



Facultad de Ciencias Económicas y Empresariales

Forward View of the Semiconductor World: Quantitative Analysis and Financial Valuation

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Abstract:

This research paper analyzes the ever-expanding semiconductor world from a forward-looking point of view. The sector has grown through continuous innovation and improving efficiency, giving rise to a wide variety of specialized subsectors that make every technological development possible. The strong bond between semiconductors and the overall technological sector is tested quantitatively through a regression model over a representative semiconductor traded fund and the technological stock index NASDAQ. The paper then focuses on defining the best-positioned player of the sector through a financial analysis based on ratios and multiples. Ultimately, as COVID-19 has affected every industry in the market, the paper concludes with an overview of the pandemic's impact on the semiconductor landscape.

Keywords: *Semiconductors, quantitative analysis, financial ratios, equity valuation, technology, COVID-19.*

Resumen:

Este trabajo analiza el desarrollo del sector de los semiconductores desde una perspectiva a futuro. El sector ha tenido un gran crecimiento debido a su continua innovación y mejora de eficiencia, creando una gran variedad de subsectores especializados que hacen posible cada avance tecnológico. La gran relación entre los semiconductores y la industria tecnológica se prueba cuantitativamente a través de un modelo de regresión, sobre un fondo representativo de los semiconductores y el índice bursátil tecnológico NASDAQ. El trabajo se centra, más adelante, en seleccionar los mejores competidores del sector a través de un análisis financiero de ratios y múltiplos. Finalmente, como el COVID-19 ha afectado a todas las industrias del mercado, el trabajo concluye con una revisión del impacto de la pandemia sobre el mundo de los semiconductores.

Palabras clave: *Semiconductores, análisis cuantitativo, ratios financieros, valoración empresarial, tecnología, COVID-19.*

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1. Introduction:

This research paper aims to study the semiconductor world since it is recognized to be one of the most attractive sectors of the last decade, exhibiting above-average growth rates and increasing importance over a wide variety of industries. Semiconductors are popularly known as the axis around which technology spins, as chips are the most essential components of any electronic device.

Although some may think of microprocessors or Silicon Valley as recent or modern terms, semiconductors have been present for many decades. Since its inception, chips have been gaining importance in our lives, conquering, and creating new customer segments and practices. As well as being one of the most innovative sectors in the market, following Moore's Law by doubling the number of transistors in a microchip every two years. After decades of progress and expansion, the semiconductor world is now one of the most promising and appealing sectors of the technological industry.

Its resemblance with the overall technology industry is clear and will be proven in this paper by testing its capacity as a leading indicator. This assumption will be tested by comparing the market performance of the semiconductor ETF¹ SOXX, with the NASDAQ² as a representative index of the technological industry in the U.S.A. Both values will be tested through a regression analysis on public market values, which will give statistical support to the matter and clear any biased judgment off the argument. If the assumption ends up being true, the semiconductor industry could have predictable power over the technological industry and could, therefore, serve as a leading indicator.

After determining its relationship with the technological market, this paper will address the competitive landscape of the sector. This analysis will be focused on the best-performing companies of the sector with a particular interest in American players, as it is one of the biggest markets and some international presence from Europe and Southeast Asia. After

¹ The acronym ETF refers to an exchange traded fund further information can be found on the following link <https://www.investopedia.com/terms/e/etf.asp>

² NASDAQ is the National Association of Securities Dealers Automated Quotations exchange, the first electronic exchange that allowed investors to trade stocks on a computerized system. It is mainly formed by technological companies, and therefore it is representative of the overall technological industry.

studying the sample and analyzing the key financial ratios for this sector based on publicly available information presented by the firms, this paper will dispatch which companies seem to be better positioned for the future in terms of financial ratios. The favored firms will be further analyzed and valued via the comparable method, based on market valuation ratios of the sample.

The objective of this thorough analysis is aimed to find investment opportunities based on gaps between the intrinsic valuation of companies and their respective market valuation. The technological industry is one of the hardest to value due to its volatility, profitability structure, and disparity over future expectations and a single valuation approach should not be taken as an investment recommendation.

The previous analysis is forward-looking and based on data up until February. This paper will conclude by delivering an extensive review of the major impacts of the COVID-19³ pandemic on society as a whole and explaining how the unprecedented epidemic will favor the semiconductor sector in particularly over the long run.

³ COVID-19 refers to the coronavirus disease that spread around the world infecting millions of people in 2020. More information about the recent pandemic can be found on the following link.
https://www.who.int/health-topics/coronavirus#tab=tab_1

2. Semiconductors:

I. Overview of the sector:

As defined by the Merriam Webster dictionary, a semiconductor is any class of solid whose electrical conductivity is between that of a conductor and that of an insulator in being nearly as great as that of a metal at high temperatures and roughly absent at low temperatures. As stated in its definition, the most significant attribute about these materials is their ability to conduct electricity at both high and low temperatures.

The first semiconductor was created in 1901 by Jagadis Chandra Bose, who invented a device to detect radio waves and called it "cat whiskers." The appearance of semiconductors enabled John Bardeen, Walter Brattain, and William Shockley to create the first transistor in 1947, allowing computers to perform the same functions using less power and space (Bellis, 2019a). Since then, semiconductors have evolved to be the most necessary component on every technological device, a clear example of this fact is the world-known Silicon Valley, which is named after the most used semiconductor material, silicon.

Along with carbon and germanium, silicon has four electrons on its outer orbital, which create perfect covalent bonds that allow them to form crystals. This silicon crystal is an insulator, but it could turn into a conductor by adding a small amount of another metal. This process is generally known as doping. There are two types of doping; The N-type is negatively charged as it will be combined with phosphorus or arsenic, whereas the P-type is positively charged due to its combination with boron or gallium. By putting these two types together, you create the simplest possible semiconductor, a diode. Finally, adding an additional layer to a diode, you generate a transistor that can act as a switch or an amplifier (Brain, 2019b).

Combining thousands of transistors acting as switches, you can create a microprocessor chip. The first microprocessor chip was the Intel 8080 in 1974, which had the ability to allocate an 8-bit computer on a single chip (Brain, 2019a). Since then, Intel has improved its chips following its co-founder's rule, Moore's Law. This law states that the number of transistors on a microchip doubles every two years while at the same time, the cost of computers halves

almost every two years (Tarda, 2019). Nowadays, this rate has even accelerated to doubling the number of transistors every 18 months.

Moore's law is a clear example of how the semiconductor industry has had an accelerated development since its origin and how it seems to develop even faster. As a result, the semiconductor sector has one of the highest expenditures on research and development of the market because of its highly competitive environment. In 2017, Intel's R&D-to-sales ratio climbed to 21.2%, following its 8% average annual growth rate in R&D⁴ spending since 2001 (Patterson, 2018).

The usage of semiconductors has expanded from the original radio in the 1960s to any thinkable electronic device that has a switch on it, as well as its valuation that has grown from over \$33 billion in 1987 to \$433 billion in 2019 (Alsop, 2020). This enlargement of the sector has given birth to many sub-sectors that can be classified by its functionality or its integrated circuit (Investopedia, 2020).

From the perspective of functionality, the semiconductor industry can be divided into four groups:

- Memory chips are used to store data and programs on computers and data storage devices. There are three main types of memory chips; Random-access memory (RAM) chips provide temporary workspaces, flash memory chips hold information permanently unless erased, and read-only-memory chips can't be modified.
- Microprocessors contain one or more central processing units (CPUs), which are the primary components of computers. Depending on the complexity of the electronic system of the product, the microprocessor would have more or fewer bits on its transistor.
- Standard chips are used for performing repetitive processing routines, typically appearing in single-purpose appliances. These semiconductors are characterized by

⁴ R&D refers to a firm's capital destined to Research & Development activities, which are an indicator of innovation within a company.

their large production volumes and narrow margins due to their simple structure. Asian manufacturers dominate this group.

- Systems-on-a chip (SoC) are the most recently developed semiconductors. They are capable of building all of the electronic components needed for an entire system in a single chip.

On the other hand, semiconductors can also be classified by its type of integrated circuit:

- Analog chips have mostly been replaced by digital chips, although they are still required for wideband signals and used as sensors.
- Mixed circuit semiconductors are digital chips combined with added technology that enables them to work with both analog and digital circuits. This combination allows the microcontroller to connect the abilities of both types of chips for optimal usage, such as receiving data from a temperature sensor or make sounds through analog devices.

All these types of semiconductors are manufactured in a fabrication plant, which are commonly called fabs or foundries. The rapid development and expansion of the industry have allowed the industry to create a differentiation between fab and fabless semiconductor companies.

Companies that have fabrication plants but don't produce their own designs are classified as pure-play semiconductor foundries. These dedicated foundries award customers with a variety of advantages, such as being able to scale production capacity to a customer's needs, offering low-quantity shuttle services along with full-scale production lines. Additionally, they allow the customer to take complete control over the design process while being compliant with the industry-standard E.D.A.⁵ systems.

On the other hand, companies that only design semiconductor chips and outsource their fabrication to a specialized foundry, are called fabless semiconductor companies. This type

⁵ E.D.A acronym refers to Electronic Design Automation, further information on the industry can be found on the following link https://semiengineering.com/knowledge_centers/eda-design/definitions/electronic-design-automation/

of companies focus mainly on research and development resources, as they benefit from having lower capital costs. This business model has become dramatically popular since the 1980s, as it allows smaller companies to compete against established competitors without allocating much capital to investing activities. The leading fabless players are based in the U.S.A. and outsource their production to Asian companies.

The companies that are able to design, manufacture, and sell semiconductor products are classified as integrated device manufacturers (I.D.M.). Originally, every company that sold semiconductor products had to design and manufacture all their devices, which required a vast amount of capital as well as high expenditure in R&D. The biggest I.D.M.s are world-known companies such as Intel, I.B.M., or Texas Instruments.

II. Competitive landscape:

Since its origin in 1901, the semiconductor segment has expanded rapidly into the global markets, making it one of the most concentrated sectors in the electronic industry.

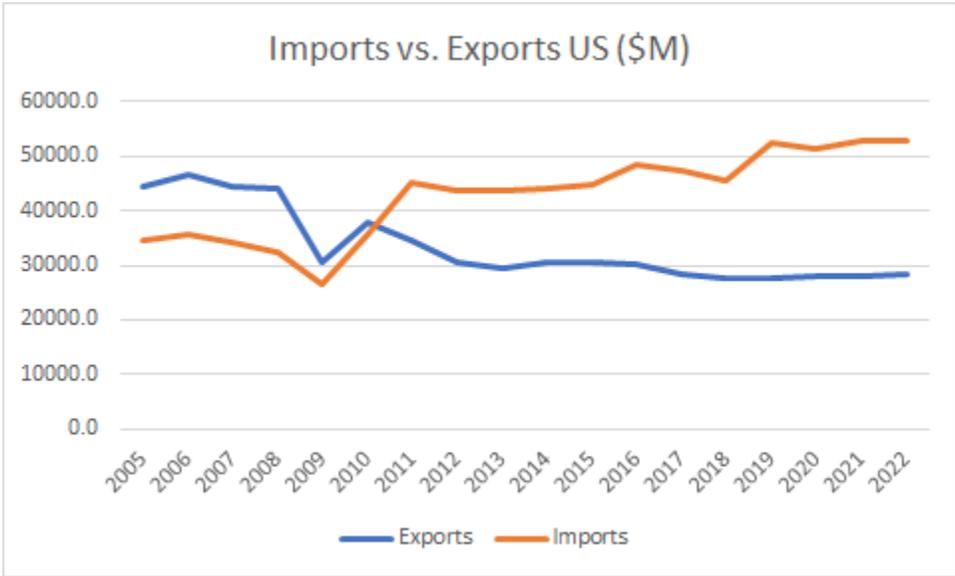
Over the last five years, the sector has become more concentrated as a result of the acquisitions of smaller companies by more significant participants that have access to more resources. Consequently, there has been an increase in the popularity of joint ventures and strategic partnerships to reduce and optimize manufacturing, development, and research costs. Besides, the largest players are also increasing their market share by acquiring smaller companies that improve the efficiency of their downstream structure.

The industry as a whole has become more competitive over time, prices for comparable products have been decreasing, showing that the most significant players will benefit from lower operating costs due to economies of scale. The most significant factor for surviving in the semiconductor sector is through continuous investment in R&D, as mentioned before, the industry follows Moore's law meaning that in order to remain competitive in the market, a company must never stop improving their products.

The main barriers to entry the market include being able to access a significant amount of investment, recruiting and attracting highly skilled employees, and the increasing dominance of already existing players in the market. New entrants must be aware of these barriers and should structure their business models accordingly.

China and the U.S. dominate the global competitive display; China has become the largest output country of semiconductor devices in the world, specialized in manufacturing devices in their foundries. On the other hand, the U.S. has a higher percentage of fabless companies in the market, which outsource their production to Asian companies while focusing on research and development.

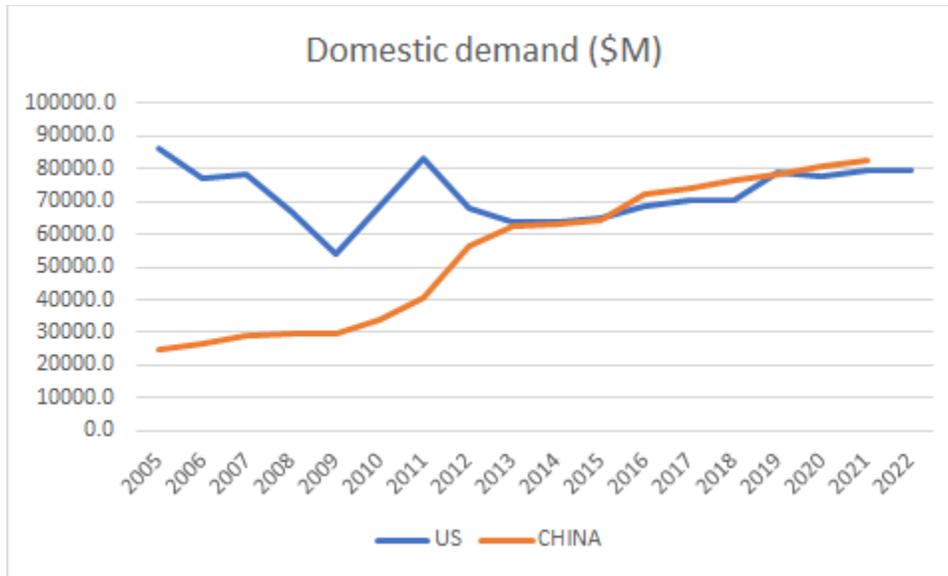
Figure 1: Imports vs. Exports U.S.



Source: Self-elaboration based on data from IBIS World, Semiconductor & Circuit Manufacturing in the U.S.

As shown in Figure 1, the U.S. has had a trade deficit in the semiconductor sector since 2010, matching the accelerated production by Chinese companies in that same time frame. The United States' domestic demand for semiconductor devices has also topped around \$80,000M over the last five years. In contrast, China's domestic demand has almost tripled over the previous ten years, as shown in Figure 2.

Figure 2: Domestic demand comparison U.S.A. vs. China



Source: IBIS World, Global Semiconductor & Electronic Parts Manufacturing

3. Quantitative Analysis of the sector:

I. Previous and current market performance:

The most precise manner to analyze the market performance of the semiconductor industry over the last couple of decades is to compare the most representative exchange-traded funds (ETF) of the sector, accounting for their specific characteristics:

Table 1: Semiconductor ETF comparison

TICKER	ISSUER	AUM	5-yr Return (annualized)	SEGMENT
SOXX	Blackrock	\$1.81B	25.64%	U.S.A.
SMH	VanEck	\$1.50B	25.33%	Global
SOXL	Direxion	\$799.49M	61.19%	Leveraged (Bull 3X) U.S.A.
SOXS	Direxion	\$187.24M	-63.90%	Inverse (Bear 3X) U.S.

Source: ETF.com, semiconductors ETF

The annualized 5-year returns in Table 1 have been calculated on a pre-Coronavirus basis, analyzing historical data for five years up until February 12th, 2020.

- **SOXX:** Issued by Blackrock⁶ in September 2001, provides capped exposure to US-listed companies in the semiconductor industry. Mainly allocated in large U.S. players accounting for 88.82% of the portfolio's weight, but with a narrow exposure to foreign markets by investing 6.74% of its capital in Dutch companies combined

⁶ Blackrock is a global investment institution that provides a wide range of financial solutions such as low-cost diversified ETFs like SOXX. Further information about the company can be found in the following link <https://www.blackrock.com/corporate/about-us>

with less than 5% coverage from Taiwan Semiconductors. Also, this ETF is wholly invested in the Semiconductor industry and has an expense ratio of 0.46%.

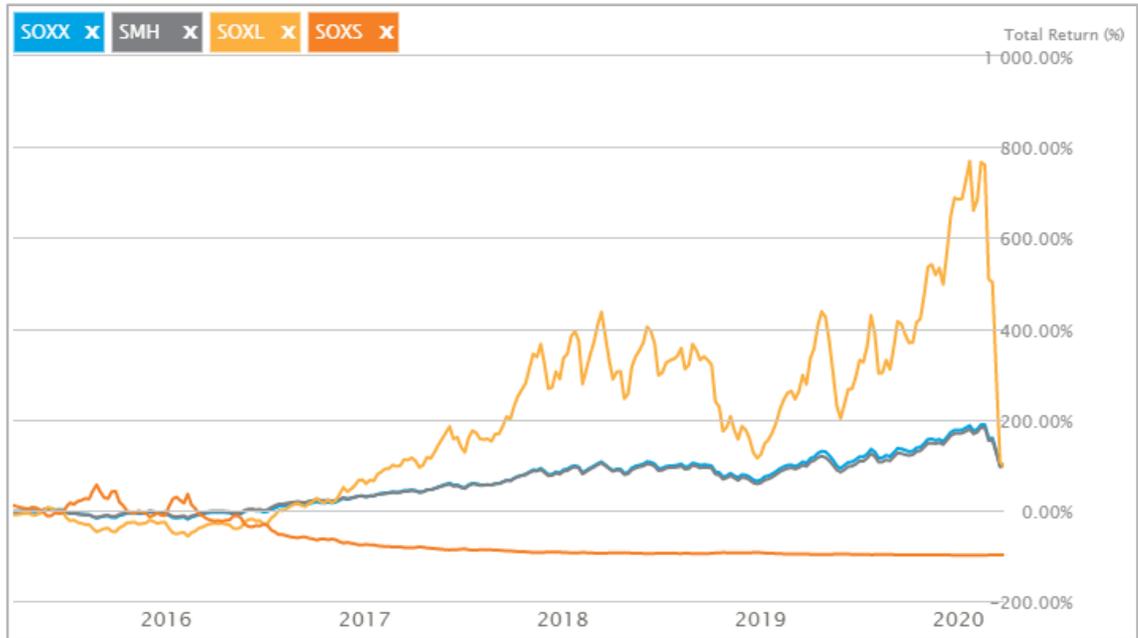
- **S.M.H.**: Issued by VanEck⁷ in May 2010, displays a more geographically diversified exposure than SOXX. U.S. equities still account for the highest weight with 75.65% of the portfolio. Still, it allows more foreign impact with 12.80% invested in Taiwan Semiconductors, 9.15% trusted in Dutch companies, and the resting 2.40% of the portfolio invested in S.T.M. from Switzerland. Besides, this ETF is highly concentrated on the Semiconductor industry, but it is also combined with a 2.62% exposure to the Software sector and has an expense ratio of 0.35%
- **SOXL**: Issued by Direxion⁸ in December 2010 provides an aggressive and bullish 1-day investment in the components of the PHLX, which is an unlevered fund by SOXX. SOXL has an expense ratio of 0.96%, which is around the average for leveraged ETFs. Besides, it has an average 60-day spread of 0.12%, and an adequate trading volume considering its 3x exposure.
- **SOXS**: On the other hand, and also issued by Direxion in December 2010, SOXS focuses on a bearish strategy against the highly concentrated semiconductor sector. Similar to its comparable SOXL, it has a 3x exposure in the opposite direction over PHLX. Although it has a higher expense ratio of 1.08% and a reduced average 60-day spread of 0.06%.

These four semiconductors ETFs address the performance of the industry from different perspectives based on the allocation of their portfolios over the last five years. As shown in Figure 3, the bullish SOXL has significantly been outperforming its peers due to its aggressive strategy. In contrast, the S.M.H. and SOXX have been following a similar route despite their differences, and the bearish SOXS hasn't been able to produce positive returns over the most recent years, showing the success of the semiconductors market performance.

