Japan 2023 Semiconductor Export Policies and its Impacts

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Case Study (Japanese Macroeconomic Policy:
Solutions to Monetary and Fiscal Policy Challenges)

Introduction

Japan's Ministry of Economy, Trade and Industry announced an amendment on March 31, 2023 to introduce new export regulations[1]. From July 23rd of 2023, the regulations require a license prior to the export of advanced semiconductor manufacturing equipment[2]. The amendment expanded regulated semiconductor manufacturing equipment export items by adding 23 additional regulated items. Countries are grouped into 'Group 1, the whitelist countries such as the U.S.', 'Group to-2', 'Group to-3 such as China', and 'Group chi such as North Korea.[3]' Added items under the new regulation are segregated into three categories: 'Export of New Items', 'Technology Related to the Design and Manufacture of New Items' and 'Technology Related to the Use of New Items.' Group 1 countries are typically granted with 'General License' or 'Special General' for some specific technologies. Stricter license requirements apply to Group to-2, Group to-3 and Group chi[4].

The tightening of export policies, however, does not serve the same purpose or to target the same country. The initial export control can be traced back to 2019 where Japan's government removed South Korea from the 'Group 1 Whitelist', and controlled three key materials in the production of semiconductors[5]. The export claims, nevertheless, were dismissed by both countries simultaneously on March 24, 2023, seven days before the new export control policies, specifically targeting China's semiconductor supply chain.

Since late 2022, the United States has taken measures in export controls in certain high-end chips to limit China's artificial intelligence system development[6]. The Dutch and Japan's governments have followed to impose restrictions on exports of advanced semiconductor equipment. Japanese companies such as Nikon and Tokyo Electron, in the semiconductor

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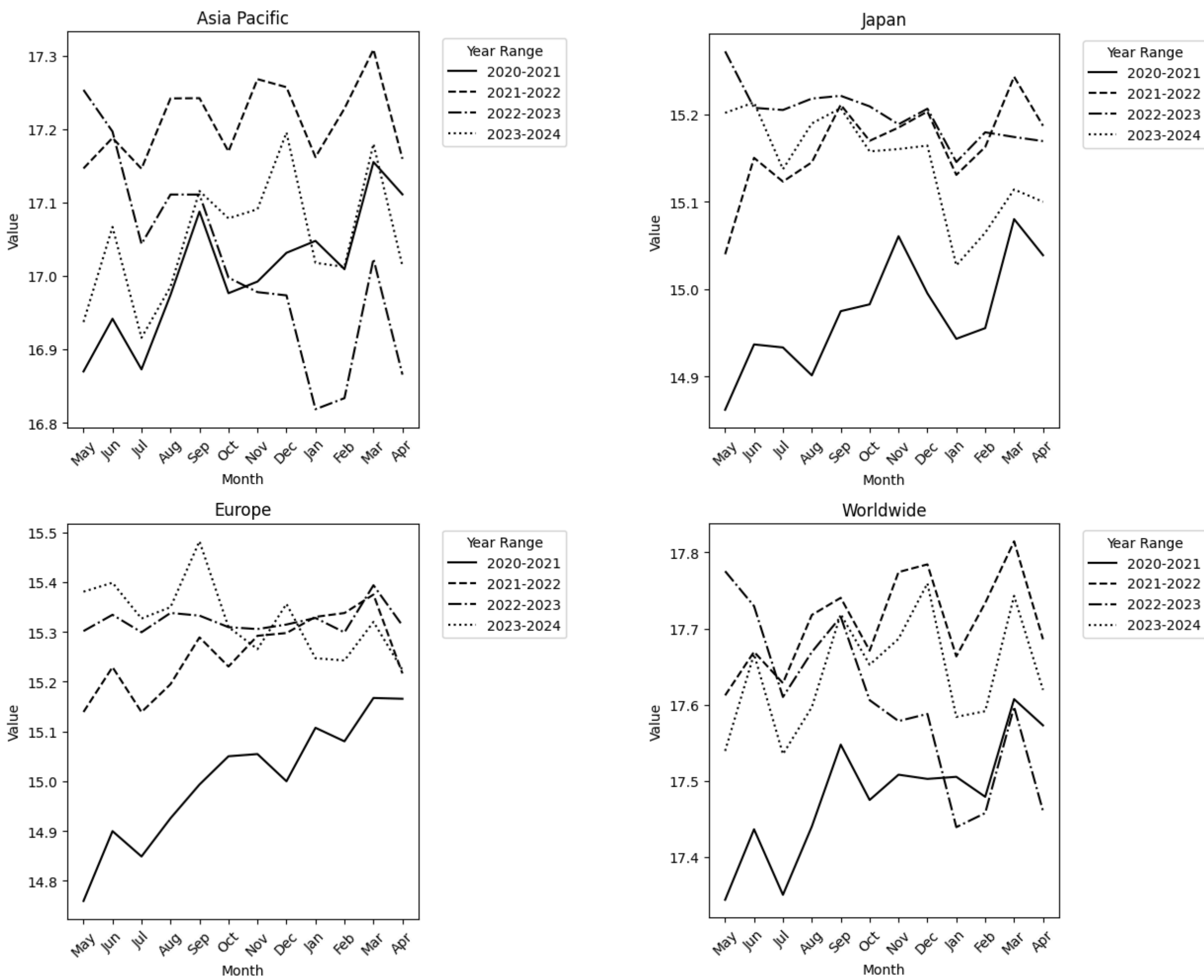
[1] Anderson Mori & Tomotsune. (2023, May 17). *Japan's new regulations on the export of advanced semiconductor manufacturing equipment*. Retrieved from https://www.amt-law.com/asset/pdf/bulletins5_pdf/230517.pdf
[2] ibid
[3] Appendix 0.2
[4] Appendix 0.1
[5] Asahi Shimbun. (2023, May 7). Japan to remove curbs on chip-material exports to S. Korea as ties warm. Retrieved from https://www.asahi.com/ajw/articles/14868929#:~:text=In%202019%2C%20Japan's%20government%20tightened,restoring%20each%20other's%20trade%20status.
[6] Kyodo, N. (2023, July). *Japan's export curbs on chip-making equipment to China take effect*. Retrieved from https://english.kyodonews.net/news/2023/07/fbe47a945a2b-japans-export-curbs-on-chip-making-equipment-to-china-take-effect.html

industry, have advanced capabilities in exposure equipment used on silicon wafers and etching equipment[7]. By 2022, China composed 26.2% of Japan's semiconductor devices exports, and Hong Kong was 14.4%. Japan imported 54.6% semiconductor devices from China, with Malaysia(8.37%) and Philippines(7.15%) succeeding[8]. Exports to China have grown 11.7% from 2017 to 2022, however growth were significantly higher in the case of Singapore(93.9%) and India(85.4)[9]. Imports of these materials and devices from China have slightly decreased 2.2%, conversely increased 91.4% imports from Singapore[10]. Such change manifests the nuance of Japan's shift of international trade partnership.



