EXTRA: Data-Driven Analysis of Export Control Changes

Alfonso Lagares De Toledo

December 2024

1 Introduction

Export controls are U.S. policies that restrict the export of certain technologies and goods by individuals, companies, and government agencies. Originating in World War II, these regulations continue to target dual-use and military-applicable items. During the Cold War, they evolved into a tool of U.S. foreign policy, limiting foreign access to advanced U.S. technology.[1]. Over time, the involvement of numerous federal agencies has created a complex system with overlapping responsibilities and a lack of clear interagency coordination. As a 2018 Congressional Research Service report on export reform noted:

> The U.S. export control regime comprises several different licensing and enforcement agencies. Exports of dual-use goods and technologies—as well as some defense articles—are licensed by the Department of Commerce, munitions are licensed by the Department of State, and restrictions on exports based on U.S. sanctions are administered by the Department of the Treasury. In addition, the Department of Defense plays a key role in evaluating licenses referred to it by these agencies. Units of the Department of Homeland Security (DHS) and the Department of Justice issue criminal penalties for violations of export control regulations[2].

The space industry is significantly affected by export controls due to the dual-use nature of many space technologies. Growing international collaboration between private and public entities, coupled with the expansion of the global commercial space economy, has strained Cold War-era export control systems. These regulations have hindered the U.S. space industry's ability to compete in international markets, while failing to fully maintain U.S. technological dominance in areas like satellite imaging and position, navigation, and

1. Linda A. Moyer Homer E. Jr.; Mabry, *Export Controls as Instruments of Foreign Policy: The History, Legal Issues, and Policy Lessons of Three Recent Cases* (University Press Of America, 1983).

2. Congressional Research Service, *The U.S. Export Control System and the Export Control Reform Initiative*, Congressional Research Service Report, R41916, 2020, https://crsreports.congress.gov/product/pdf/R/R4681.

timing (PNT) services.[3]. Consequently, exporters, government agencies, and allied nations have widely called for modernizing export controls for the 21st century[4].

Export control reform as it impacts the space industry has struggled to balance two competing goals: supporting the U.S. private space sector in global markets and maintaining national security. This challenge has persisted since 2013, when commercial satellite technology was removed from the U.S. Munitions List and reclassified under the Export Administration Regulations (EAR)[5]. The Department of Commerce, responsible for these regulations, faces pressure from private space companies and civil institutions, like NASA, to reduce licensing requirements. These entities argue that the current regulations hinder international collaboration and slow business operations[6]. Conversely, regulators at the Department of Commerce, as well as at the Departments of State and Defense, emphasize the need to prioritize national security when considering any reduction in controls. While all stakeholders agree on enhancing U.S. competitiveness, they differ on how to achieve this without compromising national security. The result is an ongoing lengthy debate around the specific licensing requirements that should be applied to each export control classification number (ECCN) in the EAR, which has significantly slowed down progress toward a resolution to this situation.

The fragmented export control process hinders stakeholders' access to comprehensive information on the impact of space-related policy changes. Without analysis of how specific regulatory changes affect legislative outcomes, stakeholders struggle to translate policy goals into concrete legal changes. To address this, this paper introduces EXTRA (EXport Regulation and TRade Analytics), a source of aggregated export control data and analysis tools designed to provide key export control metrics intended to gauge the impact of changes to the export control process.[7]. This paper also presents an application of this tool and data to understand a recent EAR revisions concerning spacecraft components, demonstrating its potential impact.[8].

2 Literature Review

A literature review examined current justifications for changes to the export control process, focusing on the methods of justification rather than the specific recommendations them-

3. Michael J. Noble, "Export Controls and United States Space Power," *Astropolitics* 6, no. 3 (2008): 251–312.

4. Congressional Research Service, *The U.S. Export Control System and the Export Control Reform Initiative*.

5. Federal Register, *Export Administration Regulations (EAR): Control of Spacecraft Systems and Related Items the President Determines No Longer Warrant Control under the United States Munitions List (USML)*, 78(101), 31431–31449, May 2013.

6. Bureau of Industry and Security, *Space Export Control Report*, February 2014.

7. Alfonso Lagares de Toledo, ""EXTRA: EXport Regulation and TRade Analytics"," December 11, 2024. https://github.com/algadoc/EXTRA, 2024.

8. Federal Register, *Export Administration Regulations: Revisions to Space-Related Export Controls*, 89(205), October 2024.

selves. This literature review is intended to determine the existing avenues to justify and analyze changes to the body of regulations.

2.1 Current analysis on the impact of changes to export control regulations

Existing formal analyses justifying recommendations for export control regulations impacting the space industry primarily focus on the broad regulations' economic impact. These analyses examine various aspects, including global market distribution, foreign markets, legal scope and issues, and effects on firms and exporters.[9]. They also tend to focus on the regulations' impact on specific industries.[10].

