Managing Risk Concerns with Ordered Backlogs in the Semiconductor Industry: An Empirical Study[1]

Abstract

Today, the semiconductor industry is integral to the functionality of many critical goods and processes that are highly valued. The increasing demand across various semiconductor-related industries has correspondingly amplified the risks faced by firms within this sector. In this study, we empirically explore the potential of ordered backlogs as a means to mitigate the risks confronting semiconductor firms. Utilizing a dataset comprising publicly traded semiconductor firms in the USA, over a duration from 1998 to 2021, we quantitatively validate our hypotheses. Our findings reveal that a substantial volume of ordered backlogs is indeed correlated to a diminished level of firm risk. However, it is important to note that this risk-mitigating effect is lessened as the marketing and research intensities of these firms escalate. Moreover, we observe that the advantageous impact of ordered backlogs in risk reduction is more subdued in large workforce firms, whereas the presence of a sizable top management team aids in lessening the impact of ordered backlogs on risk. These managerial insights are invaluable in advancing both theoretical understanding and managerial practices within the realm of the semiconductor industry.

Keywords: Ordered backlogs, risk mitigation, semiconductor firms, firm-related factors

1. INTRODUCTION

Although semiconductors represent a modest proportion of the global GDP, they are integral to the functionality of goods and processes worth trillions of dollars. The escalating demand for smart devices, automobiles, and other chip-enabled products has progressively heightened the significance of the semiconductor industry (Laricchia, 2023). Consequently, the semiconductor industry stands as a vital component of the worldwide economy. It provides the pivotal technology across diverse sectors (Varshney and Jain, 2022), including and beyond high-tech sectors (Choi, 2023).

[1] We sincerely thank the editors and reviewers for their critical and helpful comments.

However, according to a recent 2022 Deloitte report, the prolonged wait faced by customers across various industries for semiconductor products has led to a significant global revenue decline, amounting to billions of dollars. In the United States, the demand for semiconductor chips has escalated following the ban on Chinese firms, Huawei Technologies and ZTE, given China's role as a major supplier of raw materials associated with semiconductor chips (Bloomberg, 2023). Consequently, the increased demand for semiconductors introduces heightened risks for U.S. semiconductor firms, potentially putting pressure on their supply chains and diminishing their attractiveness to investors in the market (Luo and Assche, 2023). Lam Research Corp. executives refer to the changes in the semiconductor industry as an "*unprecedented business environment*" characterized by rapidly escalating uncertainty and risk caused by geopolitical tensions (The Washington Post, 2023). These combined factors influence investor perceptions towards semiconductor companies. The investors supply the necessary funds to expand firms' capacity, make new technology acquisitions, or explore strategic partnerships (Ozmel et al., 2013; Pandit and Siddharthan, 1998). Hence, they play an integral role in the growth of semiconductor firms (Henisz and Macher, 2004). However, unstable market dynamics may alarm investors concerning the profitability of semiconductor firms, and they may consider them high-risk investments (Brown and Linden, 2011). Considering investments in semiconductor firms as high-risk declines the investors' future investment intention, leading to an increase in the financial risk for the firms. As a result, investors' hesitation to allocate funds due to the high perceived risk exacerbates firms' challenges and hinders their capacity to survive in the market. Therefore, semiconductor firms must formulate an effective strategy to reduce this financial risk. Previous research has concentrated on exploring a range of strategies such as corporate social responsibility (CSR), operational management, and capital allocation (Hankins, 2011; Hsu and Chen, 2015; Perold, 2005) to address risk, but it has given limited attention to the public disclosure of ordered backlogs. We investigate the effects of ordered backlogs as a method to mitigate financial risk faced by semiconductor firms. The ordered backlog refers to the inventory of semiconductor products and related items that customers have purchased but are still pending delivery by the firm (Ramani et al., 2022). The disclosure of ordered backlogs by semiconductor firms indicates strong demand for their products/services, potentially resulting in enhanced future sales (Feldman et al., 2021). We suggest that these ordered backlogs in semiconductor firms could also serve to reduce the firm's financial risk by attracting investors for reliable financing. There is a plethora of literature on the topic of ordered backlogs (Ghemawat and McGahan, 1998; Mashud et al., 2021; Schaffir and Scott, Jr. 1962; Taylor, 1996), and prior literature has also established the ordered backlog as an indicator of firms' future profits (Dechow et al., 2011). However, they scarcely discuss the effect of ordered backlogs on the semiconductor firm's risk. Our study is pioneering in its exploration of the relationship between organized backlogs and firms' financial risk, and how this relationship may be influenced by other factors related to the firm.

We focus on examining two research questions (RQs):

RQ1: What effect do ordered backlogs have on the financial risk faced by firms in the semiconductor industry?

RQ2: How can firm-related factors affect the contribution of the ordered backlogs on a semiconductor firm's financial risk?

To address the above two RQs, we first conduct an extensive literature review and examine recent reports. We build hypotheses. We use a longitudinal dataset of U.S. publicly traded semiconductor firms from 1998 to 2021 to test our hypotheses empirically. We employ fixed and random effect models to analyse the dataset and also utilise a potential instrumental variable to address endogeneity.

Our statistical findings suggest that an increased volume of ordered backlogs mitigates the financial risk of the semiconductor firms. Moreover, we uncover that as the marketing efforts of these companies intensify, the risk-reduction effect of ordered backlogs diminishes. Additionally, we observe that a higher level of research activity within semiconductor firms weakens the capacity of ordered backlogs to mitigate risk. Furthermore, we have noticed that the positive influence of ordered backlogs on risk reduction is less prominent in large workforce firms. Furthermore, our research indicates that a larger top management team in semiconductor firms contributes to a reduction in the impact of ordered backlogs on risk. This study contributes to the production economics literature from both theoretical and managerial perspectives.

Our research has theoretical implications by providing insights into inventory and risk management within the semiconductor industry. Strategies related to the ordered backlogs serve as a mechanism to reduce risk and extend the contribution of this study to the risk management theories. Our introduction of the interaction of backlogs with marketing expenditure minimizes the contribution of backlogs on risk mitigation and opens new avenues for research in the operations- marketing interface. The interaction of the workforce and backlogs decreases the involvement of backlogs on firm risk, which provides new avenues for human capital research by suggesting that an increase in workforce size may only sometimes be advantageous for firms. We also find that a larger top management team reduces the effectiveness of backlogs. This brings in new insights, too.

Our research also has several managerial implications to improve practices. We provide effective strategies to managers for managing ordered backlogs to mitigate firm risk. Production managers should realise the potential of ordered backlogs and formulate appropriate strategies associated with them for risk mitigation. They should be able to manage resource allocations to R&D and marketing in case of high-ordered backlogs within the semiconductor industry because it may increase the firm risk. For large firm managers with a high workforce size, it is recommended to focus on inventory management to adjust the backlogs because the interaction of workforce size with high order backlogs can increase the firm risk. Furthermore, the top management team members must develop an optimal plan to manage high-order backlogs because the large size of the top management team may affect the firm's risk in the presence of ordered backlogs.