[7] TrendForce. (2024, April 29).Semiconductor Devices in Japan. OEC. Retrieved from https://www.trendforce.com/news/2024/04/29/news-strengthening-controls-on-semiconductor-equipment-exports-to-china-japan-reportedly-tightens-export-control-measures-further/#:~:text=In%20fact%2C%20in%202023%2C%20Japan,to%20crucial%20semiconductor%20fabrication%20technologies.
[8] Observatory of Economic Complexity (OEC). (n.d.). *Bilateral trade for semiconductor devices: Japan*. Retrieved from https://oec.world/en/profile/bilateral-product/semiconductor-devices/reporter/jpn
[9] Observatory of Economic Complexity (OEC). (n.d.). *Bilateral trade for semiconductor devices: Japan*. Retrieved from https://oec.world/en/profile/bilateral-product/semiconductor-devices/reporter/jpn?yearExportSelector=exportYear1&tradeValueExport=tradeScale2&compareExports0=comparisonOption5
[10] ibid

By graphing the logged regional semiconductor revenue, it can be observed that the semiconductor market led by 'Asia Pacific' manufacturers exhibited great influence on the *Worldwide* revenue from late 2022 to early 2023, however *Japan* was comparatively steady in value compared to other Asian countries. *Europe(countries)* on the other hand, had more steady values compared to *Worldwide* ones. There also appear to be some seasonal patterns, with certain months consistently showing higher or lower values.

Both presidential candidates Joe Biden[11] and Donald J. Trump have taken initiatives in onshoring more manufacturing businesses back to the United States, therefore the international relation between U.S. and China, Japan and China would perspectively intensify with the 2024 election approaching. Both the U.S. and Japan's plan in de-risking, building supply chain resilience and economic security in terms of policy would potentially impact its export value. This paper, therefore, seeks to investigate the direction and magnitude of these impacts in the wake of the July 2023 export control policy implementation, offering insights into the evolving landscape of global semiconductor trade and its broader economic implications.

Literature Review

From Wang(2024)'s Decomposition of CPI-version model, it can be observed that supply chain disruptions grew smaller from early 2020 to the end of 2023. It is possibly due to stabilization of the supply chain after countries began onshoring manufacturing businesses to counter the supply chain disruptions after the series of COVID-19, Russia invasion of Ukraine, Israel-Palestine Conflicts, and etc. This analysis laid the foundation for this paper's research intentions. Wang(2024) finds supply chain disruptions have a significant impact on prices and production in Japan, especially during and after the COVID-19 pandemic. The disruptions led to a sustained increase in prices and a temporary decline in production. Wang(2024) further indicates that rising energy and food prices contributed significantly to the inflationary pressures in Japan. The impact of these price shocks is immediate but fades within about a year.

Integrated Chips(IC), one of the key components for operations of electronic devices, have their supply chain distributed all around the world. With the series of geopolitical conflicts (Russia-Ukraine, Israel-Palestine, US-China…) occurring since COVID-19 lockdowns, the supply chain experienced significant turbulence and suspensions. Thus, many countries are taking initiatives in onshoring the manufacturing factories of semiconductor and other components that are essential for ICs. For example, Japan has consistently invested ¥3.9 trillion in the semiconductor sector from 2021 to 2023, which is a greater proportion of its GDP than the United States or Germany[12]. Furthermore, Japan has improved Economic Security Act since 2022 to prevent technological leakage across borders[13].

[11] Japan External Trade Organization (JETRO) Research and Analysis Department. (2023, July). *JETRO global trade and investment report 2023: International business facing fragmentation risks*. Retrieved from https://www.jetro.go.jp/ext_images/en/reports/white_paper/trade_invest_2023_rev2.pdf
[12] Nippon.com. (2023, January 23). Japan's trade balance for 2022 in deficit for second year running. Retrieved from https://www.nippon.com/en/japan-data/h01965/
[13] TrendForce. (2024, May 30). New regulations reportedly introduced by Japan regarding semiconductor exports. Retrieved from

There are limited articles and research analyzing the actual impact of export control. Japan's coalition with the United States in imposing sanctions might lead to negative consequences for its own manufacturing industry due to its relatively fewer resources and technologies compared to its allies. Although Japan is a major player in wafer production, contributing to 60% of the world's wafer supply, this represents only one of many processes involved in chip manufacturing. Additionally, Japan lags in critical technologies such as Extreme Ultraviolet (EUV) Lithography and chip miniaturization.

Method

Regression Discontinuity Design (RDD) is used for this paper's analysis on three different datasets, where the implementation of export control is treated as an intervention. 'Control' group and 'treatment' group will be segregated based on years without and with 2023 export control. The RDD model will build on strong assumptions of no external factors influencing the semiconductor revenue. The parallel trend assumption is additionally implemented, meaning that in the absence of treatment, the difference between the 'treatment' and 'control' group is constant over time.

The three independent variables used for the RDD models in this analysis are:

1. ***Japan's Semiconductor Revenue****:* This variable captures the historical billing data of Japan's semiconductor industry. The logged monthly revenue figures are used to assess the impact of the export control policy on the financial performance of the semiconductor sector in Japan.

2. ***Export Item Values****:* This variable represents the monthly export values of nine semiconductor-related items to China, as recorded by Japan Customs - Export Statistics by Commodity. By examining the export values before and after the policy implementation, the analysis seeks to understand the specific impact of the export control on different semiconductor-related items.

3. ***Stock Prices of Semiconductor Companies****:* This variable consists of the daily closing stock prices of ten major semiconductor companies listed on the Tokyo Stock Exchange. The stock prices serve as a proxy for public sentiment and investor reaction to the export control policy. By analyzing the changes in stock prices before and after the policy implementation, the dataset represents market sentiments towards the policy.