Government agencies involved in export control frequently use export control metrics and statistics to justify proposed changes, as evidenced by Congressional Research Service reports.[11]. However, the only readily available documentation linking proposed changes to policy goals are agency publications, such as BIS final rules in the Federal Register.[12]. While these publications are useful for understanding agency intent, they do not contribute to pre-enactment discussions. Moreover, these documents are often complex and require specialized knowledge of agency jargon and procedures.

Current analyses of export control changes do not readily incorporate export control metrics. To understand why and to inform how to improve the accessibility of this data for future analysis, the available sources of information regarding the export control process will be examined.

9. Belay Seyoum, "Export Controls and International Business: A Study with Special Emphasis on Dual-Use Export Controls and Their Impact on Firms in the US," *Journal of Economic Issues* 51, no. 1 (2017): 45–72; Berne C Kluber, "Global Distributions: The Effect of Export Controls," *Hous. J. Int'l L.* 23 (2000): 429; "The impact of US export controls on the Canadian space industry," *Space Policy* 22, no. 1 (2006): 29–34, ISSN: 0265-9646, https://doi.org/https://doi.org/10.1016/j.spacepol.2005.11.002; Xueyue Liu, Yu Liu, and Jaya Wen, "The Consequences of Export Controls in Target Countries," 2024, Andrew Doornaert, "Export controls of the US government: Scope and legal challenges," *Michigan Bar Journal* 84, no. 12 (2005): 28.

10. George Abbey and Neal Francis Lane, "United States Space Policy: Challenges and Opportunities Gone Astray," 2009; Antonella Bini, "Export control of space items: Preserving Europe's advantage," *Space Policy* 23, no. 2 (2007): 70–72, ISSN: 0265-9646, https://doi.org/https://doi.org/10.1016/j.spacepol.2007.02.012.

11. Congressional Research Service, *Export Controls: Key Challenges*, Congressional Research Service Report, IF11154, 2021, https://crsreports.congress.gov/product/pdf/IF/IF11154; Congressional Research Service, *U.S. Export Controls and China*, Congressional Research Service Report, IF11627, 2022, https://crsreports.congress.gov/product/pdf/IF/IF11627; Congressional Research Service, *Export Controls as Foreign Policy Tools*, Congressional Research Service Report, R46337, 2021, https://crsreports.congress.gov/product/pdf/R/R46337.

12. Federal Register, *Export Administration Regulations: Revisions to Space-Related Export Controls*.

2.2 Available sources of information regarding the export control process

Given the numerous agencies and processes involved in export control, exploring all potentially relevant data sources is impractical. Because space technologies are increasingly regulated by the Bureau of Industry and Security (BIS) and the Export Administration Regulations (EAR), this analysis focuses on data related to the export licensing process for these technologies. This process is currently required for exporting many space-related commodities and most satellite technology. Publicly available data sources managed by BIS include:

- The Commerce Country Chart[13].
- Annual Country Licensing and Trade Analysis reports[14].
- A report on deemed export licensing statistics from 2018 to 2022[15].
- Reports on quarterly statistics of changes from the U.S. Munitions List (USML) to the Commerce Control List (CCL) from 2016 to 2023[16].
- Two discontinued datasets on export statistics for non-ECCN classified commodities from 2015[17].

Two key observations emerge. First, all data in these reports originates from either the Commerce U.S. Exporter Support System or the Automated Export System (AES). The AES is an electronic system for exporters to submit documentation and request licenses and related services[18]. Access requires submitting a Letter of Intent to U.S. Customs and Border Protection and affiliation with a company intending to export. It is unclear whether the aggregated statistics in these documents are available to all AES users. The Commerce U.S. Exporter Support System resulted from BIS's 2018 CUESS project to replace its previous internal system.[19]. No public access to this system was found, suggesting it is limited to BIS personnel. Second, the BIS website has been undergoing a transition from a legacy platform to a modern implementation for the past year. Consequently, all listed data products are

13. Bureau of Industry and Security, "Commerce Country Chart," 2024, https://www.bis.doc.gov/index.php/documents/regulations-docs/federal-register-notices/federal-register-2014/1033-738-supp-1/file.

14. Bureau of Industry and Security, "Annual Country Licensing and Trade Analysis," 2009, https://www.bis.doc.gov/index.php/annual-country-licensing-and-trade-analysis.

15. Bureau of Industry and Security, "Report on Deemed Export Licensing," 2023, https://www.bis.doc.gov/index.php/documents/technology-evaluation/ote-data-portal/licensing-analysis/3261-statistics-of-deemed-export-licensing-2018-2022/file.