The remaining sections of paper are arranged as follows: Section 2 gives a review of the related literature. Section 3 outlines the conceptual framework employed in the study. Section 4 outlines the research methodology adopted in this paper. Section 5 presents the findings from our analysis. Section 6 discusses both the managerial and theoretical implications of our research findings. Finally, Section 7 gives the conclusion of the whole study.

2. LITERATURE REVIEW

In our analysis, we primarily examine ordered backlogs and the financial risk of the firm as the key variables. Our focus revolves around these two constructs and involves summarizing the relevant literature within these broad research areas.

2.1 Firms' Financial Risk Management Strategies

Blome and Schoenherr (2011) investigate the strategies employed by firms in addressing supply chain risk management in the context of economic and financial crises. They utilize a multiple case-study approach to explore eight multinational companies across diverse industries in Europe with a particular emphasis on the significant role of a firm's financial risk as a key factor influencing its supply chain risk management during financial crises. They argue that firms should adopt a more comprehensive supply chain risk management approach by adjusting financial risk identification and mitigating it during a financial crisis. Though the research provides insights into risk management approaches during financial crises, it overlooks the demand-side risks which could be caused by ordered backlogs and focuses primarily on the supply side of risk management. Through comprehensive literature reviews and citation analysis, Tang and Musa (2011) demonstrate that financial risk within firms has been one of the prominent risks in production economics during both the periods of 1995-1999 and 2005-2008, along with informational and material risks. The authors highlight that in spite of the awareness of supply chain risk management in the global supply chain, there is a lack of quantitative models for reducing firms' risk. We contribute to the literature by filling this gap on how ordered backlogs contribute to firm financial risk using quantitative modelling methods.

In Lord's (1996) study, the authors look into the impacts of financial leverage, net profit, operating leverage, and output variability on the overall risk of firms within the airline, automotive, and electric industries, drawing on publicly available datasets. Employing seemingly unrelated regression, they reveal that operating leverage, net profit, and output variability show a positive correlation with firm risk. While their study provides an understanding of how financial and operating attributes affect firms' risks, it also opens the room to investigate the temporal dynamics of those strategies on the financial risk relevant to other critical industries like semiconductors, in which our study focuses on. Orlitzky and Benjamin (2001) investigate how corporate social performance relates to the company's financial risk. Through a meta-analysis method, they identify a negative correlation between them. However, the authors further delineate that the CSP impact is more pronounced at market risk than at firms' overall risk. Hence, an indication of future revenues and production commitments could be more pronounced to firms' risk, which could be identified through ordered backlogs.

Hankins (2011) explores the risk management challenges of bank holding companies by studying whether operational hedging can substitute financial hedging. Leveraging quarterly Federal Reserve data of bank holding companies and an instrumental variable approach, the author reveals that operational hedging may serve as an alternative to financial hedging within the banking industry. Our study provides support to further investigate the effects of particular operational strategies, such as ordered backlogs, on a firm's financial risk management. Liu and Cruz (2012) examine how financial risks influence the profitability of the interconnected companies along the supply chain. Utilizing analytical modelling methods, they find that suppliers may be inclined to forgo some of their profits in order to secure more business from manufacturers characterized by lower future financial risks. They also observe that firms exhibiting lower financial risk are deemed more valuable by their suppliers because they can provide consistent revenue streams to suppliers during economic downturns. Our study recommends exploring strategies to reduce firms' financial risk as the suppliers prefer less risky firms.

Kölbel et al. (2017) investigate how corporate social irresponsibility, which represents the adverse aspect of CSR, leads to the emergence of financial risk, focusing on the role of media coverage. The authors perform a longitudinal estimation analysis using ten thousand news articles data for corporate social irresponsibility of firms along with firm-specific variables. They discover that the extent of media coverage of corporate social irresponsibility has an incremental impact on financial risk. The authors highlight the adverse impact of media signalling of irresponsible actions, which can increase firms' risk. However, they also argue that exploring how signalling other strategies may reduce firms' risk, which we investigate in our research. Likewise, within the extensive literature on firm financial risk management, a wide range of risk management strategies have been addressed, including capital allocation (Perold 2005), financial derivatives (Hentschel and Kothari, 2001), and hedging mechanisms

(Campello et al., 2011), among others. However, it's worth emphasizing that the impact of the ordered backlog strategy on firm risk, which constitutes the primary focus of our research, has received relatively limited attention in the existing literature. Next, we look into the literature on ordered backlog to identify and examine previous studies related to our research topic within this domain.

2.2 Ordered Backlog and Firm Performance

Inventory costs are naturally related to firm performance (Choi and Chiu, 2012; Choi, 2016). Numerous studies have explored the impacts of strategies related to ordered backlogs on firm performance. For example, Schaffer and Scott, Jr. (1962) investigate a heuristic system designed to control ordered backlogs rather than inventory in a particular job operation. They use historical data to propose that the rate at which orders are accepted should be contingent upon the fractions of the present booked capacity and the accepted available business, taking into account recent order bookings. Similarly, Mak et al. (1976) employ the control theory to devise a controlling system specifically for ordered backlogs. They use mathematical modelling and simulated data to advocate the application of modal control theory to generate control policies for the production-inventory process, including ordered backlogs. Both Schaffer and Scott, Jr. (1962) and Mak et al. (1976) assume that ordered backlogs have a detrimental impact on firm performance, and it is crucial to control them. However, they haven't explored the critical aspect of how backlogs can also affect firm risk, which we explore in our study.

De Vany and Frey (1982) examine the link between ordered backlogs and capacity utilization within the steel industry. They use a twenty-year logistics dataset and employ a stochastic model to find that steel producers effectively create an implicit futures market by setting a fixed price for customers and managing backlogs on a first-come, first-served basis. Their study advocates a deeper insight into production management under varying demand environments, which influences us to explore the impact of ordered backlogs on firm risk in other key sectors like semiconductors. Kingsman et al. (1989) explore the processes of managing lead time to find out whether it can be effectively controlled by optimizing the backlogs within the structure via a conceptual analysis. They find that proper planning related to orders, deadlines, and order dispatches can optimize decision-making for backlog hierarchy. Benton and Krajewski (1990) examine the impact of lead time as an important factor of vendor quality on firms' production. They use a manufacturing systems simulator to create the environments with intermediate inventory locations at various phases. They discover that ambiguous lead times negatively affect firms' productivity due to an increase in backlogs. These studies have a significant gap in combining ordered backlog strategies with production management to examine the effect on firm risk. Investigating the impact of backlogs on financial risk fills this gap and broadens the focus of this area. Taylor (1996) examines how to manage backlogs in small-scale production when the organization expands. Employing an optimization modelling approach, they propose the use of linear programming techniques as a solution, which can enhance management capabilities by facilitating optimal workforce allocation during irregular maintenance periods and distinguishing between backlog jobs and their respective processing times. Their research establishes a practical framework for labour force optimization in the maintenance process, but it ignores the strategic significance of backlogs in signalling to shareholders that goes beyond cost-effectiveness and operational ramifications. Aull-Hyde (1996) examines the issue of planning for backlogged orders during periods of discounted sales prices using mathematical modelling. The author suggests that it would be optimal for firms to execute special orders at the end of the sales period to take advantage of cost reduction. The main limitation of their research is the absence of empirical validation, even though it provides a thorough understanding of inventory management in specific situations. However, we investigate in this paper the impact of backlog on firms with an empirical approach using secondary data.