⁷ VanEck is a financial services firm specialized in investment opportunities offering a wide variety of solutions. Further information can be found in the following link <https://www.vaneck.com/row/about-us/>

⁸ Direxion is an investment management firm specialized in index-based products. Further information can be found in the following link <https://www.direxion.com/about>

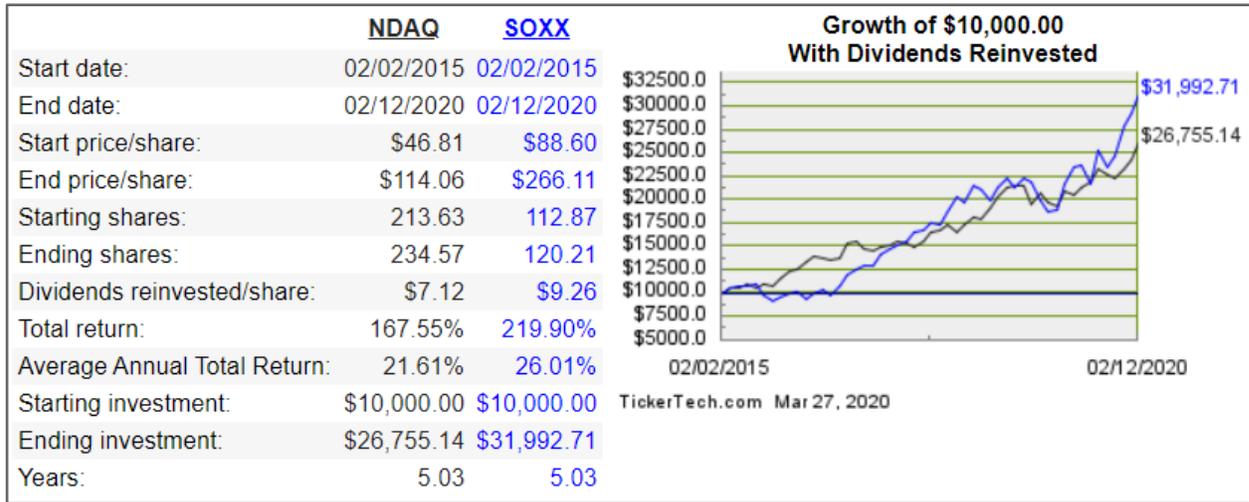
Figure 3: 5-year ETF performance



Source: ETF.com, SOXX overview

As shown by the displayed data, the semiconductor sector has followed a steady uptrend over the last five years. As shown in Figure 4, semis have outperformed comparable indexes such as the NASDAQ, which has a 5-year annualized return of 21.61% compared with the 26.01% return from SOXX, showing the comparison between the semiconductor and tech sectors in the U.S.

Figure 4: NASDAQ vs. SOXX



Source: TickerTech.com, Nasdaq YTD Return

Although the semiconductor industry has outperformed the overall tech industry over the last years, they still seem to follow a similar uptrend and cohesion. As chips now are involved in every technological and electronic device, the performance of the sector should be highly correlated to the development of the overall tech industry and, therefore, the stock market. The correlation between the SOXX and the NASDAQ in the last five years (Pre-COVID19) is 0.9874, showing that their returns follow a similar path. As Andres Cardenal said in one of his articles for Seeking Alpha, "In the same way that the transport sector was considered a key indicator for the economy in the 19th century, semiconductors are now a critical barometer for global economic activity" (Cardenal, 2019). Analyzing and predicting the movements of the semiconductor business cycle could then be of great help for determining the future performance of the stock markets.

II. Statistical analysis:

Economic analysis has been around for centuries, concentrating mainly on determining the length and direction of business cycles, which are the upward or downward movement of economic activity occurring around a growth trend. Many experts have focused their studies in finding a cause for these cycles, such as the British economist William Jevons, who blamed

"sunspots" to be the originators of recessions in the 19th century, supported by the fact that sunspots caused a decline in agricultural production, which ended up affecting the economic environment of societies.

All these studies found common ground in their pursuit of predicting the direction of business cycles before they occurred. Analysts now focus on studying sets of leading indicators that aim to show if a market is overbought or oversold. The market will typically suffer a pull-back or correction if it is overbought and rebound when it is oversold. Leading indicators can then be used to determine entry and exit points based on market prices within a settled trend.

These economic business cycles are similar to industry business cycles, following the four fundamental phases in every cycle: peak, downtrend, trough, and uptrend. Although the indicators may not be the same, as the factors that impact each industry are usually different. In order to find the most suitable indicators for the analysis, it is recommended to follow the tests that define the classical criteria for selecting leading indicators. Based on the Business Cycle Indicators Handbook written by the The Conference Board in 2001, leading indicators must follow:

- Conformity—the series must conform well to the business cycle
- Consistent Timing—the series must exhibit a consistent timing pattern over time
- Economic Significance—cyclical timing must be economically logical
- Statistical Adequacy—data must be collected and processed in a statistically reliable way
- Smoothness—month-to-month movements must not be too erratic
- Currency—the series must be published on a reasonably prompt schedule.

Two of the most representative leading indicators for the semiconductor industry are new orders of semiconductors, which shows an indication of the demand in the industry, and the producer price index (PPI) for the sector, which represents the balance between supply and demand in the market.

As shown in Figure 5, there is a high positive correlation between the SOXX and the new orders of semiconductors, as the market price of the industry reflects the variation in market

demand for these products. Additionally, the producer price index indicates a high negative correlation with the other variables. Not only is it an indicator of the balance between supply and demand in the market, but it also demonstrates the effect of improving technologies and economies of scale, which end up decreasing prices over time. The steady rise of NASDAQ over the last five years has been matched by an almost equal increase in new orders and, ultimately, a decline in semiconductor prices.

Figure 5: Correlation Table SOXX-NO-PPI

	<i>SOXX</i>	<i>New Orders</i>	<i>PPI</i>
<i>SOXX</i>	1		
<i>New Orders</i>	0.875377	1	
<i>PPI</i>	-0.90832	-0.912258063	1

Source: Self-elaboration based on U.S. Bureau of Labor Statistics data⁹

Since the early 19th century, analysts and mathematicians have been performing regression analysis to estimate the relationship between a dependent variable and one or more independent variables. The analysis will only be meaningful if it relies on the established assumptions; The sample must be representative of the population, the independent variables must be measured with no error, deviations from the model have an expected value of zero, the variance of the residuals is constant across observations, and the residuals are uncorrelated with one another.

Regression modeling is highly popular for evaluating relationships between variables, and therefore much useful for analyzing leading indicators. The dependent variable that the model explains is the SOXX returns, while the new orders and PPI are taken as independent variables. The highest frequency obtained is monthly, constrained by both the new orders and PPI figures. The analyzed period is still five years, as compared previously; therefore, the model will have 60 monthly statistics of all the variables.

⁹ This figure is a section of the Appendix 1, which covers a regression model of the SOXX, New Orders of Semiconductors and the Producer Price Index.

One of the most representative figures of a regression model is R Square, as it shows the proportion of the variance in the dependent variable that is predictable from the independent variable. Its value ranges from 0 to 1, although it is mostly used as a percentage. As this model has more than one independent variable, the coefficient of determination must be adjusted as it is no longer a linear regression. As shown in figure 6, the regression model has an adjusted R Square of 0.8323, meaning that 83.23% of the variance in SOXX returns is predictable from the independent variables.

Figure 6: Regression Summary

<i>Regression Statistics</i>	
Multiple R	0.915465
R Square	0.838076
Adjusted R Square	0.832395
Standard Error	20.18398
Observations	60

Source: Self-elaboration based on Yahoo Finance data¹⁰

Although other professionals prefer to evaluate a regression model based on its Standard Error, as it is an indicator of the average distance that the data points fall from the regression line. The objective of a significant model is to have a high R Square and a low Standard Error. As shown in the previous figure, the model matches a high enough adjusted R Square, as well as a sufficiently low standard error. According to the mathematical theory, 95% of the results must be within a range of +/- two times the standard error from the regression line; in this case, the figure is low enough when compared with the values of SOXX. Overall, this regression model has high predictive power and sufficient precision to forecast future returns of the semiconductor industry.

After analyzing the main components underlying the semiconductor industry, and understanding their predictive power, the regression analysis can be used to prove the

¹⁰ This figure is a section of the Appendix 1, which covers a regression model of the SOXX, New Orders of Semiconductors and the Producer Price Index.

relationship between the returns of both NASDAQ and SOXX over the last five years. As the purpose of this paper is to establish the predictive power of the semiconductor industry over the electronics market, now the dependent variable used is the NASDAQ returns, and the SOXX returns will be the independent variable. To introduce the previous independent variables would now be redundant as their effect will already be entailed on the SOXX figures. Although the analyzed period is still the same, now the model will be based on daily returns of both indexes, ending up with 1257 observations.

The new model is more accurate due to the increase in analyzed observations, although it is offset by a decrease in its predictability reflected on an R Square of 0.6931. The technological industry has changed over time, and particularly the semiconductor sector has gained momentum over the last five years. To better analyze the relationship between these two indexes, it is optimal to run a regression analysis over each year throughout the entire period. Figure 7 shows the variation in the regression parameters over each of the five analyzed periods.

Figure 7: Regression analysis over time

Daily returns	BETA	CORRELATION	R SQUARE	St. Error
2015-16	1.077	0.818	0.670	0.007
2016-17	1.211	0.809	0.655	0.005
2017-18	1.463	0.866	0.751	0.004
2018-19	1.159	0.856	0.733	0.007
2019-20	1.394	0.826	0.683	0.005

Source: Self-elaboration based on Yahoo Finance data¹¹

As shown in the previous figure, the beta calculated on the different analyzed periods has been increasing over time, indicating that the semiconductor sector has increased its volatility in reference to the overall technological industry. A beta over one means that the variations of the SOXX will be more extensive than the ones of NASDAQ, showing a higher increase

¹¹ This figure summarized the findings from the annual regression models done over the 5-year analyzed period, the entire excel file can be found on Appendix 2.

in expanding periods and a harder decline in contraction periods. The beta of SOXX with respect to NASDAQ shows that the semiconductor sector has experienced higher returns than the overall technological industry, especially over the 2017-18 expansion and last year. It is indicating the superior growth of the semiconductor sector compared to the global technology landscape. Additionally, the correlation has remained strong over the analyzed time frame, supported by resilient R Square and St. Error figures on its model.

The idea behind leading indicators relies on the fact that a variable could be studied to anticipate future movements of another variable. The time gap between the similar changes in the variables represents an opportunity as it allows investors to predict the performance of the independent variable.

Even though the technology industry is highly dependent on semiconductors, the market returns of SOXX do not seem to anticipate the market performance of the technology industry, as represented by the NASDAQ returns. After a thorough study of different regression analyses comparing the returns of NASDAQ with previous returns of SOXX with a time gap variation of days, weeks, and months, the model did not show any improvement. If the SOXX could impact the forward performance of the NASDAQ, the model would have shown a higher R Squared coefficient when the time gap was applied. However as shown in Figure 8, the model not only did not improve but worsened its predictability after applying the time gap, lowering its R Square to less than 0.10 and its correlation to less than 20%. This worsening was general across different time periods and different time gaps applied to the model.

Figure 8: Regression summary 2015-16 one week gap

One week leading gap 2015-2016	
<i>Regression Statistics</i>	
Multiple R	0.207946
R Square	0.043241
Adjusted R Square	0.023309
Standard Error	0.025384
Observations	50

Source: Self-elaboration based on Yahoo Finance data¹²

These results support that the semiconductor industry does not display a leading ability over the technology industry overall, but that it shares a highly similar market movement when analyzed simultaneously. This is a characteristic of coincident indicators, which are useful for showing the current state of the underlying economic activity within a particular area, in this case, the technological industry. Although these indicators may not be useful for predicting future performance of independent variables, they are used as a primary source of information to document "official" business-cycle turning points. The steady growth that the semiconductor sector has shown over the last five years supports the undeniable expansion of the technological industry.

¹² This figure shows the findings from the regression model over the 2015-2016 period with a one week leading period for SOXX, supporting how the model became less predictable when anticipated by any time gap. The entire excel file with more leading trials can be found on Appendix 3.

4. Key players:

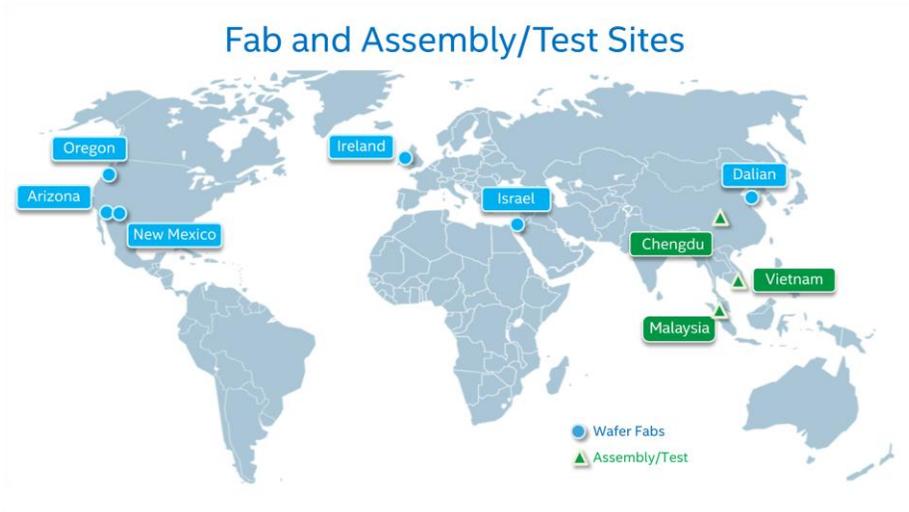
The semiconductor sector has been growing since its inception, reaching international markets and expanding into new specialized sub-sectors. Companies around the world arise with new technologies and expertise, conquering market share in one of the most competitive and innovative business landscapes of the market. As stated previously, the sector is dominated mainly by American companies. This paper will analyze Intel, NVIDIA, Texas Instruments, and Broadcom as representatives of the Yankee nation, as well as international players like ASML (Netherlands) and Taiwan Semiconductors. This study aims to find the best positioned firms in the sector by analyzing its fundamentals and qualitative characteristics.

I. Overview of the sample:

- **INTEL CORPORATION (NASDAQ: INTC):**

Intel was founded in 1968 in Santa Clara, California, and provides computing, networking, data storage, and communication solutions worldwide. It is a respectable player in the sector, as it was the first company to develop a microprocessor chip since then, they have specialized and maintained their leading position in data storage. As shown in Figure 9, the Company counts with six wafer fabs, and three assembly sites located efficiently to deliver their products to their customers around the globe.

Figure 9: Geographical presence of Intel's facilities



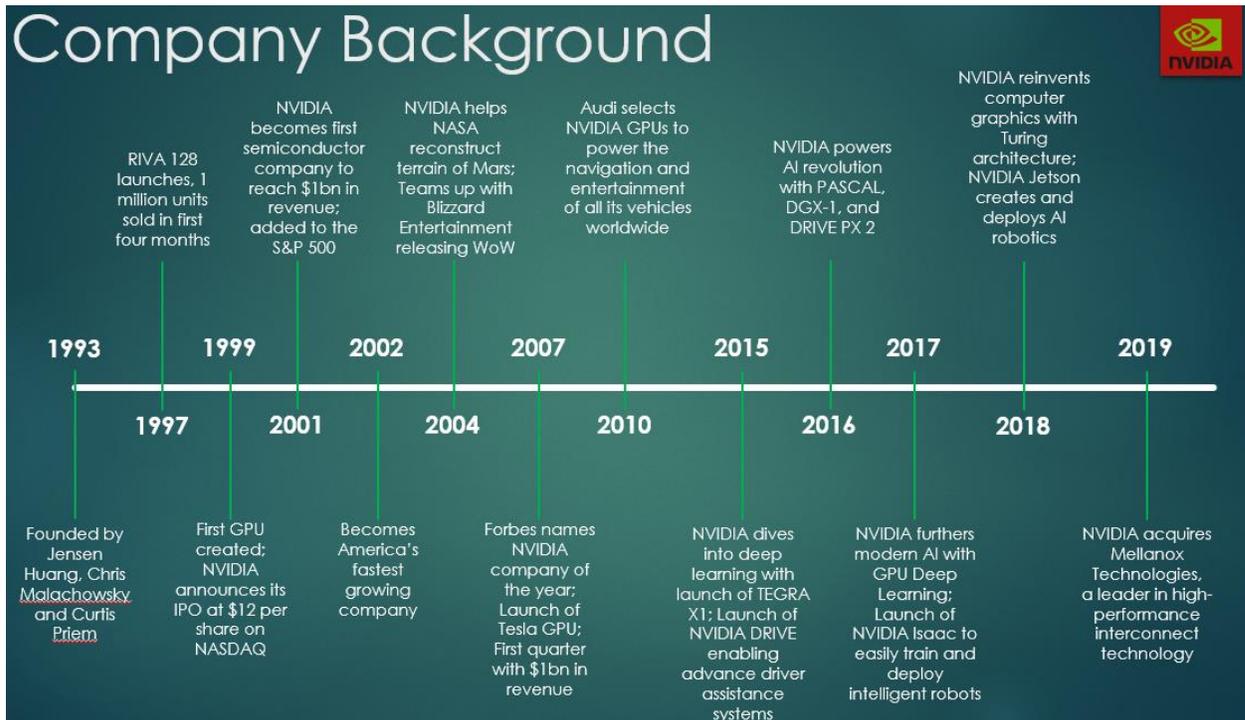
Source: Intel.com¹³

- **NVIDIA CORPORATION (NASDAQ: NVDA):**

Nvidia was founded in 1993 in Santa Clara, California, and it's specialized in two broad segments: GPU and Tegra processor. They were the creators of the first Graphics Processing Unit (GPU), which creates interactive graphics for laptops, P.C., and notebook. They revolutionized the gaming world and have been continuously improving their products to remain as undeniable leaders of this fast-growing market. The Tegra Processor segment provides devices and services designed to harness the power of mobile-cloud to revolutionize home entertainment, A.I., and robotics. As shown in Figure 10, they have long-lasting partnerships with world-known players like Audi, Tesla, or NASA to develop the visual graphics of their navigation and entertainment systems. Over the last few years, they have been expanding into robotics, deep-learning, and high-performance interconnect technology with the recent acquisition of Mellanox Technologies.

¹³ This figure can be found on the Company's website <https://www.intel.com/content/www/us/en/company-overview/company-overview.html>

Figure 10: Timeline NVIDIA Corporation



Source: Self-elaboration based on NVIDIA website; History¹⁴

- BROADCOM Inc. (NASDAQ; AVGO):

Broadcom was founded in 1961 in San Jose, California, and it is a designer, developer, manufacturer, and global supplier of a wide range of semiconductors and infrastructure software products. Their products focus on technologies that connect our world, being a leader and innovator in a variety of divisions like data center, networking, software, broadband, wireless, and storage and industrial markets. Their continuous innovation has enabled them to produce the first fiber optic transmitters and receivers for data communications, as well as the first single-chip DOCSIS cable modem to allow cable T.V. operators to provide Internet access. Additionally, they have completed Industry's First End-to-End 5G Mobile Networking Switch Portfolio and many other pioneering advances in the sector. They have a long and successful growth history through acquisitions, combining

¹⁴ This figure is self-elaborated and based on the firm's information provided on their website <https://www.nvidia.com/en-us/about-nvidia/corporate-timeline/>

leading firms like LSI, Broadcom Corporation, Brocade, CA Technologies, and Symantec under the same corporation to drive the industry into the future.

- TEXAS INSTRUMENTS Inc. (NASDAQ; T.X.N.):

Texas Instruments was founded in 1951 in Dallas, Texas, and it is a designer and manufacturer of semiconductors and various integrated circuits operating in two primary segments: Analog and embedded processing. The analog segment offers products to manage power requirements in various levels using battery management solutions, portable components, power supply controls, switches and interfaces, integrated protection devices, high-voltage products, and mobile lighting and display products. Moreover, they manufacture signal chain products that sense, condition, and measure signals to allow information to be transferred or converted for further processing and control for use in end markets. The Embedded Processing segment offers connected microcontrollers with integrated wireless capabilities and stand-alone wireless connectivity solutions that are used in electronic equipment. T.X.N. has lead essential innovations for the world, such as inventing the silicon transistor in 1954, the first integrated circuit in 1958, or developing the first hand-held calculator. The Texan manufacturer succeeded at launching the first family of single-chip digital cellphone solutions in 2007, making cellphone technology more affordable and adding features to make phones smarter.

- TAIWAN SEMICONDUCTOR MANUFACTURING COMPANY Ltd. (NYSE; T.S.M.):

Taiwan Semiconductor Manufacturing was established in 1987 in Taiwan, after many years of development they have become the number one pure-play semiconductor foundry in the world and focuses solely on manufacturing their customers' products. They have accomplished partnerships with leading players on a variety of divisions around the globe, by maintaining a competitive and respectable approach throughout its history as well as taking advantage of its expertise in the specialized manufacturing stage.

- ASML Holding (NASDAQ: ASML):

ASML was founded in 1984 in the Netherlands, it designs, manufactures, and sells advanced semiconductor equipment systems consisting of lithography related systems for memory and logic chipmakers. Over the last 20 years, the humble Dutch company has enabled the industry to design and produce smaller and faster chips by projecting light through a layer of water between the lens and the wafer. The firm believes in growth through continued innovation and collaboration with its loyal customers.

II. Financial Analysis:

This paper aims to analyze the fundamental financial components of the leading players in the sector, seeking to find the best-performing company for the current and upcoming business landscape. This analysis considers the most influential ratios and indicators of the semiconductor sector over the last five years, considering the six analyzed companies as a representative sample. Aiming to deliver the most consistent and objective analysis possible, this study has calculated the compounded annual growth rate (CAGR) of each ratio from the median of the results instead of from the latest released data.

This analysis is mostly based on publicly available information delivered by the companies on their earnings reports. It is, therefore, objective and not influenced by any personal judgment.

- Net profit margin:

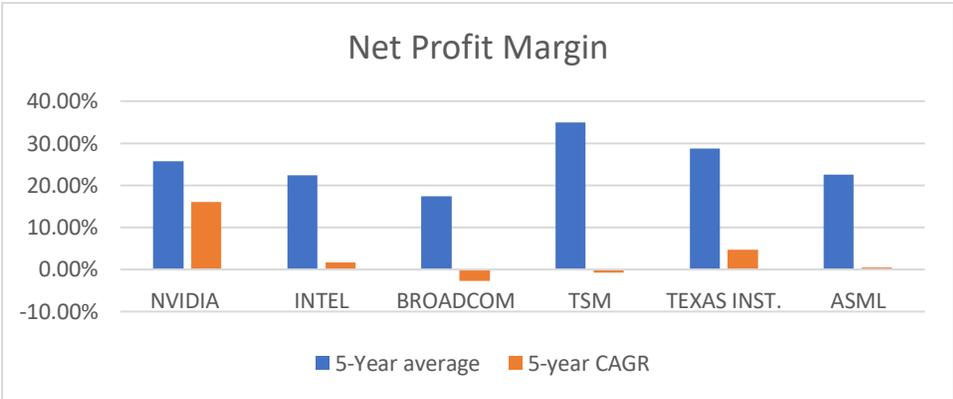
The net profit margin is one of the most crucial indicators for assessing a company's financial health, as it shows the percentage of revenues that remain after paying operating expenses, interests, taxes, and preferred stock. Investors pay close attention to the net profit margin performance of a company as it indicates how well the management team is converting revenues into profit for shareholders.