16. Bureau of Industry and Security, "USML to CCL Regulatory Changes," 2024, https://www.bis.doc.gov/index.php/ecr-analysis.

17. Bureau of Industry and Security, "2015 BIS Licensing," 2015, https://www.bis.doc.gov/index.php/all-articles/28-technology-evaluation/1101-data-sets.

18. U.S. Customs and Border Protection, "Introduction to the Automated Export System (AES)," 2024, https://www.cbp.gov/trade/aes/introduction.

19. U.S. Customs and Border Protection, "Privacy Threshold Analysis for the Commerce USXPROTS Exporter Support System," 2018, https://www.commerce.gov/sites/default/files/opog/bis_cuess_pta.pdf.

currently sourced from the legacy website.

The dispersed nature and difficulty in interpreting these data sources explain their limited use in existing literature analyzing export control reform outcomes. These sources will now be examined and used to create data products for further study.

3 Approach and Methodology

From the data sources available to this analysis identified during the literature review step, the annual export data reports were identified as the most interesting source of information to form the foundational data source for EXTRA. The reports are individual documents created by BIS and include trade and export statistics for a subset of countries for each year. These reports are the densest sources of information available to the public regarding the export control process and provide an overview of multiple important metrics. The reports have been available since 2018, but vary significantly in format and data provided between countries and years. Some countries do not have individual reports for a given year or have specially formatted reports due to their geopolitical circumstances,like Cuba or Ukraine. This makes the task of extracting specific information from these documents especially challenging.

3.1 Parameter definition

First, a set of target parameters was defined that could be found in all reports across all available years, countries, and formats. These selected parameters are:

1. Total import and export volume.
2. Import and export volume for defined commodity categories.
3. Trade volume falling under individual jurisdictions. The jurisdictions listed are:
    - Department of State
    - Other USG Agencies
    - Department of Commerce, further subdivided into licensing processes:
        - BIS license.
        - BIS license exception.
        - NLR reporting an ECCN.
        - NLR reporting EAR99.
        - NLR not reporting ECCN.
        - 600-Series license.
4. Country Chart at the time of making the report and associated Reasons for Control.

5. Top ten ECCNs by value exported under license, license exception, and NLR with ECCN regimes.

6. Top ten ECCNs and description by count exported under license, license exception, and NLR with ECCN regimes.

7. Export applications count and resulting outcomes (Approved, Return Without Action, and Denied).

8. Deemed Export applications count and resulting outcomes (Approved, Return Without Action, and Denied).

These parameters were selected for their relevance in answering a multitude of export control questions, as well as their presence on all the reports available.

The individual report files were scrapped from BIS's website and downloaded. This resulted in 109 individual reports. Because of the magnitude of the task of extracting the identified parameters from each of these reports, a systematic approach was desired to extract the selected parameters from the reports. Due to the inconsistency in the format of the reports, a fully programmatic solution was not possible. The solution chosen was the use of a large language model (LLM) to extract the information from the PDFs without the need for manual parsing of the information. LLMs excel at processing multimodal information which makes them an excellent tool to parse and aggregate the multiple sources of information that characterize the export control process. However, they risk hallucinating information and providing incorrect data if not utilized correctly. The steps taken to validate the data extracted by the model and minimize the risk of incorrect data will be discussed later in the Validation section.

3.2 Data processing

Google's Gemini 1.5 model was selected to process the documents. This model was selected for its ease of use through a Python API and its ability to constraint the information provided by the model into specific JSON formats, which made tabulating the information back into a database possible. The following workflow was used to extract information from each report. This workflow is implemented in Python and is publicly available as a Github repository[20]:

1. A model session was created and configured through the Google Gemini API.

2. The report of interest was uploaded to the model.

3. The model was constrained to answer using a specific JSON data schema corresponding to a subset of the parameters of interest.

4. A prompt was sent to the model targeting the parameters of interest defined in the data schema.

20. Toledo, ""EXTRA: EXport Regulation and TRade Analytics"."

5. Steps 3 and 4 were repeated a total of six times to cover all parameters of interest.

6. The responses were stored as JSON files for further analysis.

The data schemas, as well as the queries used, are available in the Github repository under the *google_ai_api_interfacing/response_schema_objects* directory. This process required a total of 763 individual queries to the Gemini model and produced the same number of model responses.

3.3 Validation

Due to the imprecise nature of using LLMs to extract information from multimodal media, some steps were taken to minimize the risk of hallucinations and errors in the model response. These steps are:

- The model response was constrained to a JSON data schema, enforcing data types and number of values for each response.

- The queries provided to the model with each data schema reference the country and page for which the information is requested to guide the model to the specific set of information and minimize the risk of misreading or misinterpreting similar pages of the report.

