than zero for all methods to define the best size match when the company size is determined by total assets. The median is also larger than zero or, when the ratio method was used to define the best size match, very close to zero. This shows that, on average, German defense contractors earn more profits as measured by ROA when total assets is used to determine the company size.

This finding is supported by the t-test. When the next bigger company is used as the best size match, the p-value of 0.0075 shows that there is overwhelming statistical evidence that German defense contractors earn better profits compared to their industry peers. The null-hypothesis, which states that there is no difference in the profitability of German defense contractors compared to their industry peers, is rejected in favor of the alternative hypothesis, which states that German defense contractors earn excessive profits. When the next smaller company is used to find the best industry match, we find strong statistical evidence for excessive profits of German defense contractors. When the absolute difference and the ratio method are used to define the best size match, there is still weak statistical evidence for excessive profits of German defense contractors. In all cases, the null-hypothesis is rejected in favor of the alternative hypothesis.

Panel B of Table 7 presents the results for the difference between ROA when the company size is determined by revenues. When the next bigger company or the absolute difference are used to determine the best size match, the mean of the difference is larger than zero, but smaller compared to the means when the company size is determined by total assets. When the next smaller company and the ratio method are used to find the best size match, we find small negative numbers for the mean. For the three size-match methods next smaller company, absolute difference, and ratio method, the median is smaller than zero. Only when the next bigger company is used to determine the best size match, the median is still larger than zero. A negative difference between ROA means that the defense contractors are less profitable than their industry peers. The results of the t-test show that there is no statistical evidence that German defense contractors earn excessive profits. The null-hypothesis is not rejected, which does not mean that the null-hypothesis is accepted.

Panel A of Table 8, which presents results of ROA for the three-digit industry match, shows that the mean of the difference between ROA of defense contractors and their industry peers is larger than zero for all methods to find the best size match when the company size is determined by total assets. In contrast, the median is negative for all methods to determine the best size match except when the next bigger company is used. The p-value of 0.0839 when the best size match is the next bigger company is interpreted as weak statistical evidence for excessive profits of German defense contractors. For the other methods to find the best size match there is not enough statistical evidence to reject the null-hypothesis.

Panel B of Table 8 shows that the mean of the difference between ROA is still larger than zero for three of four methods to determine the best size match when the company size is determined by revenues. The median is larger than zero for two of the four methods to find the best size match. The p-values, however, show that there is not enough statistical evidence for excessive profits of German defense contractors, when the first three digits of the SIC are used to determine the industry, and when revenues is used to define company size.

When the four-digit SIC is used to define the industry, we cannot find any evidence for excessive profits of German defense contractors. The median is smaller than zero for all methods to determine the best size match and for both size measures. The mean is smaller than zero when total assets are used to define the industry and for all methods to find the best size match except when the next bigger company is used. Table 9 shows further, that the mean of the difference between ROA of defense contractors and ROA of their industry peers is larger than zero for all methods to determine the best size match except when the next smaller company is used. For all methods to determine company size and for all methods to find the best size match, there is not enough statistical evidence for excessive profits of German defense contractors.

To summarize, we found statistical evidence for excessive profits of German defense contractors when the company size is determined by total assets and when the first two digits are used to determine the industry. In all other cases, the t-tests did not provide enough evidence to reject the null-hypothesis. In Subsection 1 of this section, we showed that the two-digit SIC is the best method to determine the industry match for the German setting. Therefore, our findings for this industry matching method should outweigh the other findings. Additionally, ROA is a profitability measure that relates profit to total assets, which makes total assets the logical size measure when profitability is measured by ROA.

3. Statistical Interpretation of the Numeric Results for ROCE

This subsection shows the statistical interpretation of our findings for ROCE. As for ROA, first the findings for ROCE are discussed when the first two digits of the SIC are used to define the industry, followed by the interpretation of the results for the three and four digit SIC. At the end of this subsection, the results are summarized.

As shown in Table 10, the mean of the difference between the ROCE of defense contractors and their industry peers ranges from 10.81% to 17.70% when the two-digit SIC is used to define the industry and total assets is the size measure of the company. For this case, the median ranges from 3.46% to 6.96%, depending on the method to find the best size match. The p-values of for the two size matching methods next bigger company and absolute difference lead to the conclusion that there is overwhelming statistical evidence for excessive profits of German defense contractors. When the next smaller company and the ratio method are used to find the best size match, we still observe strong statistical evidence for excessive profits of German defense contractors in terms of ROCE.

