



**HISTORICAL ANALYSIS OF THE POST-EARNINGS ANNOUNCEMENT DRIFT  
IN THE U.S. SEMICONDUCTOR SECTOR 2018-2023**

Lappeenranta–Lahti University of Technology LUT  
Bachelor's Programme in Strategic Finance, Bachelor's thesis  
2024  
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Examiner: Associate professor Anni Tuppur

## ABSTRACT

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Despite being one of the most studied anomalies in financial markets, research on Post-Earnings Announcement Drift (PEAD) has diminished in recent years, necessitating a contemporary analysis of its persistence and potential shifts. This thesis examines the phenomenon of PEAD within the U.S. semiconductor sector over a six-year period from 2018 to 2023. The aim of the study is to explore the prevalence of PEAD in this sector, particularly in light of different market conditions.

The research employs the event study methodology to analyze stock price reactions to quarterly earnings announcements. The dataset includes 1,872 observations from 78 U.S.-based semiconductor companies, covering 24 quarters. The study measures abnormal returns using the market model and applies significance tests to results to ensure statistical robustness. Abnormal returns are analyzed throughout the event window, focusing on cumulative abnormal returns to evaluate the drift's magnitude and persistence.

The empirical results show that the behavior of PEAD in the U.S. semiconductor is aligned with previous studies, confirming the presence of PEAD in the semiconductor sector. The results show that PEAD is still present, but its prevalence varies depending on the time period. The notable changes are most pronounced during the COVID-19 pandemic. During this period, increased market volatility and investor uncertainty seemed to amplify the PEAD anomaly, highlighting the impact of financial disturbances on market inefficiencies.

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## **HISTORIALLINEN ANALYYSI TULOSJULKISTUSTEN JÄLKEISESTÄ POIKKEAMASTA YHDYSVALTALAISILLA PUOLIJOHDESEKTORILLA 2018- 2023**

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Vaikka Post-Earnings Announcement Drift (PEAD) on yksi rahoitusmarkkinoiden eniten tutkituista poikkeavuuksista, sen tutkimus on vähentynyt viime vuosina. Tästä johtuen sen pysyvyyttä ja mahdollisia muutoksia on tutkittava nykyaikaisesti. Tässä tutkielmassa tarkastellaan PEAD-ilmiötä Yhdysvaltojen puolijohdesektorilla kuuden vuoden ajanjaksolla 2018-2023. Tutkimuksen tavoitteena on tutkia PEAD:n esiintyvyyttä tällä sektorilla erityisesti erilaisten markkinaolosuhteiden valossa.

Tutkimuksessa käytetään tapahtumatutkimusmenetelmää analysoimaan osakekurssien reaktioita neljännesvuosittaisiin tulosjulkistuksiin. Aineisto sisältää 1 872 havaintoa 78 yhdysvaltalaisesta puolijohdeyrityksestä, jotka kattavat 24 vuosineljännestä. Tutkimuksessa mitataan epänormaaleja tuottoja markkinamallin avulla ja tuloksiin sovelletaan merkitsevyyttestejä tilastollisen kestävyuden varmistamiseksi. Epänormaaleja tuottoja analysoidaan läpi tapahtumaikkunan ajan ja painopiste on kumulatiivisissa epänormaaleissa tuotoissa. Niiden avulla arvioidaan mahdollisten poikkeamien suuruutta ja pysyvyyttä.

Empiiriset tulokset osoittavat, että PEAD:n käyttäytyminen Yhdysvaltojen puolijohdealan markkinoilla on linjassa aikaisempien tutkimusten kanssa, mikä vahvistaa PEAD:n läsnäolon puolijohdesektorilla. Tulokset osoittavat, että PEAD on edelleen havaittavissa, mutta sen esiintyvyys vaihtelee riippuen ajanjaksosta. Muutokset ovat selvimmillään COVID-19-pandemian aikana. Tänä aikana markkinoiden lisääntynyt volatilitteetti ja sijoittajien epävarmuus näyttivät vahvistavan PEAD poikkeamaa, mikä korostaa rahoitushäiriöiden vaikutusta markkinoiden tehottomuuteen.

## Table of Contents

Abstract

<b>1</b>	<b>Introduction .....</b>	<b>1</b>
	1.1. Background.....	1
	1.2. Literature Review & Previous Studies.....	2
	1.3. Research Questions & Objectives .....	3
	1.4. Scope and delimitations of the study .....	5
	1.5. Structure of the study.....	5
<b>2</b>	<b>Theoretical framework .....</b>	<b>6</b>
	2.1 Efficient Market Hypothesis (EMH) .....	6
	2.2 Capital Asset Pricing Model (CAPM).....	7
	2.3 Earnings Surprise .....	8
	2.4 Market Anomalies.....	9
	2.5 Behavioral Finance .....	10
	2.5.1 Underreaction & Overreaction .....	11
	2.5.2 Prospect Theory.....	11
	2.5.3 Behavioral Asset Pricing.....	12
<b>3</b>	<b>Empirical analysis &amp; methodology .....</b>	<b>13</b>
	3.1 Earnings Announcement.....	13
	3.2 Event Study Method (ESM).....	14
	3.3 Normal and Abnormal Returns.....	15
	3.4 Significance Tests .....	17
<b>4</b>	<b>Data.....</b>	<b>20</b>
	4.1 Sample Selection.....	20
	4.2 Sample Description.....	22
<b>5</b>	<b>Empirical results.....</b>	<b>25</b>
<b>6</b>	<b>Conclusion.....</b>	<b>36</b>
	6.1 Research Questions .....	36
	6.2 Discussion.....	37
	6.3 Limitations and Further Studies .....	38
	<b>References .....</b>	<b>40</b>
	<b>Appendices</b>	

## **List of Figures**

**Figure 1:** Event study timeline

**Figure 2:** Philadelphia Semiconductor Index (SOX)

**Figure 3:** Distribution and Average Percentages of Earnings Surprises

## **List of Tables**

**Table 1:** Sample data breakdown

**Table 2:** AAR, whole sample data

**Table 3:** CAAR, whole sample data

**Table 4:** AAR, whole sample data divided by earnings surprise

**Table 5:** CAAR, whole sample data divided by earnings surprise

**Table 6:** AAR, sample data segmented into individual years

**Table 7:** CAAR, sample data segmented into individual years

## **List of Appendices**

**Appendix 1:** List of the stocks

# 1 Introduction

## 1.1. Background

Investors constantly search for a winning edge in today's ever-rising stock market. A couple of the most influential factors that drive stock prices are significant macroeconomic changes, quarterly earnings reports, and positive or negative news. This new information often leads to rational thinking being overthrown by emotional reactions and impulsive decision-making while investing in the stock markets (Wärneryd, K.-E. 2001). Among the most impactful types of news are quarterly earnings reports, which provide crucial insights into a company's financial health and prospects. Company stock prices often react sharply to these earnings announcements, reflecting market sentiment in response to better-than-expected or disappointing results (Beaver, W. H. 1968).

This thesis will focus specifically on the Post-Earnings Announcement Drift (PEAD) anomaly discovered by Ball & Brown (1968). This anomaly, which has been studied for nearly six decades, indicates that stock prices continue to drift toward the earnings surprise after the initial reaction to the earnings report. This directional surprise move suggests that markets have underreacted to the initial news. Contrary to the Efficient Market Hypothesis (EMH) that suggests stock markets are "informationally efficient". An efficient stock market should immediately incorporate all available information into the stock prices (Fama 1970). Under this theory, systematic anomalies should not persist, as new data, such as earnings reports, are quickly incorporated into stock prices, leaving little opportunity for abnormal returns.

PEAD anomaly differs from other stock market anomalies as it has persisted in all market conditions (Liang & Zhang 2020). This sparked my interest in understanding how the anomaly, known as PEAD, behaves before, during, and after earnings announcements in the U.S. semiconductor sector, empowering the modern lifestyle. Semiconductors and related products are crucial to technological innovations that enable global economic growth (Bhattacharya et al., 2011).

This study will analyze the stock price movements of United States-based, publicly traded semiconductor and related device manufacturing companies before, during, and after their earnings reports over a 6-year period from 2018 to 2023. The objective is to assess the persistence of PEAD within the U.S. semiconductor sector across different periods and market conditions. By focusing on this extended timeframe, the research evaluates whether PEAD is a consistent market feature and whether inefficiencies persist following earnings announcements.

## 1.2. Literature Review & Previous Studies

This section summarizes the most relevant findings related to Post-Earnings Announcement Drift. These findings will consist of previous studies, and they can be used as a support or comparison to the findings of this study. As previously mentioned, PEAD has been studied for decades. Ball and Brown (1968) conducted one of the first studies focusing on earnings announcements and the price action around them. Their research revealed that stock prices react to earnings announcements as soon as the information becomes available. After an earnings announcement, stock prices continued to drift in the same direction as the earnings surprise. A positive earnings surprise results in a sustained upward price drift, while a negative earnings surprise results in a sustained downward drift. These findings were later reinforced by Bernard and Thomas (1989), who provided further evidence of this PEAD anomaly. From this, we can conclude that quarterly earnings announcements provide valuable information about the current state of the company's financial situation, which the market gradually incorporates into the stock price. This opens the theoretical possibility of exploiting this delayed adjustment for abnormal returns.

While these early studies established the foundation for PEAD research, recent studies have focused on its evolution in the context of modern market dynamics. A more recent study on PEAD by Martineau (2021) suggests that PEAD anomaly has weakened in the stock markets due to greater availability of financial information, decreased trading costs, and increased spending in price discovery. This multi-year study, conducted using financial data from U.S. publicly traded firms, employed an event study method to measure abnormal returns and

analyze the magnitude of PEAD. This study brings forth the idea of market efficiency improving due to more readily available financial information to all market participants. Similarly, Richardson and Veenstra (2022) observed that improvements in financial information dissemination have reduced the prevalence of PEAD. Their study adopted a quantitative approach and focused on earnings announcements across various industries. These findings support the EMH, as decreasing information asymmetry leads to quicker incorporation of earnings news into stock prices.