- The temperature of the model was tuned down to 0.1. This is a model hyperparameter that controls the creativity allowed to the LLM when answering prompts. The possible values range from 0 to 2, meaning the configured value minimizes the risk of the model creating fake information if it is unable to find the data requested.

Even then, the information provided by the model was verified to ensure the data reported is accurate to the information contained in the reports. For each year 3 countries were randomly selected and every parameter was checked manually. The result of this verification helped inform the validity of the remainder of the data.

3.4 Data analysis

Once the data extracted by the model was validated, multiple methods to work with the data and plot results of interest were created. These tools include:

- Data loading and unloading from available model responses.

- Evolution of export and import balances for each country.

- Evolution of trends in top ECCNs for individual countries over the years.

- Evolution of aggregate ECCN rankings over the years.

These initial results from a subset of the provided data were used to analyze the recent changes in regulations regarding the export of satellite technology under ECCN 9A515 and its possible impact in commercial and national security outcomes[21].

4 Data and Analysis

4.1 Data

The data products resulting from the methodology outlined above comprise 109 JSON files stored in the Github repository, which can be loaded and unloaded for analysis using the functions provided in the *google_ai_response_analysis data_parsing.ipynb* notebook. The data covers between 14 and 28 countries individually, as well as aggregate results for the world, the European Union and Africa.

During data validation, all numerical parameters were manually checked for the 12 selected reports and found to have no errors. However, the Reasons for Control reported for each country's Country Chart were shown to be incorrect for all cases. This was manually tracked to a scaling issue in the input of the PDF into the model. The reports created by BIS mark the Reasons for control for each country using thin red X marks in the corresponding cells on the Country Chart. When the file is uploaded to the model, the file resolution is decimated and the red X marks disappear. As such the model is unable to see the marks in the chart and hallucinates incorrect results. Providing a higher resolution image of the table proved to fix the issue, but a programatic method of extracting these images from the reports was not found due to the inconsistencies in the reports' formatting. As such this parameter was discarded from further analysis.

4.2 Analysis

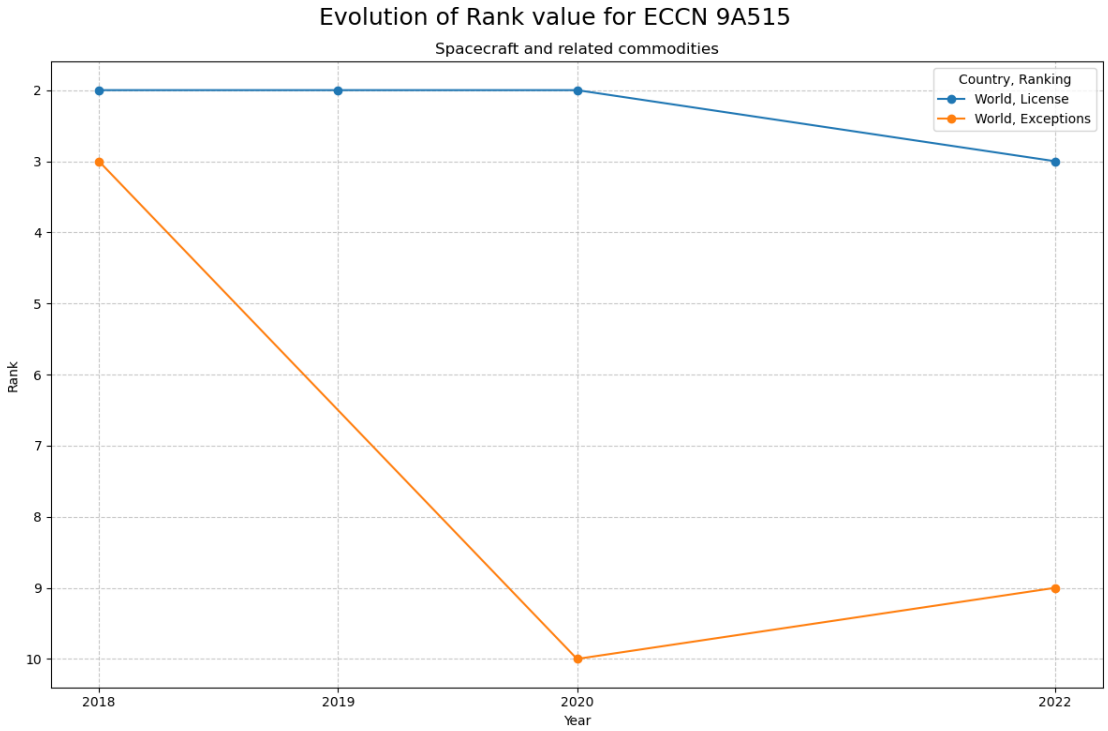
Although the data collected is intended to serve multiple avenues of analysis, here trends in the evolution of exports of space commodities were investigated to showcase the relevance of the data to space export control reform. This analysis was performed on the data describing the top ten ECCNs by value and associated license regimes.