Ghemawat and McGahan (1998) use a game theoretical framework to explore competitive pricing under production backlogs in the Turbine Generator industry. They use the GLS regression method to analyze historical data of US firms, which supports their game theoretical prediction that the association between the level of backlogs and relative pricing is strategic. Although their research broadens our understanding of backlogs, it might not effectively communicate its complexities transferable to other industries where ordered backlogs have a different strategic importance. Olhager et al. (2001) use a conceptual analysis to examine long-term capacity planning, asserting that sales and operations planning plays a more pivotal role in production over the long term than backlogs and inventory management. However, their paper lacks empirical support and investigating the impact of ordered backlogs with empirical data may open new avenues in this field.

In another study, Jiambalvo et al. (2002) investigate how earnings from stock prices affect institutional ownership. They use financial and stock price databases and regression analysis to indicate a positive correlation between stock price earnings and institutional ownership. Furthermore, their study reveals that institutional investors prioritize ordered backlog more than other types of investors do. Rajgopal et al. (2003) investigate the impact of backlogs as a predictive measure using the US firm's datasets and GLS analysis. Their findings indicate that backlogs are vital for predicting firms' future earnings. All the above reviewed prior studies lay the groundwork for our research, which extends this area by examining the impact of backlogs as a leading indicator of firms' risk.

Akkermans and Vos (2003) look into the effect of amplification on service supply operations in the telecommunications industry. With the help of manager interviews and qualitative analysis, they conclude that amplification affects the tasks and backlogs which disrupt the service supply chains. However, as they use interview and group workshop data, the complexity of experiences may not be well-captured. Therefore, our analysis of variations in backlogs with secondary data enhances the understanding of this field of research.

In addition, So and Zheng (2003) investigate the impact of suppliers' lead time performance and the retailer's demand forecasting on the fluctuations of the seller's orders in the semiconductor industry. They use an analytical modelling framework and suggest that the suppliers' lead time may increase the fluctuations in the retailers' orders. Our investigation of the effects of backlogs with real-world semiconductor industry dataset can provide additional insights into supply chain dynamics to supplement the theoretical findings by So and Zheng (2003).

Yan et al. (2010) explore the effects of lead time variation on internet purchase transactions. They use simulated data originating from actual internet purchase transactions and regression analysis to determine that backlogs can be managed by enforcing a deadline policy and delaying order dispatches. The possible limitation of their paper is the focus on a specific backlog variation rather than all backlogs. Studying the impact of all backlogs with the original industry database may fill this limitation and open new avenues. Chang et al. (2018) investigate how the bullwhip effect influences earnings prediction through the order backlog using a US public firm's database and regression analysis. They emphasize that ordered backlogs may not be suitable predictors for firm earnings due to information distortion to investors. We extend their investigation and focus on the impact of backlogs on financial risk. As a remark, numerous studies are looking into different facets of ordered backlogs and how they affect various areas of firm performance. None of this research, nevertheless, has looked into the connection between firm risk and ordered backlogs in the context of semiconductor industry. By investigating the potential impact of ordered backlogs on a firm's risk profile, we want to fill this gap in the literature. By doing this, we seek to add significant knowledge to the corpus of existing literature and offer a more thorough understanding of the effects of ordered backlogs on a firm's overall performance. Drawing from prior research, we formulate a conceptual framework and establish hypotheses in the next section to provide deeper insights into this association.

3. CONCEPTUAL FRAMEWORK

3.1 Firm Risk and Ordered Backlogs

Shareholders are often at a disadvantage regarding the information they have about a firm's operations compared to its managers, who are engaged in the daily running of the business and consequently possess a deeper knowledge of its inner workings (De Menezes, 2019; Miller, 2009). This disparity in information can lead to an agency problem, where there may be a divergence between the interests of the managers and those of the shareholders (Kamrad et al., 2021). To bridge this information gap and alleviate possible conflicts of interest, firms employ the strategy of information disclosure (Denis, 2001). There is certain information, such as details about mergers and acquisitions or the appointment of executives, that firms are obliged to reveal to their stakeholders; this is referred to as mandatory disclosure (Boot and Thakor, 2001; Zhao et al., 2019). Beyond these requirements, companies may also choose to share information on their own accord in what is known as voluntary disclosure. Such disclosure can foster increased trust among shareholders and lead to an enhancement in the firm's stock value (Cheynel, 2013).

The existing body of research indicates that the information disclosure of ordered backlogs is associated with favourable future earnings (Rajgopal et al., 2003). This association is based on the reasoning that ordered backlogs signify strong demand for a firm's product/services leading to increased future profitability. However, it is crucial to note that ordered backlogs not only bolster future earnings but also play a substantial role in mitigating a firm's financial risk.

Following the principles of information disclosure theory, when a firm publicly discloses the information of ordered backlogs, it effectively secures its future revenue stream. Firms possessing substantial ordered backlogs are better positioned to address challenges associated with economic downturns or unforeseen disruptions due to the availability of a reservoir of ongoing work, which provides stability during turbulent periods. This disclosed information establishes a reliable income stream, consequently attracting investors for secure financing. Investors place their trust in these firms and formulate improved financial strategies based on the information disclosed.

This pattern is prominent in semiconductor firms. After the information disclosure of ordered backlogs, investors commonly display a high level of confidence in semiconductor firms due to the trust and certainty inherent in their operations. The trust that investors place in the semiconductor industry serves as a catalyst for the formulation of more sophisticated financial strategies. This is because investors can harness the insights derived from the disclosed information to make informed and prudent decisions. Hence, the public disclosure of ordered backlogs serves as a means to alleviate the financial risk faced by semiconductor firms in connection with the fluctuation of stock prices. Therefore, we propose the below hypothesis:

H1: An increase in ordered backlogs in semiconductor firms leads to a reduction of firms' financial risk.

Information overload occurs when investors receive more information than they can effectively understand or process (Chapman et al., 2019). Investors are sometimes inundated with a vast array of intricate information, encompassing various strategies employed by firms to capture their attention (Pernagallo and Torrisi, 2022). Confronted with an excess of information, investors often find it challenging to distinguish between crucial and irrelevant data, leading to difficulties in making informed and timely decisions (Kelton and Pennington, 2012). Hence, if semiconductor companies inundate investors with excessive information, it could heighten risk due to the resulting information overload. In this section, we explore various strategies and attributes of firms that could potentially cause information overload for investors, subsequently escalating the firms' financial risk.