Panel B of Table 10 shows the results for the difference between ROCE when revenues is the size measure of companies. The mean of this difference ranges from 6.72% to 31.84%. The median ranges from 0.30% to 4.01%. When the next bigger and the next smaller company are used to determine the best size match, we observe weak statistical evidence for excessive profits of German defense contractors, when profit is measured by ROCE. Using the absolute difference and the ratio method to determine the best size match does not provide enough statistical evidence to reject the null-hypothesis.

When the first three digits of the SIC are used to determine the industry, the average of the mean in the difference between ROCE of defense contractors and their industry peers ranges from 5.72% to 10.91% for total assets as measure for the size of companies. The results in panel A of Table 11 further show that the median ranges from 2.55% to 3.05%. The t-test reveals that there is overwhelming statistical evidence for excessive profitability of German defense contractors when the ratio method is used to determine the best size match and when total assets is the measure of company size. When the next bigger company and the absolute difference are used to determine the best size match, there is strong statistical evidence for excessive profits of German defense contractors. When the next smaller company is the best size match for defense contractors, there is still weak statistical evidence for excessive profits in terms of ROCE.

When the first three digits of the SIC are used to define the industry and revenue is the size measure of the companies, the mean of the difference between ROCE of defense contractors and their matching companies ranges from 4.46% to 6.45%. As shown in panel B of Table 11, the median ranges from -0.01% to 4.32%. The p-values for the ratio method to find the best size match and the next smaller company as the best size match reveal that our sample provides weak statistical evidence for excessive profits of German defense contractors. For the remaining two methods to define the best size match there was not enough statistical evidence to reject the null-hypothesis.

When all four digits of the SIC are used to define the industry, the mean of the difference between ROCE ranges from -2.84% to 6.28% for both size measures and all four methods to determine the best size match. Table 12 also shows that the median ranges from -2.09% to 2.09%. Only when the number of total assets is the size measure and the next smaller company is used as benchmark firm, there is weak statistical evidence for excessive profits of German defense contractors. In all other cases, there is not enough statistical evidence to infer that German defense contractors earn excessive profits.

To conclude, we observed statistical evidence for excessive profits of German defense contractors when profitability is measured by ROCE, and the first two and first three digits of the SIC are used to define the industry. There is stronger statistical evidence for excessive profits when total assets are the size measure of the company compared to the results when revenue is the size measure. Again, statistical evidence could not be found when all four digits of the SIC are used to define the industry. As shown in Subsection 1 of this section ("Sample Size and Quality of Size Matches"), the best method to define the industry for the German setting is the two-digit SIC. More digits have negative effects on the sample size and the quality of the size match. We use our findings for industry matches defined by the first two digits of the SIC to infer that there is sufficient statistical evidence to infer that, in terms of ROCE, German defense contractors earn excessive profits.

4. Other Profitability Measures

We performed similar analyses based on two alternative profit measures, namely, PMR and OMR. Untabulated results (available upon requests) show that there is no statistically significant difference between the profitability of defense contractors and that of their peers. However, the lack of evidence could be due to the small sample size of German defense contractors, which reduced the power of the hypothesis test.

5. Summary of the Statistical Interpretation

This subsection provides the conclusion drawn from our statistical analysis of the different measures of profitability for German defense contractors and their benchmarks, which were identified by using the industry-year-size match. We found that German defense contractors earned excessive profits, based on the profitability measures ROA and ROCE. As discussed in Subsection 1 of this section, we found that the best method to determine the industry match is to use the first two digits of the SIC. For this reason, we draw our conclusion based on this method of defining the industry.

For ROA and ROCE we found statistical evidence that German defense contractors earn excessive profits when the reported number for total assets is used to determine the company size. This finding is not supported when revenues is used to determine the company size. ROA is a profitability measure, which is based on total assets. For this measure of profitability, total assets are a good measure for company size. The fact that we were not able to reject the null-hypothesis when revenues are used to define the company size does not mean that we accept the null-hypothesis. Based on our findings we infer that German defense contractors earn excessive profits when profitability is measured by ROA and ROCE.

C. ECONOMIC SIGNIFICANCE

This section compares the differences of the profitability measures with the actual profitability measures of defense contractors and their benchmark firms. When the difference of the profitability measures makes up a significant part of the original profitability measures, the excessive profits are economically significant. If the difference is only a small part of the original profitability measures, excessive profits are economically less significant.

Table 14 shows the mean of the profitability measures ROA and ROCE of defense contractors, benchmark firms, and the difference of these profitability measures when the two-digit SIC was used to define the industry. The comparison of the differences in profitability and the profitability of defense contractors and benchmark firms shows that the difference is always a significant portion of the profitability measure. This means that the difference in profitability of defense contractors and their benchmark firms cannot be rejected as insignificant and shows that there is an economical significant difference between profitability of defense contractors and benchmark firms.