Prior studies examining post-earnings announcement drift have primarily focused on the broader stock market, often overlooking sector-specific PEAD anomaly behavior. The semiconductor sector presents a unique opportunity to investigate these variations in stock prices due to its distinct characteristics. These characteristics include rapid product cycles, high R&D intensity, and sensitivity to macroeconomic and geopolitical changes (Deloitte 2024). The goal of this thesis is to address this research gap by examining PEAD anomaly in the context of the U.S. semiconductor sector. It also contributes to the academic literature on sector-specific market anomalies and offers practical insights for investors and analysts seeking to navigate inefficiencies in the semiconductor sector.

### 1.3. Research Questions & Objectives

The main objective of this thesis is to analyze the prevalence of PEAD occurrences in the semiconductor sector of the U.S. stock market over a six-year time frame. By focusing on the semiconductor sector, this study aims to determine if this relevant and timely sector provides new insights into PEAD anomaly. One key aspect of the research is understanding how PEAD has changed from 2018 to 2023. By studying this timeframe, the thesis aims to identify whether PEAD remains as prevalent as in the past or has diminished. Another important focus is the impact of significant financial events, as this research's timeframe contains a COVID-19 pandemic. The pandemic created unprecedented levels of market volatility and uncertainty (Goodell 2020). This may have influenced how investors react to earnings announcements. According to Martineau (2021), the number of studies focused on

PEAD has steadily declined in recent years. The timeframe 2018–2023 was chosen to capture the most recent trends in PEAD.

This study will not contain a model portfolio to demonstrate possible abnormal returns. It solely focuses on analyzing PEAD occurrences through stock price movements. This approach aligns with the following research questions, each of which has been designed to explore specific aspects of PEAD:

Main research question:

- *How has Post-Earnings Announcement Drift evolved in the U.S. stock market semiconductor sector?*

Sub-questions:

- *Has the prevalence of PEAD in the U.S. semiconductor sector changed over time between 2018 and 2023?*
- *Did PEAD behave differently during significant financial events like the COVID-19 pandemic?*

As this is a historical analysis of PEAD in the U.S. semiconductor sector, I believe these sub-questions will help understand the trends affecting PEAD over time more in-depth. The first sub-question explores whether PEAD has become more or less common in recent years. The second sub-question focuses on whether major economic events like the COVID-19 pandemic affected how PEAD manifests in the semiconductor sector. The empirical analysis of this study will answer the main question, and the sub-questions listed above.

#### 1.4. Scope and delimitations of the study

This study is conducted over a 6-year timeframe in recent history, focusing on the U.S. stock market's semiconductor sector. The primary objective is to analyze the stock price movements of U.S. technology companies before, during, and after their earnings reports to identify the prevalence of Post-Earnings Announcement Drift (PEAD). The first observation is from Q1 2018, and the last is from Q4 2023. However, the 6-year timeframe introduces certain limitations, such as a limited pool of available companies with continuous data, the potential impact of major economic events, and a sector-specific focus. As a result, the empirical findings may not be fully generalizable to other industries or market conditions.

#### 1.5. Structure of the study

This thesis is structured into six sections. Section 1 introduces the background, research questions, and the scope and limitations of the study. Section 2 presents the theoretical framework, focusing on the concept of Post-Earnings Announcement Drift (PEAD) and relevant mathematical and non-mathematical theories related to stock market anomalies. Sections 3, 4, and 5 focus on the empirical analysis, including a description of the research methodology, sample data, and a detailed explanation of the empirical results and their interpretation. Finally, Section 6 summarizes the key findings, discusses their implications, and suggests directions for future research.

## 2 Theoretical framework

This section aims to provide background to the relevant financial theories surrounding the PEAD anomaly in the form of a literature overview and previous studies. First, I will discuss market efficiency and common stock market anomalies, followed by efficient stock valuation methods. This provides the standards for normal market conditions. I will then briefly expand on other market anomalies and finish with related behavioral finance theories. By the end of this chapter, the reader should understand the basic concept of stock market efficiency, stock valuation, and market anomalies.

### 2.1 Efficient Market Hypothesis (EMH)

The efficient market hypothesis refers to the theory that claims all publicly available information is directly incorporated into the stock price, meaning no investor can outperform the stock market in the long run (Fama 1970). This hypothesis has been tested extensively under various market conditions and continues to hold true, demonstrating that investors cannot generate above-average returns (Malkiel 2003).

Fama (1970) categorized market efficiency into three different levels. The first is the weak form of the efficient market hypothesis. The second one is the semi-strong form of the efficient market hypothesis. The third is known as the strong form of the efficient market hypothesis. The difference between these levels lies in how quickly all market participants take into account the public and insider information. The speed at which stock prices adjust to all available information determines the efficiency of the market.

Three levels of market efficiency are defined followingly, weak form of market efficiency suggests that stock prices reflect all past trading prices and volumes. Under these conditions, investors cannot use technical analysis to gain above-average returns. A semi-strong form of market efficiency suggests that stock prices reflect all publicly known information. as

soon as they become known. This means that information such as quarterly reports and news are incorporated into the stock price as soon as they become known to the public. Under these conditions, investors cannot use fundamental analysis to gain above-average returns. The strong form of market efficiency suggests that stock prices reflect all public and insider information. Under these conditions, investors cannot gain above-average returns even if they possess insider information. (Fama 1970; Fama 1991).

The concept of market efficiency is central to this thesis, as it provides a theoretical foundation for understanding how stock prices move when new information is introduced. Post-earnings announcement drift challenges this assumption of efficient markets by suggesting that stock price movement may continue to rise or fall after the initial reaction to new information. This implies there are deviations in the markets, which are not always efficient. EMH also serves as a benchmark for rational stock market behavior (Ball, 1994). Deviations from this rationality during quarterly earnings reports create an opportunity to explore the extent of the PEAD anomaly occurrences in the semiconductor sector of the U.S. stock market.

## 2.2 Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model, also known as CAPM, created by Sharpe (1964), Lintner (1965), and Mossin (1966), is a widely recognized model used to calculate the expected return of an asset based on its systematic risk. Ferruz, Gómez-Bezares, and Vargas (2010) explain that CAPM serves as a benchmark for evaluating whether an asset is overvalued or undervalued based on its risk-adjusted return. Investors can gauge an asset's risk-return tradeoff by comparing the expected return calculated with CAPM with the asset's actual return. The formula for CAPM is as follows:

$$E(R_i) = R_f + \beta_i (E(R_i) - R_f) \quad (1)$$

In the CAPM formula,  $E(R_i)$  represents the expected return of the asset  $i$ ,  $R_f$  is the risk-free interest rate,  $\beta_i$  denotes the beta of asset  $i$ , and  $E(R_m - R_f)$  is the expected return of the market portfolio. (Fama, E. F. & French, K. R. 2004). The CAPM is based on several key assumptions: investors hold diversified portfolios, markets are rational and efficient, and a linear relationship exists between an asset's risk and its expected return (Markowitz 2005). These principles make CAPM an essential tool for evaluating abnormal returns in normal market conditions. Deviations from these assumptions can lead to anomalies like PEAD, where actual returns differ from the calculated expected return.

CAPM allows investors to calculate abnormal returns, which in this thesis are critical for assessing the presence of Post-Earnings Announcement Drift (PEAD) in the U.S. semiconductor sector. Abnormal returns represent the difference between the actual return on an asset and the expected return. Expected returns calculated using CAPM serves as a benchmark for assessing stock performance under normal market conditions and allow investors to detect systematic anomalies such as PEAD.

### 2.3 Earnings Surprise

Earnings surprise represents the deviation between a company's actual earnings per share (EPS) and forecasted financial analyst expectations. This surprise occurs when a company's actual quarterly earnings differ from analysts' forecasts, leading to significant stock price movements (DeFond & Park 2001). Standardized unexpected earnings (SUE) value is calculated using the following formula:

$$\text{Standardized Unexpected Earnings} = \frac{\text{Actual EPS} - \text{Expected EPS}}{\text{Expected EPS}} \quad (2)$$

Earnings surprises usually cause one of the following, as proven by Kaestner (2005). Underreaction is where investors fail to fully adjust stock prices to the new information immediately, leading to a gradual price drift. Overreaction is where investors excessively adjust stock prices based on the earnings news, often causing prices to temporarily overshoot and subsequently revert to their intrinsic value.

Earnings surprise is selected as one of the metrics for this thesis as it plays a central role in understanding Post-Earnings Announcement Drift (PEAD), as it triggers the initial price reaction that PEAD anomaly builds upon. Previous studies have shown that positive SUE values generally lead to upward price drifts, and negative SUE values generally lead to downward drifts. These delayed price drifts highlight the limitations of market efficiency and contradict the assumptions of the EMH.

## 2.4 Market Anomalies

In addition to PEAD, several other anomalies exist in financial markets, some of which have been extensively researched, while others remain less researched. Among the most notable and academically studied anomalies are the January Effect, the weekend Effect, and the momentum Effect.

The January Effect (Keim 1983) refers to the tendency of certain stocks which rise more in January. This phenomenon is often attributed to tax-loss selling in December and repurchasing those stocks back in January. The weekend effect, also known as the Monday effect (French 1980), describes the phenomenon where stock returns tend to be lower on Mondays compared to other weekdays. This is often attributed to negative news released over the weekend. The Momentum Effect (Jegadeesh & Titman 1993) suggests that stocks that have performed well in the past continue performing well in the future. This anomaly reinforces the persistence of stock trends.