Marketing intensity for semiconductor firms is the degree of marketing expenditure for promoting the goods and services in the semiconductor industry (Bae et al., 2017). It quantifies the extent to which semiconductor firms actively promote their products and allocates resources towards their marketing endeavours. As firms ramp up their marketing efforts, they swamp investors with an array of information through advertisements, product launches, press releases, and more, all aimed at showcasing the firms' market competitiveness (Anderson and De Palma, 2012). Alongside marketing activities, if firms provide voluntary disclosure of their ordered backlogs, the investors receive a substantial amount of information to process. Investors often find it challenging to prioritize information about ordered backlogs over the deluge of marketing-driven data, due to the overwhelming increase in the volume of information they receive. Investors might struggle to identify which pieces of information are crucial for assessing the future financial well-being of the firms. Hence, the combined strategies of semiconductor firms might fail to draw investors' interest, thereby escalating the financial risk for these firms. Therefore, we put forth the following hypothesis:

H2: As the marketing intensity of semiconductor firms increases, the impact of ordered backlogs on lowering firms' financial risk is reduced.

The research intensity of semiconductor firms is the degree of allocation of resources towards firms' research and development activities (Padgett and Galan, 2010). It signals firms' dedication to pioneering and advancing technology within the semiconductor sector. A high investment in R&D means that firms devote the majority of their resources to research and development projects. Semiconductor firms utilize this investment to develop advanced-level products, reducing the risk associated with technological redundancy (Sher and Yang, 2005). It also means that firms constantly generate new data related to innovations and breakthroughs and information about these research activities, including technical details, could be extensive and complex. When firms couple their detailed R&D information with comprehensive data on ordered backlogs, it creates an overwhelming amount of information for investors to digest. Investors are tasked with identifying which pieces of information are most pertinent to their investment decisions, and the task of processing these large volumes of complex data can result in information overload. The information overload experienced by investors can lead to an escalation in the financial risk of the firms. Therefore, we propose the below hypothesis:

H3: As the research intensity of semiconductor firms increases, the impact of ordered backlogs on lowering firms' financial risk is reduced.

Workforce size is the total number of employees working for a firm (Burns and Carter, 1985). It is a crucial metric in the semiconductor industry for evaluating production capacity (Chien et al., 2010; Tseng et al., 2022). When a semiconductor company increases its employee count, it signifies an expansion of its business operations (Malerba, 1985). The growth in the workforce typically entails the development of new departments and the enlargement of administrative teams. Consequently, investors receive an abundance of information regarding the strategies for employee hiring, human resource policies, and the labour costs associated with this expansion of the workforce (Ghaly et al., 2020). If firms simultaneously disclose details of ordered backlogs, investors are faced with an abundance of information to process, potentially leading to information overload. Due to this information overload, investors may find themselves unable to effectively determine their financial strategies for firms that are simultaneously implementing these two approaches. Hence, we propose the below hypothesis:

H4: The impact of the ordered backlogs on lowering semiconductor firms' financial risk is weakened as the semiconductor workforce size increases.

An expanded *top management team* (TMT) generally features a greater variety of viewpoints, strategies, and methodologies for decision-making (Wong et al., 2011). While this diversity can enhance the strategic depth of the firm, it simultaneously complicates the information flow to investors. Investors are now tasked with processing intricate details about the numerous strategies and objectives of the expanded management team. Thus, an expanded TMT introduces an additional layer of complexity, potentially leading to a large inflow of information to investors. When firms release details of ordered backlogs in conjunction with an expanding TMT, investors are faced with processing a substantial volume of information, leading to a scenario of information overload. Hence, it becomes challenging for investors to develop investment strategies for firms that present this information simultaneously, especially when considering future investments. Therefore, we propose the below hypothesis:

H5: As the TMT size of semiconductor firms increases, the impact of ordered backlogs on lowering firms' financial risk is reduced.

The conceptual framework is given in Figure 1.

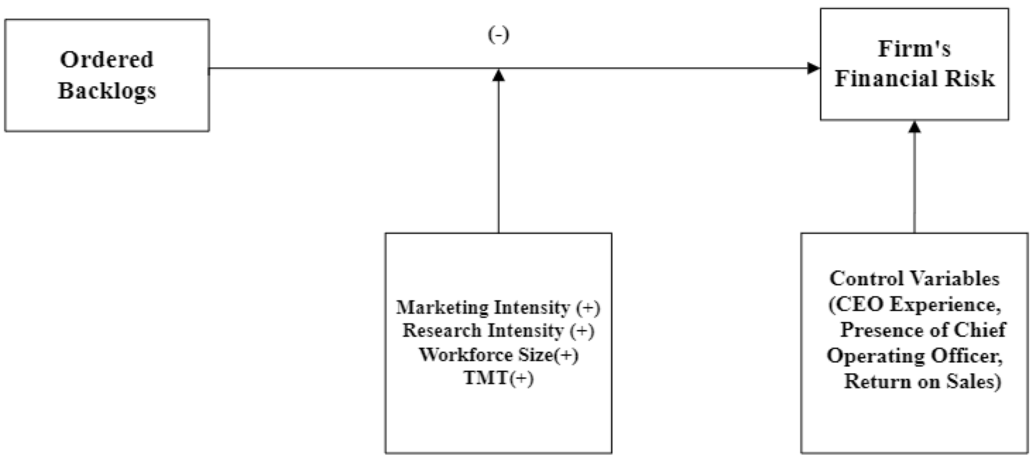

Figure 1. Conceptual Framework.

4. METHOD

We leverage the dataset of publicly traded semiconductor firms in the United States to validate our empirical hypotheses. It is important to highlight that U.S. semiconductor firms constitute a notable 46% of global semiconductor chip production (Yahoo Finance, 2022). Therefore, investigating the data of these U.S. based firms not only enables us to comprehend the intricacies of the U.S. semiconductor industry but also provides invaluable viewpoints on global technology trajectories and economic evolutions. We employ the Compustat dataset to extract observations for semiconductor firms. The Compustat dataset encompasses a broad range of variables, incorporating financial, market, and industry segment datasets, which facilitate our analysis related to ordered backlogs. Furthermore, it comprises a historical database, enabling us to conduct the required longitudinal analysis for our study. Previous researchers have also utilized the Compustat database for analyses related to ordered backlogs and various moderating factors (Dass and Fox, 2011).

We utilize the *Center for Research in Security Prices* (CRSP) database to compute a firm's risk, leveraging its detailed and high-quality data, which encompasses security prices and stock volume. CRSP ensures the minimal presence of missing values within the dataset, thereby facilitating precise risk calculation. Previous studies have also employed CRSP to validate their hypotheses and models (e.g., Bendig et al., 2018; Ni et al., 2014). Furthermore, we employ the ExecuComp database to integrate the characteristics of top management team members, vital for our analysis. The ExecuComp dataset provides comprehensive and well-organized data concerning executives, which is pivotal in examining the influence of executive attributes on firm risk. The ExecuComp database has also been utilized in previous literature to empirically substantiate their hypotheses (Jung and Kwack, 2023).

We combine these three datasets to compile a comprehensive dataset that encompasses all vital information about semiconductor firms required for our analysis. Our focus is exclusively on semiconductor firms and those associated with the semiconductor industry, identified by the initial two-digit "Standard Industrial Classification" (SIC) codes 35 and 36. This results in a total of 5785 observations, encompassing 624 firms, spanning the period from 1998 to 2021[2].