The average 5-year net profit margin median of the sample is 24.14%, which is higher than the average figure for the overall semiconductor industry of 19.42%, and more than twice as high as the global market's average of 7.71%, as stated by an N.Y.U. Stern industry research

(N.Y.U. Stern, margins). As shown in figure 10, Taiwan Semiconductor leads the sample with an average net margin of 34.98%, followed by T.X.N. with 28.79% and NVIDIA with 25.73%. Although T.S.M. stands out as a leader, it is also essential to consider the recent growth in margins.

The 5-year net margin CAGR¹⁵, shows which company has experienced the highest improvement of its operating efficiency. As shown in the figure below, NVIDIA clearly shows the greatest improvement over the last five years, with a 16% compounded annual growth rate in net margins, followed by T.S.M. with growth below 5%. On the other hand, the worst figures come from Broadcom, with a net margin of 17.43%, below the industry average, and negative growth of 2.69%, the lowest of the sample.

Figure 11: Net Profit Margin



Source: Self-elaboration based on Company's data¹⁶

These results conclude that NVIDIA seems to be the best positioned when considering operating efficiency compared to its peers, as it has the highest recent growth in margins and a higher than average current net margin. Additionally, its Texan peer follows closely with a higher net profit figure but less than a third of its growth.

¹⁵ The term CAGR refers to Compounded Annual Growth Rate, and shows the performance of the ratio over the analyzed period. Further information can be found on the following link <https://www.investopedia.com/terms/c/cagr.asp>

¹⁶ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

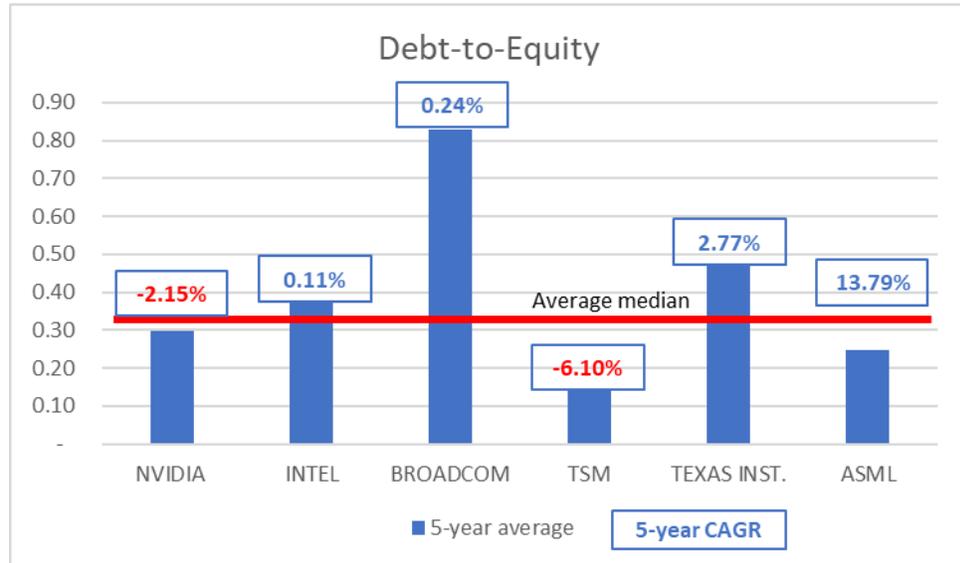
- Debt/Equity:

The debt-to-equity ratio is one of the fundamental core ratios as it is used to evaluate a company's financial leverage. It is calculated as total debt over shareholders' equity and measures the degree to which a company is financing its operations through debt versus external equity. A company's financing combination directly affects its cost of capital. Historically the cost of debt has been cheaper than the cost of equity, which will allow companies with a higher leverage to access a lower cost of capital. At the same time, an inconceivable high leverage will end up increasing the firm's credit risk and, therefore, increase its overall cost of borrowing. This fundamental ratio must be analyzed considering the firm's contemporary situation, as a high debt-to-equity (D/E) ratio will be dangerous for a company facing difficulties as it may not be able to deal with its liquidity obligations. In contrast, a low debt-to-equity ratio could mean that a company is over-relying on equity to finance its business, which can be costly and inefficient.

As represented in figure 12, the average median D/E ratio of the sample is 0.33, which is below the 0.6 average of the overall technology sector. Broadcom clearly leads the sample with the highest rate above 0.8, followed by Texas Instruments below 0.5 and Intel below 0.4. Debt is not as popular out of the U.S.A., with the Taiwanese foundry having the lowest debt-to-equity ratio followed by ASML with less than 0.15 and 0.25, respectively.

It is also essential to analyze the tendency of these firms over time. The Asian foundry has been decreasing its ratio by 6.10% over the last five years, followed by NVIDIA with a negative D/E CAGR of 2.15%. On the other hand, ASML has been the only firm growing at a double-digit rate as an effort to reduce its overall cost of capital.

Figure 12: Debt/Equity



Source: Self-elaboration based on Company's data¹⁷

- Return on Equity (RoE):

Return on equity is measured as net income over shareholders' equity, showing how much profit a company is generating from its shareholder's investment. RoE is a profitability ratio from the investor's point of view, as it measures how efficient a company is at using equity financing to grow its operations. It is always interesting to have a high RoE figure but must pay close attention to its performance over time as it will determine its consistency.

The average 5-year return on equity median of the sample is 21.98%, which is higher than the average figure for the overall semiconductor industry of 20.29%, and more than twice as high as the global market's average of 13.63%, as stated by an N.Y.U. Stern industry research (N.Y.U. Stern, RoE). As presented in Figure 13, Texas Instruments leads the sample with an average RoE of 43.66%, followed by NVIDIA with 30.13% and Taiwan Semiconductors with 23.24%. Although T.X.N. stands out as a leader with an RoE of more than twice the

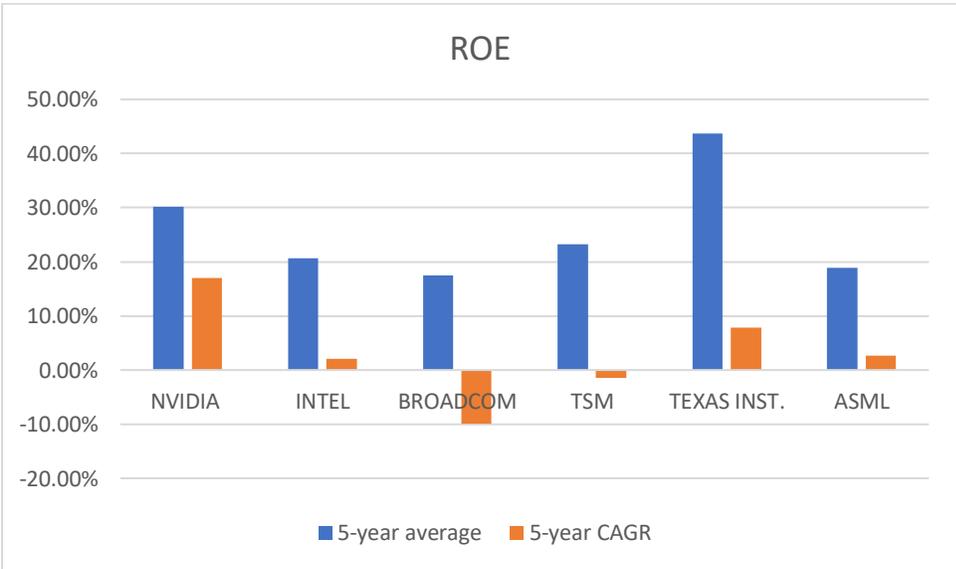
¹⁷ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

industry's average, it is also essential to consider the evolution over time to ensure its uniformity.

The 5-year RoE CAGR median of the sample is 2.36%, there is a high contrast on this analysis as Broadcom and T.S.M. have had negative growth on RoE of 9.90% and -1.50% over the last five years, and on the other hand, NVIDIA and Texas Instruments have shown high growth of 17.02% and 7.78% respectively. Overall, Broadcom shows the worst performance, with the lowest return for investors and a menacing negative growth.

These figures point out Texas Instruments to be more attractive from an investor's point of view as it exhibits a return on equity investment of more than twice the average and a high growth compared with its peers. NVIDIA follows closely with high double-digit growth and a rate higher than the industry.

Figure 13: Return on Equity



Source: Self-elaboration based on Company's data¹⁸

¹⁸ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

- Return on Investment (RoI):

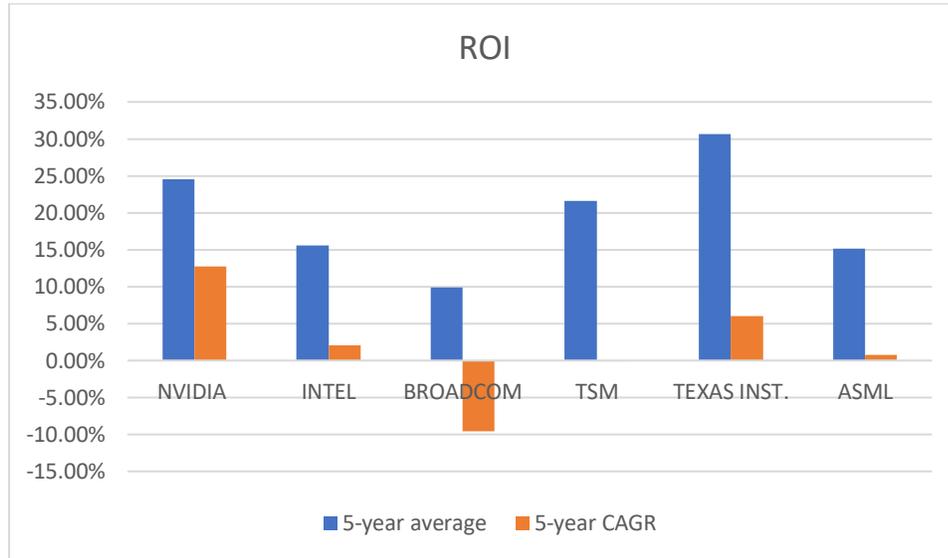
The return on investment is a profitability ratio that measures the profits of an investment as a percentage of its cost. It is calculated as the investment revenue minus the investment cost over the investment cost, it is a flexible formula, as each industry or specific firm can determine the investment revenue and cost as they consider. The most common way of calculating the RoI for shareholders is by dividing net profit over the cost of the investment, as it already takes into account the interests and taxes on the return and considers the amount of profit available for its investors.

The average 5-year return on investment median of the sample is 18.56%, which is similar to the 2019 average figure for the overall semiconductor industry of 18.64%, as calculated by C.S.I. Market. Although the sample median for 2019 is 19.71%, higher than its related industry in the same year. Figure 14 shows how Texas Instruments leads the sample with an average RoI of 30.65%, followed by NVIDIA with 24.51% and Taiwan Semiconductors with 21.57%. Although T.X.N. stands out as a leader with an RoE 50% higher than the industry's average, it is also essential to consider the improvement overtime to ensure its future performance.

The 5-year RoI CAGR median of the sample is 1.38%, there is a high contrast on this analysis as Broadcom and T.S.M. have had negative growth on RoE of 9.55% and 0.09% over the last five years, and on the other hand, NVIDIA and Texas Instruments have shown strong growth of 12.77% and 6.05% respectively. The Asian foundry holds the third-highest 5-year average RoI and has maintained its return stable over time with a slight decrease over the last three years. On the other hand, Broadcom shows the worst performance, with the lowest return as a percentage of cost and threatening negative growth.

Texas Instruments seems to be the best positioned when considering RoI, as it exhibits a high return on investment and has been growing at a higher rate than its peers. Additionally, NVIDIA has grown at the most robust rate and has the second-highest return on investment, which could help it ensure its leadership in the upcoming future.

Figure 14: Return on Investment



Source: Self-elaboration based on Company's data¹⁹

- Return on capital employed (ROCE):

The return on capital employed (ROCE) is an additional profitability ratio that is useful for comparing the profitability based on the amount of capital applied. It is calculated as EBIT²⁰ over capital employed, taking total assets minus current liabilities as the divisor. This ratio considers how efficient a company is at generating operating income from its shareholders' equity and debt liabilities. It is complementary to RoE, but it also considers the amount of debt that a firm relies on for its operations.

The average 5-year ROCE median of the sample is 20.30%; this figure is similar to the previous analyzed RoE as the sample average is not highly leveraged. As exposed in Figure 15, T.X.N. dominates the sample as it has the lowest debt/equity ratio of the peers with an average ROCE of 37.44%, almost twice as high as the median, followed by NVIDIA with

¹⁹ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

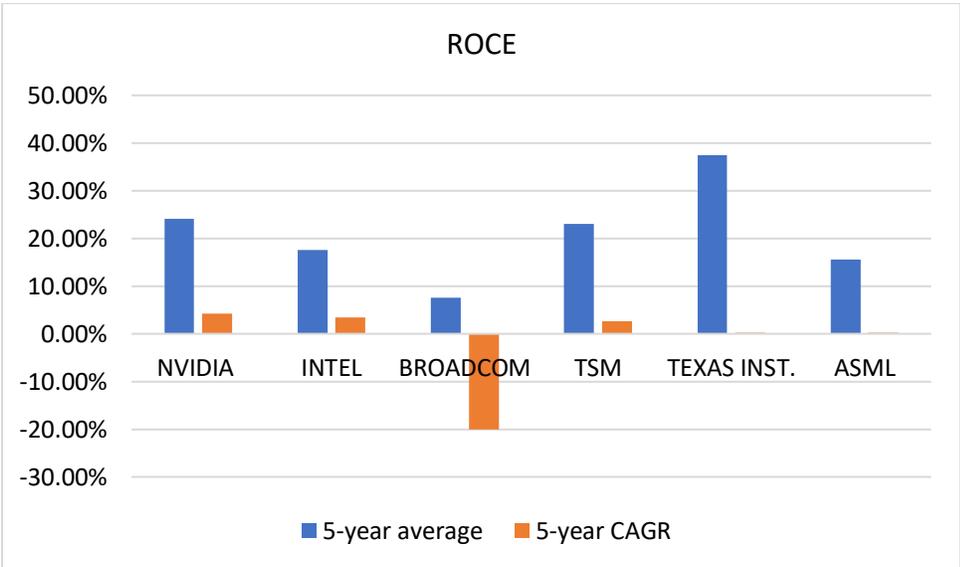
²⁰ The acronym EBIT refers to Earnings Before Interests and Taxes, which is one of the main components of an income statement.

24.17% and T.S.M. with 23.05%. Although Texas Instruments leads the sample, it is also important to consider consistency and growth in the analysis.

The 5-year ROCE CAGR shows that Broadcom is in a dangerous situation as it has the lowest average ROCE of the sample and has had negative growth of 20% over the last five years. Moreover, T.S.M. will likely lose its podium position as it has not been able to improve its ROCE at the same rate as its American competitor Intel, which has had the second strongest growth behind NVIDIA.

T.X.N. will likely maintain its leadership as it has proved to grow its already strong ROCE at a 2.64% 5-year CAGR, as long as it holds its low debt-to-equity ratio.

Figure 15: Return on Capital Employed



Source: Self-elaboration based on Company's data²¹

- FCF/Share:

Free cash flow (FCF) per share is a highly useful and comprehensive financial ratio that demonstrates the amount of cash flow available to be distributed to both debt and equity shareholders. This ratio shows a company's ability to pay debt, dividends, buy back stock,

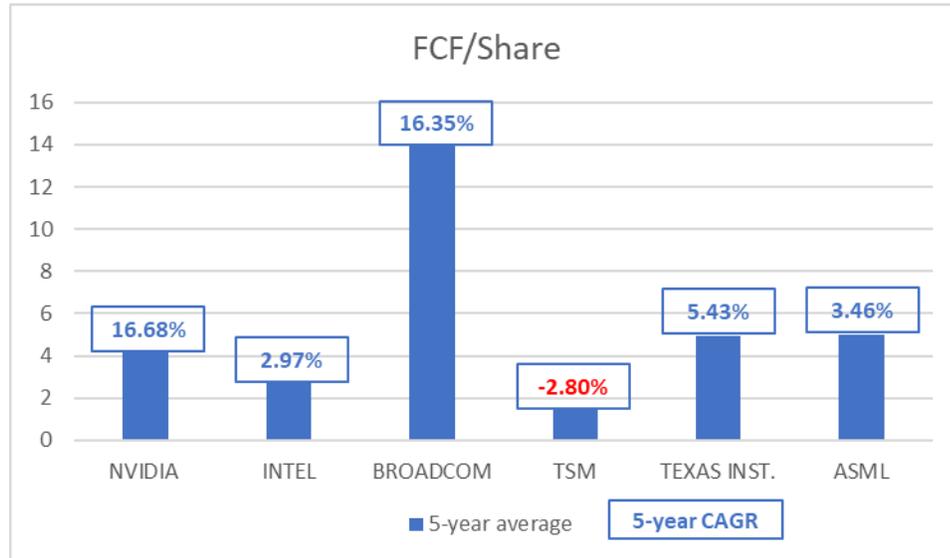
²¹ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

and ensure the growth of the firm. It is calculated as free cash flow over the number of outstanding shares of a company. Therefore it could be used as an indicator for changes in earnings per share. Positive growth in FCF/Share is always a sign of financial health, as a firm will aim to grow its cash flow from operations and to invest while maintaining a stable number of shares.

Due to the variation in the number of shares outstanding that each company has, the absolute value of FCF/Share is not as representative as its growth over an analyzed period. The median 5-year FCF/Share CAGR of the sample is 4.44%, which implies that these companies have been able to generate more cash from its operations over time, supporting the strength of the sector. The well-defined leaders, as shown in Figure 16, are NVIDIA and Broadcom with a growth of more than four times the sample median, whereas, on the other hand, the Asian foundry has been decreasing its FCF over the analyzed period while maintaining its shares outstanding at a stable amount.

Overall, NVIDIA and Broadcom are the best-positioned companies with growth rates considerably above the sample median and following a steady upward slope over the last five years. Taiwan Semiconductors, on the other hand, seems to be struggling with its cash flow generation.

Figure 16: FCF/Share



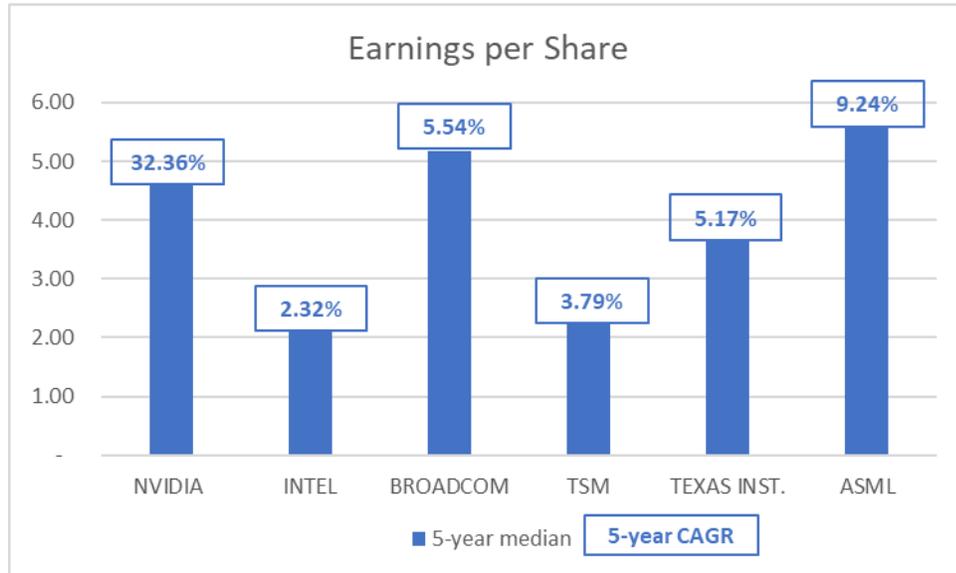
Source: Self-elaboration based on Company's data²²

- Earnings per Share:

As stated above, FCF/Share is an indicator of earnings per share (EPS), which is one of the most anticipated figures of every quarterly report. EPS is a profitability ratio that represents the portion of a company's earnings, excluding preferred stock dividends, that is allocated to each share of common stock. Following the same rationale as with FCF/Share, the absolute value of EPS should not be compared across companies, while growth is now more representative than ever. Additionally, as analysts tend to forecast the quarterly EPS figure of companies, it is also significant to consider if a company has been able to beat its estimates over the most recent periods.