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https://www.trendforce.com/news/2024/05/30/news-new-regulations-reportedly-introduced-by-japan-regarding-semiconductor-exports/

1. *Impact Examination via Japan's Semiconductor Revenue*

$$Y_{it} = \alpha + \beta D_{it} + f(T_{it}) + \varepsilon_{it}$$

where:

Y_{it} is the dependent variable of *Japan Semiconductor Historical Billing*.

D_{it} is a binary variable indicating treatment (1 if post-implementation, 0 if pre-implementation).

T_{it} is the running variable (e.g., time in months relative to July 2023).

$f(T_{it})$ is a function of the running variable to control for time trends.

ε_{it} is the error term.

Data

Control Group: January 2022 - February 2023
Buffer Period: March 2023 - June 2023
Treatment Group: July 2023 - April 2024

Monthly and logged data of regional *Semiconductor Revenue* is retrieved from World Semiconductor Trade Statistics[14]. Significant fluctuations in revenue data are assumed to be associated with supply chain disruptions such as shortages or delays.

R-squared indicates that approximately 34.8% of the variance in Japan's semiconductor industry revenue is explained by the export control treatment, which is a fairly reasonable model fit. *F-statistic* of 12.27 with *p-value* of 0.00191 means that the treatment effect is statistically significant at 1% level. *Coefficient of Treatment* D_{it} being -0.00646 implies the July 2023 export control policy is associated with a decrease in logged revenue by approximately 0.0646 units, having 1% level of significance. The graph has *Policy Implementation* labeled as red line vertically. It presents the overall downward trend of logged revenue values after July 2023.

To verify the robustness of the observed treatment effect, *Placebo Tests* were conducted using alternative cutoffs where no policy intervention occurred. The *Placebo* cutoffs set in July 2022, October 2022, and January 2023 resulted in treatment effects that were not statistically significant.

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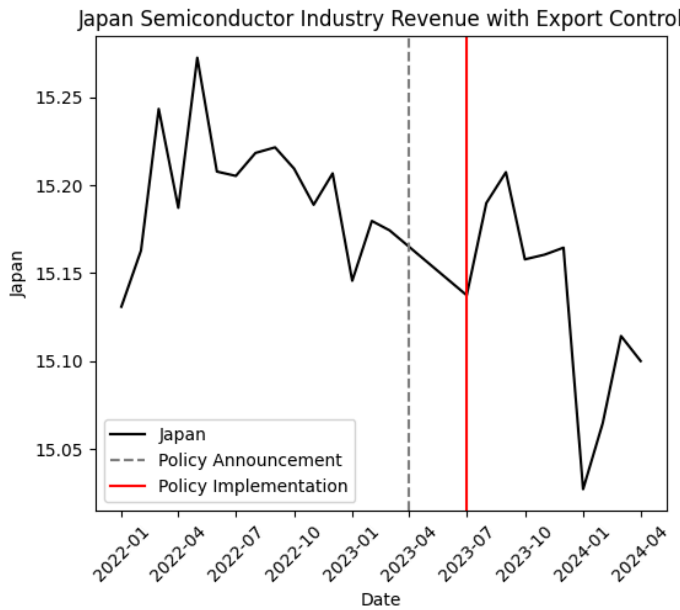
[14] World Semiconductor Trade Statistics. (n.d.). *Historical Billings Report: Three decades of billings statistics of the WSTS Blue Book with latest data from April 2024*. Retrieved July 20, 2024, from https://www.wsts.org/65/WSTS



Their *p-values* were 0,138, 0,904, and 0.216 respectively. These results support the validity of the first RDD model results, indicating that the observed treatment effect is not due to random events or other underlying trends unrelated to the policy intervention.

Bandwidth Sensitivity Analysis further proves that the treatment effect is consistent and statistically significant across various bandwidths. Specifically the treatment effects for bandwidths of 3 months, 6 months, and 9 months were -0.059, -0.055, -0.065 with *p-value* of 0.029, 0.013 and 0.002 respectively.

The analysis provides evidence that the July 2023 Export Control Policy had a significant negative impact on Japan's semiconductor industry revenue. The robustness checks, including placebo tests and bandwidth sensitivity analysis, consolidated the validity of the observed treatment effect, suggesting that the policy implementation directly influenced the logged revenue, reducing it by approximately 0.0646 units on average.

2. *Impact Examination via Export Items*

By examining the impact item by item, the analysis could be further comprehended and inclusive. The method is still Regression Discontinuity Design (RDD), however, it intends to use different datasets to explore the specific effects on various semiconductor-related export items. This detailed examination allows for a more granular understanding of the policy's impact on different segments of the semiconductor industry.

9 semiconductor-related exporting items' value to China were retrieved from Japan Customs - Export Statistics by Commodity[15]. Without a direct dataset, only data points from August 2022 to

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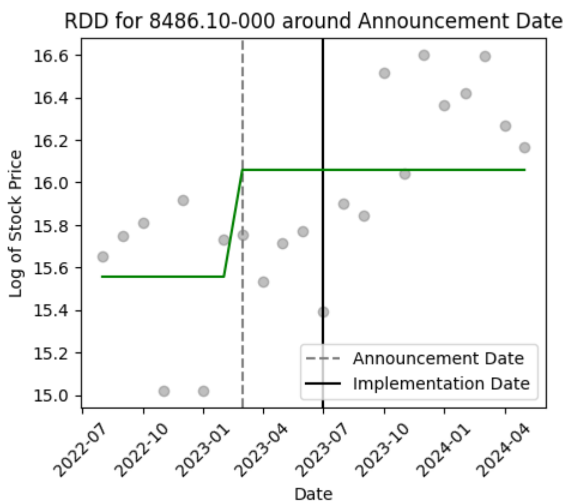
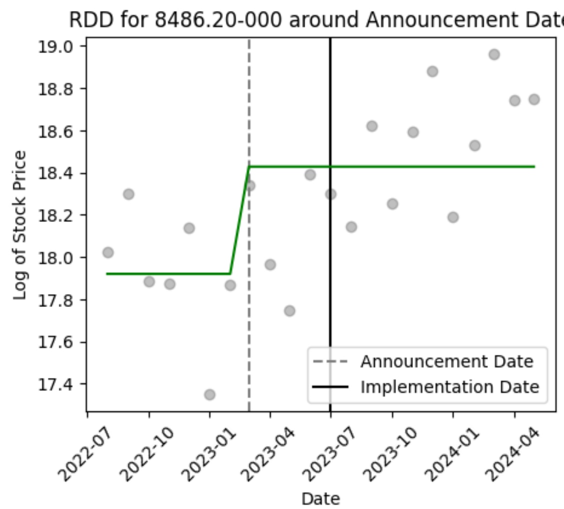
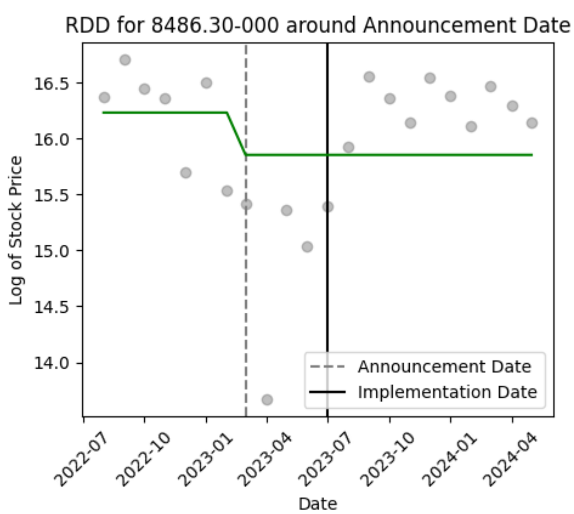
[15] Appendix 2.2

