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Analyzing China's export-import dynamics amid global disruptions

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Abstract
As one of the world's largest importing and exporting countries, China is pivotal in international trade. This article uses official statistics from the Chinese customs website to analyze the factors that have influenced the structure of China's imports and exports from 2015 to 2023. The raw data, which are classified by Harmonized System (HS) code, are further mapped to the Standard International Trade Classification (SITC) in this study to facilitate better international comparison. Our study highlights the impact of external factors, in particular the COVID-19 pandemic, on trade dynamics. Key findings show that while the percentage composition of exports remained stable, imports experienced some fluctuations throughout the period, but the main categories of imports and exports remained the same. This analysis helps to understand how global disruptions, such as the pandemic, can affect China's trade structure in world trade.

Keywords:
China's trade analysis, export/import, the impact of COVID-19, SITC classification

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INTRODUCTION

As a developing country with a large population, China has played an important role in international trade in recent decades. With its rapidly growing gross domestic product (GDP), China has become one of the world's largest exporters and importers. Since 1994, China has maintained a trade surplus, and its exports reached a record high of 303.62 billion US dollars in December 2023 (General Administration of Customs of the People's Republic of China, 2024). China's exports are concentrated in a few destinations, mainly in Asia and Europe, with the United States being China's largest export destination. The United States, South Korea, Japan, Australia and other countries are the main sources of China's imports.

Participating in international trade is key to helping China develop economically. Sun & Heshmati (2010) show that participation in global trade has a positive impact on China's static and dynamic benefits. However, in recent years, China's international trade pattern has also faced unprecedented challenges and opportunities. Since 2018, the trade conflict between the US and China has intensified, and the increase in bilateral tariffs has put constant pressure on the import and export trade of both countries. According to a study by Fajgelbaum et al. (2021), the trade war has led to negative growth in China's exports to the United States, causing direct economic losses to China. Meanwhile, the outbreak of the COVID-19 pandemic in 2020 has disrupted global supply chains. The resulting chain reaction has had a profound impact on the flow of international trade, particularly in terms of restricted supply of raw materials, transport routes, etc (Chowdhury et al., 2021).

Against this backdrop, this paper provides a detailed analysis of China's import and export data from 2015 to 2023 to understand how the composition of China's trade changes during such crises and the resilience of the economy. Our study highlights significant year-on-year changes in export and import categories, and provides insights into the overall trends in China's trade composition. This study uses data derived from Chinese customs statistics, and the analysis maps the Harmonised System (HS) codes of the original data to the Standard International Trade Classification (SITC) system to facilitate comparison with international trade literature and analysis of global trade patterns. The aim of this work is to provide a better understanding of the resilience and adaptability of China's trade structure in the face of daily fluctuations and unprecedented global crises.

LITERATURE REVIEW

Previous studies by Wang et al. (2009) have examined structural shifts in China's trade, analyzing changes from 1981 to 2006 and identifying key turning points, including the unification of exchange rates in 1994, the Asian financial crisis in 1997 and China's accession to the WTO in 2001. These shifts illustrated the impact of policy reforms and external shocks on China's trade composition and global integration. By focusing on the period from 2015 to 2023, our study offers an updated view, analyzing how China's trade has adapted to recent global challenges and providing new insights into the resilience of its import and export structures under modern economic pressures.

Lu & Wolszczak-Derlacz (2024) examined the impact of the Belt and Road Initiative (BRI) on trade diversification and found that while the BRI has strengthened infrastructure and trade connectivity, it has tended to increase export concentration by concentrating investment in sectors such as energy and transport. This dual effect suggests that while the BRI has promoted regional integration, it may limit the export diversification of member countries. Sudden events, such as the COCID-19, the US-China trade war, or the Russia-Ukraine war, further affect countries' economic security. Building on this literature, this study spans the observation period of recent global turbulent events. It examines the response of China's trade structure during the turbulence.

Oum et al. (2024) provide an important analysis of the effects of air connectivity on China's bilateral service trade between 2005 and 2018, offering insights into how trade dynamics respond to infrastructural improvements. The study highlights that enhanced air connectivity widens China's overall service trade deficit, as rising imports outpace exports in key categories. These findings underscore the critical role of transport infrastructure in shaping trade patterns. By focusing on both structural enablers like air connectivity and disruptive factors like global crises, these studies collectively enhance our understanding of trade resilience and adaptation.