First, the ECCN data was used to find ECCNs that were present in the dataset and were related to space technology. This yielded 3 ECCNs:

- 9A515: Spacecraft and related commodities.
- 9A004: Space Launch Vehicles and Spacecraft.
- 9B515: Test, Inspection, and Production Equipment Specially Designed for Spacecraft.

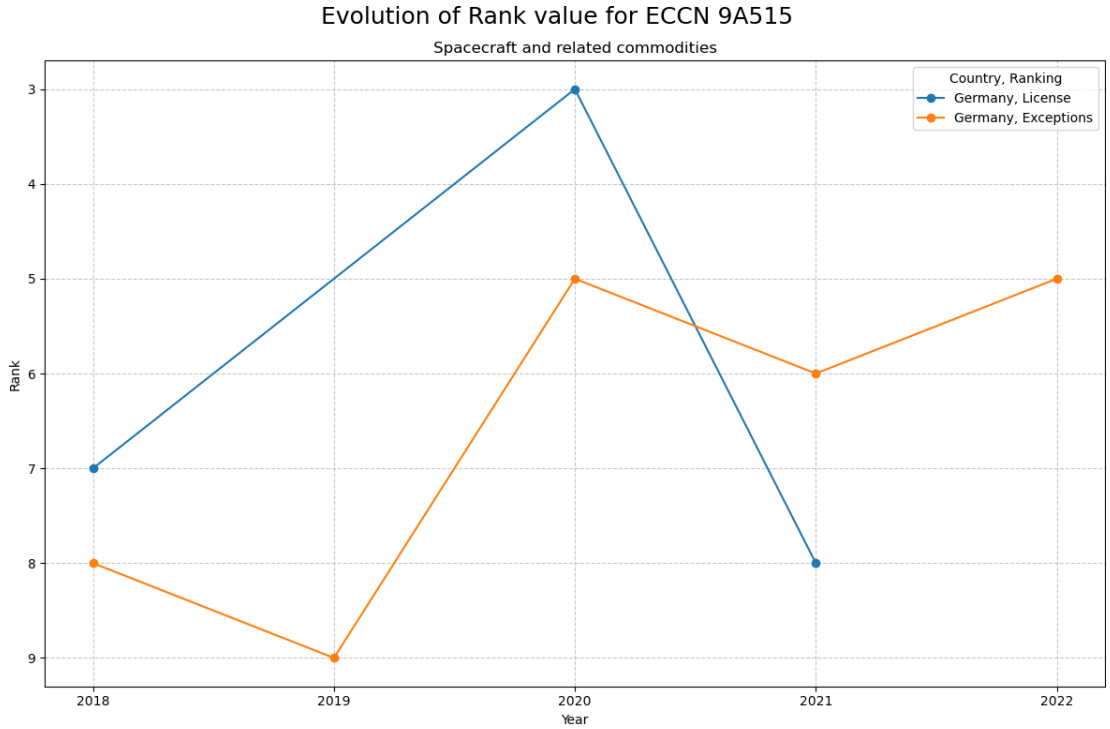
21. Federal Register, *Export Administration Regulations: Revisions to Space-Related Export Controls*.

The evolution of the rankings for each of these ECCNs for the available countries was then computed. All of these results for each ECCN are available under the *eccn_rank_evolution* directories in the Github repository. As an example, the ranking evolution of 9A515 for the entire world is presented below.