May 2024 item value(monthly) were collected. The same RDD model is applied to each item value, and three items were found to have experienced statistically significant impact.

It is quite contradictory to see this results that export items 8486.10-000[16] and 8486.20-000[17] sales value to China were positively impacted after the implementation date. It could be potentially explained by China's domestic shortfall on wafer-related items. Japan is a leading manufacturer of wafer in the world semiconductor supply chain with its available resources.







Therefore, with China's domestic semiconductor manufacturing capabilities not fully meeting the needs, there's urgency to secure as much as equipment before more stringent measures are taken into effect in the future. It is realized in 2024 that in fact stricter policies underwent discussion. Another explanation could be the Japanese government, even though it imposed the export control policy, and listed China to Group to-3, equipment is still acquirable after

[16] Equipment for manufacturing semiconductor balls or semiconductor wafers
[17] Equipment for manufacturing semiconductor devices or integrated circuits

applications of certain certificates. Diplomatic negotiations and specific agreements might have allowed some level of continued trade in critical semiconductor items. The diplomatic maneuver aims to prevent a complete breakdown of bilateral trade relationships.

8486.30-000[18], Flat Panel Display is tested statistically significant and negatively impacted by the export control policy. However, its R-Squared value is only 6.66% compared to the previous two types of equipment where 8486.10-000 and 8486.20-000 is 28.74% and 36.21% respectively. It indicates that only very little of the 8486.30-000 variations were explained by the policy implementation. Furthermore, the Japanese FDP industry report testified that its export towards China continues to hold strong, sizing up to 50% of Japan's total FDP exports[19]. The article also mentions US-China trade friction has led Chinese production lines to switch to general purpose products, which increased purchases in FDP[20]. Moreover, China has increased focus and investment on production of renewable energy vehicles where semiconductor processors with 28 nanometers size are in demand[21]. Washington's key aim is to restrict Beijing's chipmaking capability to 14nm[22], 28nm processor for general purposes vehicle production is out of concern in this chip war.

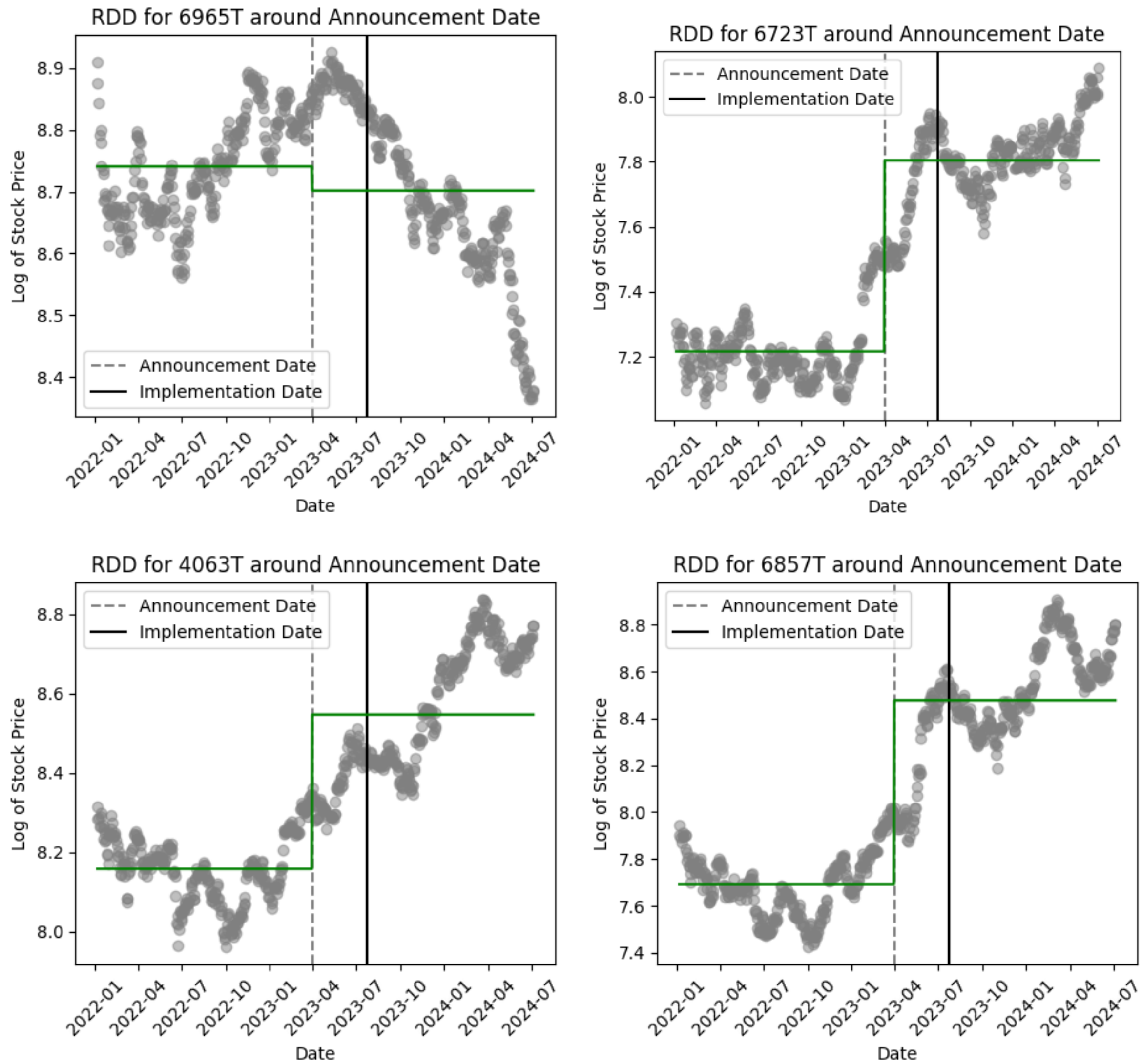
The positively impacted equipment exports to China seems contradictory to previous findings of revenue slowdown. It is also due to the limitation of this paper that impact of the newly listed 23 items could not be directly examined. Only some export equipment data were found on the Japan Customs, and these data were not clearly linked to the export controlled equipment items.