²² This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

Figure 17: Earnings per Share

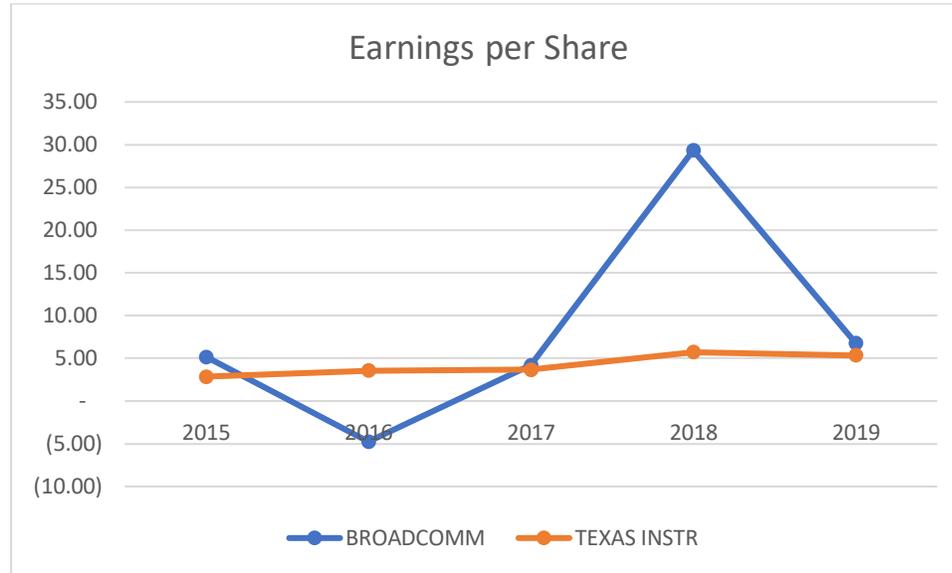


Source: Self-elaboration based on Company's data²³

As shown in Figure 17, NVIDIA exceeds the median CAGR of the sample with a 5-year growth in EPS of 32.36%, followed by the Dutch designer with 9.24%. Although Broadcom and Texas Instruments have been growing at similar CAGR, it is essential to point out that Broadcom has had much more variance than its Texan peer, as shown in Figure 18. Consistency is vital for companies, as these variances in its results increase their share price volatility and deteriorate their overall corporate profile.

²³ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

Figure 18: EPS Broadcom vs. Texas Instruments



Source: Self-elaboration based on Company's data²⁴

- Sustainable Growth Rate (SGR):

The sustainable growth rate is an additional measure of financial development, as it is a representation of the maximum growth a firm can achieve, excluding external financing from equity or debt. It is important to consider the SGR of a company to avoid over-leveraging and financial distress. The SGR is calculated as RoE multiplied by the retention ratio (1 – dividend payout ratio). Following the DuPont method of calculating RoE, an analyst can determine the most influential components of growth of a company and the effects of its changes, as it is derived from the multiplication of asset turnover²⁵, financial leverage, and net profit margin. Additionally, it is crucial to consider the progress of SGR over time, as a firm must always aim to increase its maximum organic growth.

The 5-year average S.G.R. median of the sample is 13.22%, led by NVIDIA with an SGR of 25.93% as shown in Figure 19, almost twice as high as the median due to both its high RoE

²⁴ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

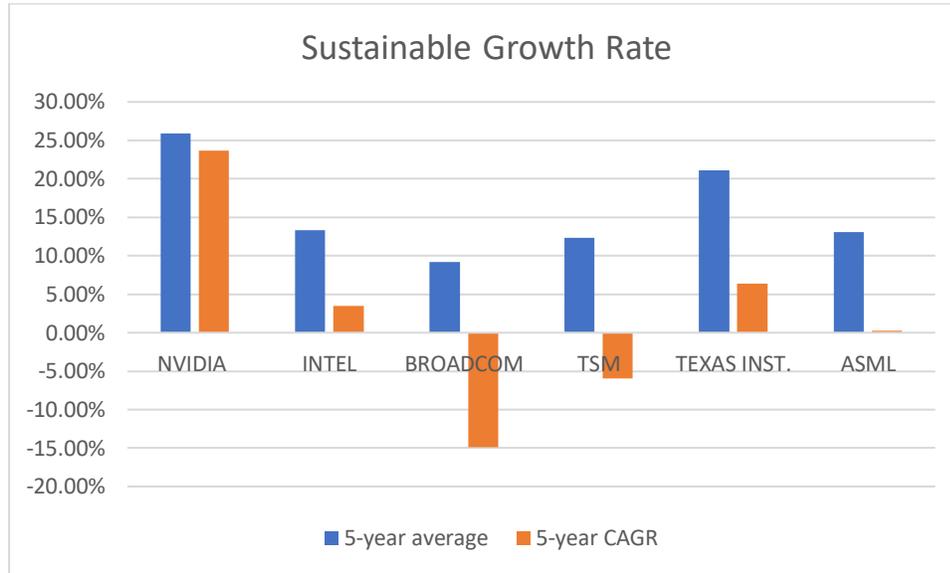
²⁵ Asset turnover is calculated as sales over total assets.

and its high retention ratio, followed by T.S.M. which as discussed previously showed the highest RoE of the sample but with an average 5-year retention ratio of 0.52 compared to NVIDIA's 0.83. Intel and ASML follow closely with an S.G.R. around the sample median due to their similar RoE and dividend payout ratios. On the other hand, Broadcom leads the low level of the sample as it had the lowest return on equity and a retention ratio below the average.

Considering the 5-year SGR CAGR, Figure 19 shows that NVIDIA will most likely remain the leader of this category as it has grown at a robust 23.66% while the rest of its peers have not been able to reach double-digit growth figures. T.S.M. follows with the second strongest growth, although their retention ratio has been decreasing over the analyzed period and will most likely reduce its maximum internal growth. A similar reduction in retention rates due to an increase in paid dividends by T.X.N. has led them to reduce its S.G.R. over the last five years, even more, extreme is the case of Broadcom, which has had a CAGR of -14.91% on the same period.

As stated previously, NVIDIA seems to be highly favored to dominate this ratio in the upcoming future as long as it manages to maintain its RoE growth and retention ratio as high as before.

Figure 19: Sustainable Growth Rate



Source: Self-elaboration based on Company's data²⁶

After careful consideration and analysis of the nine indicators discussed above, Figure 20 shows which companies seem to be better positioned from a fundamental point of view by determining the best and second-best performing firms:

- NVIDIA Corporation exhibits the best results overall compared with its sampled peers. The Company has been able to grow its Net Profit margin at the highest rate, with a 16% 5-year CAGR, reaching the third-highest margin of the sample after T.S.M. and T.X.N. It shows the highest RoE. and RoI CAGR, being the only firm to grow at a double-digit rate over the last five years. Its decreasing and below-average debt-to-equity rate has enabled them to achieve the highest sustainable growth rate of the sample, as well as being the only company to reach a CAGR higher than 20% on the same indicator. Its earnings per share have shown a 32% compounded growth over the last five years, more than three times higher than the sample average and only followed by ASML with growth below 10%. Overall, NVIDIA has proven its

²⁶ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

high strength as a growth firm and seems to be able to hold the leading position of the sector for the upcoming periods.

Figure 20: Financial Ratios Comparison

Company	NVIDIA	INTEL	BROADCOM	TSM	TEXAS INST.	ASML	MEDIAN
Net Profit Margin	25.73%	22.45%	17.43%	34.98%	28.79%	22.55%	24.14%
Net Profit Margin CAGR 5-year	16.00%	1.70%	-2.69%	-0.76%	4.62%	0.44%	1.07%
ROI	24.51%	15.55%	9.86%	21.57%	30.65%	15.13%	18.56%
ROI CAGR	12.77%	2.02%	-9.55%	-0.09%	6.05%	0.74%	1.38%
ROE	30.13%	20.71%	17.51%	23.24%	43.66%	18.84%	21.98%
ROE CAGR	17.02%	2.07%	-9.90%	-1.50%	7.78%	2.65%	2.36%
FCF/SHARE	4.152	2.766	13.926	1.44	4.9368	5.026	4.54
FCF/Share CAGR 5-year	16.68%	2.97%	16.35%	-2.80%	5.43%	3.46%	4.44%
DEBT/EQUITY	0.30	0.37	0.83	0.15	0.47	0.25	0.33
D/E CAGR	-2.15%	0.11%	0.24%	-6.10%	2.77%	13.79%	0.18%
Sustainable Growth Rate	25.93%	13.34%	9.22%	12.30%	21.11%	13.11%	13.22%
SGR CAGR	23.66%	3.49%	-14.91%	-5.95%	6.37%	0.28%	1.89%
AVERAGE ROCE	24.17%	17.55%	7.50%	23.05%	37.44%	15.55%	20.30%
ROCE CAGR	4.25%	3.41%	-20.02%	2.64%	0.20%	0.26%	1.45%
EPS CAGR	32.36%	2.32%	5.54%	3.79%	5.17%	9.24%	5.36%
EPS MEDIAN	4.59	2.12	5.17	2.24	3.68	5.57	4.14

Best 2nd best

Source: Self-elaboration based on Company's data²⁷

- Texas Instruments follows with a better than average performance over the last five years. The Texan manufacturer holds the second-highest net profit margin 5-year CAGR, achieving a 28.8% net margin average. The Company seems highly attractive for investors, as it has been able to operate with the highest RoE and RoI of the sample with returns of 43.66% and 30.65%, respectively, supported by the highest growth rates after NVIDIA. Additionally, T.X.N. has the highest ROCE of the sample, with an average return on capital employed of 37.44%, almost twice as high as the sample average. Moreover, the firm has been able to grow its earnings per share at nearly 10% over the last five years of operations. Texas Instruments shows growth potential accompanied by stable historical performance and a 50% retention ratio, making it highly attractive for investors willing to enter the semiconductor sector.

²⁷ This chart is part of the Overall Analysis tab on the Player Analysis excel file attached on Appendix 4.

III. Market valuation analysis:

After studying and analyzing the fundamental factors of each one of the selected players, two companies seem to be better positioned to outperform their peers in the future. This section examines these favored companies from a market valuation perspective, with the objective of understanding the investor sentiment behind their performance.

As defined by the Corporate Finance Institute, the stock price is a reflection of the company's value, which is based on the idea of how much the public is willing to pay for a piece of the company. However, it is not always representative of its intrinsic value, as it is affected by external factors such as supply and demand or market sentiment. It is, therefore, crucial to analyze the market value of a company along with its operating performance.

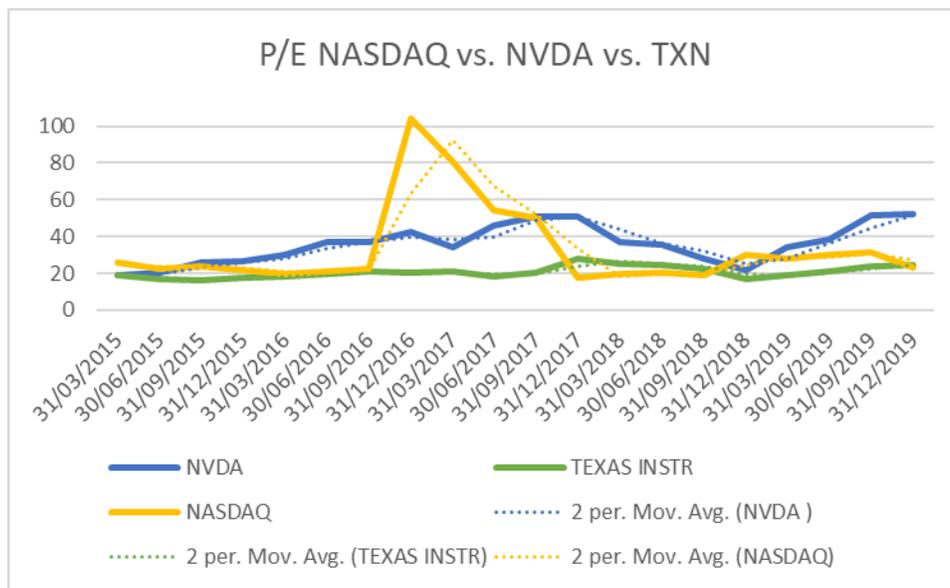
The price-to-earnings ratio (P/E ratio) is one of the most popular stock analysis tools, as it is used to determine whether a company's share price is overvalued or undervalued relative to its operating performance. It is calculated as the current share price of a company divided by its earnings-per-share (EPS). Companies usually measure this ratio based on the latest released earnings or forecasted future earnings when calculating the forward P/E ratio. There is no such thing as a high or low ratio, as it must be compared relative to its sector or peers over a long period of time. Companies with a high P/E ratio will be expected to deliver high growth in earnings compared to peers with a lower rate, or simply show that the firm is overvalued in the market. On the other hand, a low P/E ratio could mean that the stock is currently undervalued or that the firm is performing better than in the past.

Focusing on NVIDIA and Texas Instruments as the best-performing companies among the sample, the paper now analyzes their market performance over the same time period. Studying the data of these companies and comparing it with the NASDAQ as their representative benchmark will help to determine if their market price is undervalued or overvalued. Additionally, it is important to consider the two-period moving average as an indicator of their expected price-to-earnings rate.

- NVIDIA has been increasing its P/E ratio over the last five years because of both an increase in its earnings and an even higher increase in its share price. This trend is

supported by their outstanding operating performance, which has improved its investors' expectations. As shown in Figure 21, the Company had a decreasing ratio from late 2017 to the end of 2018, as it went from holding a P/E ratio twice as high as the NASDAQ at the end of 2017 to halving the same ratio and reaching levels below its index in only 12 months, showing how the market noticed its overvaluation and regulated accordingly. This behavior seems to be repeated over the last year, when NVIDIA has been increasing its P/E ratio over its two-period moving average and has again reached levels of over two times the NASDAQ which could be a sign of overvaluation, and therefore an expected price correction in the upcoming future.

Figure 21: P/E NASDAQ vs. NVIDIA vs. Texas Instruments



Source: Self-elaboration based on Company's data and Yahoo Finance²⁸

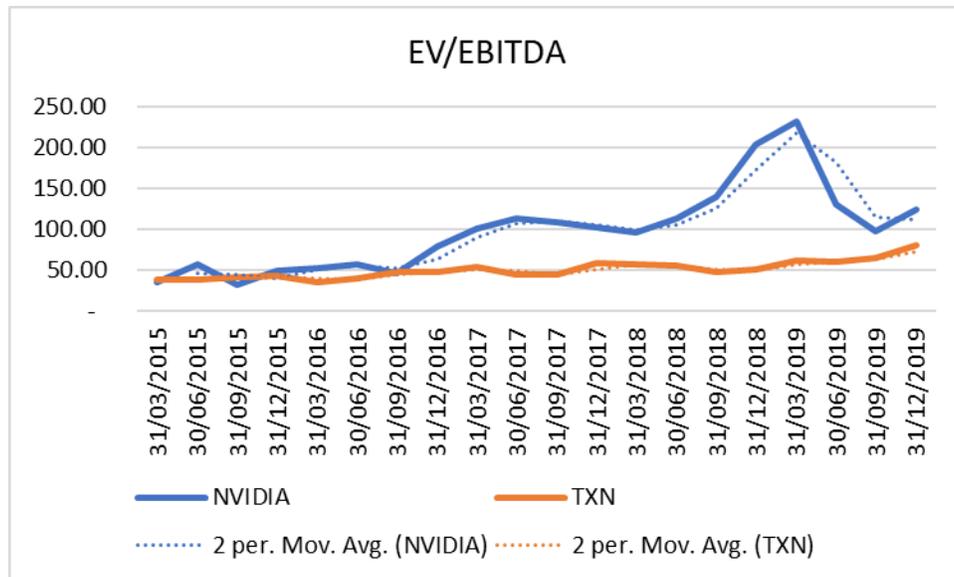
- Texas Instruments managed to grow its earnings at the same rate as its share price throughout the past five years, maintaining a stable price-to-earnings ratio around 20. As shown in figure 21, the Company has reached the same ratio as its index at the end of 2019, after a steady increase over the previous 12 months. Based on its P/E

²⁸ This chart is based on stock prices found in Yahoo Finance and earnings figures presented by the companies, and it is part of the Valuation Ratios tab on the Player Analysis excel file attached on Appendix 6.

performance, it seems correctly valued as it has been able to move along its two-period moving average and keeping its historically firm ratio. These findings favor the Texan manufacturer as its outstanding fundamental performance is supported by a realistic market representation, which improves its attractiveness for investors even more.

An additional measure to determine whether a firm is undervalued or overvalued in the market is the enterprise multiple. The enterprise multiple is derived after dividing the enterprise value (E.V.) of a company by its EBITDA²⁹. The E.V. realistically measures the value of a firm, as it is calculated by adding its market capitalization, value of debt, minority interests, and preferred shares and subtracting the firm's cash and cash equivalents.

Figure 22: EV/EBITDA NVIDIA vs. T.X.N.



Source: Self-elaboration based on Company's data and Bloomberg³⁰

Figure 22 shows the enterprise multiple performances of both NVIDIA and Texas Instruments over the last five years. This graph supports the fact that the Texan manufacturer

²⁹The acronym EBITDA refers to Earnings Before Interests Taxes Depreciation and Amortization and it is one of the main components of the income statement.

³⁰ This chart is part of the Valuation Ratios tab on the Player Analysis excel file attached on Appendix 6.

has a less volatile market valuation when compared with its operating performance, as explained in the P/E ratio analysis. Additionally, NVIDIA suffered a correction at the beginning of 2019 after increasing its enterprise multiple over its 2-period moving average and almost reaching values close to 250. Although both companies have been able to increase its EBITDA, T.X.N. seems to have a higher resemblance to its market capitalization over time, making it a more cautious investment.

IV. Valuation via comparable method:

After analyzing and studying the development of these companies through a variety of multiples, this paper now focuses on equity valuation through the comparable method.

Gathering the entire sample again as a representation of the semiconductor sector and using the median of the results as the benchmark, the comparable method offers a valuation range for NVIDIA and Texas Instruments. The share price is determined as the median P/E ratio of the sample multiplied by the EPS of the company at the end of 2019, and as the median P/FCF ratio of the sample multiplied by the FCF/Share of the firm at the end of 2019. This data was extracted from Yahoo Finance (Share price) and Bloomberg (EPS, EV, and EBITDA)

As shown in Figure 23, NVIDIA has the highest P/E ratio of the sample and a higher than average P/FCF. This valuation approach settles the firm as overvalued when compared with its peers. The ratios offer a share price range between \$153.22 and \$190, both below the price settled at the end of 2019. On the other hand, T.X.N. exhibits an upward potential of more than 20% when compared with the sample. Its surprisingly low P/E ratio and below-average P/FCF offer a valuation range between \$168.45 and \$175.25 dollars per share at the end of 2019.

Figure 23: Comparable method analysis

Company	Date	Price	EPS	EV	EBITDA	FCF/Share	P/E	P/FCF	EV/EBITDA
NVIDIA	31/12/2019	235.3	4.59	145.039	3.386	6.91	51.26	34.05	42.83
INTEL	31/12/2019	59.85	4.33	270.2	42.14	3.78	29.63	15.83	6.41
BROADCOMM	31/12/2019	316.02	8.51	149.52	10.42	22.32	37.14	14.16	14.35
TAIWAN SEMI	31/12/2019	58.1	13.39	8193.15	660.209	0.99	4.34	58.69	12.41
TEXAS INSTR	31/12/2019	128.29	5.25	120.32	6.88	6.126	11.40	20.94	17.49
ASML	31/12/2019	295.94	6.16	109.3	3.32	6.66	48.04	44.44	32.92
Median							33.38	27.50	15.92
							Target Price	Target EV	
NVIDIA							153.22	190.00	53.90
TXN							175.25	168.45	109.52

Source: Self-elaboration based on Yahoo Finance and Bloomberg³¹

Additionally, figure 22 also analyses the enterprise multiple of the sample, showing how both NVIDIA and T.X.N. are above the median of the sector. NVIDIA has the highest enterprise multiple, almost doubling the average, and is therefore determined as significantly overvalued under this ratio. Texas Instruments has a slightly higher than average multiple and could be identified as vaguely overvalued in terms of enterprise value.

³¹ This chart is part of the Valuation Ratios tab on the Player Analysis excel file attached on Appendix 6.

5. Impact of COVID-19 on the Semiconductor Industry:

Although this paper has focused on analyzing the performance of the semiconductor industry over the last five years up until the end of 2019, the world has now been impacted by an unexpected pandemic that has strongly affected the overall economy, and therefore modified the expected performance of many companies. This section will aim to study these changes and their influence over the analyzed sector.

While the pandemic outbreak was originated in a seafood market in the city of Wuhan in China, it quickly spread around the world, reaching more than 200 countries in every continent in less than three months. This rapid expansion was possible due to a combination of both the extremely high infection rate of the virus and the deep international connections resulting from globalization. As stated in the paper of Chakraboity and Maity, "the World Trade Organization (W.T.O.) and the Organization for Economic Cooperation and Development (OECD) have indicated COVID-19 pandemic as the largest threat to the global economy since the financial emergency of 2008-2009."