4.1. Dependent Variable

Firm Risk: Using the CRSP database, we assess the firm financial risk, which refers to the volatility of a particular semiconductor firm's stock price as a result of its unique strategies to entice stockholders (Bartram et al., 2011). Firm risk is thus correlated with daily market returns, which represent the percentage change in the firm's daily stock prices relative to the overall market index (Bouslah et al., 2018). The CRSP database provides comprehensive data on the returns of stocks and market indices over time for various firms (Kiessling et al., 2023). Consequently, we employ the following equation to gauge the risk associated with semiconductor firms:

Return of a stock $= \beta 0+\beta 1(\text{Market Index}) + \varepsilon$……………………….(1)

The slope of the line, denoted as $\beta 1$, represents the firm risk of a firm in relation to the market (Hamada, 1972). After calculating the risk from beta estimation from equation (1), we averaged these values over a year to get year-wise estimates of firm risk (Shin and Stulz, 2000). We utilize them as a proxy for our dependent variable in the analysis.

4.2. Independent Variables

Ordered Backlog: The ordered backlog for semiconductor firms comprises products such as chips, devices, and related products that customers have ordered but have yet to receive. The Compustat database provides annual total dollar values of these ordered backlogs. We scale the value of ordered backlogs with firms' assets using this ratio as a proxy for our leading

[2] Given the semiconductor industry's rapid technological and structural changes over time, we refrain from utilizing older data. Overemphasizing historical data could potentially misrepresent the current dynamics, including the recent challenges and opportunities faced by firms.

independent variable following the prior literature (Rajgopal et al., 2003). The backlog-to-asset ratio allows us to set the value of ordered backlogs to a common standard, facilitating comparison across semiconductor firms of different sizes.

Marketing Intensity: We measure marketing intensity as the ratio of semiconductor firms' marketing expenditure to sales using the Compustat dataset. The marketing intensity ratio helps us to compare the marketing investments across all semiconductor firms within the industry. The method of calculating the marketing intensity ratio aligns with the methodology used by prior researchers (Ehie and Olibe, 2010).

Research Intensity: We calculate the research intensity by taking the ratio of a semiconductor firm's R&D expenditures to its sales, leveraging data from the Compustat database. A high ratio of research intensity signals a greater stress on innovation by the semiconductor firm. As prior literature suggests, the research intensity ratio enables us to compare various size firms within the semiconductor industry (Ettlie and Sethuraman, 2002; Leachman et al., 2005; Wei et al., 2022).

Workforce Size: The workforce size of semiconductor firms is quantified by examining the number of employees, as accessible in the Compustat database. The workforce size serves as a proxy for the firm's production capacity, with a larger number of employees often correlating to greater production capabilities. Consequently, this capacity enables semiconductor firms to address the needs of a broad clientele, encompassing a variety of sectors. Each sector associated with semiconductor firms typically presents unique specifications and demands for semiconductor components. With an increased production capacity derived from a sizable workforce, these semiconductor firms are more adept at effectively managing the requirements of these diverse sectors. Prior research also validates the use of employee numbers as a credible metric for determining firm size (Brusco et al., 1998; Liu et al., 2022; Min and Galle, 1999).

Top Management Team Size: In our analysis, the "top management team size" is quantified by counting the number of C-suite executives within a semiconductor firm, with data sourced from the ExecuComp database. Employing the number of C-suite executives as a metric for top management team size is both conventional and fitting, especially when investigating strategic decision-making processes and organizational results, as supported by the prior literature (Wiersema and Bantel, 1992).

Control Variables: We incorporate additional control variables that could influence firm financial risk. These include the CEO's previous experience, quantified in years, as a seasoned CEO is likely to implement strategies that mitigate firm risk (Guthrie and Datta, 1997). Furthermore, we consider the presence of a Chief Operating Officer (COO) within semiconductor firms, assigning a value of 1 if a COO is present and 0 if not. The COO plays a vital role in reducing firm risk by effectively managing the supply chain process (Marcel, 2009). We also account for the firm's financial performance, using returns on sales (ROS) as a proxy. A semiconductor firm in a robust financial position is likely to face less risk and enjoy an enhanced reputation (Chen et al., 2015). These variables are included as controls to ensure our hypotheses hold true in an empirical setting, even when these factors are taken into account. Table 1 summarizes the description of the major variables, while Table 2 presents the descriptive statistics and correlation coefficients.

Table 1. Details of the Measures

Conceptual Variables	**Measure**	**Data Source**
Firm Risk	Beta Coefficient calculated by market returns and the returns of the S&P 500 index	CRSP
Ordered backlog	Ratio of total dollar value of ordered backlogs to assets	COMPUSTAT
Marketing Intensity	Ratio of marketing expenses to sales	COMPUSTAT
Research Intensity	Ratio of research expenses to sales	COMPUSTAT
Workforce Size	Number of employees in the firm	COMPUSTAT

Top Management Team (TMT)	Total number of C-suite members in the firm	ExecuComp
CEO Experience	Number of Years spend by the CEO in the firm	ExecuComp
Presence of Chief Operating Officer (COO)	=1 if COO is presence, otherwise 0.	ExecuComp
Return on Sales	Ratio of firm profit to Revenues	COMPUSTAT

Table 2. Correlation and Descriptive Statistics (*p<0.01)

		1	2	3	4	5	6	7	8	9
1	Firm Risk	1								
2	Ordered Backlogs	-0.04*	1							
3	Marketing Intensity	-0.01	-0.05*	1						
4	Research Intensity	-0.01	-0.02	0.12*	1					
5	Workforce Size	0.05*	-0.05*	-0.01	-0.01	1				
6	TMT	0.11*	-0.17*	-0.01	-0.02	0.28*	1			
7	CEO Experience	0.10*	-0.11*	-0.01	-0.02	0.13*	0.68*	1		
8	Presence of COO	-0.01	-0.03*	-0.00	-0.00	0.00	0.16*	0.14*	1	
9	Return of Sales	0.01	0.00	-0.29*	-0.71*	0.00	-0.03*	0.02	0.00	1
	Mean	0.08	0.37	0.01	0.21	6390	2.20	4.81	0.16	0.26
	SD	0.13	0.57	0.02	3.97	18860	2.89	8.47	0.13	4.37
	Sample Size	5785	5785	5785	5785	5785	5785	5785	5785	5785

4.3. Endogeneity Correction

We use ordered backlogs as our primary independent variable. However, there remains the potential for other variables to impact our dependent variable, which would be captured in the error term. To address this potential endogeneity, we employ an instrumental variable approach. Our selected instrument is the lagged year inventory value, sourced from the Compustat database.

The inventory levels of semiconductor firms refer to the materials available for the production process and finished products available for sale (Rajagopalan and Malhotra, 2001). The high level of ordered backlogs suggests a high product demand which firms manage by maintaining a higher inventory level (Wang and Tang, 2013). This makes the firm's inventory level inherently linked to ordered backlogs (Cattani and Souza, 2002). Secondly, semiconductor firms maintain optimal inventory levels to manage productional and operational flexibilities, which allows them to address immediate demand fluctuations (Plaza et al., 2018). This inventory level may be associated with the firms' increased costs, but it is not directly related to the firms' financial risk. Third, we consider the lagged (t-1) inventory level as our instrument variable affecting the ordered backlogs in the current period (t). We examine the impact of current period ordered backlogs (t) on firm risk in the subsequent period (t+1) to remove the endogeneity due to "simultaneity". Therefore, inventory level from the prior period (t-1) is not directly associated with firm risk in the following period (t+1). Hence, our instrumental variable follows the criteria of exclusion restrictions.