3. Impact Examination via Stocks Reactions (Public Sentiment)

The Japanese equity market is less liquid compared to the United States one, partially due to its high boundary to entry (restrictions in lowest requirement on shares acquirement) and relatively lower volatility thus lower level of returns. Nevertheless, it still demonstrates implicitly market sentiment of those large shareholders and speculators with better instruments and information in reaction to the news. Therefore, this paper also lists major semiconductor-related companies and analyzes to reflect the public sentiment of the export control policy[23].

Same RDD model applies to 10 semiconductor companies listed on Tokyo Stock Exchange. The stock Close Price on daily frequency is utilized from January 2022 to July 2024.

[18] Equipment for manufacturing flat panel displays
[19] China News Japan. (2024, June 14). 日本の半導体製造設備輸出の*50%*以上は中国向け. Retrieved July 20, 2024, from https://chinanews.jp/archives/19054
[20] ibid
[21] ibid
[22] Dominguez, G. (2023, September 20,). *China seeks new methods to counter US chipmaker export controls.* Japan Times Retrieved from https://www.japantimes.co.jp/business/2023/09/20/tech/china-us-chipmakers-export-controls/
[23] Appendix 3.1



Four of the ten models results find statistically significant impact by the policy. 6723T, 6857T and 4063T had a positive impact from the export control policy. The close price of the stocks underwent an overall rise in price after the announcement of the policy, which the graphs above clearly indicate each transition. R-Squared values were 85.91%, 80.81%, and 69.13% respectively for 6723T, 6857T, and 4063T, demonstrating the model's high explanatory power. From the graph and the coefficients of the treatment, directly after the announcement of the export control policy, 6723T and 6857T were not only positively impacted, but also saw huge price gaps.

Renesas Electronics Corporation (6723T) is a major player in the semiconductor industry, focusing on the design, manufacture, and sale of semiconductor products. During the sample period, Renesas’s financial statistics remained robust. Notably, the two annual shareholders' meetings following the initial announcement date did not discuss 'China' or 'export.' This omission is likely due to their focus on the automotive and industrial, infrastructure, and IoT segments, which are not typically sensitive to export controls.

Furthermore, Renesas's sales have been shifting towards India in recent years, providing a hedge against external volatilities. Additionally, Renesas has operations and factories in China, meaning export controls would likely have a limited impact on their overall business.

The positive results from the model could be attributed to the global attention on Japan's semiconductor industry following the announcement. Public sentiment suggests that the coalition between Japan, the U.S., and the Netherlands would benefit the Japanese semiconductor sector. Investors might reasonably select Renesas Electronics Corporation, recognizing it as a company less affected by export controls and poised to remain strong among competitors with its global presence.

The negative impact of the policy on 6965T had small R-Squared values of 2.85%, indicating the model's limited explanatory power for the sample stock price. While the significance of the predictors is encouraging, the low R-squared value highlights that other important factors influencing the dependent variable may not have been included in the model. Additionally, the simplicity of the current model may not capture the complexity of the relationships between the variables.

For example, in May 2023, between the policy announcement date and implementation date, Japan's Hamamatsu Photonics stated that Denmark denied approval for the NKT Photonics acquisition, which was negative news for business expansion[24]. This event exemplifies how external geopolitical and regulatory factors can significantly impact stock prices, which might not be fully captured in a simplified model.

Conclusion

This paper demonstrates the negative impact of the July 2023 Export Control Policy on Japan's semiconductor industry revenue. Robustness checks validate the observed treatment effect, indicating that the policy directly influenced logged revenue, reducing it by approximately 0.0646 units on average. However, the analysis of the majority of examined export item sales and stock prices of related companies showed a positive impact from the export control policy.

Additionally, the differences observed between revenue and stock price results highlight the importance of considering multiple dimensions and factors when assessing the impact of policy changes on the industry. This approach ensures a comprehensive understanding of how such policies influence various aspects of the semiconductor sector from investor sentiments to real revenue impact.

[24] Photonics Media. (2023, May 15). *Hamamatsu completes acquisition of NKT Photonics*. Retrieved from https://www.photonics.com/Articles/Hamamatsu_Completes_Acquisition_of_NKT_Photonics/a70021#:~:text=The%20acquisition%20gained%20regulatory%20approval,its%20initial%20agreement%20in%202022

In early 2024, discussions around tightening export controls might distort prices and revenue further. Future research should focus on refining models to capture the multifaceted impacts of export control policies on global semiconductor markets. Also investigate the long-term effects of such policies, considering potential shifts in global supply chains and technological advancements. Understanding the nuanced interplay between policy, market dynamics, and geopolitical developments will be crucial for stakeholders in the semiconductor industry and policymakers aiming to enhance economic security and resilience.