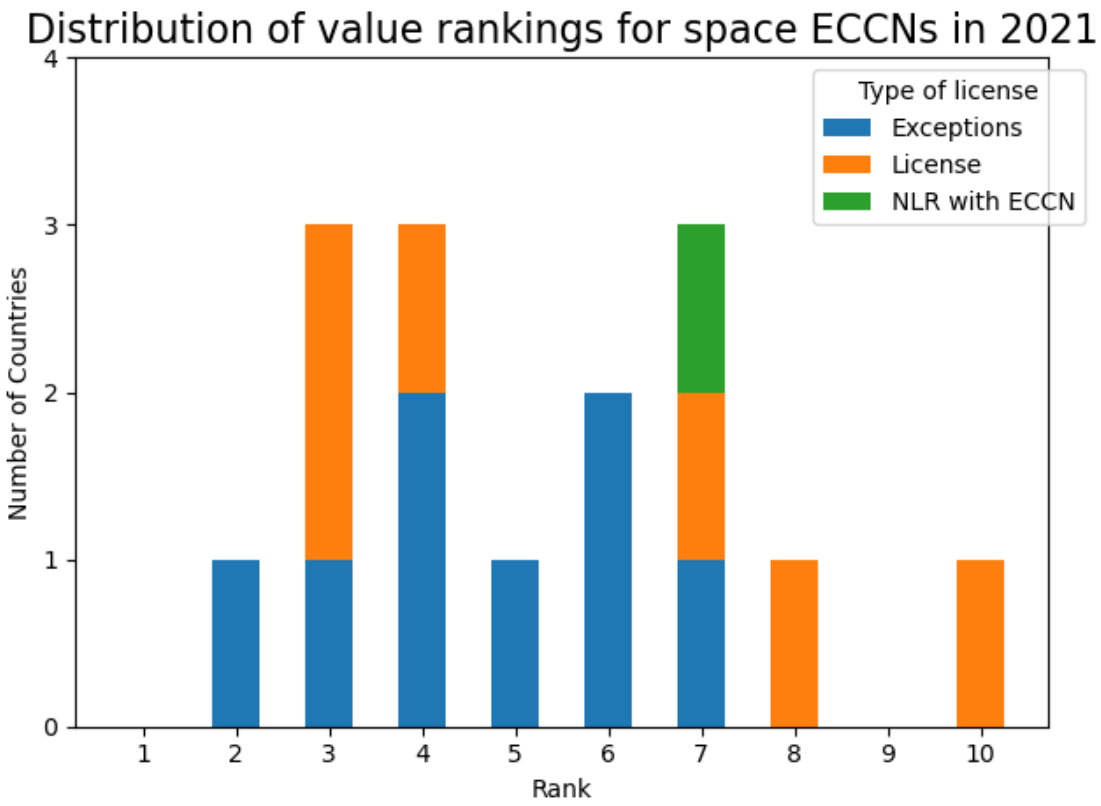


This shows 9A515 has been amongst the highest value ECCNs for the last four years, and that license exceptions for this ECCN dropped drastically after 2018 and have recovered slightly ever since.

To showcase a different example, the evolution of the same ECCN for the country of Germany is presented below.



This graph shows a different trend - while global trends show a sustainment of 9A515 exports through 2020 and into 2022, 9A515 imports in Germany slow down after 2020 and do not appear amongst the top ten ECCNs imported after 2021 using export licenses. At the same time, license exceptions for the same ECCN increase, suggesting a change in the underlying category within 9A515 of the technology being imported or a change in the intended end use of the technology. Both situations would explain the change from regular export license processing to license exception processing.

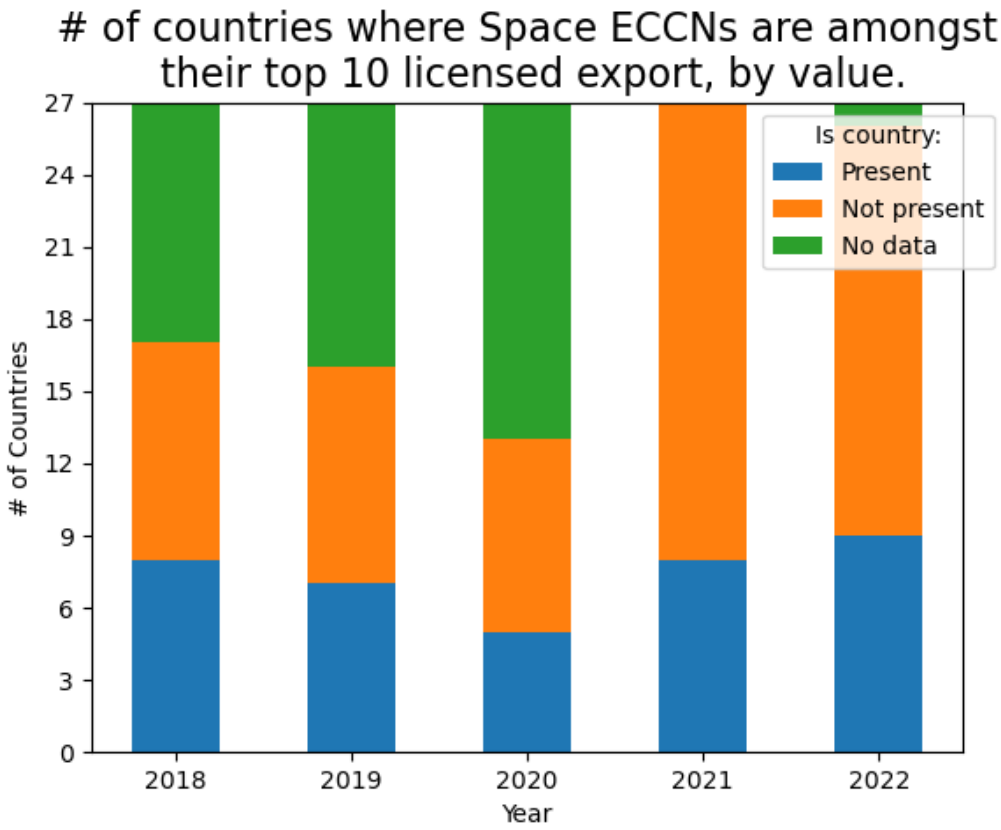


Next, in order to analyze the importance of space technology exports to the export control process, the number of countries with one of the identified space ECCNs among their top 10 ECCNs was counted. This yielded the histograms recorded under the *eccn_rank_distribution_per_year* directory in the GitHub repository. As an example, this is the ranking distribution for the space ECCNs for the year 2021:

This result shows that for the year 2021, 15 individual country rankings counted space ECCNs as part of their top 10 ECCNs for one of the export license categories (License, License Exception, or No License Required with ECCN). Furthermore, we can see space ECCNs occupied a broad range of positions among these rankings but were not the top ECCN for any country.

The ECCN ranking data was further processed to showcase the evolution of space ECCNs across the years and their prevalence among country's top ECCN imports. The number of countries where a space ECCN was present among their top value ECCNs were counted for each year in the dataset.

The countries marked as "Present" have space ECCNs among their top value imports, while the countries marked as "Not present" do not. Some countries do not have individual reports for every year in the dataset, meaning it cannot be determined if space ECCNs were part of their top imports. The changing number of countries for which no data is available reflects this.



Finally, with the information available we can determine a set of countries for which space ECCNs have historically figured among their top imports. These countries are: Australia, Brazil, Canada, France, Germany, Hong Kong, India, Indonesia, Japan, Korea, Mexico, Netherlands, Russia, Spain, Taiwan, and the United Kingdom.

5 Discussion

5.1 Relevance

The collected data and presented analysis can inform stakeholders across the export control discussion about the high-level impact of their recommendations for EAR changes. It can also enable debate around specific changes in the EAR and the implications of including specific ECCNs and countries to the change. To showcase this, a case study was conducted on recent changes impacting the EAR and ECCN 9A515.

5.2 Case study: Revisions to Space-Related Export Controls

As a case study to showcase the value of export control data in analyzing changes to export control regulation, we can examine the implications of the changes introduced by BIS on

October of 2024 to the ECCN 9A515[22]. These changes changed the Reasons for Control for technology classified under 9A515.x (Spacecraft Components) from the more stringent National Security 1 category to National Security 2. This change effectively eliminates the requirement for exporters to acquire licenses to export these goods to 40 nations. The stated reason for this change, as per the justification published by BIS, is as follows:

> This IFR reduces license requirements on less sensitive items to reflect the close relations with certain countries to better facilitate space collaboration; and makes refinements and clarifications to existing controls. These changes will better enable a globally competitive U.S. space industrial base while continuing to protect U.S. national security and foreign policy interests[23].

This vague description of purpose provides little insight into the tradeoff struck between the commercial interest of U.S. exporters and foreign policy interests. We can use the data and analysis provided by EXTRA to understand this tradeoff better.

With the set of 40 countries where these requirements have been lightened and the previous list of top importers of space-related ECCNs, we can form three distinct groups of countries depending on how they are impacted by this change in policy:

1. Countries where space ECCNs are among the top imports and license requirements have been lightened: Japan, Germany, India, Spain, France, United Kingdom, Mexico, Australia, Netherlands, and Canada.

2. Countries where space ECCNs are among the top imports but license requirements have not been lightened: Brazil, Indonesia, Hong Kong, Russia, and Taiwan.

3. Countries where space ECCNs are not among their top imports but license requirements have been lightened: Switzerland, Italy, New Zealand, Belgium, Estonia, Sweden, Luxembourg, South Korea, Hungary, Liechtenstein, Austria, Poland, Iceland, Ireland, Latvia, Slovakia, Czech Republic, Romania, South Africa, Norway, Croatia, Greece, Portugal, Argentina, Bulgaria, Denmark, Lithuania, Türkiye, Slovenia, and Finland.

The presence of each country in these groups answers to a specific motivation. Group 2 countries might have presented a more valuable market for U.S. exporters, but BIS prioritizes foreign policy interests by not extending the lightening of regulation to these markets. Group 3 might not present a currently valuable market for exporters, but as allied countries BIS can expand this loosening of regulations without significant risk to national security. It can also allow for deeper collaboration between the countries on existing commercial or scientific partnerships where spacecraft components are involved, or might even encourage the development of a market for these components in these nations thanks to the lower regulatory burned. Finally, Group 1 present a win-win situation where exporters can access already

22. Federal Register, *Export Administration Regulations: Revisions to Space-Related Export Controls*.
23. Federal Register.

valuable markets with lower regulatory burdens and BIS meets its foreign policy objectives. This deregulation will also lower the bureaucratic burden on BIS to process export licenses for this ECCN category.