Table 14. Average profitability and difference in profitability of defense contractors and benchmark firms.

	Size measure: Total Assets			Size measure: Revenues		
Mean of	**Defense contractor**	**Benchmark firm**	**Difference**	**Defense contractor**	**Benchmark firm**	**Difference**
Panel A: Best size match by choosing the next smaller company						
ROA	2.69%	0.32%	2.36%	2.67%	2.78%	-0.13%
ROC	11.61%	-1.92%	13.53%	11.62%	4.59%	6.72%
Panel B: Best size match by choosing the next bigger company						
ROA	3.15%	-0.69%	3.80%	3.15%	1.80%	1.31%
ROC	14.80%	-2.63%	17.70%	14.80%	-16.77%	31.84%
Panel C: Best size match by determining the smallest absolute difference						
ROA	2.67%	0.72%	1.92%	2.67%	2.13%	0.48%
ROC	11.51%	-0.20%	11.84%	11.51%	-10.22%	21.72%
Panel D: Best size match by ratio method						
ROA	2.67%	1.20%	1.44%	2.67%	2.64%	-0.03%
ROC	11.51%	0.82%	10.81%	11.51%	-8.82%	20.34%

D. COMPARISON OF EXCESSIVE PROFITS OF GERMAN AND U.S. DEFENSE CONTRACTORS

This section compares the findings for German defense contractors with the findings of Wang and San Miguel (2012) for U.S. defense contractors. First, the data source and sample size are compared. Second, the results of both studies are discussed.

Last, differences and commonalities of the findings for German defense contractors and U.S. defense contractors are summarized.

Wang and San Miguel (2012) were able to use data provided by the U.S. government to identify defense contractors while such data are not provided by the German government. In addition, the Compustat database provides annual fundamentals beginning as early as 1950 for U.S. companies, while data for international companies are only available starting in 1989. These two facts resulted in significantly different sample sizes. Wang and San Miguel (2012) identified 112 publically traded U.S. defense contractors and 4,099 firm years for their study. In contrast, only 10 German defense contractors were identified, which yielded data for up to 170 firm years. Based on these numbers, the power of the hypothesis test for German defense contractors is significantly lower.

Other reasons for the low number of identified defense contractors compared to the study for U.S. defense contractors are differences in structure and size of the German industry compared to the U.S. industry, and the difference in the size of defense budgets. According to The World Bank, the 2013 GDP of the United States was $16.8 Trillion while the German GDP for the same year was $3.6 Trillion (2014). These numbers show that both economies are different in size. Additionally, the backbone of the German industry is small and medium sized companies. This is true for the German industry in total and for the German defense industry. Most of these companies are not publically traded, which reduces the data base for our study. As shown in Chapter II.B.3, the German defense budget for 2013 was €33.26 Billion, which are approximately $44.57 Billion. The U.S defense budget proposal by President Obama for the same year was $613.9 Billion (U.S. Department of Defense, 2012). This difference in budget is connected to fewer defense contracts by the German government.

To facilitate the comparison, the results of Wang and San Miguel (2012), which were already shown in Table 1, are combined with the findings for German defense contractors, which were shown in Tables 7 and 10. We focus on the findings for ROA and ROCE for this comparison. Table 15 shows the combined results. For the comparison, we used the numbers of the two-digit industry match from the findings for

German defense contractors because this is the best method for the German setting. The best size match for German defense contractors is determined by the smallest absolute difference. This is the method that was used by Wang and San Miguel (2012) for their study.

The direct comparison of the sample sizes N shows that Wang and San Miguel found significantly more matches. The comparison of the standard deviations shows that the results for German defense contractors vary stronger than the results for U.S. defense contractors. When total assets are used to measure the size of companies, the means of all profitability measures show that excessive profits are even more pronounced for German defense contractors. Especially the mean of ROCE for German defense contractors is, with a value of 11.84%, much higher compared to the same finding for U.S. defense contractors (only 3.65%). When revenues is used to determine the company size, the number of ROCE for German defense contractors is higher compared to the same number of U.S. defense contractors. The difference between ROA is lower for German defense contractors when revenues are used to determine the company size.

The comparison of the p-values reveals the higher power of the study of Wang and San Miguel (2012) compared to our findings for German defense contractors. We attribute this difference in power of the hypothesis tests to the significant difference in sample size.

Table 15. Comparison of excessive profits of German defense contractors and U.S. defense contractors.

