IMPACT OF TARIFFS ON THE SEMICONDUCTOR INDUSTRY

By

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A capstone project submitted for Graduation with University Honors

November 4, 2021

University Honors
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Abstract

The US-China Trade War focuses on China's threat to US national security and has cost the US over $30 billion since its beginning in July 2018. This empirical research analyzes abnormal returns of the PHLX Semiconductor Sector (^SOX), which is comprised of the 30 largest companies primarily involved in the design, distribution, manufacture, and sale of semiconductors. ^SOX's abnormal returns were negative, signaling that the index did not compensate investors as much as it should have per unit of market risk. Despite adverse effects of the Trade War, the semiconductor industry outperformed the S&P500. Companies have responded to tariffs by diversifying their supply chains outside of China. This research contributes to our understanding of the semiconductor industry's performance through early phases of the Trade War.

Acknowledgements

I would like to thank Professor Mike Dong for his guidance and insight throughout this research. He has been flexible and understanding of challenges faced while working during the COVID-19 pandemic. I would also like to express my gratitude to my former coworkers and finance professors for their contribution to my understanding of the semiconductor industry. I am especially thankful for my family and friends' support. Without their help, I would not be where I am today.

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Introduction

Trade is a quintessential contributor to economic growth allowing countries to benefit through specialization. Governments prefer their citizens produce domestically to contribute to Gross Domestic Product (GDP). To deter businesses from importing goods, nations implement quotas, tariffs, and other taxes. Although these practices reduce resource importing and labor outsourcing, their costs can outweigh benefits in times of crisis.

This paper examines how tariffs and trade barriers have impacted large semiconductor companies between January 2018 and August 2019. Semiconductors are physical substances designed to control and manage electric currents in devices and equipment. The global semiconductor market was approximately $426 billion in 2020 and is predicted to reach $600 billion by 2025; this represents a 5.3% compound annual growth rate (CAGR) through the forecast period. Its rapid growth may be attributed to use of semiconductors for computers, smartphones, televisions, and other electronic devices.

China has a dominant supply of rare earth metals, accounting for approximately 69% of worldwide silicon produced in 2020 (Appendix 1). During the US-China Trade War, former President Trump implemented a 25% universal tariff on silicon and semiconductor wafer components (e.g., boxes, quartz reactor tubes, and holders). This adversely affected semiconductor companies, as silicon and other components are heavily used in production.

Tariffs' impacts were measured by analyzing abnormal returns that were calculated using rolling betas. Abnormal returns depict the difference between an investment's actual return and its expected return. Rolling betas are used to increase accuracy of expected returns. 3-year and 1-year abnormal returns for the PHLX Semiconductor Sector were negative, meaning that investors undervalued semiconductor companies during this period. US trade controls increased uncertainty

regarding future cash flows, resulting in a negative abnormal return as investors valued semiconductor companies below fundamentals. Given these results, it is reasonable to conclude that large semiconductor companies are resilient to tariffs due to high demand from consumers and businesses for its products.

Background

Benefits of global trade were demonstrated during the 1973 oil shock when over a million workers lost their jobs in France, Japan, Italy, and Britain and unemployment rose above 9% in the United States (Bergsten 24). Rather than implementing tariffs, these nations participated in the Multilateral Trade Negotiations (MTN) of 1973 to discuss internationally agreed upon proscriptions against import barriers mentioned in the General Agreement on Tariffs and Trade (GATT). Countries including France, Italy, Japan significantly reduced tariffs, while the US dropped its import quotas on steel sugar and meat allowing for these countries to recover faster from the recession (Bergsten 25). The US also implemented the Trade Act in the end of 1974, providing better conditions for workers and unemployed individuals. China was eager to participate in these trades and accepted suboptimal terms to join the World Trade Organization (WTO) in 2001.

Tensions between the US and China escalated in 2005 after the 30-year-old Multifiber Arrangement (MFA) expired, providing China's strong textile business to increase its global market share from a predicted 17% (in 2003) to 50% by 2007 (Hughes 101). This has contributed to misconceptions that China is stealing US jobs, undervaluing the yuan by pegging it to the dollar, exporting deflation by selling its products abroad at unfair prices, violating the rights of its workers to keep labor costs low, and failing to meet its commitments to the World Trade Organization (WTO). The Bush administration responded to textile trade concerns by issuing "nine 'threat-

based' petitions to limit imports of Chinese pants, shirts, and underwear" (Hughes 103). The administration later initiated safeguard proceedings against China, believing that quotas must be implemented to reduce disruption of the US economy.

China has since established its dominant position as the world's largest exporter and the United State second-largest trade partner after Canada (Dollar 129). Economists agree that trade between China and the US has impacted manufacturing employment in the states, with most believing manufacturing employment would be 25% higher if the trade deficit were eliminated completely (Dollar 130). There are many components to China's success, with one being its government's controls on imports to prevent the economy from overheating and another being low wages offered to workers. This has led the US to question the ethics involved in China's explosive trade growth and trade surplus.

Federal Policy

The United States periodically reviews US corporate interests and policy makers to restructure trade relations. Its government intervenes when US interests are being challenged or when the global economy is weakening. In recent decades, the US has applied controls to limit the impacts of unfair Chinese trade practices. For example, the Obama administration imposed tariffs on Chinese tires in 2009, Chinese solar panels in 2012, and Chinese steel in 2016 (Rosenberg et al. 11). These tariffs targeted specific products determined to benefit from unfair practices, so the aggregate impact was limited. In contrast, the current trade war began with universal tariffs imposed by the US.

President Trump implemented trade controls in hopes of repositioning the US global leader through federal policy. This decision should be analyzed as a weak attempt to replicate results achieved by President Nixon's 1971 abandonment of the Bretton Woods dollar-gold peg standard

and President Reagan's 1985 Plaza Accord. Unfortunately, the US-China conflict is unlikely to resolve in a similar fashion given the United States' weaker global position and China's leverage from exports.

New Economic Program

The US economy faced rising inflation in the 1960s from spending on the Vietnam War, the cold war arms race with the USSR, the race of the moon, and expanding social programs. In response, then-President Richard Nixon introduced the "New Economic Program" (NEP) in August 1971. Nixon's NEP called for US abandonment of the 1944 "Bretton Woods" international monetary system, in which the US dollar was pegged to gold at $35 an ounce (Rasmus 352). This was intended to counter rising US inflation by devaluing the dollar, effectively making US businesses more competitive with European rivals.

Nixon supplemented this program by imposing tariffs on European imports to the United States while implementing tax cuts and subsidies for US businesses exporting US products. The Smithsonian Agreement of 1973 finalized the new dollar standard: the dollar is now pegged against currencies of other industrialized countries. This solution restructured the global trading system by establishing the US central bank, the Federal Reserve, as the dominant central bank; other countries had to respond to its initiatives on global interest rate determination (Rasmus 352). The United States was able to coerce Europeans to correct the problem at their expense—reduced share of global trade—rather than rectifying US policy errors. Although the US dollar devalued as intended, Nixon's policy resulted in financial instability in 1973, the failure of several large banks, the worse recession to date (1973–1975), and stagnation for the rest of the decade (Rasmus 353).

Plaza Accord

President Ronald Reagan also faced rising inflation during his term with the United States' experiencing double digit inflation in the early 1980s. He responded by raising domestic interest rates to 18% and running a $300 billion annual federal budget deficit (Rasmus 2006 Rasmus 352). US companies raised their prices to account for the increase in rates and borrowing costs. Japanese businesses capitalized on this weakness by importing more goods to the United States. Since US policies had not lowered rates or inflation significantly by 1985, Reagan decided to renegotiate terms of trade with Japan. This concluded in an agreement between the two nations named the "Plaza Accord." As a result, Japan inflated its own economy by raising the price of its goods and erasing its export competitiveness.