Like the PEAD anomaly, all three anomalies challenge the Efficient Market Hypothesis (EMH) by revealing predictable patterns in stock returns that could theoretically be exploited for abnormal profit. The difference between PEAD anomaly and other anomalies mentioned is that it has been present in various stock market conditions (Liang & Zhang 2020). Reoccurring patterns in stock prices suggest that prices may not fully or immediately incorporate new information, contrary to EMH assumptions. Understanding the theory behind these anomalies provides a foundation for exploring how PEAD specifically manifests within the U.S. semiconductor sector.

## 2.5 Behavioral Finance

Market efficiency is influenced by the collective investment behavior of market participants. A key factor shaping this behavior is rooted in behavioral finance, which diverges from traditional finance models by incorporating psychological influences on financial decision-making. Unlike earlier theoretical models, such as the Capital Asset Pricing Model (CAPM), which assumes rational, emotion-free decisions, behavioral finance explores how biases, emotions, and cognitive limitations lead to deviations from theoretically optimal choices. This can lead to deviations from traditional economic theories that assume rational investor behavior. (Brealey et al., 2022). These differences between rational, model-driven predictions and real-world, emotion-driven decisions can lead to market inefficiencies, where anomalies, such as PEAD, can occur.

PEAD anomaly challenges the EMH by proving that stock prices do not immediately reflect all available earnings information (Ball & Brown, 1968). To better understand this disconnect between the information available and stock price, there are a few key behavioral finance theories. All these theories explain why stock prices fail to fully and immediately adjust to new earnings information through different psychological and behavioral factors.

Recent studies about PEAD have incorporated these behavioral finance theories. For example, a study conducted on the Chinese stock market by Shu and Tan (2022) shows that investor bias is correlated with the level of investor knowledge about the stock, often amplifying the PEAD effect following earnings announcements. Another study conducted by Avramov et al. (2023) explores the difference between traditional valuation methods and newer approaches that incorporate irrational investor behavior. Their study highlights that behavioral factors play a significant role in traditional valuation methods. Leaving irrational factors out can lead to anomalies such as PEAD.

### 2.5.1 Underreaction & Overreaction

The theories of underreaction and overreaction are directly tied to the persistence of PEAD anomaly. Underreaction, as described by Hong and Stein (1999), occurs when stock prices adjust gradually to new earnings information because it takes time for the news to fully reach and be processed by all market participants. This delayed adjustment explains why stock prices continue to drift in the direction of an earnings surprise after the announcement. On the other hand, overreaction, where stock prices rise or fall too quickly due to momentum trading and investor feedback loops (Hong & Stein, 1999), can also influence PEAD. In cases of significant earnings surprises, an initial overreaction may amplify initial price movements, which is followed by gradual corrections as the market reassesses the news.

### 2.5.2 Prospect Theory

Next, a key behavioral finance theory, prospect theory, was introduced by Kahneman and Tversky (1979) to challenge traditional economic assumptions of rational decision-making. Unlike classical models, such as the CAPM, which assume that all investors evaluate decisions based on a universal absolute reference point, prospect theory suggests that individuals assess outcomes relative to their own unique reference points. This distinction is further supported by Barberis and Thaler (2002), who highlight how individual reference points shape investor behavior. This provides a broader understanding of the decision-making processes involved in financial markets.

Prospect theory explains asymmetrical reactions to earnings surprises, where negative earnings tend to elicit more substantial price drops due to loss aversion. Supporting this, Berkelaar and Kouwenberg (2009) highlight that loss aversion can cause disproportionately large stock price declines following negative earnings announcements. Anomalies like PEAD can occur in situations like these, where the overreaction caused by loss aversion triggers a negative PEAD drift.

### 2.5.3 Behavioral Asset Pricing

Behavioral asset pricing explains financial market valuations by including the influence of human behavior. Traditional models like the CAPM assume markets are efficient and investors act rationally. Behavioral asset pricing models challenge these assumptions by incorporating factors such as investor sentiment and cognitive biases (Nanayakkara et al., 2019). One notable behavioral asset pricing model is the Behavioral Capital Asset Pricing Model (BCAPM), introduced by Shefrin and Statman (1994). BCAPM expands on CAPM by integrating these behavioral elements, offering a framework to explain market anomalies that traditional models fail to address.

Behavioral asset pricing is beneficial for understanding inefficiencies like PEAD. Behavioral factors such as underreaction or overreaction to earnings announcements can cause prices to adjust gradually or excessively. By considering how psychological influences shape investor decisions, these models provide deeper insights into why anomalies like PEAD persist.

### 3 Empirical analysis & methodology

This section outlines the methodological framework and analytical approach used to assess the presence and persistence of Post-Earnings Announcement Drift (PEAD) in the U.S. semiconductor sector. First, I will introduce the earnings announcement concept and its significance to this thesis, as it forms the basis for analyzing market reactions to earnings announcements. Next, the Event Study Method (ESM) is discussed as a tool for evaluating the impact of these quarterly earnings announcements. This section concludes with a discussion about the normal and abnormal returns and the statistical significance tests used to determine whether the observed market patterns are consistent with the presence of PEAD. The goal of this chapter is to establish a robust framework for empirically examining market efficiency and the occurrence of anomalies like PEAD.

#### 3.1 Earnings Announcement

Earnings announcements are quarterly events where publicly traded companies disclose their financial performance, including key metrics such as net income, revenue, and earnings per share (EPS). These reports are mandated by the Securities Exchange Act of 1934 (15 U.S.C. §78) to ensure transparency and fairness in the financial markets. Standardized quarterly earnings announcements serve as concentrated releases of new information, often leading to sharp stock price movements. As previously mentioned, these reactions are prone to cause deviations in the stock price, which are known as earnings surprises (DeFond & Park 2001).

In this thesis, earnings announcements serve as the focal events for the event study. The empirical analysis will concentrate on the periods surrounding these announcements, examining how stock prices react before, during, and after the release to evaluate the persistence of Post-Earnings Announcement Drift (PEAD). Acting as catalysts for immediate price adjustments, earnings announcements provide a unique opportunity to assess market reactions to new information. This study utilizes pre-calculated earnings surprise values sourced from Refinitiv Workspace to facilitate the analysis.

### 3.2 Event Study Method (ESM)

The event study methodology pioneered by Fama, Fisher, Jensen & Roll (1969) is a commonly used tool in financial research to assess the impact of specific events on stock prices. This methodology was later modernized by MacKinlay (1997) to include daily changes in calculations. ESM is particularly effective for examining stock market anomalies like PEAD, as it provides a structured approach to measuring abnormal returns during defined event windows (Vaihekoski, 2022).

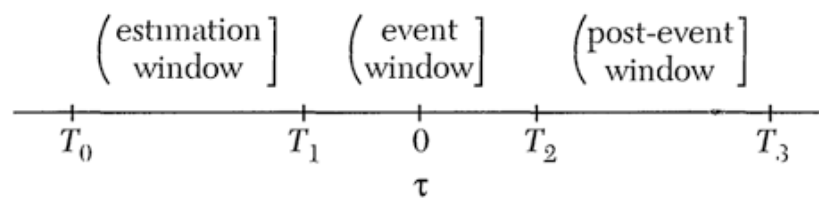


Figure 1: Event study timeline (MacKinlay 1997).

The Event Study Method involves defining specific timeframes to analyze the market's reaction to an event. As illustrated in Figure 1 above, this methodology is divided into three distinct windows: the estimation window, the event window, and the post-event window (MacKinlay 1997). The estimation window is used to establish a baseline for expected returns before an event occurs. This baseline allows us to measure deviations in actual returns caused by the event. According to Vaihekoski (2022), the average estimation window is 250 days before the event. However, the estimation window of this study spans 60 trading days prior to the start of the event window ( $T_0$  to  $T_1$ ). Data from this duration is used to calculate the expected returns for each stock based on historical data. The event window, defined as 10 trading days before and 10 trading days after the event day ( $0$ ), is marked as  $\tau$  in Figure 1 ( $T_1$  to  $T_2$ ). This captures stock price movements before, during, and after the earnings announcement, allowing a detailed examination of immediate and delayed market reactions. The focus of the study is to analyze these reactions where PEAD could

occur. Finally, the post-event window, spanning 10 trading days after the event window ( $T_2$  to  $T_3$ ), is included to analyze any delayed after-effects from the earnings announcement.

The event study methodology for this study follows the framework outlined by Vaihekoski (2022) for analyzing abnormal returns in the Nordic stock market, while the specific model used in this study is based on Juha Soininen's work. Soininen's event study model is a slight variation of Vaihekoski's framework, tailored to be used with market model calculations.

### 3.3 Normal and Abnormal Returns

In event studies, normal and abnormal return values are used to measure the market's reaction to specific events, such as quarterly earnings announcements. Before calculating these values, the expected return for the stock is estimated using the market model. This expected return represents the return a stock would achieve based solely on its historical relationship with the overall market, assuming no event occurred (Pettengill & Clark, 2001). The market model is expressed as:

$$(E)R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \quad (3)$$

Where  $(E)R_{it}$  describes the expected return,  $\alpha_i$ , and  $\beta_i$  are the parameters of the market model,  $R_{mt}$  describes the market return at time  $t$ . The error term variable  $\varepsilon_{it}$  represents deviations from the model's predictions. (MacKinlay 1997).