Two-Stage Least Square: To empirically validate our hypotheses, we employ the two-stage least squares (2SLS) method. The 2SLS method is a widely applied method to help resolve problems of endogeneity caused by measurement errors, omitted variable bias or selection bias (Semykina and Wooldridge 2010; Zaefarian et al., 2017). We also conducted a Hausman test and found that the fixed effects model is more appropriate to use along with 2SLS to analyse the longitudinal dataset. The fixed effects model considers time-invariant unobserved heterogeneity and individual-specific effects into account while performing the analysis (Plümper and Troeger, 2007). In the initial stage, we use ordered backlog as the dependent variable and inventory level as an instrumental variable. In the subsequent stage, firm risk is the dependent variable, with the predicted values of ordered backlogs from the first stage serving as the independent variable. The equation we used to estimate the second stage is as follows:

$$Firm\ Risk_{i(t+1)} = \beta_0 + \beta_1 Ordered\ Backlogs_{it} + \ \beta_2 Ordered\ Backlogs_{it} * Marketing\ Intensity_{it} + \beta_3 Ordered\ Backlogs_{it} * Research\ Intensity_{it} + \beta_4 Ordered\ Backlogs_{it} * Workforce\ Size_{it} + \beta_5 Ordered\ Backlogs_{it} * TMT_{it} + \beta_6 Marketing\ Intensity_{it} + \beta_7 Research\ Intensity_{it} + \beta_8 * Workforce\ Size_{it} + \beta_9 * TMT_{it} + +\beta_{10} CEO\ Experience_{it} + \beta_{11} COO\ Presence_{it} + \beta_{12} Return\ on\ Sales_{it} + \varepsilon \ldots\ldots\ldots\ldots (2)$$

In the above expression, all independent variables are lagged. This structure prevents the possibility of causality and signals a unidirectional effect. Note that prior literature also uses lagged variables to address the endogeneity problem caused by simultaneity (Decampos et al., 2022).

5. RESULTS

5.1 Hypothesis testing

Upon applying the 2SLS fixed effects model, our findings lend support to our hypotheses (Table 3). The specifics of the results are outlined below:

Results for H1: The results of our analysis show that the coefficient of ordered backlogs is negative (β = -0.19) and statistically significant ($p < 0.05$). This empirical evidence supports our first hypothesis (H1) that an increase in ordered backlogs is associated with a decrease in the risk of semiconductor firms.

Results for H2: Our analysis also reveals that the coefficient for the interaction between ordered backlogs and marketing intensity is positive (β = 3.47) and statistically significant ($p < 0.1$). Hence, H2 is empirically supported. This suggests that as the marketing intensity of semiconductor firms increases, the influence of ordered backlogs in diminishing the firms' risk is mitigated.

Results for H3: We also find that the interaction between ordered backlogs and research intensity has a positive coefficient (β = 0.05), with statistical significance ($p < 0.05$) which gives empirical support to H3. This implies that as semiconductor firms increase their research intensity, it mitigates the effect of ordered backlogs in reducing the firms' risk.

Results for H4: Our analysis also indicates that the interaction between ordered backlogs and workforce size is positively correlated (β = 0.002) and is statistically significant ($p < 0.1$). Therefore, H4 is also empirically supported. This suggests that the effect of ordered backlogs in diminishing the risk for semiconductor firms is reduced in the case of larger firms.

Results for H5: Our analysis also indicates that the interaction between ordered backlogs and firm size has a positive correlation (β = 0.01), but it lacks statistical significance ($p < 0.1$). Thus, H5 is not empirically supported. Hence, we are not able to confirm that an increase in the size of the TMT of semiconductor firms has an effect on mitigating the impact of ordered backlogs in reducing the firms' risk. There is a higher likelihood that there could be unaccounted random factors influencing the relationship. Hence, we conduct a robustness analysis employing a random effects model to mitigate this potential bias.

All control variables are included in the analysis presented in Table 3. Hypotheses H1 to H4 receive empirical support when these controls are factored in. Therefore, variables such as CEO experience, the presence of a COO, and firm performance do not impact our study's outcomes.

Table 3. Main Model Results, DV-Firm Risk, ***p<0.01, **p<0.05, *p<0.1

Variables	**Model 1**	**Model 2**	**Model 3**
Ordered Backlog	**-0.16** (0.07)**	**-0.23** (0.09)**	**-0.19** (0.08)**
Ordered Backlog * Marketing Intensity			**3.47* (1.91)**
Ordered Backlog * Research Intensity			**0.05** (0.02)**
Ordered Backlog * Workforce Size			**0.02***

			(0.01)
Ordered Backlog * TMT			**0.01** **(0.01)**
Marketing Intensity		-0.06 (0.51)	-0.43 (0.59)
Research Intensity		0.00 (0.01)	0.00 (0.01)
Workforce Size		-0.00 (0.00)	-0.01 (0.00)
TMT		-0.04 (0.02)	-0.01** (0.02)
CEO Experience		0.01 (0.01)	0.00 (0.00)
Presence of COO		-0.03 (0.02)	-0.02 (0.01)
Returns on Sales		0.01 (0.04)	0.00 (0.04)
Inventory Level (Instrument)	Present	Present	Present
Wald Chi2 Statistics	5.01***	1497.80***	2422.39***
R -Square	0.01	0.03	0.10

Model 1: Results with the main effect only

Model 2: Results with main effect and other variables

Model 3: Full model results with interaction and controls

5.2 Robustness Analysis

Alternative Dependent Variable: We consider the year-averaged beta as a proxy of firm risk calculated using observed and predicted stock returns. It is a useful metric to measure risk, but there are alternative ways to calculate firm risk. We find that the Altman Z score is one of the variables to measure firm risk (Patel et al., 2022). Altman Z score is a financial metric used to calculate a firm's likelihood of going bankrupt (Altman et al., 2017). It is measured using five different ratios covering the financial and operational leverages. Prior research also used the Altman Z-score as a proxy for measuring firm risk (Zhang et al., 2019). The formula for Altman Z-score is given below (Holpus et al., 2021):

Altman Z-score= 3.3(Earnings before interest and taxes to assets ratio) + 0.99*(Sales to assets ratio) + 0.6*(Market value of equity to liabilities ratio) +1.2*(Working capital to assets ratio) +1.4*(Retained Earnings to assets ratio) …………………..(2)*

All these variables are available in the Compustat database. We collect the information on all these variables from 1998 to 2021 and calculate the Altman Z-score for all the semiconductor firms available in our longitudinal dataset. We reverse the Altman z-score to maintain the consistency with the main model results and also winsorize them to avoid the influence of outliers following prior literature (Altman, 2018; Mishra and Modi, 2016). We run the fixed effects model, considering the Altman Z-score as the dependent variable along with all other independent and control variables used in the main model analysis. The results are reported in Table 4. All of our hypotheses are empirically supported.