The United States succeeded again in coercing another country to resolve trade issues rather than fixing problems with its own policies. However, the unilateral approach created even more financial instability following the stock, junk bond, and housing market crash in the latter half of the 1980. This was followed by the 1990–1991 recession. These two examples of the US using a unilateral approach have proved unsuccessful in the long term, as the states still struggled economically.

US-China Trade War

Concerns with China's WTO compliance were addressed by the US in 2017 through an anti-China trade offensive. President Trump ordered the Office of the United States Trade Representative (USTR) to identify how China undermines US companies' control over their technology in China. The USTR responded on August 18, 2017 with four charges in a formal investigation in which China was accused of actions designed to "obtain cutting edge in intellectual property (IP) and generate technology transfer" (Rasmus 350). This investigation document was

reproduced verbatim on March 22, 2018, confirming expected findings and recommendations. President Trump publicly initiated a dual track trade offensive shortly after. Track One announced US bilateral free trade agreements, including tariffs on steel and aluminum intended to adjust preexisting trade terms with allies in NAFTA (North American Free Trade Agreement), Europe, and South Korea. Track Two pursued a hard line with China to address military-defense concerns, obtain more access to Chinese markets for US businesses, and reduce the current US account deficit with China. Trump imposed a 25% tariff on $34 billion worth of Chinese imports on July 6, 2018, launching the largest trade war in recent history (USTR 1). These tariffs impacted approximately 66 percent of Chinese imports. This policy effectively raised the average tariff rate on Chinese goods from 3 percent—the Most Favored Nation (MFN) rate—to 19 percent resulting in a 17.3 percent decrease in US-China trade between 2016 and 2018 (Reinsch 5).

Trump's goal to strengthen the US economy through trade controls has proved unsuccessful, as business responded by diversifying supply chains to other countries. Employment across impacted sectors also declined given added financial pressure on companies reliant on China for supplies and manufacturing. The president believes in the unilateral exercise of American power, having avoided the multilateral system that is focused on diplomacy. His policies were successful in renegotiating the 2012 free trade deal with South Korea, exempting the third largest steel importer in 2017 from tariffs. However, China is unlikely to be pressured into accepting favorable terms for the US because Western demands are perceived as bad politics. China responded by imposing counter-tariffs on 60.3 percent of American exports (Rosenberg et al. 24).

According to a 2019 report released by Chinese customs authorities, Chinese exports to the United States fell by approximately 12 percent compared to 2018. Although US tariffs reduced the

volume of Chinese exports to the United States, it did not decrease aggregate Chinese exports globally. A United Nations Conference on Trade and Development (UNCTAD) economic analysis released in November 2019 reported that US tariffs appeared to reduce US imports of tariffed products by approximately 25 percent (Rosenberg et al. 16). In contrast, Chinese exports to Europe, Asia, Canada, and other markets grew 0.5 percent in 2019 despite a decline in exports to the US. Nonetheless, the decrease in US imports from China appears to have decelerated China's growth in 2019: growth fell to a 30 year low of 6.1 percent.

The United States has since shifted its focus on this conflict to an issue of national security, demanding for Chinese market reforms. It intends to prevent China from committing economic espionage and acquiring "emerging and foundational technologies from US companies that could position China to overtake US military superiority" (Rosenberg et al. 15). Unfortunately, the unilateral approach is unlikely to resolve the conflict as it had during President Nixon and Reagan's terms. This is because the United States is not as economically strong as it once was, and because China has much more leverage from its exporting dominance than Europe and Japan did. Furthermore, the Chinese Communist Party (CCP) appears to "embrace the narrative that the United States is in an inescapable decline and that China inevitably will replace the United States as the global hegemon" (Rosenberg et al. 24). As a result, many US businesses are paralyzed from a dilemma: China is simultaneously their best customer and their biggest threat. These policies may create a competitive advantage for US companies against Chinese-government subsidized businesses, though American corporations are reluctant to support any policies that might force them to abandon China and profits made there. The lack of a "cohesive response by the US to China's economic coercion has convinced Chinese leadership that its deployment of coercive

economic measures is a low risk, high reward tool that does not impose painful economic risks on its own economy" (Rosenberg et al. 31).

To pay for deficits induced by the Trade War, the Federal Reserve raised interest rates and sold US Treasury bonds and securities. The Trump administration hoped that fiscal stimulus and increased exports from trade renegotiations would "offset the economic slowdown generated by rising US central bank interest rates, [but] this rearranging of fiscal, monetary, and trade policies will almost certainly not prove successful-just as similar policy trade-offs under Reagan and Nixon ultimately failed as well" (Rasmus 354). President Trump's business-investor tax cuts have also mostly been diverted by companies as companies paying out dividends to shareholders, paying down corporate debt, repurchasing stock, or acquiring competitors.

Negotiations have continued over the past few years, though the two countries have yet to reach an agreement on critical issues. While the US believes it must apply pressure for China to hold up its end of negotiated commitments, China has no incentive to make a deal without immediate tariff withdrawal (Sun 1). Negotiations between the two nations have made significant progress, but the remaining 10% of demands are unlikely to be met due to political conflicts. China's leader, Xi Jinping, is unable to make further concessions or risk public outcry on the legitimacy of his political wisdom and credibility. Furthermore, this discontent would undermine the power of China's Communist Political Party.

Methodology

Federal policy related to the ongoing US-China Trade War is analyzed to explain the rationale for tariffs and challenges preventing the conflict's resolution. Trump's tariff policies are then reviewed to identify which specific tariffs affected the semiconductor industry. The tariffs' impact is measured by computing abnormal returns using a rolling beta, which represent the

industry's performance relative to the entire stock market. Financial data between January 1, 2018 and August 31, 2019 are used for these computations to consider prices and rates months prior to tariff implementation and to avoid impacts of COVID-19 on the indexes. This information is evaluated to provide insights on how the semiconductor industry responded and how these companies may perform under the Biden Administration.

Data Collection

Data for this research was collected from government reports, market research companies, Yahoo Finance, and the Kenneth R. French Data Library. Press releases from the Office of the United States Trade Representative (USTR) were reviewed to identify federal policies related to the ongoing US-China Trade War. Charts depicting market and consumer data are sourced from Statista. JSTOR was used to select academic reports and journals discussing economic relations and historic trade wars. Yahoo Finance was used to extract weekly price data for the selected semiconductor index and the S&P 500 (listed as ^GSPC). These weekly prices are used to compute returns, which is calculated as the change in an index's price over the week divided by its price the previous week. These returns are subtracted from its relative risk-free rate to compute risk-adjusted returns. In this research, the risk-free rate is represented by weekly 3-month treasury bill rates downloaded from the Kenneth R. French Data Library. Daily returns and historical stock price were graphed using R statistical programming language's BatchGetSymbols, finreportr, and ggplot2 packages (Appendix 5).

The PHLX Semiconductor Sector index, listed as ^SOX on Yahoo Finance, was chosen to represent semiconductor industry because it comprises of the 30 largest companies with market caps over $5 billion involved in the design, distribution, manufacture, and sale of semiconductors. These leading companies rely on China to a certain extent for labor or resources given China's

dominant silicon production (Appendix 1). As a result, they are more likely to have been affected by the 2018 tariffs. Investor confidence decreased during this period of uncertainty, which is reflected in ^SOX and ^GSPC prices. The 30-company sample size also satisfies requirements to identify as a normal distribution, allowing for statistical analysis.

Rolling Beta

Beta is a measure of the volatility—or systematic risk—of a security or portfolio relative to the entire stock market. It represents the slope of a line through a regression of data points; the data points are an investment's risk-adjusted returns against those of the market. The closer beta is to 1, the more in line the security's price moves with the market. A beta greater than 1 means that the security is more volatile than the market, while a beta less than 1 indicates that it is less volatile than the market.