The results of the market model provide the baseline for calculating Abnormal Returns (AR), which measure the deviation between a stock's actual return ( $R_{it}$ ) and its expected return. AR is calculated using the formula:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \quad (4)$$

Where  $AR_{it}$  represents abnormal returns, and  $R_{it}$  represents the actual return of the stock. Abnormal returns measure the degree to which a stock's actual returns deviate from its expected returns, reflecting the event's impact on stock price performance (Mackinlay 1997).

To evaluate broader market reactions, Average Abnormal Returns (AAR) are calculated by averaging abnormal returns across all sample stocks for each day in the event window. AAR provides insights into whether the event had a uniform impact across the market or varied among companies. AAR is calculated as follows:

$$AAR_t = \frac{1}{N} \sum_{i=t}^N AR_{it} \quad (5)$$

Where  $AAR_t$  describes the average abnormal returns, and N describes the number of events (MacKinlay 1997). AAR helps identify whether stock prices consistently deviate from their expected returns following earnings announcements.

Next, Cumulative Abnormal Returns (CAR) are calculated to measure the total impact of an event on stock prices over the event window. CAR is used to identify whether an event has a significant overall impact over the long term rather than focusing solely on the abnormal return on the event day (MacKinlay, 1997). CAR is calculated using the following formula:

$$CAR(t_1, t_2) = \frac{1}{N} \sum_{t=t_1}^{t_2} AR_{it} \quad (6)$$

Where  $CAR(t_1, t_2)$  describes the cumulative abnormal returns. CAR values capture both immediate and delayed market reactions, providing a more comprehensive view of how quarterly earnings announcement influences the stock price over time.

Finally, Cumulative Average Abnormal Returns (CAAR) are calculated to evaluate the aggregate market reaction to earnings announcements across the 29 sample companies over the event window. CAAR is calculated using the following formula:

$$CAAR(t_1, t_2) = \frac{1}{N} \sum_{t=t_1}^{t_2} CAR(t_1, t_2) \quad (7)$$

Where  $CAAR(t_1, t_2)$  describes the average cumulative abnormal return (Vaihekoski 2022). In this study, CAAR allows for the identification of persistent market trends following earnings surprises, particularly whether stocks with positive earnings surprises continue to experience upward price drift and those with negative surprises exhibit sustained declines.

### 3.4 Significance Tests

Significance tests are essential for evaluating the presence of PEAD in the sample data. This study employs a Student's T-test, invented by Gosset under the pseudonym Student (1908), and the Patell Z-test (Patell, 1976) to determine the significance of calculated AAR and CAAR values. These tests help verify whether the deviations from normal returns calculated using the market model are statistically attributable to the quarterly earnings announcements or are they random fluctuations in stock prices. As indicated by Mishra et al. (2019), both of these tests involve a null and an alternative hypothesis, where the alternative hypothesis assumes a significant difference exists between the estimated and actual returns, while the null hypothesis indicates no statistically significant difference.

This event study follows Juha Soininen's adaptation of Vaihekoski's (2022) event study framework. Both t-tests and z-tests are employed to assess the significance of abnormal returns. The t-test evaluates whether average abnormal returns differ significantly from zero, as demonstrated by Kolari and Pynnönen (2010). The z-test, particularly useful for large samples, assumes a normal distribution to test the significance of abnormal returns. A similar significance z-test has been applied in event studies, such as Singh et al. (2014) on stock price movements. These statistical tests are essential for rigorously analyzing the effects of events on financial markets.

If AR values for positive or negative earnings surprises consistently show statistical significance, it supports the hypothesis that stock prices fail to fully adjust immediately to new information, leading to the price drift known as PEAD. To understand the significance of AAR results, the Student's T-test is conducted using the following formula:

$$t(AAR_t) = \frac{AAR_t}{(\sqrt{\sigma^2 AAR_t})} \sim N(0,1) \quad (8)$$

Where  $AAR_t$  is the calculated average abnormal return, and  $\sigma^2(AAR_t)$  is the variance of average abnormal returns. The standardized t-test evaluates whether the observed AAR differs significantly from zero (Student, 1908). In this study, the T-test indicates that the quarterly earnings announcement has an above-average impact on stock prices. The hypotheses for the T-test are as follows:

Null hypothesis: There is no abnormal return on a specific day.

Alternative hypothesis: There is a statistically significant abnormal return on a specific day.

$$t(CAAR_t) = \frac{CAAR(t_1 t_2)}{(\sqrt{\sigma^2 CAAR(t_1 t_2)})} \sim N(0,1) \quad (9)$$

Where  $CAAR_t$  is the calculated cumulative average abnormal return, and  $\sigma^2 CAAR(t_1, t_2)$  is the variance of average abnormal returns. The Patell Z-test evaluates whether the observed CAAR significantly deviates from zero under the null hypothesis that no abnormal returns exist (Patell, 1976). A significant Z-value in this study indicates that the cumulative abnormal returns reflect a systematic market response to the earnings announcements rather than random price fluctuations. The hypotheses for the Z-test are as follows:

Null hypothesis: There is no cumulative abnormal return over the event window.

Alternative hypothesis: There is a statistically significant cumulative abnormal return over the event window.

## 4 Data

In this section, the data utilized for this study is further defined. A Brief overview of the semiconductor sector is provided, highlighting its key characteristics. Furthermore, the reasons behind the chosen criteria are discussed, along with the factors that influenced the selection.

### 4.1 Sample Selection

Sample data for this study was gathered from Refinitiv Workspace. It includes economic data of U.S.-based publicly traded semiconductor and related device manufacturing companies under the industry NAICS code 334413. The semiconductor sector is known to focus on researching, developing, and producing essential components used to power modern electrical devices, which can range from smartphones to industrial machinery (Singh M. et al., 2023).



Figure 2: Philadelphia Semiconductor Index (SOX) Performance 2018-2023 (Refinitiv Workspace)

As illustrated in Figure 2, the performance of the Philadelphia Semiconductor Index (SOX) from 2018 to 2023 highlights significant trends in the semiconductor sector. The SOX index

comprises 30 of the largest U.S.-traded companies operating directly or indirectly in the semiconductor industry (Nasdaq, 2024). It is widely recognized as a benchmark for assessing the overall performance of the semiconductor sector. The historical price chart reveals notable periods of growth, including a sharp recovery following the COVID-19 market crash, as discussed by Goldstein et al. (2021). The chart also shows moments of volatility caused by macroeconomic changes and industry-specific challenges. The presence of sharp spikes and gradual drifts in the index price suggests the possibility of market inefficiencies, where anomalies such as the PEAD can occur.

In total, 78 companies were listed in Refinitiv Workspace. These will be narrowed down to fit the set criteria listed below:

1. The company is based in the United States
2. The company is active and operating during the whole timeframe
3. The company shares are publicly traded on the National Association of Securities Dealers Automated Quotations (NASDAQ) or the New York Stock Exchange (NYSE)
4. The company must have the following financial data available in Refinitiv Workspace for the timeframe of 1.1.2018 – 31.12.2023.
  - a. Historical share prices.
  - b. Historical EPS values (analyst forecast and actual).
  - c. Quarterly earnings and earnings surprise value.
  - d. Industry name.

These criteria ensure that the study remains focused on examining the occurrence of Post-Earnings Announcement Drift within the U.S. semiconductor sector during the selected timeframe. Companies that did not meet the complete data requirements were excluded from the sample. Precisely, firms that began operations after January 1, 2018, or ceased to exist before December 31, 2023, were removed to maintain consistency in the analysis. Firms lacking reported NAICS codes or earnings announcement dates during the period were also disqualified, as such information is essential for accurate categorization and event analysis. These eligibility requirements ensure the reliability and relevance of the sample data.

## 4.2 Sample Description

The sample data initially consisted of 1,872 observations from 78 U.S.-based companies in the semiconductor and related device manufacturing industry, spanning 24 quarters. Observations were filtered based on the previously listed criteria. A detailed list of the 78 stocks included in the initial sample is provided in Appendix 1. First, companies not based in the U.S. were excluded, removing 48 observations. Next, all observations that did not have semiconductor and related device manufacturing as their primary industry were excluded, resulting in the exclusion of 456 observations. Furthermore, only companies listed on NASDAQ or NYSE were included, leading to the removal of 288 observations. Observations with incomplete historical share price data were excluded, eliminating 288 observations. Additionally, observations missing earnings surprise values or forecasted and actual EPS data were filtered out. Resulting in the removal of 96 observations. After applying these criteria, the final dataset comprises 29 companies and 696 observations, with 1,176 observations excluded. This refined dataset ensures that only relevant data is included for the empirical analysis. A breakdown of this is listed in table 1 below:

Category	Criteria	Observations	Excluded Observations
All companies	78 Companies, 24 Quarters	1872	0
Exchange Location	U.S-Based	1824	48
Industry Name	Semiconductor and Related Device Manufacturing	1368	456
Exchange Name	NASDAQ or NYSE	1080	288
Historical Share Price	No Complete data	792	288
Earnings Surprise & EPS	Missing Values	696	96
<b>Total Observations</b>		<b>696</b>	<b>1176</b>

Table 1: Sample data breakdown

The remaining 696 observations were divided into positive, neutral, and negative earnings surprises. Chiang et al. (2019) highlight the importance of accurately measuring earnings surprises to capture their impact on stock price movements. In their analysis, they emphasize

the limitations of traditional measures as they are prone to bias. Based on this framework, this study uses thresholds where positive surprises exceed 1,5%, neutral falls between 0–1,5%, and negative falls below 0%. This threshold ensures a clear differentiation between minor forecast errors and significant surprises. In addition, One of the sample companies reported earnings based on fiscal years, which were re-aligned to calendar quarters to ensure consistency of the same time frame across all observations in the study. The study utilized pre-calculated earnings surprise values from Refinitiv Workspace.