Huang (2024) conducted an empirical analysis of the macroeconomic factors influencing China's imports and exports from 2002 to 2022, revealing key dynamics in trade responsiveness. Using multiple linear regression models, the study identifies the Producer Price Index (PPI) and the Consumer Price Index (CPI) as significant drivers of both import and export volumes, while GDP plays a secondary role, especially in influencing imports. Exchange rate fluctuations, contrary to conventional wisdom, had a relatively small impact. The results underline the importance of domestic factors, such as industrial production and consumption trends, in shaping trade patterns. This research complements the present study by highlighting the more subtle interplay of macroeconomic variables on trade structures.

METHOD

Data Source and Processing

The data for our research were obtained from China's customs statistics (http://stats.customs.gov.cn/indexEn) covering monthly import and export data of China from January 2015 to December 2023. The original datasets included 783,020 rows of export data and 735,795 rows of import data, categorized by 8-digit Harmonized System (HS) codes, which can be divided into 21 sections and 99 chapters. To facilitate our analysis, we mapped these HS codes to the 4th version of the Standard International Trade Classification (SITC) into 10 broader categories. This mapping followed an established correlation table from the Statistics Division of the United Nations' website (https://unstats.un.org/unsd/classifications/Econ). A total of 40,207 data points could not be matched, leaving us with 1,478,608 data points for our research.

The data processing and implementing the mapping of HS codes to SITC classifications were performed using Python. The Python library pandas was used to clean, organize and map the original data, while matplotlib facilitated all of the visualizations in this article. The choice of Python ensured the reproducibility and efficiency of our data processing pipeline.

The decision to use SITC classification instead of the original HS codes in our research was based on several key considerations. The SITC system facilitates international comparisons by categorizing products based on materials, production processes, and uses, allowing for detailed analysis of how specific categories were affected by Covid-19. In addition, the SITC is widely recognized and used in international trade analysis, which enhances the comparability of our findings with other countries' trade data and existing literature. This classification allows for a more perceptive examination of trade patterns and disruptions, providing valuable insights into the sectoral impact of the pandemic on China's import and export activities.

The SITC classification used in this study includes the following ten categories, exactly as the 10 sections defined in the formal publication of SITC version 4:

0. Food and live animals
1. Beverages and tobacco
2. Crude materials, inedible, except fuels
3. Mineral fuels, lubricants, and related materials
4. Animal and vegetable oils, fats and waxes
5. Chemicals and related products, not elsewhere specified (n.e.s.)
6. Manufactured goods classified chiefly by material

7. Machinery and transport equipment
8. Miscellaneous manufactured articles
9. Commodities and transactions not classified elsewhere in the SITC.

Composition of Imports and Exports

Figures 1 and 2 show how the structure of China's import and export trade changed between 2015 and 2023, with pie charts illustrating the share of different categories in total yearly exports and imports. In each picture, five major categories have been selected that account for a large share of the total, while the remaining five categories are categorized as 'Other'.

In terms of export data, "machinery and transport equipment" (Standard International Trade Classification, category 7) has consistently been a major component of China's total exports over the observation period. In 2023, this category accounted for 44.2 percent of total exports, which is a significant increase from 39.0 percent in 2015. Other notable categories include 'manufactured articles classified mainly by material' (SITC, Cat. 6) and 'miscellaneous manufactured articles' (SITC, Cat. 8), both of which remained generally stable in terms of share.

In contrast, China's import data show a more balanced distribution. It is worth noting that 'machinery and transport equipment' (SITC, Cat. 7) also accounts for a large share of China's imports. However, in contrast to the rising trend in the export share of category 7 products, its import share shows a declining trend, from 24.6 percent in 2015 to 17.1 percent in 2023. At the same time, 'mineral fuels, lubricants and related materials' (SITC, Cat. 3) emerges as another important component of imports, with a significant increase in its share over the observation period.

Furthermore, according to Bekkers et al. (2021), the share of services in China's economy will gradually increase over the next two decades, while the relative shares of manufacturing and agriculture will decline. This trend may coincide with the gradual decline in the share of imports of 'machinery and transport equipment' (SITC, Cat. 7) in Figure 5 in appendix.