For the rolling beta calculation, the covariance of ^SOX's risk-adjusted returns and ^GSPC's risk-adjusted returns is divided by the variance of the market's returns over a specified period. 3-year and 1-year betas were computed for this research using Microsoft Excel's slope function. Comparing these two time periods provides a better understanding of how changes in the risk-free rate affect estimated returns. The beta is "rolling" because the indexes' returns each week are subtracted from the 3-month treasury bill rate from that same week. Calculating beta this way provides a more accurate estimate of the semiconductor industry's volatility relative to the market.

Abnormal Return

Abnormal return gives us an idea of how Trump's tariffs have affected the semiconductor industry by describing unusually large profits or losses generated by an investment or portfolio over a specified period. It is computed by subtracting expected return from actual risk-adjusted return. Expected return is calculated using the Capital Asset Pricing Model (CAPM), which

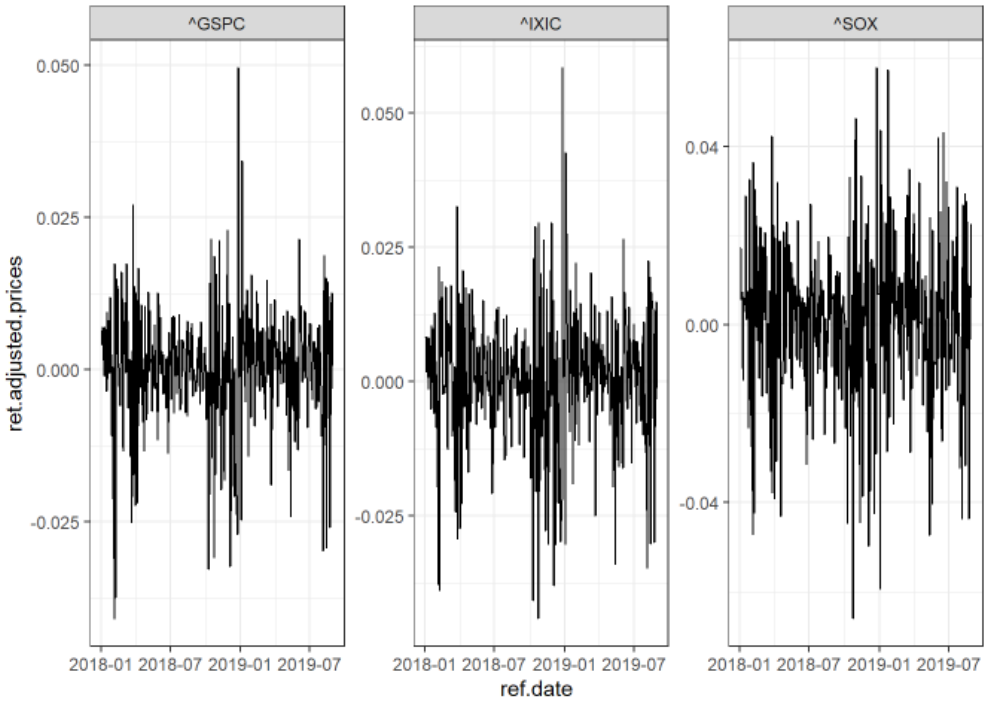
describes the relationship between systematic risk and expected return for assets. The formula for CAPM is the risk-free rate plus beta times the market risk premium. Market risk premium is the difference of the return on the market and the risk-free rate.

Before calculating ^SOX's abnormal return, its risk-adjusted expected return must be calculated using the CAPM formula. It is important that a rolling beta is used with its corresponding risk-free rate for these calculations. The specified period for these calculations is 3-years and 1-year. Expected return is then subtracted from ^SOX's actual risk-adjusted return to compute abnormal return.

Empirical Results

Semiconductor Industry Performance

Figure 1



Trump's universal 25% tariff on steel imports and 10% tariff on aluminum imports shocked the global economy. The steel tariffs especially impacted Mexico, Brazil, Canada, South Korea,

and Germany, which were collectively responsible for $15 billion of steel imports annually. They also affected Russia, Canada, and the United Arab Emirates, which are the primary aluminum importers. The manufacturing sector (producing semiconductors) fared poorly through the trade war, as growth contracted for the fifth straight month, dropping to 47.2 in December 2019—the lowest reading in over a decade (Rosenberg et al. 30). Figure 1 shows the daily returns of ^GSPC, ^IXIC (Nasdaq index), and ^SOX graphed using R (Appendix 5).

The President's tariff on silicon was detrimental to the semiconductor industry due to the material's frequent use in production. Some companies were unable to withstand the pressure, such as Chinese semiconductor company Fujian Jinhua Integrated Circuit which had been included on the US's Entity List in October 2018. Other companies such as Huawei circumvented the US ban by increasing purchases from Japan and deploying more indigenous Chinese-made parts. The Entity List requires businesses to have a license to operate with listed companies, introducing barriers. US semiconductor companies are concerned that "broader restrictions on sales to China could undercut their revenues to the point that it impairs U.S. tech research and development (R&D) spending compared to competitor nations, ultimately undercutting U.S. technological leadership" (Rosenberg et al. 18). As a result, semiconductor firms have diversified supply chains and passed increased costs onto consumers.