Figure 3 illustrates the earnings surprises from 2018 to 2023. The bar chart represents the yearly distribution of earnings calls across positive, neutral, and negative surprises, while the color-coded line graphs display the average percentage of each category. The sample data comprises 532 positive, 74 neutral, and 90 negative earnings surprise observations.

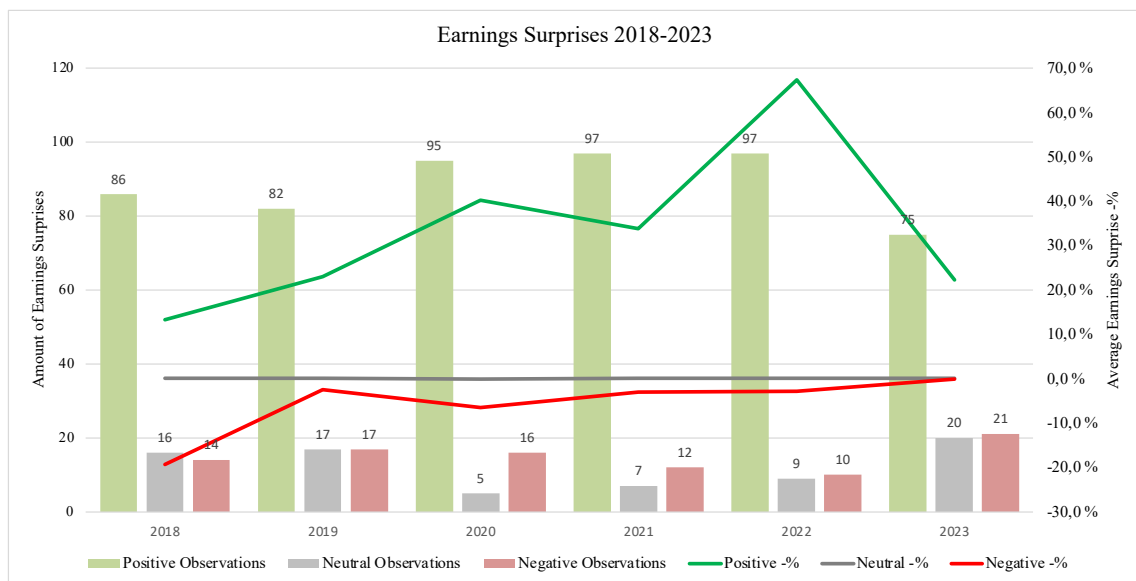


Figure 3: Distribution and Average Percentages of Earnings Surprises (2018–2023)

The number of positive observations peaked at 97 in 2021 and 2022, with the highest average positive surprise percentage in 2022. Both neutral surprises and neutral percentages remained relatively stable over the period, while negative surprises showed the most significant fluctuations. Despite their lower frequency, negative percentages remained consistently steady, reflecting underperformance. The figure above also provides a visual

representation of earnings surprises, highlighting patterns and trends that are essential for understanding the presence and persistence of PEAD anomaly.

## 5 Empirical results

This section will present all the empirical results used to answer the research questions. A brief explanation of each research question is provided, followed by empirically researched answers. A summary of the event study is provided at the end of the section.

The study's results are presented in tables showing Average Abnormal Returns (AAR) and Cumulative Abnormal Returns (CAAR) for the event window. In the AAR tables,  $t$  represents days relative to the earnings announcement (Day 0), with each row corresponding to a specific day. AAR (%) shows the average deviation of stock returns from expected returns, the  $t$ -ratio indicates the significance of AAR, and the  $p$ -value below 0.05 confirms statistical significance. Similarly, CAAR tables display cumulative deviations over time intervals  $[t_1, t_2]$ , with each row representing a specific period. CAAR measures cumulative return differences, variance shows variability, the  $J_1$  statistic assesses CAAR significance, and the  $p$ -value below 0.05 confirms statistical reliability. Earnings announcement day is highlighted with light green in the tables.

The first event study focused on analyzing how the PEAD anomaly has evolved in the U.S. semiconductor sector. The analysis was conducted on the entire dataset over a six-year timeframe using the event study methodology. The results, presented in Table 2, reveal significant stock price movements before, during, and after the event day. AAR increases notably as the event day approaches, peaking at 0.24% one day before the event. This suggests that information leakage or anticipatory trading may influence stock prices ahead of earnings announcements.

On the event day, AAR is 0.04%, indicating a modest immediate market reaction to earnings announcements. While this value is relatively small, its  $T$ -ratio (18.08) and  $P$ -value (0.000) confirm its statistical significance. The  $T$ -ratio measures the size of the abnormal return relative to its variability, with higher values indicating more substantial effects. The  $P$ -value evaluates the likelihood that the observed result occurred by chance; a lower  $P$ -value

indicates more substantial statistical evidence against the null hypothesis. Using a commonly accepted significance level of 5% ( $p < 0.05$ ), the results demonstrate that the abnormal returns are not random but are statistically significant.

<b>All stocks</b>			
<b>t</b>	<b>AAR</b>	<b>t-ratio</b>	<b>P-value</b>
-10	-0,06 %	-25,76	0,000
-9	-0,10 %	-44,71	0,000
-8	-0,09 %	-38,46	0,000
-7	-0,08 %	-34,46	0,000
-6	0,03 %	13,37	0,000
-5	-0,01 %	-4,12	0,000
-4	-0,04 %	-17,71	0,000
-3	0,04 %	19,75	0,000
-2	0,19 %	85,25	0,000
-1	-0,24 %	-106,93	0,000
0	0,04 %	18,08	0,000
1	0,01 %	3,93	0,000
2	-0,06 %	-27,96	0,000
3	-0,18 %	-79,36	0,000
4	-0,07 %	-29,52	0,000
5	-0,15 %	-67,21	0,000
6	-0,08 %	-35,01	0,000
7	-0,06 %	-28,36	0,000
8	0,03 %	12,82	0,000
9	0,07 %	32,56	0,000
10	-0,03 %	-14,93	0,000

Table 2: AAR, whole sample

Similarly, CAAR values were also calculated to capture the cumulative market impact of earnings announcements. Table 4 highlights distinct stock price patterns across pre-announcement, event-day, and post-announcement windows.

All stocks				
$[t_1, t_2]$	CAAR	Varianssi	J1	p-value
[-10,-1]	-0,34 %	0,00000	-48,63	0,000
[-5,-1]	-0,05 %	0,00000	-7,51	0,000
[-1,+1]	-0,19 %	0,00000	-26,85	<b>0,000</b>
<b>[0,0]</b>	<b>0,04 %</b>	<b>0,00000</b>	<b>5,72</b>	<b>0,000</b>
[0,+1]	0,05 %	0,00000	6,96	<b>0,000</b>
[+1,+5]	-0,45 %	0,00000	-63,29	<b>0,000</b>
[+1,+10]	-0,52 %	0,00000	-73,69	0,000

Table 3: CAAR, whole sample data

Table 3 shows that CAAR is -0.34% 10 days before the event. This indicates a consistent negative drift in stock prices, likely reflecting pre-announcement anticipatory trading or market inefficiencies. On the event day, CAAR was at 0.04%, which aligns with the earlier AAR findings of a modest immediate reaction to earnings announcements. The post-announcement windows show significant negative drifts of -0.45% and -0.52%, respectively. A negative drift in CAAR means that, on average, stock prices are underperforming compared to expected returns during the days following the earnings announcement. This indicates that the stock market is slow to incorporate the new information from earnings announcements, challenging the assumptions of the efficient market hypothesis.

Overall, the results from the whole sample data show that PEAD anomaly is present in the U.S. semiconductor sector. These results correlate with a previous study conducted by Fink (2021), which examined the presence of PEAD in the broader context of the U.S. stock markets. As previous studies have shown, excess returns disappear quickly as the market adapts to new information. In addition, these findings align with Bernard and Thomas (1989), who identified delayed market reactions as a defining feature of the PEAD anomaly. The gradual negative drift in CAAR values post-announcement reflects market underreaction, which challenges the EMH (Fama 1970) by suggesting that stock prices do not immediately incorporate all available information.

The second event study divides earnings reports into positive, neutral, and negative earnings surprises. Results presented in Table 4 present how PEAD behaves in different earnings surprises. In the case of positive earnings, stock prices exhibit speculative pre-event activity, with a spike in AAR at 0,14% two days before the event. However, this speculative activity is not persistent throughout the event, and AAR drops to -0,27% one day before the event. This might be due to investors taking profit before the earnings report is published. On the event day, AAR was 0.03%, indicating a statistically significant but small immediate reaction. Neutral earnings show how the market recalibrates before and after the earnings announcement. AAR exhibits a peak of 0.53% three days before the event. This means investors sell before the event day, which is then followed by a relatively strong event-day reaction of 0.21% as investors buy back.