Furthermore, this data allows us to make predictions to validate if the stated goal of the policy is met when it is implemented. Given that the goal of the policy is to reduce licensing requirements on ECCN 9A515, countries with large imports through 9A515 export licenses should see a decrease in these licenses and see a corresponding increase of exports under the No License Required with ECCN export regime. If this shift is not observed, the policy might have targeted the wrong category underneath the ECCN.

5.3 Limitations

The ability of EXTRA to provide insightful analysis of the available export control data is limited by the resolution of the data currently available. Primarily, it is difficult to estimate the economic impact of specific changes to the EAR without exact associated values and license counts for each ECCN exported. Limiting the analysis to a relative metric such as the top 10 ECCNs makes the analysis less detailed and means countries where space technology might be present but is not among the most valuable export are not represented. However, there might be so few individual exports for some countries that it might be possible to identify individual transactions and entities in the data, which raises a privacy issue.

Furthermore, the analysis of this data only encompasses technology exported for non-military use. Intended military use changes the applicable jurisdiction on an export from the Department of Commerce to the Department of State. Aggregating information sources from the DoS would be necessary to capture exports related to space technologies intended for military use.

5.4 Recommendations

The development of this tool has led to the formation of specific recommendations for BIS regarding the delivery and presentation of export control data:

1. The listed parameters should be provided programmatically through an API. Although the country data reports are great tools for understanding the export control landscape for a single country, they are not conducive to the in-depth discussion needed to justify changes to the EAR.

2. Reported data should be presented in a consistent format that is machine-readable.

3. A version of the AES and/or the Commerce U.S. Exporter Support System that protects the privacy of individual exporters should be made available to export control stakeholders. The information contained in these systems would enable productive discussions regarding the specific changes needed to meet U.S. export control goals.

Finally, EXTRA fulfills a key recommendation for space export control reform: when proposing EAR changes, stakeholders should analyze the affected ECCNs and countries, and demonstrate how their proposals will achieve stated goals using measurable export control metrics.

6 Conclusion

The intersection of export controls and the rapidly evolving space industry presents a significant challenge that demands careful consideration of both national security and economic competitiveness. This paper has introduced EXTRA, a tool and associated dataset intended to provide greater transparency into the complex landscape of export control data. By utilizing a large language model to extract and aggregate information from a multimodal information source, EXTRA offers a framework for evaluating the effects of policy decisions on the export environment.

The analysis conducted reveals how changes in license requirements for specific Export Control Classification Numbers (ECCNs), such as 9A515, can impact trade for specific countries and also the overall export ranking of said ECCNs. The case study examining recent modifications to ECCN 9A515 serves as an illustrative example, demonstrating EXTRA's capacity to assess the consequences of policy adjustments and to evaluate whether the outcomes align with stated objectives. The analysis of countries based on their prominence as export destinations enables a more focused consideration of strategic and economic trade-offs in policy formation.

The insights derived from this research have several implications for informed decision-making:

- In space technology development: EXTRA provides enhanced visibility into the regulatory environment, potentially enabling companies to better anticipate and plan for licensing requirements. This may contribute to the reduction of market access uncertainty and aid strategic planning.
- In international affairs: Policymakers are able to use EXTRA to analyze trade-offs between economic considerations and national security priorities. This may facilitate the development of regulations that seek to balance both objectives. Furthermore, the tool may allow the identification of trade patterns and policy alignments to create stronger international partnerships.
- In export control reform: The methodology introduced provides an empirical basis for evaluating proposed regulatory revisions, enabling the assessment of their efficacy in achieving policy goals and contributing to a more data-driven framework for taclke export control issues.

However, the effective utilization of this tool and its potential to inform policy decisions is contingent upon certain operational improvements, most notably:

- Enabling the programmatic access to export control data through an API: Such access would allow for a more dynamic and flexible environment for data utilization by stakeholders.
- The standardization of data reporting formats: Consistent, machine-readable formats will facilitate data analysis and integration with other decision-making systems.
- The secure release of more granular data: With due regard to the privacy of individual exporters, access to de-identified datasets from systems such as AES needs to be provided to relevant stakeholders to enable deeper, more insightful analysis.

The relevance of this research extends beyond the confines of the space industry. It addresses a broad concern: the limitations of policy evaluation that lack a strong empirical foundation. While the space industry serves as a specific use case, the implications of this work extend to any sector affected by export controls. This paper presents a tool that can aid in achieving a balance between trade, security, and technological progress through the use of data. By promoting transparency and empirical analysis, policymakers can move toward more effective export control practices that benefit the United States and its global partners.