Rolling Beta Analysis

Figure 2

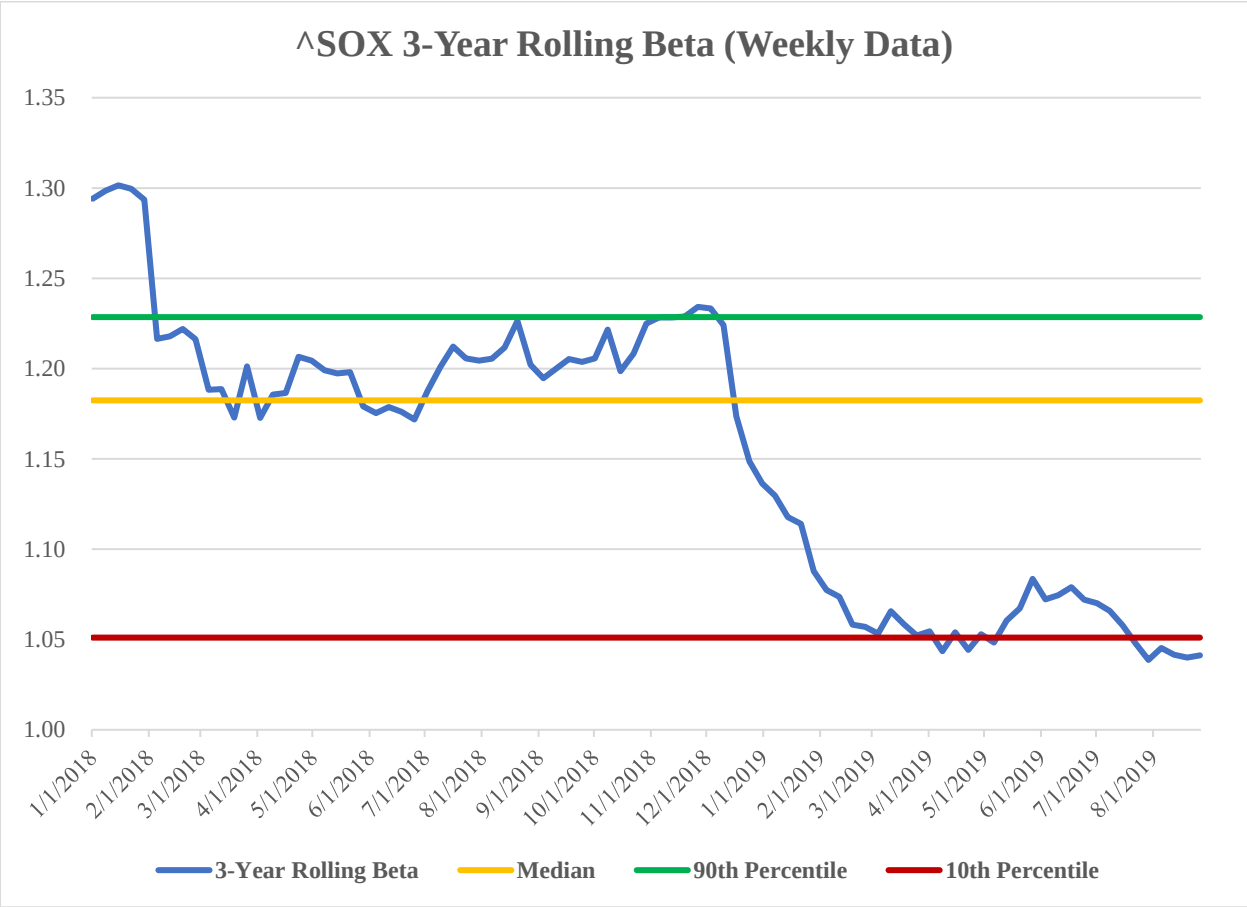


Figure 2 shows that the 3-year beta has a downward trend as it declined from 1.29 to 1.04. ^SOX's beta decreased closer to 1 between January 2018 and August 2019, signaling a reduction of the semiconductor industry's risk. The index is growing more in line with the total market, though it is still more volatile given the final beta above 1 using 1-year rolling inputs.

Figure 3

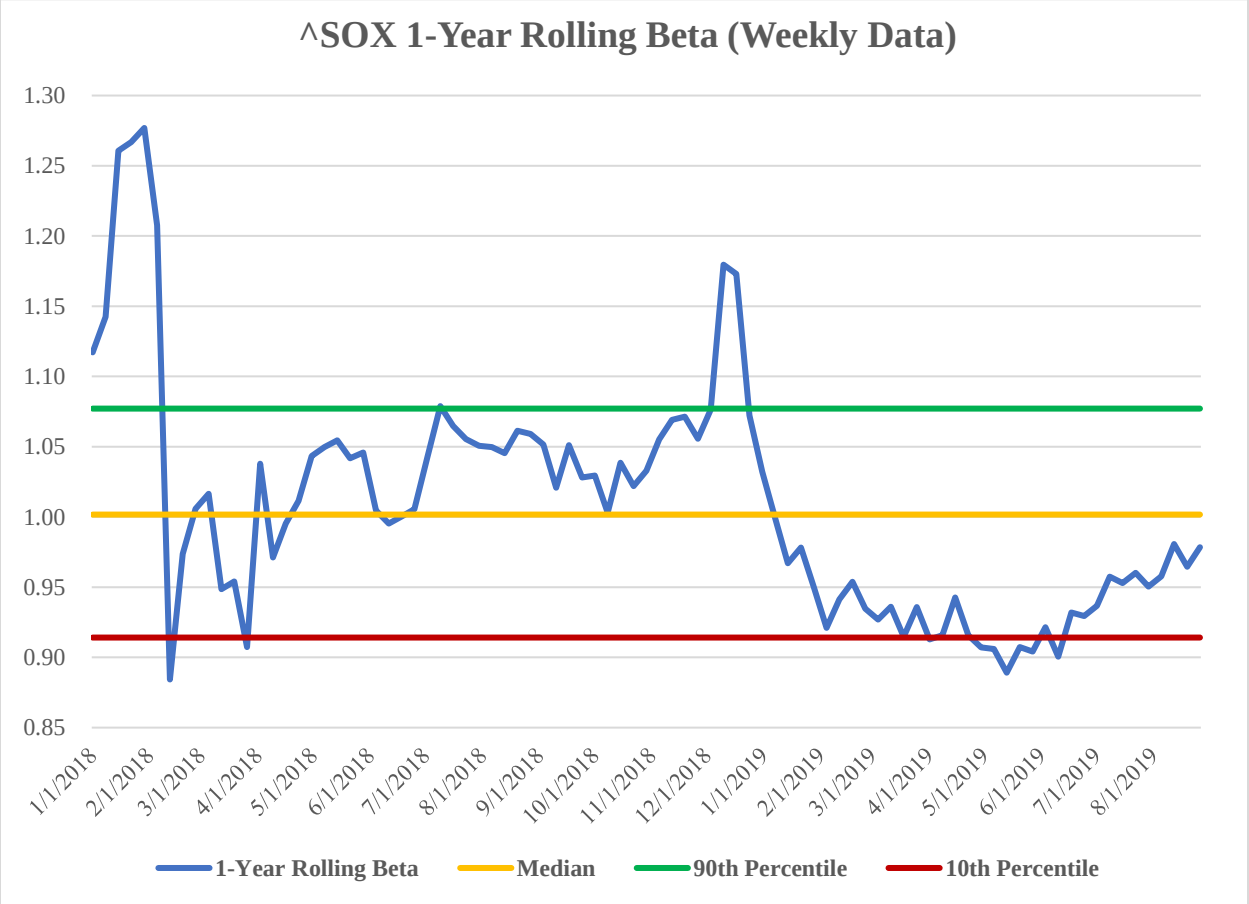


Figure 3 shows that the 1-year beta has a downward trend as it declined from 1.12 to 0.98. ^SOX's beta decreased closer to 1 between January 2018 and August 2019, signaling a reduction of the semiconductor industry's risk. The index is growing more in line with the total market, though it is less volatile given the final beta below 1 using 1-year rolling inputs.