Appendix

Appendix 0.1 半導体製造装置23品目の貨物等省令追加に関する省令改正案の概要 対象23品目内訳[25]

Number	品目カテゴリ	品目概要	改正省令 (第6条1項)
1	洗浄	真空下で不純物の除去を行う装置	ヤ
2		各種工程の前処理として表面の不純物の除去を行う装置	マ
3		表面の性質を変えた上で不純物の除去を行う装置	ケ
4	デポジション (成膜)	めっき法によりコバルトを成膜する装置等	レ
5		化学的な方法でタングステンの層を成膜する装置	ソ
6		タンタル等メタルをリサイプラズマを選択的に成膜する装置	ツ
7		ルテニウム成膜装置を成膜する装置	ネ
8		プラズマを用いウェハを回転させ、原子レベルで成膜する装置	ナ
9		絶縁体の層を細長い溝の中に成膜する装置	ラ
10		EUVマスク用の成膜を行う装置	ム
11		シリコンやシリコン化合物を規則正しく成膜させ成膜する装置	ウ
12		プラズマを用いてエッチング耐性のある膜を成膜する装置	ヰ
13		プラズマを用いて原子レベルでタングステンを成膜する装置	ノ
14		プラズマを用いて絶縁体の層を隙間なく成膜する装置	オ

[25] Center for Information on Security Trade Control (CISTEC). (2023, May 17). *Public comments on semiconductor export controls*. Retrieved from https://www.cistec.or.jp/service/doushikoku/handotai23_pubcome00.pdf

Number	品目カテゴリ	品目概要	改正省令 (第6条1項)
15	アニーリング (熱処理)	熱処理によって薄膜内の隙間等を除去する装置	ク
16	リソグラフィ (露光)	EUVマスク用防護カバー	17号の2
17		EUVマスク用防護カバー製造装置	ル
18		EUV用に設計された塗布・現像装置	ワ
19		ArF-Wet（フッ化アルゴンレーザー液浸）露光装置	ヲ
20	エッチング (化学的除去)	最先端の半導体構造（立体構造）を実現するエッチング装置	カ
21		薬液を用いたエッチング装置	ヨ
22		微細で深いエッチングを行うための装置	タ
23	検査	EUVマスクの検査装置	フ

Appendix 0.2 July 2023 Export Control Categories and Countries Groupings

Category	Group i-1 ("Whitelist" countries, including the US)	Group to-2	Group to-3 (Such as China)	Group chi (Such as North Korea)
Export of New Items	General or Special	General	Special	N/A
Technology Related to The Design and Manufacture of New Items	Special	Special	Special	N/A
Technology Related to The Use of New Items	General or Special	General	Special	N/A

Appendix 1.1 RDD Model Summary

```
                 OLS Regression Results
==============================================================================
Dep. Variable:              Japan   R-squared:                  0.348
Model:                        OLS   Adj. R-squared:             0.320
Method:             Least Squares   F-statistic:                12.27
Date:            Mon, 15 Jul 2024   Prob (F-statistic):       0.00191
Time:                    06:45:25   Log-Likelihood:            43.011
No. Observations:              25   AIC:                       -82.02
Df Residuals:                  23   BIC:                       -79.58
Df Model:                       1
Covariance Type:        nonrobust
==============================================================================
             coef    std err        t      P>|t|     [0.025     0.975]
------------------------------------------------------------------------------
const       15.1969     0.012   1303.489     0.000     15.173     15.221
treatment    -0.0646     0.018     -3.503     0.002     -0.103     -0.026
==============================================================================
Omnibus:                    1.108   Durbin-Watson:              1.222
Prob(Omnibus):                0.574   Jarque-Bera (JB):            0.830
Skew:                       0.493   Prob(JB):                  0.661
Kurtosis:                   2.583   Cond. No.                   2.38
==============================================================================
```

Appendix 1.2 Placebo Cutoff 2022-07-01

```
                 OLS Regression Results
==============================================================================
Dep. Variable:              Japan   R-squared:                  0.085
Model:                        OLS   Adj. R-squared:             0.049
Method:             Least Squares   F-statistic:                2.348
Date:            Mon, 15 Jul 2024   Prob (F-statistic):         0.138
Time:                    06:45:25   Log-Likelihood:            72.722
No. Observations:              27   AIC:                       -141.4
Df Residuals:                  25   BIC:                       -138.8
Df Model:                       1
Covariance Type:        nonrobust
==============================================================================
             coef    std err        t      P>|t|     [0.025     0.975]
------------------------------------------------------------------------------
const       15.1971     0.011   1386.641     0.000     15.175     15.219
placebo_treatment  -0.0284     0.018     -1.532     0.138     -0.066     0.009
==============================================================================
```

Appendix 1.3 Placebo Cutoff 2022-10-01

```
                    OLS Regression Results
==============================================================================
Dep. Variable:                  Japan   R-squared:                       0.001
Model:                            OLS   Adj. R-squared:                 -0.037
Method:                 Least Squares   F-statistic:                     0.015
Date:                Mon, 15 Jul 2024   Prob (F-statistic):              0.904
Time:                        06:45:25   Log-Likelihood:                 72.123
No. Observations:                  27   AIC:                            -140.2
Df Residuals:                      25   BIC:                            -137.6
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
            coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        15.1964      0.012   1267.917      0.000      15.173      15.220
placebo_treatment  0.0022      0.018      0.124      0.904     -0.034      0.038
==============================================================================
```

Appendix 1.4 Placebo Cutoff 2023-01-01

```
                    OLS Regression Results
==============================================================================
Dep. Variable:                  Japan   R-squared:                       0.061
Model:                            OLS   Adj. R-squared:                  0.024
Method:                 Least Squares   F-statistic:                     1.617
Date:                Mon, 15 Jul 2024   Prob (F-statistic):              0.216
Time:                        06:45:25   Log-Likelihood:                 72.475
No. Observations:                  27   AIC:                            -140.9
Df Residuals:                      25   BIC:                            -138.3
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
            coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        15.1959      0.012   1255.839      0.000      15.173      15.219
placebo_treatment -0.0234      0.018     -1.272      0.216     -0.061      0.014
==============================================================================
```

Appendix 1.5 Bandwidth Sensitivity Analysis - 3 Months

```
                    OLS Regression Results
==============================================================================
Dep. Variable:                  Japan   R-squared:                       0.289
Model:                            OLS   Adj. R-squared:                  0.242
Method:                 Least Squares   F-statistic:                     6.121
Date:                Mon, 15 Jul 2024   Prob (F-statistic):             0.0290
Time:                        06:45:25   Log-Likelihood:                 22.556
No. Observations:                  13   AIC:                            -41.11
Df Residuals:                      11   BIC:                            -40.04
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
              coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        15.1880      0.017    874.528      0.000      15.151      15.225
treatment    -0.0590      0.024     -2.474      0.029      -0.111      -0.007
==============================================================================
```

Appendix 1.6 Bandwidth Sensitivity Analysis - 6 Months

```
                    OLS Regression Results
==============================================================================
======
Dep. Variable:                  Japan   R-squared:                       0.309
Model:                            OLS   Adj. R-squared:                  0.269
Method:                 Least Squares   F-statistic:                     7.613
Date:                Mon, 15 Jul 2024   Prob (F-statistic):             0.0134
Time:                        06:45:25   Log-Likelihood:                 33.567
No. Observations:                  19   AIC:                            -63.13
Df Residuals:                      17   BIC:                            -61.25
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
              coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const        15.1878      0.015   1042.246      0.000      15.157      15.218
treatment    -0.0554      0.020     -2.759      0.013      -0.098      -0.013
==============================================================================
```