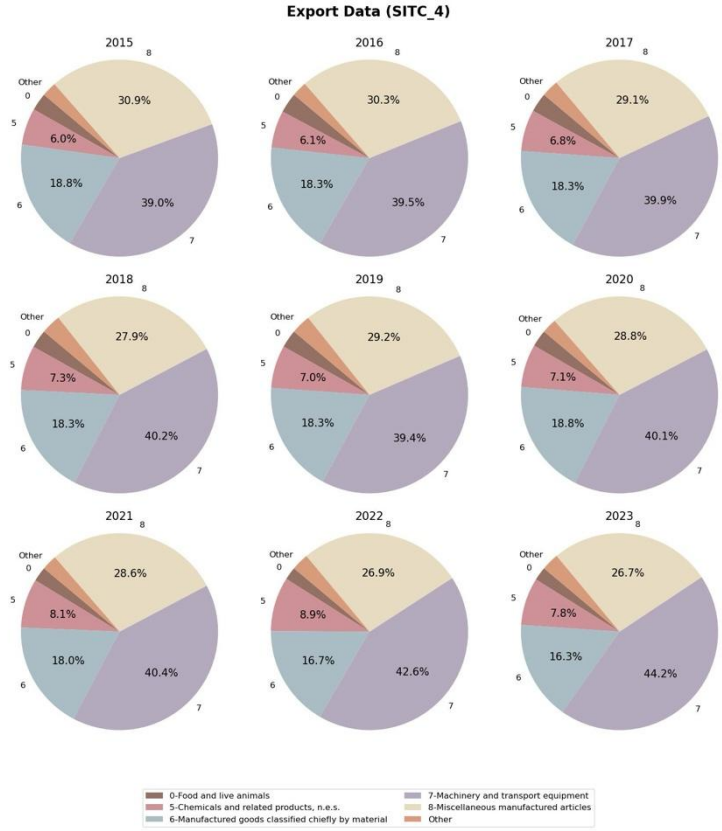


Figure 1. Export Data (SITC)

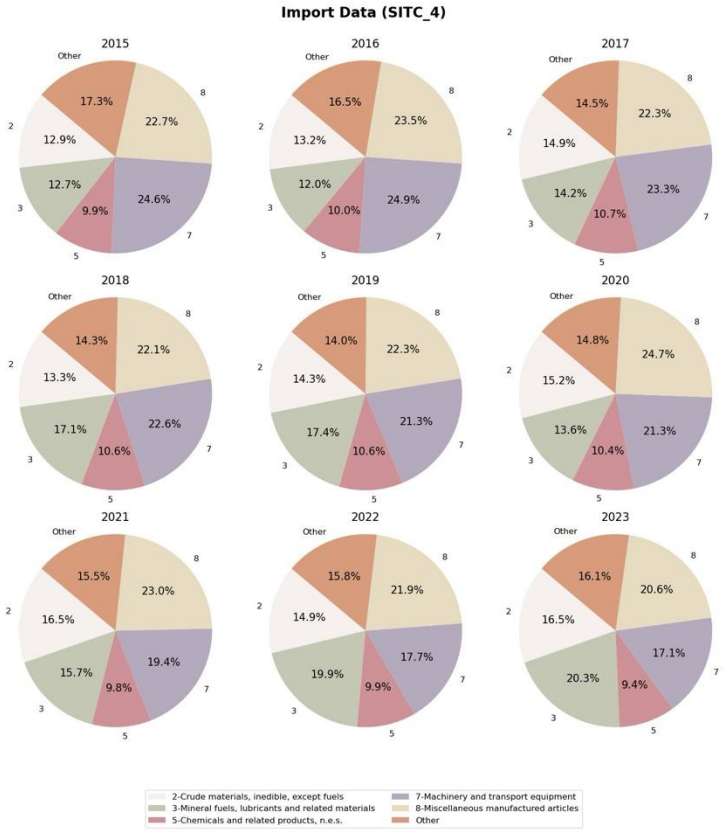


Figure 2. Import Data (SITC)

Analysis of Annual Percentage Changes in Export and Import

Tables 1 and Table 2 list the top five annual percentage increases and decreases in export and import data, respectively, between 2015 and 2023. These annual changes help provide a deeper understanding of the dynamics of China's trade activities, especially in response to external factors such as global market trends and the COVID-19 pandemic.

In particular, export data (Table 1) show strong growth in "machinery and transport equipment" (SITC, Cat. 7), especially in 2022 and 2023, with increases of 2.1 percent and 1.6 percent, respectively. This consistent rise highlights the growing global demand for machinery and equipment during the post-pandemic recovery, reflecting China's strengthening role in manufacturing and exports of these goods. The fluctuations in exports of "miscellaneous manufactured articles" (SITC, Cat. 8) are also noteworthy.