Abnormal Return Analysis

Figure 4

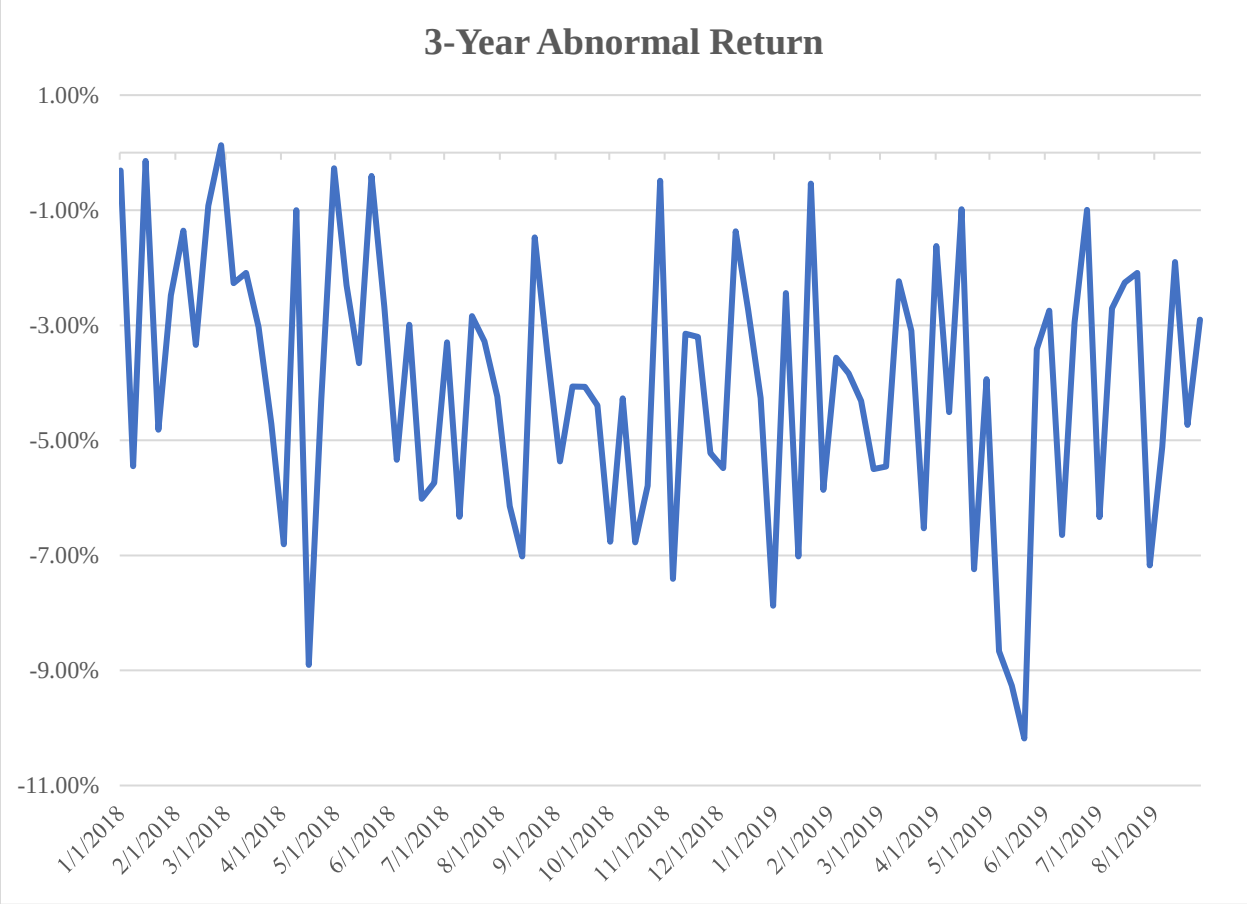
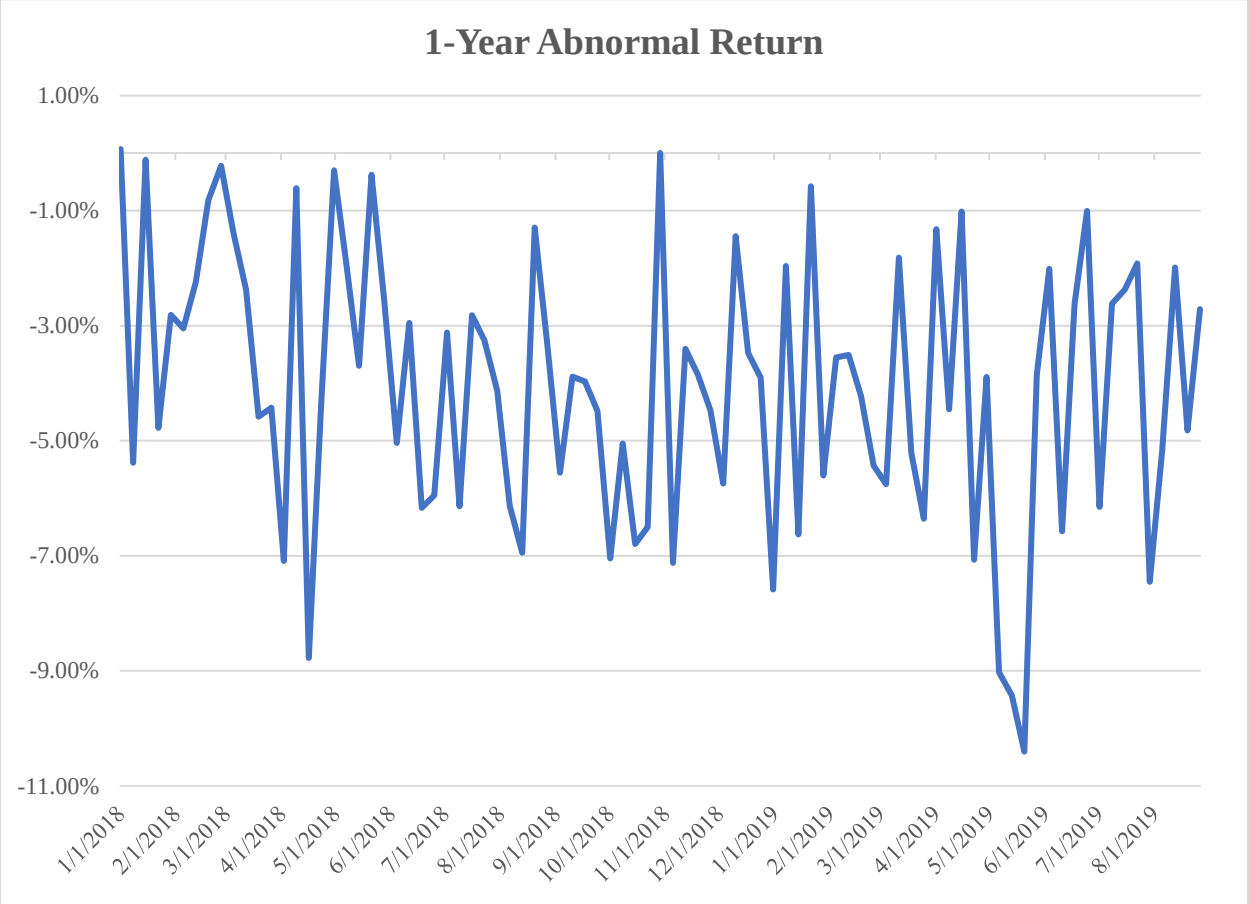


Figure 4 shows that ^SOX's 3-year abnormal return is negative, meaning that the index's returns compensated investors less than it should have for each unit of market risk. Investors undervalued semiconductor companies believing that they were worth less than fundamentals, as the index's value is smaller than it should have been given the amount of risk. Since companies' input, manufacturing, and distribution costs increased from the trade war, the discount rate increased resulting in a lower return. A negative abnormal return signals that investors see higher risk, making them more pessimistic about semiconductor industry's future cash flows.

Figure 5



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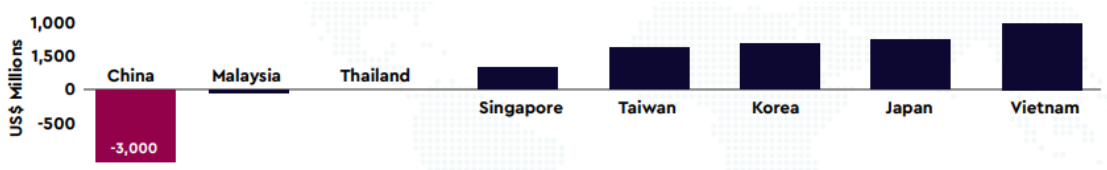
Economic Implications

Consumers

Evaluations of the 2018 tariffs' impact on the US economy has shown that US consumers have shouldered the burden of US tariffs imposed on Chinese exports. American companies in China reported increased manufacturing costs as the most significant impact of the US-China trade tariffs as of September 2018 (Appendix 2). 37.1% of American companies in China also reported increasing sales price of their products in September 2018 (Appendix 2). It is estimated that consumer costs have increased with a range between $460 and $1,000 per person per year due to US tariffs on China (Rosenberg et al. 18). These costs relate to materials used in production and supply chain diversification.

Supply Chain

Figure 6



64.6% of American manufacturers in China had no plans to relocate manufacturing facilities in September 2018, while 18.5% relocated to Southeast Asia due to the US-China trade tariffs (Appendix 3). Of these companies, 30.9% altered their supply chain by sourcing components and/or assembly outside the US (Appendix 4). In contrast, 30.2% adjusted their supply chain by sourcing components and/or assembly outside China (Appendix 4). Figure 6 shows a $3 billion decrease in total average monthly exports to the US from China, which have been offset by exports to Asian countries including Vietnam, Japan, Korea, and Taiwan (Cheng et al 4). These results show that companies have responded to tariffs by negotiating with new suppliers and manufacturers to continue production and improve logistics.