Table 4. Alternate Model Results, DV- Altman Z-Score (Rev.), ***p<0.01, **p<0.05, *p<0.1

Variables	**Model 1**	**Model 2**	**Model 3**
Ordered Backlog	**-0.02*** (0.01)**	**-0.02*** (0.01)**	**-0.04*** (0.01)**
Ordered Backlog * Marketing Intensity			**0.01** (0.00)**
Ordered Backlog * Research Intensity			**0.17*** (0.06)**
Ordered Backlog * Workforce Size			**0.01* (0.01)**
Ordered Backlog * TMT			**0.07*** (0.01)**
Marketing Intensity		0.42 (0.38)	0.44 (0.37)
Research Intensity		-0.03 (0.01)	-0.10 (0.01)
Workforce Size		0.01** (0.01)	0.01 (0.01)
TMT		0.01 (0.01)	0.00 (0.05)

CEO Experience		1.70 (1.64)	1.79 (1.61)
Presence of COO		-0.01 (0.01)	-0.03 (0.01)
Returns on Sales		-0.04 (0.01)	-0.06 (0.1)
F-Statistics	18.22***	7.22***	16.39***
R -Square	0.03	0.09	0.17

Model 1: Results with the main effect only

Model 2: Results with main effect and other variables

Model 3: Full model results with interaction and controls

Random Effects Model: We also conduct a random effects model analysis on the longitudinal dataset as a robustness check. For this analysis, we employed the same 2SLS approach, using inventory levels as an instrument for ordered backlogs in the first stage and the estimated values of ordered backlogs in the second stage. The empirical evidence supports our first hypothesis (H1), demonstrating that an increase in ordered backlogs corresponds to a decreased risk for semiconductor firms. This evidence also supports our second hypothesis (H2), which posits that as the marketing intensity of semiconductor firms rises, the effect of ordered backlogs in mitigating firms' risks lessens. Similarly, the results back our third hypothesis (H3), indicating that increased research intensity among semiconductor firms diminishes the impact of ordered backlogs on risk reduction. Our analysis provides further support for our fourth hypothesis (H4), showing that the influence of ordered backlogs in reducing risk is weaker for larger firms. Finally, the results confirm our fifth hypothesis (H5), suggesting that a larger TMT in semiconductor firms plays a role in lessening the impact of ordered backlogs on risk reduction. These findings are detailed in Table 5 (Column 1).

Multicollinearity, Heteroskedasticity and Serial Correlation: We also examine the model for multicollinearity and heteroskedasticity. The model exhibits no multicollinearity, with a mean variance inflation factor (VIF) of 1.98. Furthermore, we conducted tests for heteroskedasticity, which indicated that the model is free from heteroskedasticity. The residuals of one-time period may be correlated with the other, causing bias in the standard errors of estimates and inflating the type I error (Zhang et al., 2015). To address this issue, we use vce(robust) command available in Stata along with the 2SLS fixed effects model, which accounts for this within panel correlation and avoids this underestimation. Prior research has used the same method to address the serial correlation problem (Chandrasekaran and Mishra, 2012). We include this process in our main model analysis and robustness checks section to address the serial correlation.

Other Control Variables: We also incorporate various control variables sequentially to validate the robustness of our results. One such variable is the presence of Chief Marketing Officers (CMOs), as they play a crucial role in formulating strategies to engage customers through multiple channels and mitigate backlogs by ensuring product alignment with customer expectations. Our findings remain consistent even with the inclusion of CMOs in the analysis. Additionally, we consider the debt levels of semiconductor firms, given that excessive reliance on debt can amplify risk. Earnings before interest is another variable we include, as substantial earnings can facilitate interest payments, subsequently reducing the firm's risk. We include US inflation and GDP growth rates from the World Bank website from 1998 to 2021 to account for economic conditions. We create recession (=1 for 2008-09, otherwise 0) and the Covid pandemic (=1 for 2020-21, otherwise 0) dummies to account for demand fluctuations from shocks in the US economy. We also include the Herfindahl Index based on sales, which measures market shares of semiconductor firms. The Herfindahl index accounts for market and competition dynamics in the semiconductor industry (Arocena and Oliveros, 2012). We also include deferred revenue liability, which is measured by the ratio of deferred revenues to sales. The deferred or future revenues account for liability in the balance sheet and reduce short-term margins (Prakash and Sinha, 2013). We include these additional control variables in fixed and random effects models and results are reported in Table 5, columns 2 and 3. Our results hold steady following the incorporation of these variables. This consistency in our results, even with the addition of factors that could potentially influence the study, reaffirms the validity of our findings.

Table 5. Robustness Analysis Results, DV-Firm Risk, ***p<0.01, **p<0.05, *p<0.1

Variables	Random Effects Model	Fixed Effects Model with Additional Controls	Random Effects Model with Additional Controls
Ordered Backlog	**-0.18*** (0.05)**	**-0.10*** (0.04)**	**-0.13*** (0.05)**
Ordered Backlog * Marketing Intensity	**3.34** (1.54)**	**2.38** (1.05)**	**2.65* (1.59)**
Ordered Backlog * Research Intensity	**0.09*** (0.03)**	**0.04*** (0.02)**	**0.07** (0.03)**
Ordered Backlog * Workforce Size	**0.01** (0.01)**	**0.01** (0.01)**	**0.03*** (0.01)**
Ordered Backlog * TMT	**0.01** (0.01)**	**0.01** (0.01)**	**0.02 (0.01)**
Marketing Intensity	-1.06 (0.39)	-0.38 (0.23)	-0.93 (0.35)
Research Intensity	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
Workforce Size	-0.00 (0.00)	-0.01* (0.00)	-0.01 (0.00)
TMT	-0.01* (0.02)	-0.01 (0.02)	-0.01 (0.02)
CEO Experience	-0.00 (0.00)	-0.00 (0.00)	-0.01 (0.00)
Presence of COO	-0.01 (0.01)	0.02 (0.01)	-0.01 (0.01)
Returns on Sales	0.00 (0.04)	-0.00 (0.04)	0.00 (0.01)
Presence of CMO		-0.01 (0.01)	-0.01 (0.01)
Covid Pandemic		0.05 (0.13)	0.04 (0.02)
Recession		0.39* (0.09)	0.19* (0.01)
Inflation Rate		0.12* (0.03)	-0.03 (0.02)
GDP Growth		-0.02	0.03

		(0.01)	(0.01)
Herfindahl Index		0.03 (0.01)	0.01 (0.01)
Debt Level		-0.03 (0.01)	-0.01 (0.02)
Deferred Revenue Liability		0.37 (0.26)	0.68 (0.37)
Inventory Level (Instrument)	Present	Present	Present
Wald Chi2 Statistics	38.33***	8934.81***	567.16***
R -Square	0.11	0.28	0.23

6. DISCUSSION AND IMPLICATIONS

Our research suggests that the semiconductor firms' ordered backlogs can reduce financial risk. The semiconductor firms face increasing risk due to the rise in the demand for semiconductors and associated products, which may negatively affect firm performance. We collect the US publicly traded semiconductor firm's data from 1998-2021 and provide the empirical evidence that ordered backlogs reduce firm risk levels after the analysis. Our study also uncovers the complexities associated with risk management with the help of potential moderators. Although ordered backlogs can reduce the firm risk marketing intensity, research efforts and workforce size can moderate the impact of ordered backlogs on firm risk. As these firm characteristics increase, the effectiveness of ordered backlogs in reducing risk diminishes. Our research findings have critical theoretical and managerial implications, which we explain in the next section.