In contrast, negative earnings announcements show strong pre-event pessimism, with AAR declining to -0.44% 5 days before the event and -0.33% one day before. This indicates that investors are concerned about the upcoming earnings announcement and act accordingly. On the event day, negative earnings AAR is -0.08%. Post-event trends reveal a pronounced decline, reaching -0.76% 5 days after the event. This indicates more investors selling after a negative earnings announcement, causing the PEAD anomaly to occur.

t	All positive earnings			All neutral earnings			All negative earnings		
	AAR	t-ratio	P-value	AAR	t-ratio	P-value	AAR	t-ratio	P-value
-10	-0,12 %	-49,60	0,000	0,08 %	11,61	0,000	0,19 %	23,71	0,000
-9	-0,15 %	-63,06	0,000	0,17 %	25,98	0,000	-0,02 %	-2,17	0,030
-8	-0,05 %	-19,58	0,000	0,12 %	18,27	0,000	-0,44 %	-56,28	0,000
-7	-0,15 %	-60,73	0,000	0,35 %	54,79	0,000	-0,02 %	-3,07	0,002
-6	0,00 %	0,68	0,497	0,08 %	11,62	0,000	0,19 %	24,56	0,000
-5	0,04 %	16,98	0,000	0,22 %	34,21	0,000	-0,44 %	-56,07	0,000
-4	-0,08 %	-31,64	0,000	0,15 %	23,79	0,000	0,05 %	6,65	0,000
-3	-0,02 %	-9,99	0,000	0,53 %	81,85	0,000	0,17 %	21,67	0,000
-2	0,14 %	57,05	0,000	0,41 %	63,60	0,000	0,39 %	50,21	0,000
-1	-0,27 %	-109,81	0,000	0,16 %	24,64	0,000	-0,33 %	-42,73	0,000
0	0,03 %	11,97	0,000	0,21 %	32,55	0,000	-0,08 %	-10,17	0,000
1	-0,01 %	-4,17	0,000	-0,28 %	-43,41	0,000	0,40 %	51,68	0,000
2	-0,06 %	-25,33	0,000	-0,07 %	-10,14	0,000	0,12 %	15,67	0,000
3	-0,11 %	-46,02	0,000	-0,22 %	-33,71	0,000	-0,41 %	-51,97	0,000
4	-0,07 %	-27,43	0,000	-0,07 %	-11,31	0,000	-0,07 %	-9,05	0,000
5	-0,13 %	-51,95	0,000	0,36 %	55,52	0,000	-0,76 %	-96,62	0,000
6	-0,14 %	-58,37	0,000	-0,03 %	-5,30	0,000	0,23 %	29,28	0,000
7	-0,19 %	-75,98	0,000	0,36 %	55,17	0,000	0,40 %	51,49	0,000
8	0,02 %	7,71	0,000	0,24 %	37,13	0,000	-0,09 %	-10,95	0,000
9	-0,02 %	-7,70	0,000	1,10 %	169,09	0,000	-0,20 %	-25,48	0,000
10	-0,05 %	-20,14	0,000	-0,10 %	-15,41	0,000	0,07 %	9,02	0,000

Table 4: AAR, whole sample data segmented by reported earnings surprises

Examining CAAR values of different earnings surprise categories provides further insights into market behavior before, during, and after earnings announcements. For positive earnings announcements, price action before the event shows a CAAR of -0.66%, indicating a negative drift before the earnings release. This suggests investors are potentially selling the stock despite the expected positive news. On the event day, a CAAR of 0.03% is observed, reflecting a modest reaction to the new information. Post-announcement, the market experiences significant negative drifts, which are shown as negative CAAR values in Table 4. These values are consistent with the PEAD anomaly, suggesting that stock prices do not fully adjust to positive news immediately. Stock market price action seems mostly rational for neutral earnings announcements. CAAR values before the event date suggest mild speculation is happening around the stocks. Negative CAAR values indicate a slight sell-off after the event day is over. This can be explained by a catalyst or momentum-based trading, where investors' strategy is based on upcoming market events.

In the case of negative earnings announcements, the pre-announcement window has mild negative drift with a CAAR of -0.26%, reflecting investors' early adjustments to anticipated negative earnings. On the event day, CAAR was -0.08%, indicating that much of the negative sentiment had already been priced prior to the announcement. The post-announcement periods, however, show a sustained downward trend. This aligns with daily AAR price action, where investors continue to sell the stock after negative earnings.

<b>All positive earnings</b>				
<b>[t1,t2]</b>	<b>CAAR</b>	<b>Varianssi</b>	<b>J1</b>	<b>p-value</b>
<b>[-10,-1]</b>	-0,66 %	0,00000	-85,29	0,000
<b>[-5,-1]</b>	-0,19 %	0,00000	-24,48	0,000
<b>[-1,+1]</b>	-0,25 %	0,00000	-32,26	<b>0,000</b>
<b>[0,0]</b>	<b>0,03 %</b>	<b>0,00000</b>	<b>3,78</b>	<b>0,000</b>
<b>[0,+1]</b>	0,02 %	0,00000	2,47	<b>0,007</b>
<b>[+1,+5]</b>	-0,38 %	0,00000	-48,98	<b>0,000</b>
<b>[+1,+10]</b>	-0,76 %	0,00000	-97,83	0,000
<b>All neutral earnings</b>				
<b>[t1,t2]</b>	<b>CAAR</b>	<b>Varianssi</b>	<b>J1</b>	<b>p-value</b>
<b>[-10,-1]</b>	2,27 %	0,00000	110,79	0,000
<b>[-5,-1]</b>	1,48 %	0,00000	72,13	0,000
<b>[-1,+1]</b>	0,09 %	0,00000	4,36	<b>0,000</b>
<b>[0,0]</b>	<b>0,21 %</b>	<b>0,00000</b>	<b>10,29</b>	<b>0,000</b>
<b>[0,+1]</b>	-0,07 %	0,00000	-3,44	<b>0,000</b>
<b>[+1,+5]</b>	-0,28 %	0,00000	-13,61	<b>0,000</b>
<b>[+1,+10]</b>	1,28 %	0,00000	62,49	0,000
<b>All negative earnings</b>				
<b>[t1,t2]</b>	<b>CAAR</b>	<b>Varianssi</b>	<b>J1</b>	<b>p-value</b>
<b>[-10,-1]</b>	-0,26 %	0,00000	-10,60	0,000
<b>[-5,-1]</b>	-0,16 %	0,00000	-6,41	0,000
<b>[-1,+1]</b>	-0,01 %	0,00000	-0,39	<b>0,349</b>
<b>[0,0]</b>	<b>-0,08 %</b>	<b>0,00000</b>	<b>-3,22</b>	<b>0,001</b>
<b>[0,+1]</b>	0,32 %	0,00000	13,13	<b>0,000</b>
<b>[+1,+5]</b>	-0,71 %	0,00000	-28,55	<b>0,000</b>
<b>[+1,+10]</b>	-0,29 %	0,00000	-11,67	0,000

Table 5: CAAR, whole sample data segmented by reported earnings surprise

These CAAR findings show that positive and neutral earnings announcements often exhibit optimism in pre-announcement periods, while negative earnings trigger early pessimistic adjustments. This pattern aligns with the observations made by Ball and Brown (1968), who demonstrated that markets react gradually to earnings news, with investors showing varying degrees of anticipation based on expected outcomes. Event-day reactions differ, with neutral earnings generating the strongest immediate market response. This is consistent with the findings of Kolari and Pynnönen (2010), who emphasized that event-day reactions often reflect a combination of market recalibration and investor speculation. The weaker reactions

to positive earnings announcements, followed by prolonged drifts, suggest that speculative trading before the event might dilute the immediate impact on stock prices.

Now that we have established that the PEAD anomaly is present in the U.S. semiconductor sector, The third event study aims to find out how PEAD has evolved in the U.S. semiconductor sector during a 6-year period. This question is also the main research question for this study. This event study also allows us to answer the sub-questions of this thesis. To find out how PEAD has evolved, earnings surprises were divided into 6 years. AAR and CAAR values and corresponding T-ratio and p-ratios were calculated for each year. These results, compared with each other, will give us insights into how PEAD has evolved and, how its prevalence has changed, and how it behaved during significant financial market events.

Table 6 represents yearly AAR values from 2018 to 2023, providing insights into the evolution of the PEAD anomaly. Between 2018 and 2020, the data reveals pronounced pre-announcement negative drifts in AAR values. Negative AAR values indicate investors' anticipatory selling leading up to earnings announcements. In contrast, the pre-announcement behavior from 2021 onwards shows a decrease in the intensity of negative drifts. This signals improved market efficiency as overall market participant consensus is more united and leaves less room for irrational behavior.

The event day reactions vary between the 6-year period. However, the AAR value is consistently positive during this time. During 2018–2020, event day AAR values ranged from 0,2% in 2018 to 0,6% in 2020, indicating varying price reactions to the earnings announcements. Towards the end of the 6-year period, AAR values turn positive, and the market seems to exhibit positive price action during the event day. This can be attributed to the diminishing overall market uncertainty after the heightened speculative period of the COVID-19 pandemic (Goodell 2020). Similarly, post-event window AAR value follow this turn from negative to positive as years pass.