Taiwan

Taiwan increased its total monthly exports to the United States following tariff implementation as shown by Figure 6. Given Taiwan's geographical position relative to mainland China, it is reasonable to predict that businesses based outside of Taiwan that do substantial business in China will consider Taiwan as they look to diversify their supply chains.

Nonetheless, the country faces challenges relating to supply chain and competitive liabilities. China's presence in global logistics makes it difficult to relocate production outside of the mainland, as over 70 percent of Taiwan's outbound investments transit through China. Furthermore, an estimated 56 percent of Taiwan's citizens employed overseas worked on the mainland (Wyne et al. 48). Taiwan's manufacturing costs are also higher than China's, making it less attractive to businesses concerned with profit margins. Taiwan is considered an "aged society" according to the World Health Organization because 14 percent or more of its population consists of individuals aged 65 and older. It is forecasted to become a "super-aged society" by 2026, meaning that segment will have surpassed 20 percent.

Malaysia

Figure 7

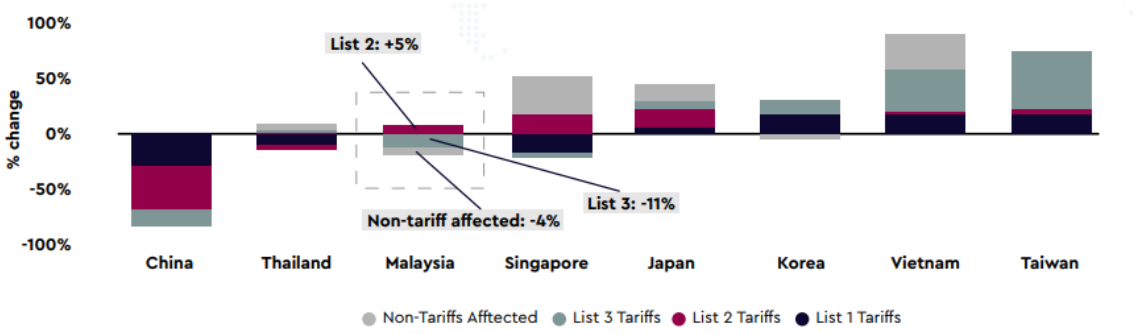


Figure 7 depicts the change in monthly average export to the US by tariff group using data from the USTR and US Census Bureau (Cheng et al. 4). The data shows that countries with substantial increases in exports to the US during the US-China conflict benefitted most from List

1 and List 3 tariffs. It also shows that Malaysia suffered from an 11% decrease in US exports due to List 3 tariffs from the US-China trade war. Malaysia's struggles are expected to persist as its economy is highly dependent on trade. China is also Malaysia's largest trading partner, having accounted for 13.7% of Malaysia's total trade in 2018 (Cheng et al. 3). Although the first two rounds of US tariffs supported Malaysia's export strengths in electrical and electronic components, ongoing global supply chain present severe headwinds for the country's economy.

Biden Administration

The United States cannot pressure China with a unilateral approach as it had with smaller countries like Venezuela and Iran because China can increase exports to other countries to partially offset loss of US market share. Under a Biden administration, prospects for active coordination between the US and Europe should improve significantly. President Biden is more interested in the multilateral approach, which increasingly appears to be the optimal solution to resolve the trade war. Enlisting allied support for economic coercion against China will magnify each measure's impact.

Considerations

The ^SOX semiconductor index only comprises 30 companies, so it does not reflect performance of the entire semiconductor industry. The included companies are likely to have sufficient capital to respond to supply chain challenges because they all have market caps above $5 billion. They are also having more cash, potentially offering more lobbying power. This is not true for other semiconductor companies, as smaller firms may not be able to withstand tariff pressures or being included in the US Entity List. If semiconductor companies do not have many operations in China, they are likely to have been less affected by the Trade War. As a result,

insights drawn from this research are limited to large-cap semiconductor firms with Chinese relations.

The chosen duration for analysis does not consider all impacts of the Trade War as data collection ended in August 2019. It excludes quarters prior to the US-China Trade War, limiting analysis of changes in ^SOX's beta. Excluding data after August 2019 minimized the impacts of COVID-19 on share prices but prevented evaluation of ^SOX's beta change. Another consideration is that every stock price is subject to idiosyncratic risk. This risk is specific to each company and, therefore, are not indicative of the entire sector. An example is agency costs, which are incurred when there is a conflict of management interests.

Conclusion

Although the US trade deficit and number of Chinese imports are targets of public opinion, the true drivers behind Trump's trade war are more likely US military planning and domestic politics. The United States is most concerned with China's "challenge to US technology development and leadership and the implications of that challenge for US security, defense armament, and US's continued dominance in war-making capabilities" (Rasmus 349). The trade war has been detrimental for both economies, with American companies paying approximately $34 billion in cumulative tariffs between January 2018 and August 2019 (Brown). The semiconductor industry was affected by these taxes due to its reliance on China for silicon, especially given the material's scarcity and heavy use in semiconductor production. (Kumar and Krenner 229). Despite challenges, the semiconductor industry grew 377% in the past decade, more than double the S&P500's 182% climb. If the US-China conflict does not resolve soon, businesses may establish new supplier and manufacturing relationships and not return to China. This is inefficient for both economies as they have many resources and could benefit from trade.

References

Bergsten, C. Fred. “Let's Avoid a Trade War.” *Foreign Policy*, no. 23, 1976, pp. 24–31.

Brown, Courtenay. “The Trade War and Tariffs Have Cost U.S. Companies $34 Billion so Far, Data Shows.” Axios, https://www.axios.com/cost-trumps-tariffs-trade-war-274b1bd4-2c51-4ec5-8afe-b29fefddfb43.html. Accessed 29 Feb. 2020.

Cheng, Calvin, et al. The US-China Trade War: Is Malaysia Benefiting from "Diversions" in US Import Demand? Institute of Strategic and International Studies, 2019, www.jstor.org/stable/resrep19606. Accessed 29 Feb. 2020.

Dollar, David. “The Future of U.S.-China Economic Relations.” *Brookings Big Ideas for America*, edited by Michael E. O’Hanlon, Brookings Institution Press, Washington, D.C., 2017, pp. 129–137.

Hughes, Neil C. “A Trade War with China?” *Foreign Affairs*, vol. 84, no. 4, 2005, pp. 94–106.

Kumar, Sameer, and Nicole Krenner. “Review of the Semiconductor Industry and Technology Roadmap.” *Journal of Science Education and Technology*, vol. 11, no. 3, 2002, pp. 229–236.

Rasmus, Jack. “Trump’s Deja Vu China Trade War.” *World Review of Political Economy*, vol. 9, no. 3, Pluto Journals, 2018, pp. 346–63, https://doi.org/10.13169/worlrevipoliecon.9.3.0346.

Reinsch, William Alan. “EU and US Policies towards China.” *Dealing with China on High-Tech Issues: Views from the US, EU and like-Minded Countries in a Changing Geopolitical Landscape*, edited by Brigitte Dekker and Maaike Okano-Heijmans, Clingendael Institute, 2020, pp. 5–10, http://www.jstor.org/stable/resrep28667.4.

Rosenberg, Elizabeth, et al. “Trends in China’s Use of Coercive Economic Measures Against the United States.” *A New Arsenal for Competition: Coercive Economic Measures in the U.S.-China Relationship*, Center for a New American Security, 2020, pp. 22–34, http://www.jstor.org/stable/resrep24222.6.