6.1 Theoretical Implications

With this research, we contribute to the conceptual theories discussed in risk management, inventory, and supply chain management. Most of the research conducted in these areas focuses on firm-related aspects across various industries. However, our research improves the granularity of the theoretical framework within the semiconductor industry. We begin by highlighting the distinctiveness of our research compared to existing literature associated with risk management using selected seminal articles to evaluate our contribution critically.

We extend the previous version of risk management theory, which focuses on financial and operational factors for risk reduction. Our research enriches the risk management area by exploring ordered backlog strategies to reduce firm risk effectively. This concept offers an applied version of the risk management theory, proposing that the management of ordered backlog strategies could play an essential role in stabilizing firm risk under market uncertainties. Our study also contributes to the supply chain management literature and uncovering that managing inventory levels is more than an operational process and mitigating firm risk.

We find that an increase in marketing spending reduces the contribution of backlogs to firm risk. We must understand this interaction of ordered backlogs and marketing intensity because these factors are focused individually on various theoretical frameworks. The marketing expenditure encourages promotional activities that can increase firm performance, but it is not helpful to firms in managing risk if they don't focus on backlogs. This is an important insight advancing our knowledge related to the operations-marketing interface. Investment in research and development (R&D) is not always helpful in the semiconductor industry because research expenditure can moderate the relationship between backlogs and firm risk. The semiconductor firms should strike the right balance between the diffusion of innovation and ordered backlogs for risk.

We also contribute to the human capital framework by suggesting that an increase in workforce size may only sometimes be advantageous for firms. We reveal that "increasing the workforce diminishes the involvement of backlogs on firm risk", which implies that the semiconductor industry should focus on the trade-off between workforce size and ordered backlogs for risk mitigation. This pertinent finding enriches the current literature on human capital and risk management strategies. We also argue that larger firms in the semiconductor industry may use alternative methods to reduce financial risk. Future researchers may hence explore another theoretical framework to connect human capital, operational strategies, and risk management in this sector.

Our contribution to the upper echelon's theory is evident because we find that a larger top management team diminishes the effectiveness of backlogs in risk reduction. Prior literature suggests the importance of the top management team for overall strategic decision-making. Even the diverse top management with a high volume of executives may not help the semiconductor industry with risk reduction if backlogs are not properly managed. Hence, we provide the foundation for researchers to explore the interplay between TMT characteristics, ordered backlog strategies, and risk management to gain insights within the semiconductor industry.

We introduce specific issues and strategic actions to advance risk management using semiconductor industry backlogs. Several research articles contribute to these areas, and we have selected a few to compare and clarify our unique implications (Blome and Schoenherr, 2011; Liu and Cruz, 2012). The conceptualization of backlog-related strategies for managing risk in a specialized sector fills the theoretical gaps in the previous literature. When interacting with backlogs, some of the firm characteristics provide additional insights for firms focusing on risk mitigation. Our research motivates researchers to explore this business operations area more.

6.2 Managerial Implications

A lot of news in the semiconductor industry causes worries to financial investors. For instance, investment managers issue warnings to potential investors in the semiconductor industry due to water shortages for production (InvestmentNews, 2023). Geopolitical challenges are another source of “worrying news”. This type of news causes concern in potential investors who may lose confidence, increasing the risk in the semiconductor industry. Semiconductor firms have to address these concerns. With our research, we assist in such situations by recommending production managers develop strategies for disclosing the information of ordered backlogs to mitigate risk effectively.

The production managers need to understand how vital ordered backlog strategies are for risk management. They should manage customer relationships and optimize operational processes to control the flow of ordered backlogs effectively. They should also understand how backlogs and marketing intensity are related because this may raise the risk level in the firm. The managers should develop strategies for optimal resource allocation in promotional strategies because it may weaken the effect of backlogs on risk mitigation. They can formulate a holistic approach to combine marketing efforts and backlogs to manage semiconductor firms’ risk.

The presence of high R&D expenditure along with ordered backlogs may not reduce firm risk. The product manager should control the additional R&D investment in case of a high volume of ordered backlogs because it may increase the firm's risk. They should compose only those strategies that align with the ordered backlog strategies and reduce firm risk. If production managers of semiconductor firms plan to allocate more resources for advanced innovation, they should manage the ordered backlogs accordingly.

If their workforce is large, semiconductor firm managers should manage their backlogs as efficiently as possible to lower risk. To take advantage of ordered backlogs, they may create supply chain and inventory management techniques. To lower corporate risk, they should consider potential uses for the large workforce. Managers need to be aware that when it comes to risk mitigation with ordered backlogs, having a large top management team may not be beneficial. Hence, rather than expanding the top management team, team members should formulate optimal risk management strategies based on ordered backlogs. As a result, in the semiconductor business, upper-echelon members can also be extremely important in managing backlogs and firm risk.

7. CONCLUSION

Our research sought to understand the impact of ordered backlogs on the risk faced by semiconductor firms, and how various firm-related factors can mitigate this impact. Our analysis of a longitudinal dataset of publicly traded US semiconductor firms reveals several important findings. First, we find that a higher volume of ordered backlogs is indeed associated with a reduction in firm risk. However, this risk mitigation effect diminishes as the marketing intensity and research intensity of the firms increase. We also find that the positive impact of ordered backlogs on risk reduction is less pronounced in large workforce firms and that a larger top management team contributes to a reduction in the impact of ordered backlogs on risk. These findings provide valuable insights for both theory and management practice, underscoring the importance of considering various firm-related factors when seeking to leverage ordered backlogs as a means of risk reduction in the semiconductor industry.

7.1 Limitations and Directions of Future Research

Our research focuses on US publicly traded semiconductor firms. Researchers can examine the impact of ordered backlogs on semiconductor firms in emerging markets, thereby broadening the research scope to gain insights into this phenomenon across diverse economic contexts. An additional limitation of this study is its limited applicability of findings to the broader spectrum of semiconductor markets, specifically private firms within the industry. Hence, researchers interested in investigating the impact of backlogs on financial risk in privately-held semiconductor firms may need to compile their own data for a more extensive analysis, thereby expanding the research's reach and breadth.

An additional limitation of our research is the absence of qualitative data. Researchers have the opportunity to gather information through in-depth interviews or surveys involving executives and industry experts, aiming to achieve a more profound comprehension of how ordered backlogs influence firm risk. Qualitative data has the potential to offer valuable insights into the decision-making procedures within semiconductor firms.

Researchers have the option to explore specific sub segments within the semiconductor industry, such as integrated circuits, sensors, memory chips, and others. These subsectors represent distinct areas of the semiconductor field. By investigating the connection between ordered backlogs and risk within these sub segments, researchers may uncover variations in the impact across different areas of the industry.

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