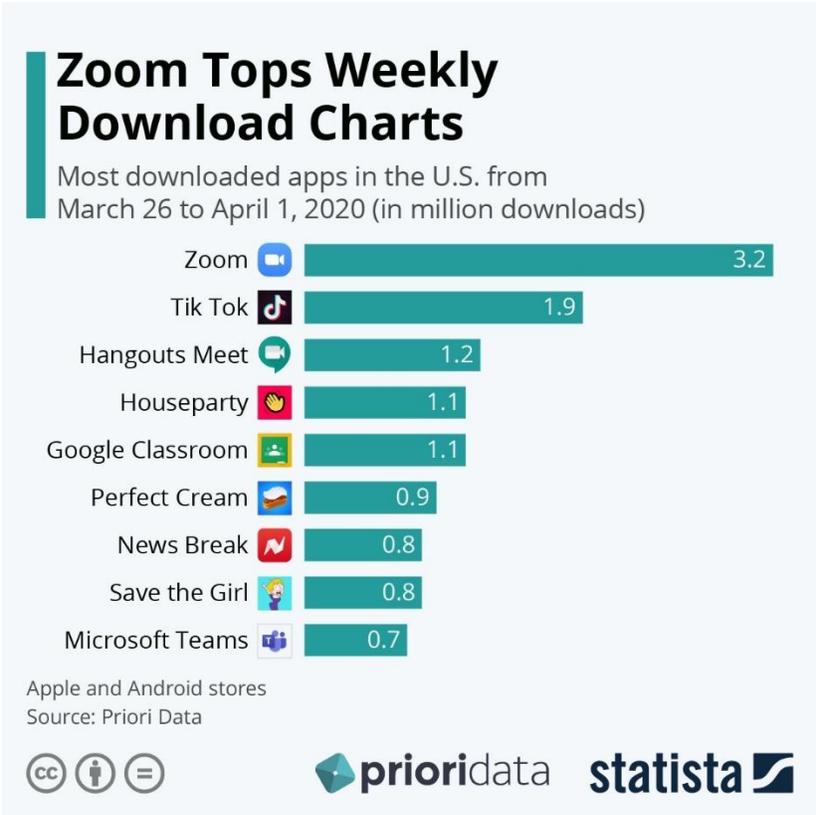
Societies have been affected on a wholesale level. The fear of being infected by this unknown disease has stopped the world in many ways. International travel has been reduced to levels below the aftermath of 9-11³², the majority of the world population has faced daily life restrictions such as lockdowns and scheduled curfews, unemployment has reached crisis rates, and those that remain employed now are challenged to work from home. Industries such as tourism face an output decrease of 50-70%, destroying small businesses and heading large and leading corporations such as Hertz to bankruptcy³³. The retail sector has encountered their essential dependency on on-line sales, as their only source of revenue due to the closure of stores, forcing top companies such as J.C. Penney or Primark to dangerous financial situations. Society as a whole has turned back to basics, leaving many industries behind, while on the other hand, others have now gained more importance than ever before.

³² The 9-11 term refers to the terrorist attack of the World Trade Center on the 11th of September, 2001.

³³ Further information about Hertz bankruptcy can be found on the following link
<https://edition.cnn.com/2020/05/22/business/hertz-bankruptcy/index.html>

As stated above, social distancing and widespread lockdowns have boosted the importance of digitalization in every industry. Society is now challenged to maintain the previously settled lifestyle and outputs through digital tools that make the stay-at-home standard possible. As shown in Figure 24, on-line communication apps such as Zoom, Houseparty, or Microsoft Teams have seen a significant increase in volume due to this situation, as not only workers need to manage their job duties remotely but also social relationships have to remain active by any means. These new forms of work, education, and social communication have become essential in these unprecedented times but have also shown that society can manage to deliver similar or even better outputs through alternative procedures.

Figure 24: Most downloaded apps in the U.S. from 26/03 to 01/04 2020



Source: Buchholz Katharina from Statista based on Prioridata figures

The novel standard has forced us to adapt to new environments that could be settled for the rest of our life. Many companies like Twitter or Square now know that their workers are

happier and more comfortable working from home, and have offered the choice of working remotely forever³⁴. Educational systems have modified their methodology rapidly, and although it may be challenging for some students and professors, others have discovered their fit in on-line learning. Undoubtedly, humanity's development will always depend on some face-to-face contact as it has great benefits; nevertheless, society has now noticed its ability to function correctly in times of social emergency through technology.

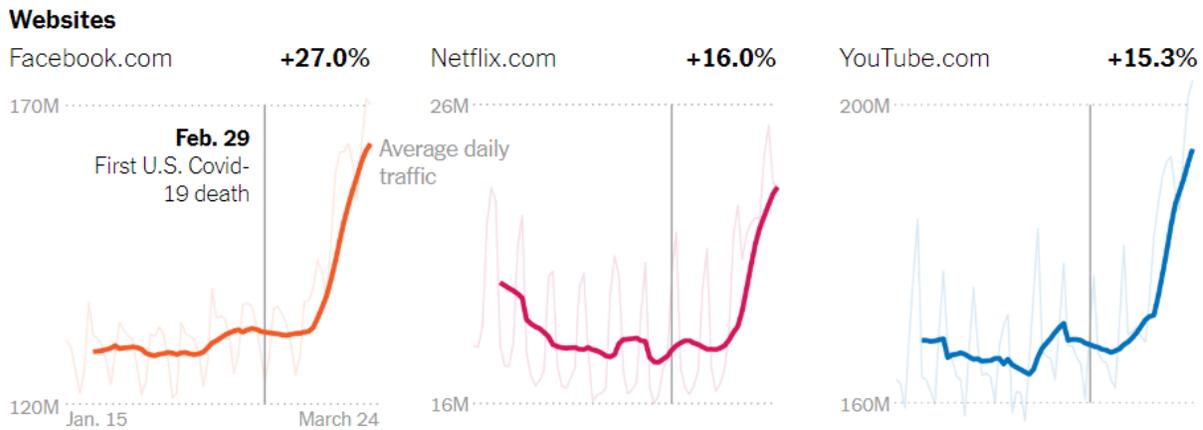
As stated in the first section of this paper, semiconductors are essentially the axis around which technology spins, and therefore follow similar growth patterns. This recent pandemic has changed the lifestyle of millions of people around the world, with the shared characteristic of an increase in the use of technological equipment.

Social distancing policies have affected the way of working in the majority of companies in the world, employees have been obliged to set up an office at their home, causing them or their company to purchase the necessary equipment and tools to function properly through telecommuting. Not only offices have been affected by this new norm, but also factories will modify their structure by further implementing robotic automation and artificial intelligence (A.I.), as these technologies cut down manual intervention, lowering transmission risks, and reducing the dependence on employees to work face-to-face.

As shown in Figure 25, internet usage has risen considerably after the first cases of the pandemic on the U.S. appeared, as users relied mainly on on-line services for entertainment. On-line shopping has saved many retail companies from bankruptcy, and as stated on the Internet Retailing article, "six out of ten consumers say that they will continue to buy as much on-line as they do today after the pandemic has passed." The new norm has modified consumer behavior, what experts expected to happen in three or four years has now been done in just a few months due to the sudden appearance of this life-changing event.

³⁴ Further details about this can be found on the following link <https://www.cnn.com/2020/05/18/square-lets-employees-work-from-home-permanently.html#:~:text=Square%20to%20allow%20employees%20to%20work%20from%20home%20permanently%2C%20following%20Twitter's%20lead&text=The%20news%20comes%20a%20week,%2C%22%20a%20Square%20spokesperson%20said.>

Figure 25: Website daily traffic after first US COVID-death



Source: Koeze E. and Poppe N. from The New York Times

These new safety measures have influenced the entire consumer journey, not only on-line sales have increased drastically, but the essential physical sales have also been modified. ATM cash volumes have dropped across the world, reaching surprising rates of as much as 90% decline YoY in Spain, or 62% drop in the United Kingdom. As both consumers and employees aim to reduce physical contact to minimum, cash is starting to disappear from many businesses. This does not necessarily mean that cash will be extinct as a result of the pandemic, but it has certainly “fuelled trends that already had momentum” (Thomas, D. and Megaw, N 2020).

The drastic increase in daily on-line traffic has involuntarily matched perfectly with the development of 5G technologies around the world. These wireless communications developments are expected to improve even more in the coming decade, as digital users will keep demanding faster and more convenient connections to perform their daily activities as comfortable as possible.

Consumers have now reached record volumes of data storage used over the pandemic lockdown, as there is a high correlation between internet usage and consumption of data cloud services. As supported by Tom Coughlin on a Forbes article, "OpenVault projects that consumption for March will reach nearly 400 GB per subscriber, an increase of almost 11% over the previous monthly record of 361 GB, established in January of this year." At the same

time, memory chips used in mobiles and P.C.s are expected to decline due to their dependence on labor intensive factories, which are mainly located in China. However, these negative figures will be balanced by strong demand from server manufacturers driven by "increasing over-the-top services, games and on-line activities," as stated by Fitch Ratings. The agency also reports that DRAMeXchange "forecasts server DRAM prices to increase by double-digit percentages throughout the year, supporting the industry's overall revenue growth."

As stated by the Fitch Ratings article, the electronic gaming industry has been one of the most advantaged sectors from the pandemic, as millions of users have boosted their playtime as a result of the lockdown. As shown in Figure 26, this industry has experienced one of the strongest growth rates of the market over the last decade, reaching an 11% CAGR from 2012-2021 based on 2018 expectations. Additionally, according to Liz Lanier's article on Variety, the gaming industry could reach \$300bn in revenues in 2025. Semiconductor companies like NVIDIA have benefitted from this trend, as graphic processing units are and will continue to be essential for the improvement of the gaming experience.

Figure 26: 2012-2021 Global games revenue growth



Source: Tom Wijman from NewZoo³⁵

³⁵ This chart is based on 2018 figures and estimates from industry's specialists.

Despite the drop in overall automobile sales during the first quarter of 2020, the electric vehicle segment has remained present and is already showing signs of high expectations. According to the article by Veronika Henze on BNEF, E.V. sales are forecast to fall only by 18% in 2020 compared to a 23% drop on combustion engine cars. Electric vehicle sales have been increasing YoY over the last decade, reaching 3% of total car sales and are forecast to achieve 7% by 2023. This drastic expansion will change the industry for the better, supported by environmental regulations, an increase in the amount of publicly accessible charging points for E.V., and an expected decrease in prices of lithium-ion batteries. Electric vehicles are supported by the development of semiconductors, as they "power electric vehicle (E.V.) batteries and components in the power train," as stated by William Crockett Jr. in an article of Manufacturing Business Technology.

Additionally, William also recalls that the amount of semiconductor components on the average automobile has expanded over the last ten years, as chips support touch screen connectivity and are "responsible for powering systems that store and apply updates to firmware." The digitalization of cars will only increase over time, as drivers have now become accustomed to visual sensors and driving assistance systems for ensuring their safety. This movement will be boosted by the much anticipated development of self-driving and autonomous cars, which depend solely on chips.

Overall, the catastrophic pandemic that will set 2020 as a memorable year has affected the entire world population in many ways that most benefit the performance of the semiconductor sector. Although annual sales may end up being lower compared to 2019, the decrease will not be comparable to the drastic impact suffered by the whole market. The most significant value will come over time, as this unprecedented situation has accelerated the digital revolution that was supposed to happen in five years, and has settled the grounds on which semiconductors will be the cornerstone of not only technology but evolution as a whole.

6. Conclusion:

The semiconductor sector has been expanding since its inception, supporting human progress through the development of technology, and conquering every border of the world via continuous innovation. This expansion has been accelerated by the surge of digitalization on societies, as the dependence of technology on the daily routine of millions has enabled the conception of a variety of subsectors inside the semis world which keep on growing and improving.

This growth has been matched by the sector's market performance, as shown on Figure 4, the semiconductor focused ETF SOXX, has outperformed the NASDAQ over the last five years showing its strength over the broad technology industry in the U.S. The high correlation between the index and the ETF supports the fact that semis are the cornerstone around which technology spins. However, this strong correlation does not necessarily imply causation.

The regression analysis over the NASDAQ and SOXX daily returns failed to support the thesis on semiconductors being leading indicators of the technology industry. Statistical results showed that the predictability of the model did not improve by anticipating the SOXX returns, indicating that the index didn't follow the leading performance of the sector. Instead, the regression model supported the fact that the semiconductor sector can be categorized as a coincident rather than a leading indicator. This finding is still highly useful, although it can not predict future performance, it constantly shows the health of the technology industry, as well as its shifts on supply and demand. Therefore, the outstanding market performance of the SOXX over the last few years supports the strength of the surge in technological equities.

Gathering a sample of the most representative players of the sector is helpful for understanding the growth of semis as well as the popularity of the different subsectors in which each company is specialized. The analysis is based on the most fundamental financial ratios of the sector, comparing each company across the sample helps determine which player is better positioned currently, and in the upcoming future. NVIDIA and Texas Instruments were selected as clear favorites after leading the majority of the analyzed ratios over the last five years. When analyzing their market performance, the study showed that NVIDIA

seemed currently overvalued while the Texan manufacturer looked more attractive. The analysis concluded with a valuation of the two favored companies via the comparable method. Based on both the P/E and P/FCF ratios, NVIDIA still looked overvalued, and TXN undervalued in terms of the share price. This simple valuation is based on a small size sample and only on financial ratios; therefore, it shouldn't be taken as an investment recommendation.

After careful research over the leading players of the sector, the paper concluded with the implication of the recent COVID-19 pandemic over the sector. The severe epidemic has altered human behavior on a global scale, hardly impacting many industries in the market, while some others have been able to benefit from this new norm. The digitalization of daily routines has benefitted the semiconductor sector, as technology is now even more present than ever before. Some of these changes have come to stay, new challenges that were expected to happen in the future have been reached due to this extreme situation.

Semiconductors have been the engine behind every technological innovation and will continue to be in the future. As experienced over the last two decades, humanity is heading towards an ever more digitalized world where semis will be present in almost every aspect of life.

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8. Appendix:

Appendix 1: Leading Indicators Model, SOXX-NO-PPI tab

All these figures are public and taken from the Labour of Bureau Statistics of the USA.

Date	SOXX	New Orders	PPI
01/03/2015	88.011368	21718	38.0
01/04/2015	87.110497	20960	37.9
01/05/2015	94.863228	20885	38.0
01/06/2015	86.434685	21195	37.6
01/07/2015	82.37809	21265	37.7
01/08/2015	78.124588	21176	37.4
01/09/2015	76.656578	20794	37.3
01/10/2015	84.733879	20759	37.3
01/11/2015	86.692772	20398	37.3
01/12/2015	85.017784	20572	37.2
01/01/2016	78.740234	20603	36.7
01/02/2016	80.105835	20409	36.5
01/03/2016	86.886421	20413	36.4
01/04/2016	83.11573	21032	36.4
01/05/2016	90.335342	21031	36.4
01/06/2016	89.070251	20620	36.3
01/07/2016	99.238144	20983	36.3
01/08/2016	103.9138	20703	36.2
01/09/2016	107.81652	20574	36.2
01/10/2016	106.70721	20225	36.0
01/11/2016	114.39209	20343	35.9
01/12/2016	117.59257	20982	35.9
01/01/2017	122.80366	21177	36.4
01/02/2017	126.26131	21473	36.4
01/03/2017	131.47656	20885	36.3
01/04/2017	131.0695	21122	36.7
01/05/2017	142.50955	21106	36.6
01/06/2017	135.00803	21061	36.6
01/07/2017	141.88591	21612	35.5
01/08/2017	146.00792	21843	35.4
01/09/2017	153.07423	22172	34.8
01/10/2017	167.27901	22499	34.8
01/11/2017	167.12402	22667	34.7
01/12/2017	164.46068	22277	34.7
01/01/2018	178.98598	22560	34.8
01/02/2018	179.38379	22470	35.0
01/03/2018	174.69739	22596	34.9
01/04/2018	164.02609	22841	34.9
01/05/2018	182.21556	23034	34.7
01/06/2018	173.28125	23339	34.7
01/07/2018	180.95972	23474	34.1
01/08/2018	185.66173	23352	33.6
01/09/2018	180.52071	23410	33.5
01/10/2018	159.67299	23987	33.3
01/11/2018	164.85631	24232	33.3
01/12/2018	153.74503	23990	33.2
01/01/2019	169.56567	23672	32.6
01/02/2019	180.41576	23555	32.5
01/03/2019	186.11081	24056	32.5
01/04/2019	208.29771	23936	32.6
01/05/2019	173.79807	24053	32.4
01/06/2019	195.35049	23691	32.5
01/07/2019	207.19617	23640	32.5
01/08/2019	202.40134	23618	32.6
01/09/2019	209.00536	23510	32.7
01/10/2019	222.79167	23595	32.5
01/11/2019	231.84833	23577	32.5
01/12/2019	249.35587	23844	32.6
01/01/2020	242.22566	23670	32.3
01/02/2020	230.99434	23513	32.4

SUMMARY OUTPUT

Regression Statistics		SOXX	New Orders	PPI
Multiple R	0.915465062	SOXX	1	
R Square	0.838076279	New Order	0.875377134	1
Adjusted R	0.832394745	PPI	-0.908321818	-0.912258063
Standard E	20.18398299			
Observatic	60			

ANOVA

	df	SS	MS	F	Significance F
Regression	2	120188.1562	60094.08	147.5088014	2.91977E-23
Residual	57	23221.41066	407.3932		
Total	59	143409.5669			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	527.6089997	224.0256466	2.355128	0.021981953	79.00538044	976.2126	79.00538	976.2126
New Order	0.010378167	0.004846227	2.141494	0.036521741	0.000673766	0.020083	0.000673	0.020083
PPI	-17.44525306	3.470240852	-5.0271	5.25894E-06	-24.3942905	-10.4962	-24.39429	-10.4962

Appendix 2: Leading Indicators model, Returns regression daily NASDAQ-SOXX tab

These regression models are done over daily stock returns from Yahoo Finance.

SUMMARY OUTPUT 15-16

Regression Statistics	
Multiple R	0.818454
R Square	0.669867
Adjusted R Square	0.668546
Standard Error	0.006657
Observations	252

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.022483	0.022483	507.2703	4.22E-62
Residual	250	0.01108	4.43E-05		
Total	251	0.033563			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	9.21E-06	0.00042	0.021931	0.98252	-0.00082	0.000836	-0.00082	0.000836
X Variable 1	0.61939	0.027501	22.52266	4.22E-62	0.565227	0.673553	0.565227	0.673553

SUMMARY OUTPUT 17-18

Regression Statistics	
Multiple R	0.866448
R Square	0.750732
Adjusted R Square	0.749731
Standard Error	0.00374
Observations	251

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.010489	0.010489	749.9266	4.47E-77
Residual	249	0.003483	1.4E-05		
Total	250	0.013972			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.000155	0.000237	0.653391	0.514107	-0.00031	0.000622	-0.00031	0.000622
X Variable 1	0.51116	0.018666	27.38479	4.47E-77	0.474397	0.547923	0.474397	0.547923

SUMMARY OUTPUT 19-20

Regression Statistics	
Multiple R	0.82641
R Square	0.682953
Adjusted R Square	0.68168
Standard Error	0.0052
Observations	251

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.014502	0.014502	536.3734	4.73E-64
Residual	249	0.006732	2.7E-05		
Total	250	0.021234			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.000286	0.00033	0.868045	0.386205	-0.00036	0.000936	-0.00036	0.000936
X Variable 1	0.487838	0.021064	23.15974	4.73E-64	0.446352	0.529325	0.446352	0.529325

SUMMARY OUTPUT 16-17

Regression Statistics	
Multiple R	0.809480932
R Square	0.65259379
Adjusted R Square	0.653880416
Standard Error	0.004865739
Observations	252

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.01125	0.01125	475.1828899	9.54959E-60
Residual	250	0.005919	2.37E-05		
Total	251	0.017169			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-2.67893E-05	0.000311	-0.08605	0.931498113	-0.000639962	0.000586383	-0.000639962	0.000586
X Variable 1	0.539076607	0.02473	21.79869	9.54959E-60	0.490371364	0.587781851	0.490371364	0.587782

SUMMARY OUTPUT 18-19

Regression Statistics	
Multiple R	0.856263776
R Square	0.733187654
Adjusted R Square	0.732116118
Standard Error	0.006834998
Observations	251

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.031966	0.031966	684.2401721	2.15182E-73
Residual	249	0.011633	4.67E-05		
Total	250	0.043598			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	7.89868E-05	0.000432	0.183041	0.854914708	-0.000770918	0.000928891	-0.000770918	0.000929
X Variable 1	0.630275135	0.024095	26.15798	2.15182E-73	0.582819258	0.677731012	0.582819258	0.677731

SUMMARY OUTPUT 5 years

Regression Statistics	
Multiple R	0.832544298
R Square	0.693130009
Adjusted R Square	0.692885491
Standard Error	0.005636876
Observations	1257

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.09007	0.09007	2834.679784	0
Residual	1255	0.039877	3.18E-05		
Total	1256	0.129947			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	4.64359E-05	0.000159	0.291452	0.770754179	-0.00026614	0.000359012	-0.00026614	0.000359
X Variable 1	0.56705255	0.010651	53.24171	0	0.54615774	0.587947361	0.54615774	0.587947