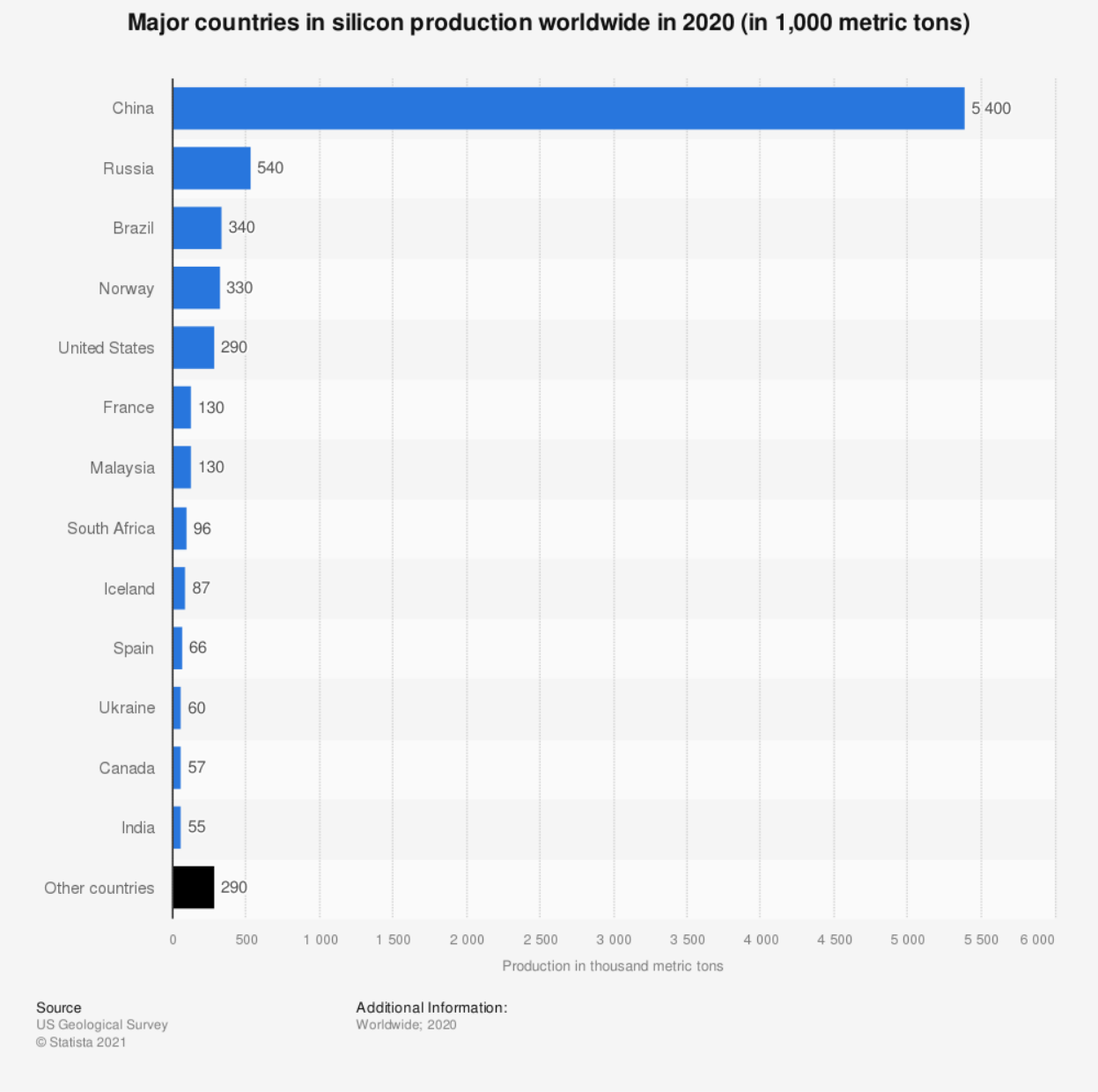
---. “Trends in U.S. Coercive Economic Measures Against China.” *A New Arsenal for Competition: Coercive Economic Measures in the U.S.-China Relationship*, Center for a New American Security, 2020, pp. 9–21, http://www.jstor.org/stable/resrep24222.5.

Sun, Yun. *Managing the Fallout of the US-China Trade War*. Stimson Center, 2019, www.jstor.org/stable/resrep20056. Accessed 23 Feb. 2020.

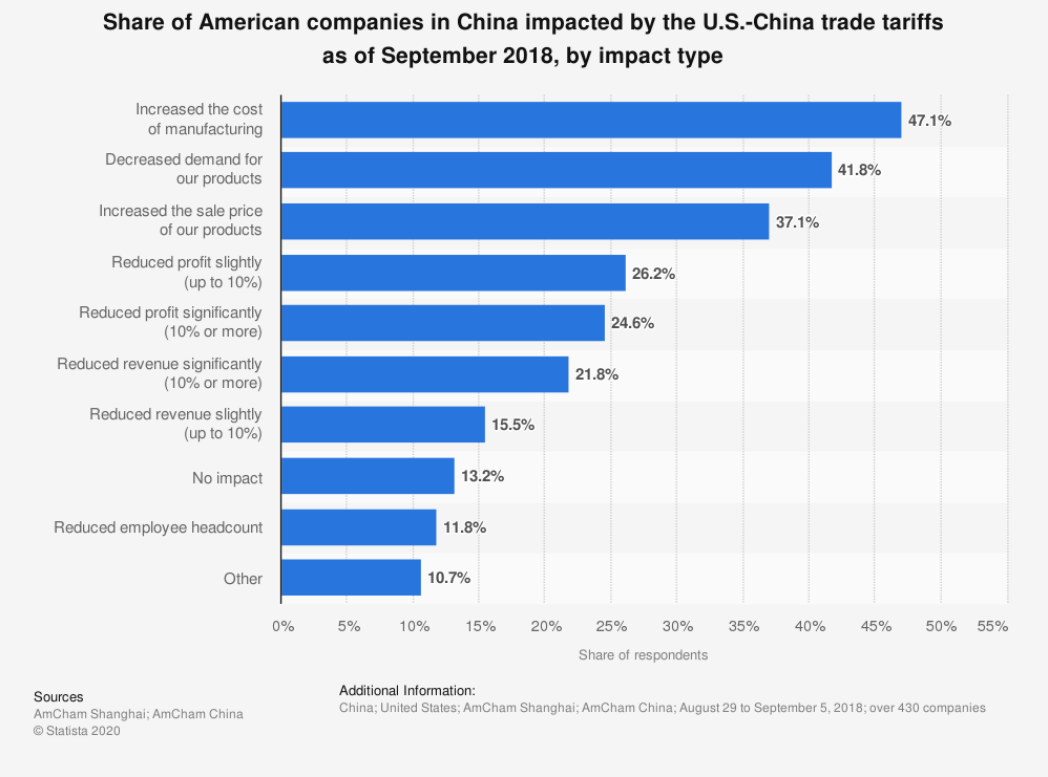
Wyne, Ali, et al. “The Impact of Trade Tensions Between the United States and China on Taiwan’s Economy: Some Preliminary Speculations.” *Perspectives on Taiwan: Insights from the 2019 Taiwan-U.S. Policy Program*, edited by Bonnie S. Glaser and Matthew P. Funaiole, Center for Strategic and International Studies (CSIS), 2020, pp. 46–50, http://www.jstor.org/stable/resrep29479.11.