Appendix 1.7 Bandwidth Sensitivity Analysis - 9 Months

OLS Regression Results

==

Dep. Variable:	Japan	R-squared:	0.348
Model:	OLS	Adj. R-squared:	0.320
Method:	Least Squares	F-statistic:	12.27
Date:	Mon, 15 Jul 2024	Prob (F-statistic):	0.00191
Time:	06:45:25	Log-Likelihood:	43.011
No. Observations:	25	AIC:	-82.02
Df Residuals:	23	BIC:	-79.58
Df Model:	1		
Covariance Type:	nonrobust		

==

	coef	std err	t	P>|t|	[0.025	0.975]
const	15.1969	0.012	1303.489	0.000	15.173	15.221
treatment	-0.0646	0.018	-3.503	0.002	-0.103	-0.026

==

Appendix 2.1 Japan Semiconductor Exports to China Items Value (Partial) 2022/08-2024/05 (単位:1000円)

Item	8486.10-000	8486.20-000	8486.30-000	8486.40-000	8486.90-000	9030.20-000	9030.82-100	9030.82-900	9031.41-000
Aug-22	6276286	67282412	12817698	8921571	15031124	50474	3778986	4209425	5205404
Sep-22	6899084	88523553	17957984	5422362	14264315	66568	2384685	2978873	7268215
Oct-22	7355502	58454571	13941737	9373171	15592501	64616	2835331	1799383	4718439
Nov-22	3331396	57987434	12659386	4743519	14842254	77790	1702623	2732394	3116870
Dec-22	8166971	75425199	6556078	7553519	12960674	74607	2553827	4521616	4220964
Jan-23	3337233	34269459	14702067	5480783	9389949	40600	1330446	2623137	2618152
Feb-23	6782411	57584249	5580472	6600426	15080605	56745	3177725	2092311	5159653
Mar-23	6963260	92518151	4937883	7110840	15410224	70746	3713899	3626797	3527293
Apr-23	5578868	63459825	863514	10397012	16377607	91034	2711001	3785816	2764372
May-23	6697769	51093727	4691162	7984985	11190879	46694	1574847	2570572	3031077
Jun-23	7053846	97168746	3394612	6884785	15924772	123213	4077927	3886709	4091886
Jul-23	4854141	88641238	4834773	10890141	31320016	83270	3710305	3997886	3556187
Aug-23	8055984	75891365	8255006	5933401	13190259	117268	1846692	3005113	4789376
Sep-23	7592388	122059926	15455133	6214907	15358939	81597	2593421	4083459	7368406
Oct-23	14907142	84467891	12676282	10659671	15218828	40800	4923807	2827285	7860185
Nov-23	9283297	118619981	10215412	6032164	13376395	67595	2007869	2635929	7219628
Dec-23	16201067	158834757	15366140	13353593	18697701	42896	5517962	4011641	7476711
Jan-24	12758826	79519297	12985235	4878025	13899148	33399	3771020	1837734	5021448
Feb-24	13523362	111492679	9865872	12980574	17722990	37846	1689222	3318998	3334934
Mar-24	16096054	171583845	14104587	9588802	20221623	73245	5977348	4341330	6289213
Apr-24	11610655	138153199	11961997	7986226	19153493	37319	2386312	4422187	6962380
May-24	10518127	138721133	10260513	7478269	21391802	135840	1404389	4275990	5876705

Appendix 2.2 Exporting Semiconductor Items Reference List

統計番号Statistical code	品名	単位	他法令
84.86	半導体ボール、半導体ウエハー、半導体デバイス、集積回路又はフラットパネルディスプレイの製造に専ら又は主として使用する機器、第84類の注11(C)の機器並びに部分品及び附属品		
8486.10-000	半導体ボール又は半導体ウエハー製造用の機器		
8486.20-000	半導体デバイス又は集積回路製造用の機器		
8486.30-000	フラットパネルディスプレイ製造用の機器		
8486.40-000	第84類の注11(C)の機器		
8486.90-000	部分品及び附属品		
9031.41-000	半導体ウエハー又は半導体デバイス（集積回路を含む。）の検査用の機器及びフォトマスク又はレチクル（半導体デバイス（集積回路を含む。）の製造に使用するものに限る。）の検査用の機器	NO	ET
9030.82-900	半導体ウエハー又は半導体デバイスの測定用又は検査用の機器(集積回路を含む。)		
9030.82-100	特性測定器	NO	ET
9030.82-900	その他のもの	NO	ET
9030.20-000	オシロスコープ及びオシログラフ	NO	KG
Data Retrieved from https://www.customs.go.jp/yusyutu/2024_01_01/index.htm https://www.customs.go.jp/yusyutu/2024_01_01/data/print_j_90.htm https://www.customs.go.jp/yusyutu/2024_01_01/data/j_86.htm			

Appendix 2.3 Table of Statistically Significant Exporting Semiconductor items by value

Items	**Coef**	**P>|t|**	**R-squared**	**F-statistic**	**Prob (F-statistic)**
8486.10-000	0.502910	0.010108	0.287454	8.068354	0.010108
8486.20-000	0.507687	0.003046	0.362149	11.355286	0.003046
8486.30-000	-0.377732	0.246149	0.066620	1.427506	0.246149

Appendix 3.1 Top Japanese Semiconductor Companies

Company	Tick	Description	Industry Type	RDD Statistically Significance
Atock	Private	provides services in polishing, grinding, and welding optical glass such as quartz glass and semiconductor devices.	High-Value Added Services and Products	
Qd Laser, Inc.	6613.T	a developer of quantum dot laser technology designed to offer high performance semiconductor lasers	Design and Development	
Nanobridge Semiconductor	Private	Semiconductor designs and manufactures advanced circuits and conducts IP-licensing sales using NanoBridge	Design and Development	
Aipore	Private	a technology company specializing in the area of nanopore sensor using semiconductor Si microfabrication technology	High-Value Added Services and Products	
Floadia Corporation	Private	Floadia Corporation is a developer of embedded flash memory IP	Design and Development	
Hamamatsu Photonics	6965.T	Coinbase customer care number Hamamatsu Photonics is a leading manufacturer of devices for the generation and measurement	High-Value Added Services and Products	1% level of significance coef = -0.0392 R^2 = 0.0285
Ricoh Company	7752.T	a global technology company provide office imaging equipment, document management systems and IT services	High-Value Added Services and Products	
Renesas Electronics Corporation	6723.T	semiconductor solutions, including microcontrollers, SoC solutions, and analog and power devices	Fabrication and Manufacturing	1% level of significance coef = 0.5888 R^2 = 0.8592