Date	SOXX returns	NASDAQ returns												
13/02/2015	0.0071	0.0075	29/05/2015	0.0038	-0.0055	10/09/2015	0.0044	0.0084	22/12/2015	0.0016	0.0065	07/04/2016	-0.0153	-0.0147
17/02/2015	0.0031	0.0011	01/06/2015	0.0006	0.0025	11/09/2015	0.0006	0.0054	23/12/2015	0.0070	0.0090	08/04/2016	0.0046	0.0005
18/02/2015	-0.0026	0.0014	02/06/2015	-0.0112	-0.0013	14/09/2015	0.0023	-0.0034	24/12/2015	0.0040	0.0005	11/04/2016	-0.0002	-0.0036
19/02/2015	0.0027	0.0037	03/06/2015	-0.0068	0.0045	15/09/2015	0.0128	0.0114	28/12/2015	-0.0039	-0.0015	12/04/2016	-0.0014	0.0080
20/02/2015	0.0060	0.0063	04/06/2015	-0.0091	-0.0079	16/09/2015	0.0021	0.0059	29/12/2015	0.0117	0.0133	13/04/2016	0.0224	0.0155
23/02/2015	-0.0062	0.0010	05/06/2015	0.0001	0.0018	17/09/2015	-0.0080	0.0010	30/12/2015	-0.0090	-0.0082	14/04/2016	-0.0077	-0.0003
24/02/2015	0.0134	0.0014	08/06/2015	-0.0188	-0.0092	18/09/2015	-0.0174	-0.0136	31/12/2015	-0.0136	-0.0115	15/04/2016	-0.0086	-0.0016
25/02/2015	-0.0052	-0.0002	09/06/2015	-0.0006	-0.0015	21/09/2015	-0.0030	0.0004	04/01/2016	-0.0116	-0.0208	18/04/2016	0.0001	0.0044
26/02/2015	0.0068	0.0042	10/06/2015	0.0124	0.0125	22/09/2015	-0.0220	-0.0150	05/01/2016	-0.0095	-0.0024	19/04/2016	-0.0122	-0.0040
27/02/2015	-0.0030	-0.0049	11/06/2015	-0.0003	0.0011	23/09/2015	-0.0074	-0.0008	06/01/2016	-0.0346	-0.0134	20/04/2016	0.0095	0.0016
02/03/2015	0.0275	0.0090	12/06/2015	-0.0090	-0.0062	24/09/2015	-0.0020	-0.0038	07/01/2016	-0.0280	-0.0303	21/04/2016	-0.0059	-0.0005
03/03/2015	-0.0185	-0.0056	15/06/2015	-0.0021	-0.0042	25/09/2015	0.0055	-0.0101	08/01/2016	-0.0144	-0.0098	22/04/2016	0.0018	-0.0080
04/03/2015	-0.0013	-0.0026	16/06/2015	0.0028	0.0051	28/09/2015	-0.0277	-0.0304	11/01/2016	0.0034	-0.0012	25/04/2016	-0.0060	-0.0021
05/03/2015	0.0006	0.0032	17/06/2015	0.0008	0.0018	29/09/2015	0.0067	-0.0059	12/01/2016	0.0083	0.0103	26/04/2016	0.0133	-0.0015
06/03/2015	-0.0103	-0.0111	18/06/2015	0.0141	0.0134	30/09/2015	0.0388	0.0228	13/01/2016	-0.0318	-0.0341	27/04/2016	0.0102	-0.0051
09/03/2015	0.0031	0.0031	19/06/2015	-0.0050	-0.0031	01/10/2015	-0.0119	0.0015	14/01/2016	0.0206	0.0197	28/04/2016	-0.0262	-0.0119
10/03/2015	-0.0185	-0.0167	22/06/2015	0.0085	0.0072	02/10/2015	0.0209	0.0174	15/01/2016	-0.0451	-0.0274	29/04/2016	-0.0264	-0.0062
11/03/2015	0.0022	-0.0020	23/06/2015	-0.0050	0.0012	05/10/2015	0.0195	0.0156	19/01/2016	0.0017	-0.0026	02/05/2016	0.0076	0.0088
12/03/2015	-0.0003	0.0089	24/06/2015	-0.0106	-0.0073	06/10/2015	0.0032	-0.0069	20/01/2016	0.0066	-0.0012	03/05/2016	-0.0114	-0.0113
13/03/2015	0.0067	-0.0044	25/06/2015	-0.0007	-0.0020	07/10/2015	0.0132	0.0090	21/01/2016	0.0148	0.0001	04/05/2016	-0.0114	-0.0079
16/03/2015	0.0152	0.0119	26/06/2015	-0.0249	-0.0062	08/10/2015	0.0066	0.0041	22/01/2016	0.0182	0.0266	05/05/2016	0.0024	-0.0018
17/03/2015	-0.0073	0.0016	29/06/2015	-0.0281	-0.0240	09/10/2015	-0.0062	0.0041	25/01/2016	-0.0138	-0.0158	06/05/2016	0.0014	0.0040
18/03/2015	0.0074	0.0092	30/06/2015	0.0036	0.0057	12/10/2015	0.0000	0.0017	26/01/2016	0.0093	0.0109	09/05/2016	-0.0013	0.0030
19/03/2015	0.0023	0.0019	01/07/2015	0.0024	0.0053	13/10/2015	-0.0123	-0.0087	27/01/2016	-0.0114	-0.0218	10/05/2016	0.0118	0.0126
20/03/2015	0.0141	0.0068	02/07/2015	0.0047	-0.0008	14/10/2015	0.0364	-0.0029	28/01/2016	-0.0023	0.0086	11/05/2016	-0.0024	-0.0102
23/03/2015	-0.0083	-0.0031	06/07/2015	-0.0146	-0.0034	15/10/2015	0.0094	0.0182	29/01/2016	0.0453	0.0238	12/05/2016	-0.0179	-0.0049
24/03/2015	-0.0086	-0.0032	07/07/2015	-0.0032	0.0011	16/10/2015	0.0023	0.0034	01/02/2016	0.0045	0.0014	13/05/2016	0.0036	-0.0041
25/03/2015	-0.0465	-0.0237	08/07/2015	-0.0270	-0.0175	19/10/2015	-0.0003	0.0038	02/02/2016	-0.0330	-0.0224	16/05/2016	0.0161	0.0122
26/03/2015	-0.0137	-0.0027	09/07/2015	-0.0127	0.0026	20/10/2015	-0.0009	-0.0050	03/02/2016	0.0024	-0.0028	17/05/2016	-0.0065	-0.0125
27/03/2015	0.0284	0.0057	10/07/2015	0.0185	0.0153	21/10/2015	0.0015	-0.0084	04/02/2016	0.0173	0.0012	18/05/2016	0.0156	0.0050
30/03/2015	0.0128	-0.0015	13/07/2015	0.0084	0.0148	22/10/2015	0.0347	0.0165	05/02/2016	-0.0343	-0.0325	19/05/2016	-0.0056	-0.0056
31/03/2015	-0.0113	-0.0094	14/07/2015	0.0105	0.0066	23/10/2015	0.0122	0.0227	08/02/2016	-0.0252	-0.0182	20/05/2016	0.0303	0.0121
01/04/2015	-0.0065	-0.0042	15/07/2015	-0.0059	-0.0012	26/10/2015	-0.0180	0.0006	09/02/2016	-0.0057	-0.0035	23/05/2016	0.0070	-0.0008
02/04/2015	-0.0022	0.0014	16/07/2015	0.0019	0.0126	27/10/2015	-0.0087	-0.0009	10/02/2016	-0.0078	0.0035	24/05/2016	0.0241	0.0200
06/04/2015	0.0044	0.0062	17/07/2015	-0.0021	0.0091	28/10/2015	0.0148	0.0130	11/02/2016	-0.0077	-0.0039	25/05/2016	0.0059	0.0070
07/04/2015	0.0004	-0.0014	20/07/2015	-0.0069	0.0017	29/10/2015	-0.0268	-0.0042	12/02/2016	0.0219	0.0166	26/05/2016	0.0033	0.0014
08/04/2015	0.0059	0.0083	21/07/2015	0.0002	-0.0021	30/10/2015	0.0080	-0.0040	16/02/2016	0.0351	0.0227	27/05/2016	0.0063	0.0065
09/04/2015	0.0131	0.0048	22/07/2015	-0.0249	-0.0070	02/11/2015	0.0088	0.0145	17/02/2016	0.0238	0.0221	31/05/2016	0.0058	0.0029
10/04/2015	0.0041	0.0042	23/07/2015	0.0149	-0.0049	03/11/2015	0.0052	0.0035	18/02/2016	-0.0048	-0.0103	01/06/2016	0.0053	0.0008
13/04/2015	-0.0059	-0.0015	24/07/2015	-0.0201	-0.0112	04/11/2015	0.0029	-0.0005	19/02/2016	0.0044	0.0038	02/06/2016	0.0002	0.0039
14/04/2015	-0.0102	-0.0022	27/07/2015	-0.0074	-0.0096	05/11/2015	0.0210	-0.0029	22/02/2016	0.0157	0.0147	03/06/2016	0.0029	-0.0058
15/04/2015	0.0167	0.0068	28/07/2015	0.0209	0.0098	06/11/2015	0.0265	0.0038	23/02/2016	-0.0157	-0.0147	06/06/2016	-0.0023	0.0053
16/04/2015	-0.0043	-0.0006	29/07/2015	0.0012	0.0044	09/11/2015	-0.0097	-0.0101	24/02/2016	0.0133	0.0087	07/06/2016	0.0095	-0.0014
17/04/2015	-0.0142	-0.0152	30/07/2015	0.0040	0.0033	10/11/2015	-0.0182	-0.0024	25/02/2016	0.0122	0.0087	08/06/2016	-0.0004	0.0026
20/04/2015	0.0085	0.0127	31/07/2015	-0.0116	-0.0001	11/11/2015	0.0008	-0.0032	26/02/2016	0.0064	0.0018	09/06/2016	0.0011	-0.0032
21/04/2015	0.0069	0.0039	03/08/2015	-0.0032	-0.0025	12/11/2015	-0.0129	-0.0122	29/02/2016	-0.0024	-0.0071	10/06/2016	-0.0164	-0.0129
22/04/2015	0.0141	0.0042	04/08/2015	-0.0111	-0.0019	13/11/2015	-0.0090	-0.0154	01/03/2016	0.0270	0.0289	13/06/2016	-0.0052	-0.0094
23/04/2015	-0.0155	0.0041	05/08/2015	0.0126	0.0067	16/11/2015	0.0123	0.0115	02/03/2016	0.0062	0.0029	14/06/2016	-0.0003	-0.0010
24/04/2015	-0.0165	0.0071	06/08/2015	-0.0179	-0.0162	17/11/2015	0.0067	0.0003	03/03/2016	0.0011	0.0009	15/06/2016	-0.0001	-0.0018
27/04/2015	0.0026	-0.0063	07/08/2015	0.0057	-0.0026	18/11/2015	0.0099	0.0179	04/03/2016	0.0103	0.0020	16/06/2016	-0.0001	0.0021
28/04/2015	0.0010	-0.0010	10/08/2015	0.0248	0.0116	19/11/2015	0.0023	-0.0003	07/03/2016	0.0045	-0.0019	17/06/2016	-0.0085	-0.0092
29/04/2015	-0.0055	-0.0063	11/08/2015	-0.0225	-0.0127	20/11/2015	0.0032	0.0062	08/03/2016	-0.0227	-0.0126	20/06/2016	0.0111	0.0077
30/04/2015	-0.0087	-0.0164	12/08/2015	0.0058	0.0015	23/11/2015	-0.0120	-0.0005	09/03/2016	0.0070	0.0055	21/06/2016	0.0032	0.0014
01/05/2015	0.0278	0.0129	13/08/2015	-0.0080	-0.0021	24/11/2015	0.0118	0.0001	10/03/2016	0.0050	-0.0026	22/06/2016	-0.0010	-0.0022
04/05/2015	-0.0020	0.0023	14/08/2015	-0.0082	0.0029	25/11/2015	0.0014	0.0026	11/03/2016	0.0190	0.0185	23/06/2016	0.0250	0.0159
05/05/2015	-0.0217	-0.0155	17/08/2015	0.0085	0.0086	27/11/2015	0.0043	0.0022	14/03/2016	-0.0023	0.0004	24/06/2016	-0.0543	-0.0412
06/05/2015	-0.0012	-0.0040	18/08/2015	-0.0189	-0.0064	30/11/2015	0.0108	-0.0037	15/03/2016	-0.0026	-0.0045	27/06/2016	-0.0406	-0.0241
07/05/2015	0.0110	0.0053	19/08/2015	-0.0090	-0.0080	01/12/2015	0.0155	0.0093	16/03/2016	0.0090	0.0075	28/06/2016	0.0262	0.0212
08/05/2015	0.0100	0.0117	20/08/2015	-0.0375	-0.0282	02/12/2015	-0.0047	-0.0064	17/03/2016	0.0069	0.0023	29/06/2016	0.0202	0.0186
11/05/2015	0.0006	-0.0020	21/08/2015	-0.0274	-0.0352	03/12/2015	-0.0060	-0.0167	18/03/2016	0.0132	0.0043	30/06/2016	0.0172	0.0133
12/05/2015	-0.0090	-0.0035	24/08/2015	-0.0224	-0.0382	04/12/2015	0.0173	0.0208	21/03/2016	0.0013	0.0028	01/07/2016	-0.0082	0.0041
13/05/2015	0.0062	0.0011	25/08/2015	-0.0099	-0.0044	07/12/2015	-0.0081	-0.0079	22/03/2016	-0.0002	0.0027	05/07/2016	-0.0183	-0.0082
14/05/2015	0.0119	0.0139	26/08/2015	0.0499	0.0424	08/12/2015	-0.0085	-0.0007	23/03/2016	-0.0131	-0.0110	06/07/2016	0.0013	0.0075
15/05/2015	0.0017	-0.0005	27/08/2015	0.0372	0.0245	09/12/2015	-0.0130	-0.0148	24/03/2016	-0.0007	0.0010	07/07/2016	0.0122	0.0036
18/05/2015	0.0098	0.0060	28/08/2015	0.0058										

Date	SOXX retur	NASDAQ returns	Date	SOXX returns	NASDAQ return	Date	SOXX retur	NASDAQ r	Date	SOXX retur	NASDAQ r	Date	SOXX retur	NASDAQ r
20/07/2016	0.0158	0.0106	31/10/2016	0.0054	-0.0002	14/02/2017	-0.0028	0.0032	30/05/2017	0.0067	-0.0011	11/09/2017	0.0190	0.0113
21/07/2016	-0.0070	-0.0031	01/11/2016	-0.0089	-0.0069	15/02/2017	0.0077	0.0064	31/05/2017	-0.0001	-0.0008	12/09/2017	0.0045	0.0034
22/07/2016	0.0050	0.0052	02/11/2016	-0.0066	-0.0093	16/02/2017	0.0016	-0.0008	01/06/2017	0.0010	0.0078	13/09/2017	0.0020	0.0009
25/07/2016	-0.0058	-0.0005	03/11/2016	-0.0017	-0.0092	17/02/2017	0.0052	0.0041	02/06/2017	0.0102	-0.0094	14/09/2017	0.0039	-0.0048
26/07/2016	0.0388	0.0024	04/11/2016	-0.0063	-0.0024	21/02/2017	0.0141	0.0047	05/06/2017	0.0024	-0.0016	15/09/2017	0.0175	0.0030
27/07/2016	-0.0001	0.0058	07/11/2016	0.0281	0.0237	22/02/2017	0.0002	-0.0009	06/06/2017	0.0033	-0.0033	18/09/2017	0.0131	0.0010
28/07/2016	-0.0055	0.0030	08/11/2016	0.0021	0.0053	23/02/2017	-0.0162	-0.0043	07/06/2017	0.0074	0.0036	19/09/2017	0.0032	0.0010
29/07/2016	-0.0044	0.0014	09/11/2016	-0.0047	0.0111	24/02/2017	-0.0007	0.0017	08/06/2017	0.0183	0.0039	20/09/2017	-0.0138	-0.0008
01/08/2016	0.0008	0.0043	10/11/2016	-0.0216	-0.0080	27/02/2017	0.0096	0.0028	09/06/2017	-0.0420	-0.0180	21/09/2017	-0.0043	-0.0052
02/08/2016	-0.0154	-0.0090	11/11/2016	0.0383	0.0054	28/02/2017	-0.0128	-0.0062	12/06/2017	-0.0057	-0.0052	22/09/2017	0.0051	0.0007
03/08/2016	0.0013	0.0043	14/11/2016	-0.0052	-0.0036	01/03/2017	0.0156	0.0135	13/06/2017	0.0068	0.0073	25/09/2017	-0.0193	-0.0088
04/08/2016	0.0094	0.0013	15/11/2016	0.0187	0.0110	02/03/2017	-0.0103	-0.0073	14/06/2017	-0.0105	-0.0041	26/09/2017	-0.0016	0.0015
05/08/2016	0.0127	0.0106	16/11/2016	0.0115	0.0036	03/03/2017	-0.0005	0.0016	15/06/2017	-0.0079	-0.0047	27/09/2017	0.0242	0.0115
08/08/2016	-0.0011	-0.0015	17/11/2016	0.0108	0.0074	06/03/2017	0.0005	-0.0037	16/06/2017	-0.0040	-0.0022	28/09/2017	0.0074	0.0000
09/08/2016	0.0081	0.0024	18/11/2016	0.0072	-0.0023	07/03/2017	0.0022	-0.0026	19/06/2017	0.0190	0.0142	29/09/2017	0.0087	0.0066
10/08/2016	-0.0068	-0.0040	21/11/2016	0.0067	0.0089	08/03/2017	0.0023	0.0006	20/06/2017	-0.0113	-0.0082	02/10/2017	0.0067	0.0032
11/08/2016	0.0038	0.0046	22/11/2016	0.0107	0.0033	09/03/2017	0.0020	0.0002	21/06/2017	0.0116	0.0074	03/10/2017	0.0028	0.0023
12/08/2016	0.0047	0.0009	23/11/2016	0.0012	-0.0011	10/03/2017	0.0114	0.0039	22/06/2017	-0.0023	0.0004	04/10/2017	0.0023	0.0004
15/08/2016	0.0136	0.0056	25/11/2016	0.0017	0.0034	13/03/2017	0.0075	0.0024	23/06/2017	0.0030	0.0046	05/10/2017	0.0009	0.0078
16/08/2016	-0.0070	-0.0066	28/11/2016	-0.0030	-0.0056	14/03/2017	-0.0030	-0.0032	26/06/2017	-0.0086	-0.0029	06/10/2017	0.0039	0.0007
17/08/2016	-0.0002	0.0003	29/11/2016	-0.0018	0.0021	15/03/2017	0.0079	0.0074	27/06/2017	-0.0267	-0.0161	09/10/2017	0.0076	-0.0016
18/08/2016	0.0072	0.0022	30/11/2016	-0.0057	-0.0105	16/03/2017	-0.0010	0.0001	28/06/2017	0.0173	0.0143	10/10/2017	0.0056	0.0011
19/08/2016	0.0086	-0.0003	01/12/2016	-0.0488	-0.0136	17/03/2017	0.0021	0.0000	29/06/2017	-0.0249	-0.0144	11/10/2017	0.0069	0.0025
22/08/2016	0.0005	0.0012	02/12/2016	0.0123	0.0009	20/03/2017	0.0074	0.0001	30/06/2017	-0.0055	-0.0006	12/10/2017	-0.0032	-0.0018
23/08/2016	0.0049	0.0030	05/12/2016	0.0122	0.0101	21/03/2017	-0.0234	-0.0182	03/07/2017	-0.0137	-0.0049	13/10/2017	0.0064	0.0022
24/08/2016	-0.0083	-0.0081	06/12/2016	0.0138	0.0045	22/03/2017	0.0106	0.0048	05/07/2017	0.0205	0.0067	16/10/2017	0.0047	0.0028
25/08/2016	0.0041	-0.0011	07/12/2016	0.0206	0.0114	23/03/2017	-0.0022	-0.0007	06/07/2017	-0.0044	-0.0100	17/10/2017	-0.0008	-0.0001
26/08/2016	0.0044	0.0013	08/12/2016	0.0087	0.0044	24/03/2017	0.0073	0.0019	07/07/2017	0.0169	0.0104	18/10/2017	0.0034	0.0001
29/08/2016	0.0040	0.0026	09/12/2016	-0.0034	0.0050	27/03/2017	0.0015	0.0020	10/07/2017	0.0115	0.0038	19/10/2017	-0.0025	-0.0029
30/08/2016	-0.0019	-0.0018	12/12/2016	-0.0078	-0.0059	28/03/2017	0.0032	0.0060	11/07/2017	0.0083	0.0027	20/10/2017	0.0051	0.0036
31/08/2016	-0.0006	-0.0019	13/12/2016	0.0117	0.0095	29/03/2017	-0.0024	0.0038	12/07/2017	0.0160	0.0110	23/10/2017	0.0049	-0.0064
01/09/2016	0.0079	0.0027	14/12/2016	-0.0009	-0.0050	30/03/2017	0.0051	0.0028	13/07/2017	-0.0031	0.0021	24/10/2017	0.0070	0.0018
02/09/2016	-0.0010	0.0043	15/12/2016	0.0171	0.0037	31/03/2017	0.0001	-0.0004	14/07/2017	0.0134	0.0061	25/10/2017	-0.0131	-0.0052
06/09/2016	-0.0023	0.0050	16/12/2016	-0.0101	-0.0036	03/04/2017	-0.0064	-0.0029	17/07/2017	-0.0041	0.0003	26/10/2017	0.0059	-0.0011
07/09/2016	-0.0076	0.0015	19/12/2016	0.0099	0.0037	04/04/2017	-0.0050	0.0007	18/07/2017	0.0031	0.0047	27/10/2017	0.0209	0.0220
08/09/2016	-0.0017	-0.0046	20/12/2016	0.0096	0.0049	05/04/2017	-0.0069	-0.0058	19/07/2017	0.0092	0.0064	30/10/2017	0.0027	-0.0003
09/09/2016	-0.0355	-0.0254	21/12/2016	0.0000	-0.0023	06/04/2017	0.0016	0.0025	20/07/2017	0.0029	0.0008	31/10/2017	0.0080	0.0043
12/09/2016	0.0187	0.0168	22/12/2016	0.0048	-0.0044	07/04/2017	0.0043	-0.0002	21/07/2017	-0.0085	-0.0004	01/11/2017	-0.0036	-0.0017
13/09/2016	-0.0088	-0.0109	23/12/2016	0.0051	0.0028	10/04/2017	-0.0077	0.0005	24/07/2017	-0.0030	0.0036	02/11/2017	0.0049	-0.0002
14/09/2016	0.0088	0.0036	27/12/2016	0.0123	0.0045	11/04/2017	-0.0081	-0.0024	25/07/2017	-0.0009	0.0002	03/11/2017	0.0177	0.0074
15/09/2016	0.0231	0.0147	28/12/2016	-0.0190	-0.0089	12/04/2017	-0.0172	-0.0052	26/07/2017	0.0110	0.0017	06/11/2017	0.0141	0.0033
16/09/2016	0.0003	-0.0010	29/12/2016	-0.0002	-0.0012	13/04/2017	-0.0067	-0.0053	27/07/2017	-0.0152	-0.0063	07/11/2017	-0.0009	-0.0027
19/09/2016	0.0012	-0.0018	30/12/2016	-0.0155	-0.0090	17/04/2017	0.0125	0.0089	28/07/2017	-0.0038	-0.0012	08/11/2017	0.0032	0.0032
20/09/2016	-0.0045	0.0012	03/01/2017	0.0000	0.0085	18/04/2017	0.0046	-0.0012	31/07/2017	-0.0078	-0.0042	09/11/2017	-0.0200	-0.0058
21/09/2016	0.0138	0.0103	04/01/2017	0.0028	0.0088	19/04/2017	0.0052	0.0023	01/08/2017	0.0062	0.0023	10/11/2017	0.0066	0.0001
22/09/2016	0.0033	0.0084	05/01/2017	-0.0085	0.0020	20/04/2017	0.0158	0.0092	02/08/2017	-0.0072	0.0000	13/11/2017	0.0029	0.0010
23/09/2016	-0.0102	-0.0063	06/01/2017	0.0080	0.0060	21/04/2017	-0.0042	-0.0011	03/08/2017	-0.0037	-0.0035	14/11/2017	-0.0009	-0.0029
26/09/2016	-0.0099	-0.0091	09/01/2017	0.0106	0.0019	24/04/2017	0.0144	0.0124	04/08/2017	0.0004	0.0018	15/11/2017	-0.0090	-0.0047
27/09/2016	0.0173	0.0092	10/01/2017	0.0048	0.0036	25/04/2017	0.0102	0.0070	07/08/2017	0.0172	0.0051	16/11/2017	0.0149	0.0130
28/09/2016	0.0020	0.0024	11/01/2017	0.0034	0.0021	26/04/2017	-0.0082	0.0000	08/08/2017	-0.0029	-0.0021	17/11/2017	-0.0044	-0.0015
29/09/2016	0.0123	-0.0093	12/01/2017	-0.0084	-0.0029	27/04/2017	0.0141	0.0039	09/08/2017	-0.0034	-0.0028	20/11/2017	0.0119	0.0012
30/09/2016	0.0158	0.0081	13/01/2017	0.0065	0.0048	28/04/2017	-0.0170	-0.0002	10/08/2017	-0.0279	-0.0213	21/11/2017	0.0114	0.0106
03/10/2016	-0.0067	-0.0021	17/01/2017	-0.0161	-0.0063	01/05/2017	0.0099	0.0073	11/08/2017	0.0056	0.0064	22/11/2017	-0.0061	0.0007
04/10/2016	-0.0026	-0.0021	18/01/2017	0.0137	0.0031	02/05/2017	-0.0105	0.0006	14/08/2017	0.0254	0.0134	24/11/2017	0.0090	0.0032
05/10/2016	0.0073	0.0050	19/01/2017	-0.0045	-0.0028	03/05/2017	0.0035	-0.0037	15/08/2017	0.0025	-0.0011	27/11/2017	-0.0125	-0.0015
06/10/2016	0.0059	-0.0017	20/01/2017	0.0129	0.0028	04/05/2017	-0.0007	0.0005	16/08/2017	0.0016	-0.0019	28/11/2017	0.0004	0.0049
07/10/2016	-0.0015	-0.0027	23/01/2017	-0.0061	-0.0004	05/05/2017	0.0040	0.0042	17/08/2017	-0.0253	-0.0194	29/11/2017	-0.0441	-0.0127
10/10/2016	-0.0050	0.0069	24/01/2017	0.0194	0.0086	08/05/2017	-0.0039	0.0003	18/08/2017	0.0015	-0.0009	30/11/2017	0.0054	0.0073
11/10/2016	-0.0209	-0.0154	25/01/2017	0.0148	0.0099	09/05/2017	0.0099	0.0029	21/08/2017	-0.0074	-0.0005	01/12/2017	-0.0108	-0.0038
12/10/2016	-0.0034	-0.0015	26/01/2017	-0.0056	-0.0002	10/05/2017	0.0212	0.0014	22/08/2017	0.0165	0.0136	04/12/2017	-0.0240	-0.0105
13/10/2016	-0.0118	-0.0049	27/01/2017	0.0124	0.0010	11/05/2017	0.0036	-0.0022	23/08/2017	0.0042	-0.0030	05/12/2017	0.0008	-0.0019
14/10/2016	0.0075	0.0002	30/01/2017	-0.0050	-0.0083	12/05/2017	0.0028	0.0009	24/08/2017	0.0001	-0.0011	06/12/2017	0.0032	0.0021
17/10/2016	-0.0052	-0.0028	31/01/2017	-0.0130	0.0002	15/05/2017	0.0155	0.0046	25/08/2017	-0.0048	-0.0009	07/12/2017	0.0097	0.0054
18/10/2016	0.0116	0.0085	01/02/2017	0.0159	0.0050	16/05/2017	0.0143	0.0033	28/08/2017	0.0030	0.0028	08/12/2017	-0.0052	0.0040
19/10/2016	-0.0042	0.0005	02/02/2017	-0.0005										