Appendix

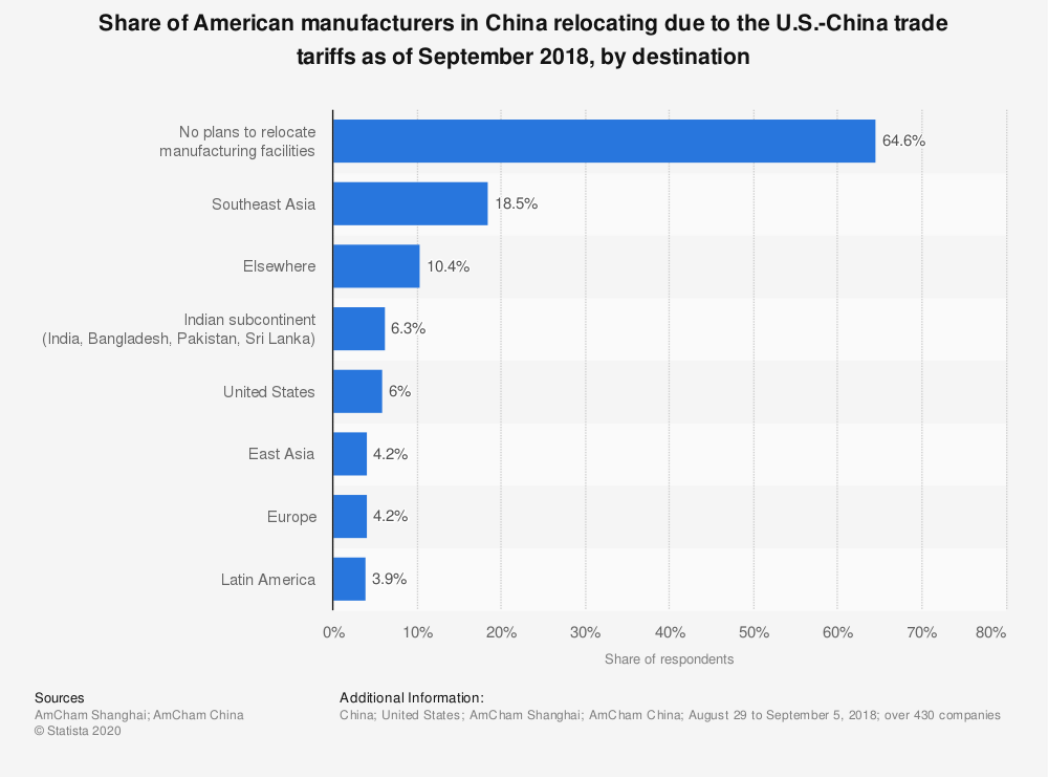
Appendix 1



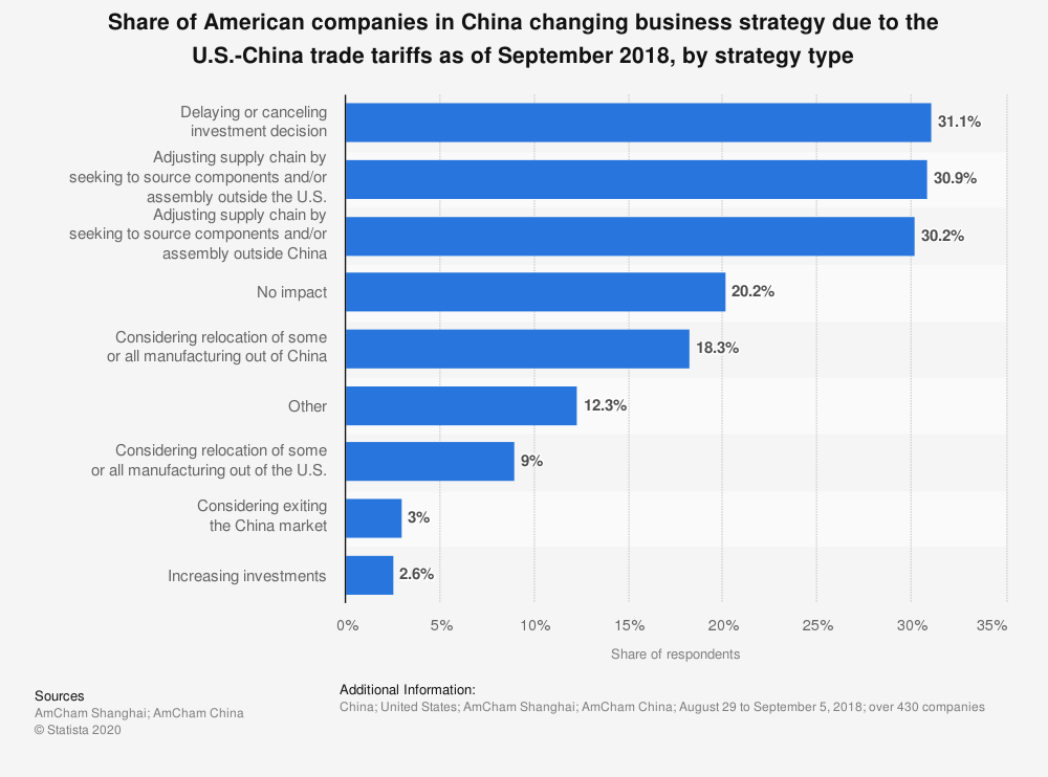
Appendix 2



Appendix 3



Appendix 4


Share of American companies in China changing business strategy due to the U.S.-China trade tariffs as of September 2018, by strategy type
Delaying or canceling investment decision
31.1%
Adjusting supply chain by seeking to source components and/or assembly outside the U.S.
30.9%
Adjusting supply chain by seeking to source components and/or assembly outside China
30.2%
No impact
20.2%
Considering relocation of some or all manufacturing out of China
18.3%
Other
12.3%
Considering relocation of some or all manufacturing out of the U.S.
9%
Considering exiting the China market
3%
Increasing investments
2.6%
0%
5%
10%
15%
20%
25%
30%
35%
Share of respondents
Sources
AmCham Shanghai; AmCham China
© Statista 2020
Additional Information:
China; United States; AmCham Shanghai; AmCham China; August 29 to September 5, 2018; over 430 companies

Appendix 5

```
# Load pacman package
library(pacman)
pacman::p_load(data.table, fixest, BatchGetSymbols, finreportr, ggplot2, lubridate)
```

Download stock price data

```
# Set Parameters. Date today is 10/13/21
first.date <- Sys.Date() - 1381
last.date <- Sys.Date() - 774
freq.data <- "daily"
tickers <- c("^SOX", "^GSPC", "^IXIC")

# Get Stock Prices
stocks <- BatchGetSymbols(tickers = tickers,
                          first.date = first.date,
                          last.date = last.date,
                          freq.data = freq.data,
                          do.cache = FALSE,
                          thresh.bad.data = 0)
```

```
##
## Running BatchGetSymbols for:
##    tickers =^SOX, ^GSPC, ^IXIC
##    Downloading data for benchmark ticker
## ^GSPC | yahoo (1|1)
## ^SOX | yahoo (1|3) - Got 100% of valid prices | Feels good!
## ^GSPC | yahoo (2|3) - Got 100% of valid prices | Feels good!
## ^IXIC | yahoo (3|3) - Got 100% of valid prices | OK!
```

```
# Verify Returns
stocks_DT <- stocks$df.tickers %>% setDT() %>% # convert to data.table
  .[order(ticker, ref.date)]                   # order by ticker and date

# Graph Returns And Prices
returns_plot_all <- ggplot(stocks_DT, aes(x = ref.date, y = ret.adjusted.prices, colour = ticker)) +
  geom_line() + theme_bw() + labs(title = "", x = "Date", y = "Daily Returns", subtitle = "")

price_plot_all <- ggplot(stocks_DT, aes(x = ref.date, y = price.close, colour = ticker)) +
  geom_line() + theme_bw() + labs(title = "", x = "Date", y = "Closing Price", subtitle = "")

returns_sep <- ggplot(stocks_DT[ticker %in% c("^SOX", "^GSPC", "^IXIC")], aes(x = ref.date, y = ret.adjusted.prices)) + geom
_line() + facet_wrap(~ticker, scales = "free_y") + theme_bw()

prices_sep <- ggplot(stocks_DT[ticker %in% c("^SOX", "^GSPC", "^IXIC")], aes(x = ref.date, y = price.close)) + geom_line() +
facet_wrap(~ticker, scales = "free_y") + theme_bw()
# print
returns_sep
```