ROHM Co., Ltd	6963.T	LSI, Semiconductor Devices, and Modules[26]	Fabrication and Manufacturing	
Advantest Corporation	6857.T	manufactures and sells semiconductor and component test system products and mechatronics-related products	High-Value Added Services and Products	1% level of significance coef = 0.7864 R^2 = 0.8081
MegaChips Corporation	6875.T	a fabless company, focuses on the development of system LSIs and systems products	Design and Development	
Sanken Electric Co	6707.T	a global supplier of analog power semiconductor products.	Fabrication and Manufacturing	
Shin-Etsu Chemical	4063.T	provides key materials and technologies people's daily lives as well as to the advance of industry and society	Fabrication and Manufacturing	1% level of significance coef = 0.3887 R^2 = 0.6913
Sumco	3436.T	a manufacturer and seller of silicon wafers for semiconductor industry	Fabrication and Manufacturing	
Taiyo Holdings Co.	4626.T	manufactures and distributes solder resist chemicals for printed wiring boards (PWBs) and others	Materials and Chemicals	

Appendix 3.2 RDD Results on Semiconductor Stock Close Price[27]

	Stock	Coef	P>|t|	R-squared	F-statistic	Prob (F-statistic)
0	**6613T**	0.054019	1.480298e-05	0.030266	19.069614	1.480298e-05
1	**6965T**	-0.039151	2.634893e-05	0.028520	17.937246	2.634893e-05
2	**7752T**	0.164175	6.158217e-114	0.569564	808.491523	6.158217e-114
3	**6723T**	0.588758	2.848510e-262	0.859184	3728.000540	2.848510e-262
4	**6963T**	0.066188	7.703948e-13	0.080680	53.621655	7.703948e-13
5	**6857T**	0.786417	3.491898e-221	0.808087	2572.738506	3.491898e-221

[26] https://finance.yahoo.com/quote/6963.T/profile/
[27] Data retrieved from Yahoo Finance: https://finance.yahoo.com/

6	**6875T**	0.260654	1.639319e-79	0.442282	484.535892	1.639319e-79
7	**6707T**	0.399766	2.334918e-67	0.388908	388.849497	2.334918e-67
8	**4063T**	0.388679	4.608119e-158	0.691250	1367.947559	4.608119e-158
9	**3436T**	0.103406	5.083019e-46	0.282656	240.752834	5.083019e-46
10	**4626T**	0.033669	3.989757e-04	0.020326	12.676949	3.989757e-04

Note: Red rows are statistically significant stocks with positive coefficients, green are the ones with negative coefficients.

References

Anderson Mori & Tomotsune. (2023, May 17). *Japan's New Regulations on The Export of Advanced Semiconductor Manufacturing Equipment*. Retrieved from https://www.amt-law.com/asset/pdf/bulletins5_pdf/230517.pdf

Asahi Shimbun. (2023, May 7). *Japan, South Korea Drop Export Claims Against Each Other*. Retrieved from https://www.asahi.com/ajw/articles/14868929#:~:text=In%202019%2C%20Japan's%20government%20tightened,restoring%20each%20other's%20trade%20status

Center for Information on Security Trade Control (CISTEC). (2023, May 17). *Public comments on semiconductor export controls*. Retrieved from https://www.cistec.or.jp/service/doushikoku/handotai23_pubcome00.pdf

China News Japan. (2024, June 14). *日本の半導体製造設備輸出の50%以上は中国向け*. Retrieved July 20, 2024, from https://chinanews.jp/archives/19054

Dominguez, G. (2023, September 20). *China Seeks New Methods to Counter US Chipmaker Export Controls.* Japan Times. Retrieved from https://www.japantimes.co.jp/business/2023/09/20/tech/china-us-chipmakers-export-controls/

Japan External Trade Organization (JETRO) Research and Analysis Department. (2023, July). *JETRO global trade and investment report 2023: International business facing fragmentation risks.* Retrieved from https://www.jetro.go.jp/ext_images/en/reports/white_paper/trade_invest_2023_rev2.pdf

Kyodo News. (2023, July). *Japan's Export Curbs on Chip-Making Equipment to China Take Effect*. Retrieved from https://english.kyodonews.net/news/2023/07/fbe47a945a2b-japans-export-curbs-on-chip-making-equipment-to-china-take-effect.html

Nippon.com. (2023, January 23). *Japan's Trade Balance for 2022 in Deficit for Second Year Running*. Retrieved from https://www.nippon.com/en/japan-data/h01965/

Observatory of Economic Complexity (OEC). (n.d.). *Bilateral Trade for Semiconductor Devices: Japan*. Retrieved from https://oec.world/en/profile/bilateral-product/semiconductor-devices/reporter/jpn

Photonics Media. (2023, May 15). *Hamamatsu Completes Acquisition of NKT Photonics.* Retrieved from https://www.photonics.com/Articles/Hamamatsu_Completes_Acquisition_of_NKT_Photonics/a70021#:~:text=The%20acquisition%20gained%20regulatory%20approval,its%20initial%20agreement%20in%202022

TrendForce. (2024, April 29). *Strengthening Controls on Semiconductor Equipment Exports to China: Japan Reportedly Tightens Export Control Measures Further*. Retrieved from https://www.trendforce.com/news/2024/04/29/news-strengthening-controls-on-semiconductor-equipment-exports-to-china-japan-reportedly-tightens-export-control-measures-further/#:~:text=In%20fact%2C%20in%202023%2C%20Japan,to%20crucial%20semiconductor%20fabrication%20technologies

TrendForce. (2024, May 30). *New Regulations Reportedly Introduced by Japan Regarding Semiconductor Exports*. Retrieved from https://www.trendforce.com/news/2024/05/30/news-new-regulations-reportedly-introduced-by-japan-regarding-semiconductor-exports/

World Semiconductor Trade Statistics. (n.d.). *Historical Billings Report: Three Decades of Billings Statistics of the WSTS Blue Book with Latest Data from April 2024.* Retrieved July 20, 2024, from https://www.wsts.org/65/WSTS