Date	SOXX return	NASDAQ r												
21/12/2017	-0.0106	-0.0006	09/04/2018	0.0063	0.0051	20/07/2018	-0.0047	-0.0007	31/10/2018	0.0127	0.0201	15/02/2019	0.0051	0.0061
22/12/2017	-0.0006	-0.0008	10/04/2018	0.0320	0.0207	23/07/2018	0.0014	0.0028	01/11/2018	0.0469	0.0175	19/02/2019	-0.0014	0.0019
26/12/2017	-0.0100	-0.0034	11/04/2018	0.0004	-0.0036	24/07/2018	-0.0109	-0.0001	02/11/2018	-0.0151	-0.0104	20/02/2019	0.0085	0.0003
27/12/2017	0.0032	0.0004	12/04/2018	0.0189	0.0101	25/07/2018	0.0038	0.0117	05/11/2018	-0.0091	-0.0038	21/02/2019	-0.0074	-0.0039
28/12/2017	0.0028	0.0016	13/04/2018	-0.0074	-0.0047	26/07/2018	0.0195	-0.0101	06/11/2018	0.0117	0.0064	22/02/2019	0.0107	0.0091
29/12/2017	-0.0103	-0.0067	16/04/2018	0.0018	0.0070	27/07/2018	-0.0044	-0.0146	07/11/2018	0.0113	0.0264	25/02/2019	0.0082	0.0036
02/01/2018	0.0271	0.0150	17/04/2018	0.0189	0.0174	30/07/2018	-0.0098	-0.0139	08/11/2018	-0.0027	-0.0053	26/02/2019	-0.0063	-0.0007
03/01/2018	0.0175	0.0084	18/04/2018	-0.0098	0.0019	31/07/2018	0.0066	0.0055	09/11/2018	-0.0191	-0.0165	27/02/2019	-0.0120	0.0007
04/01/2018	0.0056	0.0018	19/04/2018	-0.0433	-0.0078	01/08/2018	-0.0015	0.0046	12/11/2018	-0.0446	-0.0278	28/02/2019	0.0006	-0.0029
05/01/2018	0.0057	0.0083	20/04/2018	-0.0118	-0.0127	02/08/2018	0.0098	0.0124	13/11/2018	0.0138	0.0000	01/03/2019	0.0089	0.0083
08/01/2018	0.0079	0.0029	23/04/2018	-0.0133	-0.0025	03/08/2018	0.0021	0.0012	14/11/2018	0.0044	-0.0090	04/03/2019	0.0001	-0.0023
09/01/2018	-0.0098	0.0009	24/04/2018	-0.0081	-0.0170	06/08/2018	0.0060	0.0061	15/11/2018	0.0338	0.0172	05/03/2019	-0.0038	-0.0002
10/01/2018	-0.0120	-0.0014	25/04/2018	-0.0012	-0.0005	07/08/2018	0.0080	0.0031	16/11/2018	-0.0121	-0.0015	06/03/2019	-0.0165	-0.0093
11/01/2018	0.0060	0.0081	26/04/2018	0.0204	0.0164	08/08/2018	0.0023	0.0006	19/11/2018	-0.0382	-0.0303	07/03/2019	-0.0108	-0.0113
12/01/2018	0.0054	0.0068	27/04/2018	-0.0070	0.0002	09/08/2018	-0.0099	0.0004	20/11/2018	0.0013	-0.0170	08/03/2019	-0.0009	-0.0018
16/01/2018	0.0033	-0.0051	30/04/2018	-0.0110	-0.0075	10/08/2018	-0.0248	-0.0067	21/11/2018	0.0041	0.0092	11/03/2019	0.0233	0.0202
17/01/2018	0.0290	0.0103	01/05/2018	0.0164	0.0091	13/08/2018	0.0015	-0.0025	23/11/2018	0.0006	-0.0048	12/03/2019	0.0038	0.0044
18/01/2018	0.0045	-0.0003	02/05/2018	-0.0044	-0.0042	14/08/2018	-0.0020	0.0065	26/11/2018	0.0181	0.0206	13/03/2019	0.0040	0.0069
19/01/2018	0.0010	0.0055	03/05/2018	0.0060	-0.0018	15/08/2018	-0.0139	-0.0123	27/11/2018	0.0015	0.0001	14/03/2019	-0.0055	-0.0016
22/01/2018	0.0074	0.0098	04/05/2018	0.0235	0.0171	16/08/2018	-0.0013	0.0042	28/11/2018	0.0234	0.0295	15/03/2019	0.0290	0.0076
23/01/2018	0.0080	0.0071	07/05/2018	0.0097	0.0077	17/08/2018	-0.0075	0.0013	29/11/2018	-0.0073	-0.0025	18/03/2019	-0.0015	0.0034
24/01/2018	-0.0229	-0.0061	08/05/2018	0.0059	0.0002	20/08/2018	-0.0009	0.0006	30/11/2018	0.0139	0.0079	19/03/2019	0.0130	0.0012
25/01/2018	-0.0174	-0.0005	09/05/2018	0.0152	0.0100	21/08/2018	0.0195	0.0049	03/12/2018	0.0263	0.0151	20/03/2019	-0.0094	0.0006
26/01/2018	0.0320	0.0128	10/05/2018	0.0182	0.0089	22/08/2018	0.0047	0.0038	04/12/2018	-0.0478	-0.0380	21/03/2019	0.0345	0.0142
29/01/2018	-0.0014	-0.0052	11/05/2018	-0.0073	-0.0003	23/08/2018	0.0011	-0.0013	06/12/2018	-0.0051	0.0042	22/03/2019	-0.0282	-0.0250
30/01/2018	-0.0199	-0.0086	14/05/2018	0.0122	0.0011	24/08/2018	0.0145	0.0086	07/12/2018	-0.0373	-0.0305	25/03/2019	-0.0125	-0.0007
31/01/2018	0.0081	0.0012	15/05/2018	-0.0108	-0.0081	27/08/2018	0.0159	0.0091	10/12/2018	0.0128	0.0074	26/03/2019	0.0096	0.0071
01/02/2018	-0.0049	-0.0035	16/05/2018	0.0129	0.0063	28/08/2018	0.0038	0.0015	11/12/2018	0.0064	0.0016	27/03/2019	-0.0140	-0.0063
02/02/2018	-0.0269	-0.0196	17/05/2018	-0.0029	-0.0021	29/08/2018	0.0026	0.0099	12/12/2018	0.0142	0.0095	28/03/2019	-0.0017	0.0034
05/02/2018	-0.0471	-0.0378	18/05/2018	-0.0143	-0.0038	30/08/2018	-0.0090	-0.0026	13/12/2018	-0.0021	-0.0039	29/03/2019	0.0148	0.0078
06/02/2018	0.0362	0.0213	21/05/2018	0.0100	0.0054	31/08/2018	0.0054	0.0026	14/12/2018	-0.0142	-0.0226	01/04/2019	0.0250	0.0129
07/02/2018	-0.0214	-0.0090	22/05/2018	0.0056	-0.0021	04/09/2018	0.0080	-0.0023	17/12/2018	-0.0130	-0.0227	02/04/2019	0.0015	0.0025
08/02/2018	-0.0420	-0.0390	23/05/2018	0.0054	0.0064	05/09/2018	-0.0048	-0.0119	18/12/2018	0.0132	0.0045	03/04/2019	0.0221	0.0060
09/02/2018	0.0288	0.0144	24/05/2018	0.0040	-0.0002	06/09/2018	-0.0265	-0.0091	19/12/2018	-0.0425	-0.0217	04/04/2019	0.0022	-0.0005
12/02/2018	0.0192	0.0156	25/05/2018	0.0081	0.0013	07/09/2018	-0.0041	-0.0025	20/12/2018	-0.0069	-0.0163	05/04/2019	0.0072	0.0059
13/02/2018	-0.0012	-0.0045	29/05/2018	-0.0060	-0.0050	10/09/2018	0.0106	0.0027	21/12/2018	-0.0170	-0.0299	08/04/2019	0.0023	0.0019
14/02/2018	0.0234	0.0186	30/05/2018	0.0065	0.0089	11/09/2018	-0.0097	0.0061	24/12/2018	-0.0293	-0.0221	09/04/2019	-0.0104	-0.0056
15/02/2018	0.0119	0.0158	31/05/2018	-0.0073	-0.0027	12/09/2018	-0.0116	-0.0023	26/12/2018	0.0600	0.0584	10/04/2019	0.0077	0.0069
16/02/2018	-0.0036	-0.0023	01/06/2018	0.0228	0.0151	13/09/2018	0.0114	0.0075	27/12/2018	0.0066	0.0038	11/04/2019	-0.0008	-0.0021
20/02/2018	0.0177	-0.0007	04/06/2018	0.0079	0.0069	14/09/2018	0.0112	-0.0005	28/12/2018	0.0072	0.0008	12/04/2019	0.0139	0.0046
21/02/2018	-0.0115	-0.0022	05/06/2018	0.0048	0.0041	17/09/2018	-0.0139	-0.0143	31/12/2018	0.0070	0.0077	15/04/2019	-0.0074	-0.0010
22/02/2018	-0.0022	-0.0011	06/06/2018	0.0063	0.0067	18/09/2018	0.0086	0.0076	02/01/2019	0.0064	0.0046	16/04/2019	0.0320	0.0030
23/02/2018	0.0214	0.0177	07/06/2018	-0.0089	-0.0070	19/09/2018	0.0016	-0.0008	03/01/2019	-0.0583	-0.0304	17/04/2019	0.0166	-0.0005
26/02/2018	0.0216	0.0115	08/06/2018	-0.0089	0.0014	20/09/2018	0.0121	0.0098	04/01/2019	0.0451	0.0426	18/04/2019	0.0001	0.0002
27/02/2018	-0.0033	-0.0123	11/06/2018	-0.0019	0.0019	21/09/2018	-0.0027	-0.0051	07/01/2019	0.0185	0.0126	22/04/2019	-0.0008	0.0022
28/02/2018	-0.0089	-0.0078	12/06/2018	0.0052	0.0057	24/09/2018	0.0035	0.0008	08/01/2019	-0.0044	0.0108	23/04/2019	0.0103	0.0132
01/03/2018	-0.0158	-0.0127	13/06/2018	-0.0015	-0.0011	25/09/2018	-0.0159	0.0018	09/01/2019	0.0257	0.0087	24/04/2019	0.0093	-0.0023
02/03/2018	0.0170	0.0108	14/06/2018	0.0060	0.0085	26/09/2018	-0.0103	-0.0021	10/01/2019	0.0088	0.0042	25/04/2019	-0.0176	0.0021
05/03/2018	0.0090	0.0100	15/06/2018	-0.0009	-0.0019	27/09/2018	0.0038	0.0065	11/01/2019	0.0107	-0.0021	26/04/2019	-0.0083	0.0034
06/03/2018	0.0150	0.0056	18/06/2018	-0.0096	0.0001	28/09/2018	0.0063	0.0005	14/01/2019	-0.0163	-0.0094	29/04/2019	-0.0012	0.0019
07/03/2018	0.0032	0.0033	19/06/2018	-0.0110	-0.0028	01/10/2018	0.0035	-0.0011	15/01/2019	0.0029	0.0171	30/04/2019	0.0079	-0.0081
08/03/2018	0.0009	0.0042	20/06/2018	0.0048	0.0072	02/10/2018	0.0000	-0.0047	16/01/2019	-0.0092	0.0015	01/05/2019	-0.0080	-0.0057
09/03/2018	0.0208	0.0179	21/06/2018	-0.0124	-0.0088	03/10/2018	0.0009	0.0032	17/01/2019	0.0092	0.0011	02/05/2019	0.0096	-0.0016
12/03/2018	0.0106	0.0036	22/06/2018	-0.0079	-0.0026	04/10/2018	-0.0177	-0.0181	18/01/2019	0.0260	0.0103	03/05/2019	0.0078	0.0158
13/03/2018	-0.0154	-0.0102	25/06/2018	-0.0294	-0.0209	05/10/2018	-0.0237	-0.0116	22/01/2019	-0.0288	-0.0191	06/05/2019	-0.0163	-0.0050
14/03/2018	-0.0001	-0.0019	26/06/2018	0.0036	0.0039	08/10/2018	-0.0112	-0.0067	23/01/2019	-0.0070	0.0008	07/05/2019	-0.0246	-0.0196
15/03/2018	-0.0008	-0.0020	27/06/2018	-0.0239	-0.0154	09/10/2018	-0.0011	0.0003	24/01/2019	0.0581	0.0068	08/05/2019	-0.0085	-0.0026
16/03/2018	-0.0004	0.0000	28/06/2018	0.0076	0.0079	10/10/2018	-0.0441	-0.0408	25/01/2019	0.0207	0.0129	09/05/2019	-0.0110	-0.0041
19/03/2018	-0.0191	-0.0184	29/06/2018	0.0021	0.0009	11/10/2018	-0.0100	-0.0125	28/01/2019	-0.0197	-0.0111	10/05/2019	0.0014	0.0008
20/03/2018	0.0073	0.0027	02/07/2018	0.0063	0.0076	12/10/2018	0.0182	0.0229	29/01/2019	-0.0144	-0.0081	13/05/2019	-0.0468	-0.0341
21/03/2018	0.0019	-0.0026	03/07/2018	-0.0182	-0.0086	15/10/2018	-0.0082	-0.0088	30/01/2019	0.0290	0.0220	14/05/2019	0.0230	0.0114
22/03/2018	-0.0263	-0.0243	05/07/2018	0.0267	0.0112	16/10/2018	0.0326	0.0289	31/01/2019	-0.0005	0.0137	15/05/2019	0.0077	0.0113
23/03/2018	-0.0333	-0.0243	06/07/2018	0.0123	0.0134	17/10/2018	-0.0040	-0.0004	01/02/2019	0.0120	-0.0025	16/05/2019	-0.0158	0.0097
26/03/2018	0.0417	0.0326	09/07/2018	0.0064	0.0088	18/10/2018	-0.0250	-0.0206	04/02/2019	0.0050	0.0115	17/05/2019	-0.0195	-0.0104
27/03/2018	-0.0368	-0.0293	10/07/2018	0.0106										