Overall, The results show that PEAD was more pronounced between 2018 and 2020, characterized by significant speculative activity and delayed market reactions. In contrast, from 2022 to 2023, reduced pre-announcement drifts and stronger event-day responses suggest increased market efficiency. While PEAD remains present during periods of uncertainty, particularly in earlier years, its persistence has diminished over time. This evolution indicates that improved information dissemination and reduced market speculation have contributed to greater market efficiency in the U.S. semiconductor sector. This was also suggested by Martineau (2021), who highlighted the broader decline in research focus on PEAD as markets have become more efficient over time.

t	2018			2019			2020		
	AAR	t-ratio	P-value	AAR	t-ratio	P-value	AAR	t-ratio	P-value
-10	-0,25 %	-51,97	0,000	-0,31 %	-58,13	0,000	-0,03 %	-5,16	0,000
-9	-0,47 %	-97,05	0,000	0,38 %	71,97	0,000	-0,76 %	-113,73	0,000
-8	-0,32 %	-66,07	0,000	-0,14 %	-27,32	0,000	0,26 %	37,97	0,000
-7	-0,35 %	-71,87	0,000	-0,10 %	-17,93	0,000	-0,43 %	-63,28	0,000
-6	-0,37 %	-76,30	0,000	-0,07 %	-12,65	0,000	0,08 %	12,02	0,000
-5	0,14 %	28,82	0,000	-0,06 %	-11,87	0,000	-0,35 %	-52,64	0,000
-4	-0,20 %	-41,54	0,000	0,03 %	4,84	0,000	-0,21 %	-30,76	0,000
-3	-0,30 %	-62,74	0,000	0,03 %	5,89	0,000	-0,06 %	-8,41	0,000
-2	0,18 %	37,01	0,000	0,35 %	66,21	0,000	-0,38 %	-56,41	0,000
-1	-0,32 %	-65,51	0,000	-0,02 %	-3,47	0,001	-0,23 %	-33,65	0,000
0	-0,22 %	-44,87	0,000	0,63 %	118,01	0,000	-0,25 %	-36,96	0,000
1	-0,39 %	-80,73	0,000	0,09 %	16,43	0,000	-0,26 %	-39,05	0,000
2	-0,59 %	-122,20	0,000	0,24 %	44,78	0,000	0,00 %	-0,47	0,637
3	-0,35 %	-72,18	0,000	-0,31 %	-58,83	0,000	-0,16 %	-24,21	0,000
4	-0,39 %	-81,81	0,000	0,12 %	23,22	0,000	-0,32 %	-47,80	0,000
5	-0,19 %	-38,88	0,000	0,10 %	18,18	0,000	-0,28 %	-42,43	0,000
6	-0,33 %	-67,99	0,000	-0,07 %	-13,31	0,000	-0,08 %	-12,01	0,000
7	-0,03 %	-5,57	0,000	-0,02 %	-3,01	0,003	-0,59 %	-88,07	0,000
8	0,05 %	9,95	0,000	-0,17 %	-32,52	0,000	-0,28 %	-41,40	0,000
9	-0,30 %	-61,66	0,000	0,24 %	45,15	0,000	-0,12 %	-18,29	0,000
10	-0,51 %	-105,78	0,000	0,22 %	41,55	0,000	-0,18 %	-26,19	0,000

t	2021			2022			2023		
	AAR	t-ratio	P-value	AAR	t-ratio	P-value	AAR	t-ratio	P-value
-10	0,00 %	0,58	0,562	0,15 %	30,23	0,000	0,06 %	13,96	0,000
-9	-0,11 %	-20,45	0,000	0,17 %	33,97	0,000	0,17 %	36,59	0,000
-8	-0,31 %	-55,10	0,000	0,14 %	28,09	0,000	-0,15 %	-32,59	0,000
-7	0,12 %	21,65	0,000	0,07 %	13,00	0,000	0,20 %	42,91	0,000
-6	0,07 %	13,15	0,000	0,25 %	49,44	0,000	0,22 %	47,95	0,000
-5	-0,41 %	-73,83	0,000	0,27 %	53,20	0,000	0,42 %	91,19	0,000
-4	-0,02 %	-3,36	0,001	0,14 %	27,88	0,000	0,04 %	8,94	0,000
-3	0,19 %	34,60	0,000	-0,08 %	-16,97	0,000	0,51 %	110,06	0,000
-2	0,20 %	35,27	0,000	0,69 %	137,93	0,000	0,11 %	23,48	0,000
-1	-0,21 %	-37,76	0,000	-0,31 %	-61,04	0,000	-0,34 %	-74,17	0,000
0	-0,27 %	-47,62	0,000	0,05 %	10,79	0,000	0,27 %	57,91	0,000
1	0,14 %	24,11	0,000	0,27 %	54,26	0,000	0,15 %	32,78	0,000
2	-0,13 %	-22,71	0,000	-0,14 %	-27,57	0,000	0,29 %	62,25	0,000
3	-0,19 %	-33,18	0,000	0,12 %	24,78	0,000	-0,14 %	-29,41	0,000
4	-0,04 %	-7,00	0,000	0,08 %	15,00	0,000	0,18 %	37,83	0,000
5	-0,75 %	-132,98	0,000	0,30 %	59,24	0,000	-0,09 %	-18,55	0,000
6	-0,24 %	-42,11	0,000	0,29 %	58,72	0,000	0,08 %	17,40	0,000
7	-0,14 %	-24,92	0,000	0,27 %	54,59	0,000	0,12 %	25,04	0,000
8	0,00 %	0,25	0,803	0,59 %	117,76	0,000	-0,05 %	-9,94	0,000
9	-0,07 %	-11,67	0,000	0,49 %	98,62	0,000	0,21 %	44,13	0,000
10	-0,01 %	-1,42	0,155	0,37 %	73,05	0,000	-0,06 %	-12,69	0,000

Table 6: AAR, sample data segmented into individual years

Table 7 consists of CAAR values segmented into six years. These values provide a clearer picture of the prevalence of PEAD and its yearly behavior. Both sub-questions of this study will be answered based on these values.

The study shows that CAAR values were consistently negative during 2018. This is aligned with the previous event studies conducted during this thesis. In this study, negative CAAR values indicate significant price drifts before earnings announcements and after the event day. Price drifts occurring during 2018 suggest that the U.S. semiconductor sector is not fully efficient in pricing stocks.

2018					2019			
[t1,t2]	CAAR	Varianssi	J1	p-value	CAAR	Varianssi	J1	p-value
[-10,-1]	-2,25 %	0,00000	-147,74	0,000	0,09 %	0,00000	5,55	0,000
[-5,-1]	-0,50 %	0,00000	-32,87	0,000	0,33 %	0,00000	19,48	0,000
[-1,+1]	-0,92 %	0,00000	-60,44	<b>0,000</b>	0,69 %	0,00000	41,42	<b>0,000</b>
[0,0]	-0,22 %	0,00000	-14,19	<b>0,000</b>	0,63 %	0,00000	37,32	<b>0,000</b>
[0,+1]	-0,60 %	0,00000	-39,72	<b>0,000</b>	0,71 %	0,00000	42,52	<b>0,000</b>
[+1,+5]	-1,91 %	0,00000	-125,16	<b>0,000</b>	0,23 %	0,00000	13,85	<b>0,000</b>
[+1,+10]	-3,02 %	0,00000	-198,23	0,000	0,43 %	0,00000	25,82	0,000
2020					2021			
[t1,t2]	CAAR	Varianssi	J1	p-value	CAAR	Varianssi	J1	p-value
[-10,-1]	-2,11 %	0,00000	-99,31	0,000	-0,48 %	0,00000	-26,96	0,000
[-5,-1]	-1,22 %	0,00000	-57,51	0,000	-0,25 %	0,00000	-14,26	0,000
[-1,+1]	-0,74 %	0,00000	-34,68	<b>0,000</b>	-0,34 %	0,00000	-19,38	<b>0,000</b>
[0,0]	-0,25 %	0,00000	-11,69	<b>0,000</b>	-0,27 %	0,00000	-15,06	<b>0,000</b>
[0,+1]	-0,51 %	0,00000	-24,04	<b>0,000</b>	-0,13 %	0,00000	-7,44	<b>0,000</b>
[+1,+5]	-1,03 %	0,00000	-48,69	<b>0,000</b>	-0,96 %	0,00000	-54,31	<b>0,000</b>
[+1,+10]	-2,28 %	0,00000	-107,49	0,000	-1,41 %	0,00000	-79,57	0,000
2022					2023			
[t1,t2]	CAAR	Varianssi	J1	p-value	CAAR	Varianssi	J1	p-value
[-10,-1]	1,48 %	0,00000	93,52	0,000	1,25 %	0,00000	84,85	0,000
[-5,-1]	0,71 %	0,00000	44,59	0,000	0,74 %	0,00000	50,44	0,000
[-1,+1]	0,02 %	0,00000	1,27	<b>0,102</b>	0,08 %	0,00000	5,22	<b>0,000</b>
[0,0]	0,05 %	0,00000	3,41	<b>0,000</b>	0,27 %	0,00000	18,31	<b>0,000</b>
[0,+1]	0,33 %	0,00000	20,57	<b>0,000</b>	0,42 %	0,00000	28,68	<b>0,000</b>
[+1,+5]	0,63 %	0,00000	39,75	<b>0,000</b>	0,39 %	0,00000	26,85	<b>0,000</b>
[+1,+10]	2,65 %	0,00000	167,11	0,000	0,69 %	0,00000	47,07	0,000

Table 7: CAAR, sample data segmented into individual years

Contrary to 2018, CAAR values for the year 2019 were consistently positive throughout the different event windows. This indicates that all participants in the stock markets were operating rationally. There was no systematic disconnect between the investors' sentiment and market pricing. This means that the EMH by Fama (1970) behaved as he suggested it should. During the years 2020 and 2021, the U.S. semiconductor sector exhibited an above-average negative drift. At the same time, the COVID-19 pandemic was ongoing (Goodell 2020). This greatly affected the stock markets, as shown in Figure 2.

However, in the later years of the 6-year period, post-announcement behavior reverses, with CAAR values becoming positive. For instance, in 2022, CAAR for the post-event window goes up to +2.65%, and in 2023, it goes only up to +0.69%, suggesting improved market efficiency and a diminished prevalence of PEAD.

The findings from AAR and CAAR values segmented by year illustrate how the prevalence of PEAD evolved during the six-year period. The pronounced pre-announcement drifts observed in 2018-2020 also align with Ball and Brown's (1968) findings on gradual market reactions to new information. Similarly, the stronger immediate reactions and reduced pre-announcement drifts from 2021 onwards suggest increased market efficiency, consistent with Richardson and Veenstra's (2022) observations on improved information dissemination. The negative CAAR values during the COVID-19 pandemic reflect heightened market uncertainty, aligning with Fama's (1970) framework, which recognizes that extreme volatility challenges market efficiency. In addition, behavior finance theories like Prospect Theory (Kahneman & Tversky, 1979) align with the results. This theory highlighted how loss aversion influences investor decisions, leading to stronger reactions to negative news compared to positive surprises.