	N	Mean	Min	Max	Std Dev	t	P-value
Panel A: U.S. defense contractors, Size matched by Total Assets							
Excessive ROA (%)	3,809	1.12	-23.49	44.17	7.08	9.773	<0.0001
Excessive ROCE (%)	3,314	3.65	-143.64	175.57	25.73	8.083	<0.0001
Panel B: German defense contractors, Size matched by Total Assets							
Excessive ROA (%)	100	1.92	-35.42	43.46	11.74	1.636	0.0525
Excessive ROCE (%)	99	11.84	-128.42	264.96	46.85	2.514	0.0068
Panel C: U.S. defense contractors, Size matched by Revenue							
Excessive ROA (%)	3,825	1.04	-21.89	44.37	7.29	8.803	<0.0001
Excessive ROCE (%)	3,246	3.71	-142.09	178.70	26.08	8.103	<0.0001
Panel D: German defense contractors, Size matched by Revenue							
Excessive ROA (%)	99	0.48	-27.75	26.18	8.97	0.527	0.2998
Excessive ROCE (%)	99	21.72	-152.71	1668.09	172.40	1.253	0.1065

In summary, the comparison of the findings for German defense contractors and for U.S. defense contractors reveals similar patterns in both countries. Excessive profitability is more pronounced for German defense contractors, but the power of the hypothesis test for U.S. defense contractors is higher. In Germany and in the United States, defense contractors are more profitable than their benchmark companies, which were found by the industry-year-size match.

V. CONCLUSION AND AREAS FOR FURTHER RESEARCH

This chapter summarizes the findings of this thesis, discusses limitations, and provides areas for further research. We found that, similar to U.S. defense contractors, German defense contractors earn economically significant, excessive profits. This work provides the first evidence that excessive profitability of defense contractors is not only a U.S. phenomenon.

We found statistical evidence that German defense contractors earn excessive profits when ROA and ROCE are used to measure profitability. Our statistical hypothesis test supports this finding especially when total assets is used to measure the company size and when the first two digits of the SIC are used to define the industry. In contrast, the hypothesis test did not support excessive profits when profitability is determined by the two revenues based measures PMR and OMR.

In addition to statistical significance, we document that the magnitudes of excessive ROA and ROCE of German defense contractors are economically significant as well.

The comparison between German and U.S. defense contractor's excessive profitability revealed similar patterns in both countries. The statistical evidence for excessive profitability is stronger for ROA and ROCE in both countries. The power of the test that was conducted by Wang and San Miguel (2012) is higher due to their higher sample size.

We also demonstrated that the perspective on profit differs between the U.S. rules and the German contracting system. While profits and fees in the United States are used as a tool to share the risk of increasing costs between the government and the contractor, profits for German cost-based contracts are determined by the Bonner Equation. Further research could reveal that profit-based risk-sharing tools can decrease costs for German defense contracts.

We limited our research exclusively to German defense contractors that were publically traded. Whether our results can be transferred to small- and medium-sized companies that are not publically traded, is beyond the scope of this work. Additionally, we have no indicators whether our findings hold for German defense contractors that are not based in Germany. For the two reasons mentioned above, our findings for German defense contractors should only be used to assess publically-traded German defense contractors.

Further research should be conducted on the topic of excessive profits of defense contractors worldwide. Countries of Western Europe, Australia, and democratic countries in Asia should provide sufficient data for further research. Results from these studies, combined with our findings for German defense contractors and with Wang and San Miguel's (2012) findings for U.S. defense contractors, provide a better picture of the profitability of defense contractors worldwide.

For the German setting, further research should not only consider companies that are based in Germany, but also countries from the European Union or the EURO-zone. This methodology is reasonable because the German economy is tightly connected to other economies of the European Union. This would provide a broader data base for possible matches and the number of defense contractors can be increased accordingly. This broader data base could increase the power of the hypothesis test. Additionally, the quality of the size match may increase.

Another way to overcome the small data base of German defense contractors is to do a study on excessive profits that is supported by data from the German government. It is in the interest of the German government to find out whether defense contractors earn excessive profits on contracts with the German armed forces.

Wang and San Miguel (2012), and Wang (2013) found determinants for excessive profits of defense contractors. This work can be used as a starting point to find determinants for excessive profits of German defense contractors. In combination with our findings for German defense contractors, a work on determinants of excessive profits can be used by the German government to adapt contracting rules and to decide whether the payment of excessive profits is necessary for the German government to reimburse defense contractors for increased risks that may come from defense contracts, or whether these profits are a waste of resources and need to be reduced or prevented. Finally, the source of excessive profits needs to be identified. Especially for the export-oriented German economy, excessive profits are not necessarily gained from contracts with the German government, but also from other contracts.

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