Date	SOXX retur	NASDAQ r	Date	SOXX retur	NASDAQ r	Date	SOXX retur	NASDAQ r
31/05/2019	-0.0149	-0.0151	12/09/2019	0.0022	0.0030	24/12/2019	0.0016	0.0008
03/06/2019	0.0024	-0.0161	13/09/2019	-0.0020	-0.0022	26/12/2019	0.0011	0.0078
04/06/2019	0.0437	0.0265	16/09/2019	-0.0064	-0.0028	27/12/2019	-0.0020	-0.0017
05/06/2019	-0.0072	0.0064	17/09/2019	0.0022	0.0040	30/12/2019	-0.0075	-0.0067
06/06/2019	0.0139	0.0053	18/09/2019	0.0018	-0.0011	31/12/2019	0.0027	0.0030
07/06/2019	0.0113	0.0166	19/09/2019	-0.0066	0.0007	02/01/2020	0.0207	0.0133
10/06/2019	0.0244	0.0105	20/09/2019	-0.0184	-0.0080	03/01/2020	-0.0187	-0.0079
11/06/2019	0.0040	-0.0001	23/09/2019	0.0118	-0.0006	06/01/2020	-0.0104	0.0056
12/06/2019	-0.0232	-0.0038	24/09/2019	-0.0165	-0.0146	07/01/2020	0.0184	-0.0003
13/06/2019	0.0048	0.0057	25/09/2019	0.0167	0.0105	08/01/2020	-0.0009	0.0067
14/06/2019	-0.0252	-0.0052	26/09/2019	0.0013	-0.0058	09/01/2020	0.0063	0.0081
17/06/2019	-0.0074	0.0062	27/09/2019	-0.0234	-0.0113	10/01/2020	-0.0058	-0.0027
18/06/2019	0.0433	0.0139	30/09/2019	0.0088	0.0075	13/01/2020	0.0117	0.0104
19/06/2019	0.0020	0.0042	01/10/2019	-0.0094	-0.0113	14/01/2020	0.0022	-0.0024
20/06/2019	0.0084	0.0080	02/10/2019	-0.0146	-0.0156	15/01/2020	-0.0106	0.0008
21/06/2019	-0.0057	-0.0024	03/10/2019	0.0176	0.0112	16/01/2020	0.0158	0.0106
24/06/2019	0.0010	-0.0032	04/10/2019	0.0166	0.0140	17/01/2020	0.0075	0.0034
25/06/2019	-0.0138	-0.0151	07/10/2019	-0.0059	-0.0033	21/01/2020	-0.0006	-0.0019
26/06/2019	0.0323	0.0032	08/10/2019	-0.0310	-0.0167	22/01/2020	0.0067	0.0014
27/06/2019	0.0145	0.0073	09/10/2019	0.0163	0.0102	23/01/2020	0.0076	0.0020
28/06/2019	0.0013	0.0048	10/10/2019	0.0098	0.0060	24/01/2020	-0.0106	-0.0093
01/07/2019	0.0252	0.0106	11/10/2019	0.0236	0.0134	27/01/2020	-0.0382	-0.0189
02/07/2019	-0.0125	0.0022	14/10/2019	-0.0001	-0.0010	28/01/2020	0.0232	0.0143
03/07/2019	-0.0046	0.0075	15/10/2019	0.0220	0.0124	29/01/2020	-0.0184	0.0006
05/07/2019	-0.0057	-0.0010	16/10/2019	-0.0142	-0.0030	30/01/2020	0.0000	0.0026
08/07/2019	-0.0077	-0.0078	17/10/2019	0.0017	0.0040	31/01/2020	-0.0357	-0.0159
09/07/2019	0.0062	0.0054	18/10/2019	-0.0106	-0.0083	03/02/2020	0.0112	0.0134
10/07/2019	0.0081	0.0075	21/10/2019	0.0197	0.0091	04/02/2020	0.0312	0.0210
11/07/2019	0.0028	-0.0008	22/10/2019	-0.0087	-0.0072	05/02/2020	0.0230	0.0043
12/07/2019	0.0182	0.0059	23/10/2019	-0.0193	0.0019	06/02/2020	0.0006	0.0067
15/07/2019	0.0088	0.0017	24/10/2019	0.0247	0.0081	07/02/2020	-0.0236	-0.0054
16/07/2019	-0.0106	-0.0043	25/10/2019	0.0209	0.0070	10/02/2020	0.0140	0.0113
17/07/2019	0.0030	-0.0046	28/10/2019	0.0182	0.0101	11/02/2020	0.0202	0.0011
18/07/2019	0.0145	0.0027	29/10/2019	-0.0104	-0.0059			
19/07/2019	-0.0012	-0.0074	30/10/2019	0.0004	0.0033			
22/07/2019	0.0191	0.0071	31/10/2019	-0.0051	-0.0014			
23/07/2019	0.0128	0.0058	01/11/2019	0.0230	0.0113			
24/07/2019	0.0305	0.0085	04/11/2019	0.0223	0.0056			
25/07/2019	-0.0168	-0.0100	05/11/2019	0.0006	0.0002			
26/07/2019	-0.0003	0.0111	06/11/2019	-0.0067	-0.0029			
29/07/2019	0.0027	-0.0044	07/11/2019	0.0060	0.0028			
30/07/2019	-0.0023	-0.0024	08/11/2019	0.0050	0.0048			
31/07/2019	-0.0332	-0.0119	11/11/2019	-0.0041	-0.0013			
01/08/2019	-0.0198	-0.0079	12/11/2019	0.0020	0.0026			
02/08/2019	-0.0147	-0.0132	13/11/2019	0.0011	-0.0005			
05/08/2019	-0.0432	-0.0347	14/11/2019	-0.0033	-0.0004			
06/08/2019	0.0128	0.0139	15/11/2019	0.0092	0.0073			
07/08/2019	0.0063	0.0038	18/11/2019	-0.0023	0.0011			
08/08/2019	0.0277	0.0224	19/11/2019	-0.0050	0.0024			
09/08/2019	-0.0175	-0.0100	20/11/2019	-0.0118	-0.0051			
12/08/2019	-0.0131	-0.0120	21/11/2019	-0.0107	-0.0024			
13/08/2019	0.0295	0.0195	22/11/2019	-0.0010	0.0016			
14/08/2019	-0.0308	-0.0302	25/11/2019	0.0240	0.0132			
15/08/2019	-0.0018	-0.0009	26/11/2019	-0.0037	0.0018			
16/08/2019	0.0266	0.0167	27/11/2019	0.0072	0.0066			
19/08/2019	0.0184	0.0135	29/11/2019	-0.0107	-0.0046			
20/08/2019	-0.0037	-0.0068	02/12/2019	-0.0154	-0.0112			
21/08/2019	0.0082	0.0090	03/12/2019	-0.0155	-0.0055			
22/08/2019	0.0000	-0.0036	04/12/2019	0.0158	0.0054			
23/08/2019	-0.0435	-0.0300	05/12/2019	0.0050	0.0005			
26/08/2019	0.0085	0.0132	06/12/2019	0.0145	0.0100			
27/08/2019	-0.0037	-0.0034	09/12/2019	-0.0046	-0.0040			
28/08/2019	0.0063	0.0038	10/12/2019	0.0042	-0.0007			
29/08/2019	0.0240	0.0148	11/12/2019	0.0205	0.0044			
30/08/2019	0.0047	-0.0013	12/12/2019	0.0271	0.0073			
03/09/2019	-0.0165	-0.0111	13/12/2019	-0.0044	0.0020			
04/09/2019	0.0269	0.0130	16/12/2019	0.0096	0.0091			
05/09/2019	0.0308	0.0175	17/12/2019	0.0045	0.0010			
06/09/2019	0.0027	-0.0017	18/12/2019	-0.0005	0.0005			
09/09/2019	0.0036	-0.0019	19/12/2019	0.0081	0.0067			
10/09/2019	0.0045	-0.0004	20/12/2019	0.0095	0.0042			
11/09/2019	0.0150	0.0106	23/12/2019	0.0032	0.0023			

Appendix 3: Leading trials tab, Player Analysis excel file

These regression models tried different time gaps to find an improvement on R Square, while the results only worsened. The SOXX and NASDAQ returns are the same as in Appendix 2, but with different leading gaps.

SUMMARY OUTPUT 15-16 (+1)

Regression Statistics	
Multiple R	0.10291216
R Square	0.010590913
Adjusted R Square	0.006568925
Standard Error	0.011555064
Observations	248

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.000352	0.000352	2.633253	0.105928
Residual	246	0.032846	0.000134		
Total	247	0.033197			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.000419936	0.000735	-0.571724	0.568031	-0.00187	0.001027	-0.00187	0.001027
X Variable 1	0.077903283	0.048008	1.62273	0.105928	-0.01665	0.172462	-0.01665	0.172462

SUMMARY OUTPUT 15-16 (+3)

Regression Statistics	
Multiple R	0.038674667
R Square	0.00149573
Adjusted R Square	-0.002596501
Standard Error	0.011651739
Observations	246

ANOVA

	df	SS	MS	F	Significance F
Regression	1	4.96E-05	4.96E-05	0.365505	0.546027
Residual	244	0.033126	0.000136		
Total	245	0.033176			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.000482176	0.000743	-0.648593	0.517212	-0.00195	0.000982	-0.00195	0.000982
X Variable 1	0.029426659	0.048674	0.60457	0.546027	-0.06645	0.125301	-0.06645	0.125301

SUMMARY OUTPUT 16-17 (+1)

Regression Statistics	
Multiple R	0.016556
R Square	0.000274
Adjusted R Square	-0.00374
Standard Error	0.008355
Observations	251

ANOVA

	df	SS	MS	F	Significance F
Regression	1	4.77E-06	4.77E-06	0.068273	0.794084
Residual	249	0.01738	6.98E-05		
Total	250	0.017385			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.001225	0.000536	2.284635	0.023176	0.000169	0.002281	0.000169	0.002281
X Variable 1	-0.01104	0.042267	-0.26129	0.794084	-0.09429	0.072203	-0.09429	0.072203

One week leading gap

2015-2016

Regression Statistics	
Multiple R	0.207946
R Square	0.043241
Adjusted R Square	0.023309
Standard Error	0.025384
Observations	50

ANOVA

	df	SS	MS	F	Significance F
Regression	1	0.001398	0.001398	2.1694	0.147309
Residual	48	0.030928	0.000644		
Total	49	0.032326			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-0.00253	0.003596	-0.70456	0.48449	-0.00976	0.004697	-0.00976	0.004697
X Variable 1	-0.16087	0.109221	-1.47289	0.147309	-0.38047	0.058733	-0.38047	0.058733

Appendix 4: Overall analysis tab, Player Analysis excel file

Figures 11-19 are based on this table that summarized the findings of the financial ratios tab displayed on Appendix 5.

Company	NVIDIA	INTEL	BROADCOM	TSM	TEXAS INST.	ASML	MEDIAN
Net Profit Margin	25.73%	22.45%	17.43%	34.98%	28.79%	22.55%	24.14%
Net Profit Margin CAGR 5-year	16.00%	1.70%	-2.69%	-0.76%	4.62%	0.44%	1.07%
ROI	24.51%	15.55%	9.86%	21.57%	30.65%	15.13%	18.56%
ROI CAGR	12.77%	2.02%	-9.55%	-0.09%	6.05%	0.74%	1.38%
ROE	30.13%	20.71%	17.51%	23.24%	43.66%	18.84%	21.98%
ROE CAGR	17.02%	2.07%	-9.90%	-1.50%	7.78%	2.65%	2.36%
FCF/SHARE	4.152	2.766	13.926	1.44	4.9368	5.026	4.54
FCF/Share CAGR 5-year	16.68%	2.97%	16.35%	-2.80%	5.43%	3.46%	4.44%
DEBT/EQUITY	0.30	0.37	0.83	0.15	0.47	0.25	0.33
D/E CAGR	-2.15%	0.11%	0.24%	-6.10%	2.77%	13.79%	0.18%
Sustainable Growth Rate	25.93%	13.34%	9.22%	12.30%	21.11%	13.11%	13.22%
SGR CAGR	23.66%	3.49%	-14.91%	-5.95%	6.37%	0.28%	1.89%
AVERAGE ROCE	24.17%	17.55%	7.50%	23.05%	37.44%	15.55%	20.30%
ROCE CAGR	4.25%	3.41%	-20.02%	2.64%	0.20%	0.26%	1.45%
EPS CAGR	32.36%	2.32%	5.54%	3.79%	5.17%	9.24%	5.36%
EPS MEDIAN	4.59	2.12	5.17	2.24	3.68	5.57	4.14

Best 2nd best

Appendix 5: Player Analysis, Financial Ratios

These financial ratios are derived from public information presented by the firms on their earnings releases. The CAGR is calculated from the median of the results.

	2015	2016	2017	2018	2019	AVERAGE	CAGR
Net Profit Margin	22.37%	18.65%	23.22%	36.30%	26.07%	25.32%	
NVIDIA	12.25%	24.11%	31.36%	35.34%	25.60%	25.73%	16.00%
INTEL	20.63%	17.37%	15.29%	29.71%	29.24%	22.45%	1.70%
BROADCOMM	19.98%	-13.13%	9.59%	58.80%	11.92%	17.43%	-2.69%
TAIWAN SEMI	36.34%	34.99%	35.29%	35.20%	33.07%	34.98%	-0.76%
TEXAS INSTR	22.97%	26.88%	24.38%	35.07%	34.65%	28.79%	4.62%
ASML	22.06%	21.66%	23.40%	23.68%	21.93%	22.55%	0.44%
Return on Investment	17.15%	14.73%	18.42%	27.83%	19.60%	19.54%	
NVIDIA	13.44%	21.42%	32.22%	36.55%	18.94%	24.51%	12.77%
INTEL	14.07%	11.87%	10.20%	21.12%	20.47%	15.55%	2.02%
BROADCOMM	16.28%	-4.98%	4.40%	28.60%	4.98%	9.86%	-9.55%
TAIWAN SEMI	21.67%	21.93%	21.75%	21.13%	21.39%	21.57%	-0.09%
TEXAS INSTR	22.85%	26.72%	26.46%	41.91%	35.30%	30.65%	6.05%
ASML	14.58%	11.41%	15.49%	17.66%	16.51%	15.13%	0.74%
FCF per share	3.4216667	3.4283333	5.1566667	7.068	7.7976667	5.37	
NVIDIA	1.92	2.31	4.6	5.02	6.91	4.15	16.68%
INTEL	2.39	2.49	2.14	3.03	3.78	2.77	2.97%
BROADCOMM	6.53	7.03	14.07	19.68	22.32	13.93	16.35%
TAIWAN SEMI	1.66	1.26	1.66	1.63	0.99	1.44	-2.80%
TEXAS INSTR	3.79	3.99	4.65	6.128	6.126	4.94	5.43%
ASML	4.24	3.49	3.82	6.92	6.66	5.03	3.46%
Debt/Equity Ratio	37.67%	38.83%	36.83%	35.50%	48.00%	39.37%	
NVIDIA	33.00%	48.00%	26.00%	21.00%	20.00%	29.60%	-2.15%
INTEL	37.00%	38.00%	39.00%	35.00%	37.00%	37.20%	0.11%
BROADCOMM	82.00%	62.00%	75.00%	65.00%	131.00%	83.00%	0.24%
TAIWAN SEMI	20.00%	18.00%	14.00%	10.00%	11.00%	14.60%	-6.10%
TEXAS INSTR	41.00%	34.00%	39.00%	56.00%	65.00%	47.00%	2.77%
ASML	13.00%	33.00%	28.00%	26.00%	24.00%	24.80%	13.79%
Return on Equity	22.26%	18.35%	23.49%	37.68%	26.64%	25.68%	
NVIDIA	13.73%	28.91%	40.78%	44.32%	22.91%	30.13%	17.02%
INTEL	18.69%	15.57%	13.91%	28.23%	27.15%	20.71%	2.07%
BROADCOMM	29.50%	-7.99%	7.72%	47.37%	10.96%	17.51%	-9.90%
TAIWAN SEMI	25.07%	24.29%	23.08%	21.85%	21.92%	23.24%	-1.50%
TEXAS INSTR	30.02%	34.32%	35.61%	62.04%	56.32%	43.66%	7.78%
ASML	16.53%	14.98%	19.84%	22.26%	20.58%	18.84%	2.65%

	2015	2016	2017	2018	2019	AVERAGE	CAGR
Earnings per share	2.75	1.63	3.79	9.30	5.10	3.79	
NVIDIA	1.13	3.08	5.09	6.81	4.59	4.59	32.36%
INTEL	1.89	2.12	1.99	4.48	4.71	2.12	2.32%
BROADCOMM	5.17	4.75	4.18	29.33	6.77	6.77	5.54%
TAIWAN SEMI	1.86	1.97	2.24	2.29	2.28	2.24	3.79%
TEXAS INSTR	2.86	3.54	3.68	5.71	5.33	3.68	5.17%
ASML	3.58	3.83	5.57	7.20	6.90	5.57	9.24%
EPS growth TTM		5%	-11%	141%	-19%	-3%	
NVIDIA		173%	65%	34%	-33%	50%	
INTEL		12%	-6%	125%	5%	9%	
BROADCOMM		-192%	-188%	602%	-77%	-77%	
TAIWAN SEMI		6%	14%	2%	0%	4%	
TEXAS INSTR		24%	4%	55%	-7%	14%	
ASML		7%	45%	29%	-4%	18%	
Dividends paid	1,772.04	2,146.22	2,661.65	3,157.86	3,893.88	2,726.33	
NVIDIA	213.00	261.00	341.00	371.00	390.00	315.20	8.2%
INTEL	4,556.00	4,925.00	5,072.00	5,541.00	5,576.00	5,134.00	2.4%
BROADCOMM	408.00	750.00	1,745.00	2,998.00	4,235.00	2,027.20	37.8%
TAIWAN SEMI	3,675.53	4,801.90	6,123.90	6,777.00	8,669.50	6,009.57	10.3%
TEXAS INSTR	1,444.00	1,646.00	2,104.00	2,555.00	3,008.00	2,151.40	8.3%
ASML	335.69	493.39	584.03	705.18	1,484.78	720.61	16.5%
Net Income	4,827.14	5,163.00	5,645.72	9,905.35	7,920.48	6,692.34	
NVIDIA	614.00	1,666.00	3,047.00	4,141.00	2,796.00	2,452.80	31.9%
INTEL	11,420.00	10,316.00	9,601.00	21,053.00	21,048.00	14,687.60	5.2%
BROADCOMM	1,364.00	1,861.00	1,784.00	12,610.00	2,724.00	4,068.60	24.4%
TAIWAN SEMI	11,038.51	11,911.20	13,365.80	12,987.40	13,034.50	12,467.48	2.5%
TEXAS INSTR	2,986.00	3,595.00	3,682.00	5,580.00	5,017.00	4,172.00	6.9%
ASML	1,540.32	1,628.80	2,394.54	3,060.68	2,903.38	2,305.54	8.4%
Retention ratio	0.65	0.63	0.52	0.70	0.38	0.58	
NVIDIA	0.65	0.84	0.89	0.91	0.86	0.83	4.94%
INTEL	0.60	0.52	0.47	0.74	0.74	0.61	0.41%
BROADCOMM	0.70	0.60	0.02	0.76	0.55	0.31	-15.30%
TAIWAN SEMI	0.67	0.60	0.54	0.48	0.33	0.52	-4.72%
TEXAS INSTR	0.52	0.54	0.43	0.54	0.40	0.49	-1.21%
ASML	0.78	0.70	0.76	0.77	0.49	0.70	-2.23%
Sustainable growth rate	14.34%	11.88%	14.29%	26.41%	12.26%	15.83%	
NVIDIA	8.97%	24.38%	36.22%	40.35%	19.71%	25.93%	23.66%
INTEL	11.23%	8.14%	6.56%	20.80%	19.96%	13.34%	3.49%
BROADCOMM	20.68%	-4.77%	0.17%	36.11%	-6.08%	9.22%	-14.91%
TAIWAN SEMI	16.72%	14.50%	12.51%	10.45%	7.34%	12.30%	-5.95%
TEXAS INSTR	15.50%	18.61%	15.26%	33.63%	22.55%	21.11%	6.37%
ASML	12.93%	10.44%	15.00%	17.13%	10.06%	13.11%	0.28%

Appendix 6: Player Analysis Excel, Valuation Ratios

These quarterly figures are taken from Yahoo Finance and Bloomberg.

P/E	31/03/2015	30/06/2015	31/09/2015	31/12/2015	31/03/2016	30/06/2016	31/09/2016	31/12/2016	31/03/2017	30/06/2017	31/09/2017	31/12/2017	31/03/2018	30/06/2018	31/09/2018	31/12/2018	31/03/2019	30/06/2019	31/09/2019	31/12/2019
NVIDIA	19.24	20.48	25.73	26.66	29.96	37.16	36.92	42.49	34.43	45.79	51.09	50.8	37.3	35.65	28.09	21.68	34.22	38.09	51.41	52.31
INTEL	11.82	11.58	11.66	13.44	12.67	14.72	16.66	16.21	14.89	12.37	12.83	22.6	22.1	17.61	14.55	10.41	12.15	11.16	12.1	12.68
TAIWAN SEMI	11.07	10.38	9.63	10.96	13.33	14.42	15.62	13.37	14.15	15.61	16.92	17.62	19.01	16.11	19.54	16.4	20.08	19.78	22.78	27.15
TEXAS INSTR	18.74	16.8	16.26	17.86	18.59	19.65	20.86	20.43	20.73	18.56	20.14	28.07	25.4	24.81	22.62	16.75	19.25	20.98	24.02	24.53
ASML	25.92	29.08	23.75	24.44	32	32.35	33.4	28.9	28.49	28.26	33.6	31.38	33.24	30.6	27.61	21.73	26.71	31.13	38.34	40.32
AVERAGE	17.358	17.664	17.406	18.672	21.31	23.66	24.692	24.28	22.538	24.118	26.916	30.094	27.41	24.956	22.482	17.394	22.482	24.228	29.73	31.398
NASDAQ	25.65	22.5	23.66	21.98	19.49	21.4	22.69	104.14	80.86	54.26	49.83	17.45	19.4	20.17	19.23	29.99	27.77	29.87	31.54	23.13
EV																				
NVIDIA	8.36	7.418	9.674	14.8	15.73	21.26	32.22	59.6	60.04	83.22	101.63	115.17	129.26	137.78	156.64	75.93	103.83	86.44	99.48	136.22
TXN	56.38	54.84	50.36	59.24	58.61	61.84	70.75	75.31	80.7	76.98	88.52	103.16	99.8	106.49	104.24	90.06	100.39	106.38	120.99	119.99
EBITDA																				
NVIDIA	237	132	301	303	298	370	693	760	601	737	944	1127	1352	1216	1126	372	449	663	1019	1096
TXN	1449	1451	1233	1373	1645	1559	1482	1559	1482	1705	2013	1787	1777	1945	2180	1765	1637	1773	1864	1499
EV/EBITDA																				
NVIDIA	3.53%	5.62%	3.21%	4.88%	5.28%	5.75%	4.65%	7.84%	9.99%	11.29%	10.77%	10.22%	9.56%	11.33%	13.91%	20.41%	23.12%	13.04%	9.76%	12.43%
TXN	3.89%	3.78%	4.08%	4.31%	3.56%	3.97%	4.77%	4.83%	5.45%	4.51%	4.40%	5.77%	5.62%	5.48%	4.78%	5.10%	6.13%	6.00%	6.49%	8.00%

Company	Date	Price	EPS	EV	EBITDA	FCF/Share	P/E	P/FCF	EV/EBITDA
NVIDIA	31/12/2019	235.3	4.59	145.039	3.386	6.91	51.26	34.05	42.83
INTEL	31/12/2019	59.85	4.33	270.2	42.14	3.78	29.63	15.83	6.41
BROADCOMM	31/12/2019	316.02	8.51	149.52	10.42	22.32	37.14	14.16	14.35
TAIWAN SEMI	31/12/2019	58.1	13.39	8193.15	660.209	0.99	4.34	58.69	12.41
TEXAS INSTR	31/12/2019	128.29	5.25	120.32	6.88	6.126	11.40	20.94	17.49
ASML	31/12/2019	295.94	6.16	109.3	3.32	6.66	48.04	44.44	32.92
Median							33.38	27.50	15.92
							Target Price	Target EV	
NVIDIA							153.22	190.00	53.90
TXN							175.25	168.45	109.52