## 6 Conclusion

This final section will summarize this study. It will include summarized answers to the main research question and the sub-questions, a discussion of the main ideas of this study, and suggestions for further studies.

### 6.1 Research Questions

The goal of this thesis was to examine the presence and evolution of the Post-Earnings Announcement Drift (PEAD) in the U.S. semiconductor sector. Using an event study spanning from 2018 to 2023, actual and expected market returns were calculated to assess how PEAD has persisted and changed over time.

The main research question was: *How has Post-Earnings Announcement Drift evolved in the U.S. stock market semiconductor sector?*

The findings show that PEAD has become less persistent, with stock markets appearing more efficient as information dissemination improves and market uncertainty decreases. This result also aligned with previous studies conducted

The first sub-question was: *Has the prevalence of PEAD in the U.S. semiconductor sector changed over time between 2018 and 2023?*

The results reveal that the prevalence of PEAD anomaly during the 6-year period varied depending on the overall economic outlook. There are signs of lower market efficiency during 2018, which cannot be attributed to an ongoing financial crisis. CAAR values in the year 2019 are positive, which means that the market was functioning efficiently compared to 2018. During the years 2020 and 2021, market efficiency has been affected by the

COVID-19 pandemic. This shows negative CAAR values, which can be attributed to heightened market speculation and higher-than-normal uncertainty. Negative drifts in both pre-announcement and post-announcement windows show that PEAD anomalies were present. CAAR values during 2022 and 2023 are positive, suggesting increased market efficiency. The prevalence of PEAD has diminished compared to years like 2020 and 2021.

The second sub-question was: *Did PEAD behave differently during significant financial events like the COVID-19 pandemic?*

The event study results confirm that PEAD behaved differently during the COVID-19 pandemic, reflecting the impact of heightened market uncertainty. During 2020 and 2021, CAAR values showed significant negative drifts, both pre- and post-announcement, indicating a more substantial presence of PEAD compared to other periods. These findings demonstrate that significant financial events like the COVID-19 pandemic amplify stock market anomalies like PEAD, emphasizing the role of market uncertainty in influencing investor behavior and stock price reactions

## 6.2 Discussion

The findings of this study highlight the persistence and evolution of the Post-Earnings Announcement Drift (PEAD) anomaly within the U.S. semiconductor sector from 2018 to 2023. The findings demonstrate that PEAD remains present but has diminished over time, reflecting a trend toward increased market efficiency. Early years, such as 2018–2020, showed pronounced pre- and post-announcement drifts, indicative of inefficiencies. In contrast, 2021–2023 saw reduced speculative activity and stronger immediate reactions to earnings announcements, suggesting improved information dissemination and investor behavior.

The semiconductor sector's unique characteristics, including rapid innovation cycles and sensitivity to macroeconomic conditions, contributed to the persistence of PEAD. High

information asymmetry and volatility create opportunities for delayed price adjustments, particularly during periods of heightened uncertainty. The impact of the COVID-19 pandemic exemplifies this, with heightened speculative behavior and negative CAAR values during 2020–2021 reflecting market disruptions and increased investor caution.

Behavioral finance theories, such as Prospect Theory, provide a framework for understanding these patterns. Loss aversion and overconfidence explain speculative trading before earnings announcements and the cautious recalibration during neutral earnings surprises. These psychological factors complement traditional finance models by offering insights into investor biases that sustain market anomalies like PEAD.

Comparisons to previous studies reinforce the findings of this thesis, aligning with Bernard and Thomas's (1989) observations of delayed market reactions and Martineau's (2021) analysis of declining PEAD prevalence. However, this study adds a sector-specific perspective, highlighting how global events and industry dynamics influence the anomaly's persistence.

From a practical standpoint, the study underscores the importance of understanding both behavioral and traditional finance in evaluating market inefficiencies. For market participants, balancing rational analysis with an awareness of cognitive biases is crucial for navigating periods of heightened uncertainty. The semiconductor sector offers a valuable lens for exploring the intersection of innovation, investor behavior, and market efficiency, making it an ideal focus for future research on PEAD and related anomalies.

### 6.3 Limitations and Further Studies

Due to the limitations of the study, the results should be interpreted with caution. 6-year period time frame is relatively short, and it also includes a significant financial market event, which might skew the results. Additionally, the sample size was relatively small, with only 29 companies included out of the 78 possible firms identified in the initial dataset. This

limited sample size may have reduced the robustness of the results and increased the likelihood of data selection bias, particularly if the excluded firms exhibit different patterns of PEAD. Future studies could mitigate this limitation by expanding the sample size and incorporating a more diverse range of companies to enhance the reliability and applicability of the findings of this study.

The semiconductor sector is one of the major sectors enabling technological advancements. Further studies on this current and timely sector could, for example, include a longer timeframe. This could bring forth new insights into how PEAD has behaved in a time when new information dissipation was even slower. This also opens the possibility of identifying the role of technological advancements in interpreting earnings announcements. Additionally, examining firm-specific characteristics, such as R&D intensity or market capitalization, could provide insights into factors that amplify or mitigate PEAD. Incorporating more data points, such as intraday trading data, may also help capture short-term reactions to earnings announcements, offering a more detailed view of investor behavior and market inefficiencies.

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# Appendices

## Appendix 1: List of the stocks

Company Name	Location	NAICS National Industry Name	Exchange
Advanced Micro Devices Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Aeluma Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Allegro Microsystems Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Alpha and Omega Semiconductor Ltd	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Ambarella Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Analog Devices Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Arrow Electronics Inc	United States	Other Electronic Parts and Equipment Merchant	NEW YORK STOCK EXCHANGE, INC.
Astera Labs Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Atomera Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
AXT Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Broadcom Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
CEVA Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Cirrus Logic Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Diodes Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
DND Technologies Inc	United States	Software Publishers	OTC MARKETS
Energy Finders Inc	United States	Research and Development in the Physical, Engineering,	OTC MARKETS
Espre Technologies Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Everspin Technologies Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NMS (GLOBAL MARKET)
GCT Semiconductor Holding Inc	United States	Semiconductor and Related Device Manufacturing	NEW YORK STOCK EXCHANGE, INC.
GSI Technology Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Guerilla RF Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Ichor Holdings Ltd	United States	Fluid Power Valve and Hose Fitting Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Impinj Inc	United States	Other Electronic Component Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Indie Semiconductor Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Innotek Corp	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Intel Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Interlink Electronics Inc	United States	Printed Circuit Assembly (Electronic Assembly) Manufact	NASDAQ CAPITAL MARKET
Kimball Electronics Inc	United States	Bare Printed Circuit Board Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Kopin Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Lattice Semiconductor Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
MACOM Technology Solutions Holdings	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Marvell Technology Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Maxlinear Inc	United States	Radio and Television Broadcasting and Wireless Commun	NASDAQ/NGS (GLOBAL SELECT MARKET)
Meltronix Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Microchip Technology Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Micron Technology Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Micropac Industries Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
MOBIX LABS, INC.	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NMS (GLOBAL MARKET)
Monolithic Power Systems Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Navitas Semiconductor Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NMS (GLOBAL MARKET)
NeoMagic Corp	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
nLIGHT Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Nortech Systems Inc	United States	Printed Circuit Assembly (Electronic Assembly) Manufact	NASDAQ CAPITAL MARKET
Nuvonyx Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
NVE Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
NVIDIA Corp	United States	Electronic Computer Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Odyssey Semiconductor Technologies Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
ON Semiconductor Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Penguin Solutions Inc	United States	Custom Computer Programming Services	NASDAQ/NGS (GLOBAL SELECT MARKET)
Peraso Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Pixelworks Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NMS (GLOBAL MARKET)
Power Integrations Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Qorvo Inc	United States	Radio and Television Broadcasting and Wireless Commun	NASDAQ/NGS (GLOBAL SELECT MARKET)
Qualcomm Inc	United States	Radio and Television Broadcasting and Wireless Commun	NASDAQ/NGS (GLOBAL SELECT MARKET)
Quicklogic Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Rambus Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Rigetti Computing Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Rogers Corp	United States	Plastics Material and Resin Manufacturing	NEW YORK STOCK EXCHANGE, INC.
SCI Engineered Materials Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Semtech Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
SigmaTron International Inc	United States	Bare Printed Circuit Board Manufacturing	NASDAQ CAPITAL MARKET
Silicon Laboratories Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Smclar Inc	United States	Printed Circuit Assembly (Electronic Assembly) Manufact	OTC MARKETS
SiTime Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NMS (GLOBAL MARKET)
Skywater Technology Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Skyworks Solutions Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Solitron Devices Inc	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
Spectra7 Microsystems Inc	Canada	Semiconductor and Related Device Manufacturing	TSX VENTURE EXCHANGE
Synaptics Inc	United States	Electronic Computer Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Techpoint Inc	Japan	Semiconductor and Related Device Manufacturing	TOKYO STOCK EXCHANGE
Texas Instruments Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Tigo Energy Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
TransSwitch Corp	United States	Semiconductor and Related Device Manufacturing	OTC MARKETS
TTM Technologies Inc	United States	Bare Printed Circuit Board Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Universal Display Corp	United States	Semiconductor and Related Device Manufacturing	NASDAQ/NGS (GLOBAL SELECT MARKET)
Vishay Intertechnology Inc	United States	Bare Printed Circuit Board Manufacturing	NEW YORK STOCK EXCHANGE, INC.
WISA Technologies Inc	United States	Semiconductor and Related Device Manufacturing	NASDAQ CAPITAL MARKET
Wolfspeed Inc	United States	Semiconductor and Related Device Manufacturing	NEW YORK STOCK EXCHANGE, INC.