Table 1. Top 5 Annual Percentage Increase/Decrease in Export

Change%	Year	Description	Category
2.1	2022	Machinery and transport equipment	7
1.6	2023	Machinery and transport equipment	7
1.3	2019	Miscellaneous manufactured articles	8
1.0	2021	Chemicals and related products, ...	5
0.9	2022	Chemicals and related products, ...	5
-1.7	2022	Miscellaneous manufactured articles	8
-1.3	2022	Manufactured goods classified ...	6
-1.2	2017	Miscellaneous manufactured articles	8
-1.1	2018	Miscellaneous manufactured articles	8
-1.1	2023	Chemicals and related products, ...	5

Table 2. Top 5 Annual Percentage Increase/Decrease in Import

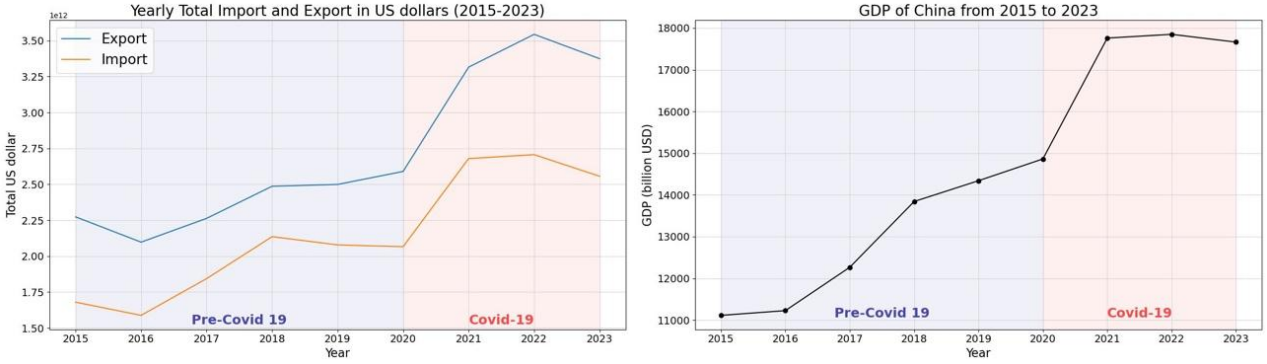
Change%	Year	Description	Category
4.1	2022	Mineral fuels, lubricants, ...	3
2.9	2018	Mineral fuels, lubricants, ...	3
2.4	2020	Miscellaneous manufactured articles	8
2.3	2017	Mineral fuels, lubricants, ...	3
2.1	2021	Mineral fuels, lubricants, ...	3
-3.8	2020	Mineral fuels, lubricants, ...	3
-1.9	2021	Machinery and transport equipment	7
-1.7	2022	Machinery and transport equipment	7
-1.7	2021	Miscellaneous manufactured articles	8
-1.6	2020	Commodities and transactions not ...	9

Comparison of Import/Export Value with China's GDP

Easterly et al. (2009) note that there is a strong correlation between manufacturing export success and GDP, with higher export volumes often driven by a few highly profitable categories, a pattern that particularly fits China's export structure. This study further compares the trends of China's total imports and exports values with GDP (Figure 3).

Figure 3 compares the trend between China's annual GDP and China's yearly total import and export values from 2015 to 2023. We can see obvious similarities between these two metrics.

Both graphs show a general upward trend during the time period. It is worth noticing that both import and export value and GDP value have a significant increase at the 2020 node and remain relatively steady during the Covid-19 period.



(a) Yearly Total Import and Export (USD) (b) China's Yearly GDP (Billion USD)

Figure 3. China's Import and Export Value V.S. GDP

RESULTS AND DISCUSSION

Following are the observations through the research analysis:

COVID-19 Impact on Export Composition: The Covid-19 pandemic showed a limited impact on China's export structure. Compared to the pre-Covid period, category 7 (machinery and transport equipment) is still dominant, with its share steadily increasing from 39% in 2015 to 44.16% in 2023. This growth highlights the global reliance on China's manufacturing capacity in the post-pandemic recovery phase. In addition, the proportions of categories such as category 8 (miscellaneous manufactured articles) and category 6 (manufactured goods classified by material) also remain relatively stable overall, although there are slight fluctuations (Figure 4 in Appendix). This is because the strong international demand for Chinese manufactured goods has not changed, despite the pandemic's profound impact on the global economy. Against the backdrop of the global pandemic's severe disruption of supply chains, China's ability to maintain the relative stability of its export structure shows its strong resilience and adaptability in rapidly

adjusting production capacity, optimizing resource allocation and maintaining the flow of international trade.

COVID-19 Impact on Import Composition: In contrast to export, the composition of imports is more sensitive to external factors such as Covid-19 than exports (Figure 5 in Appendix). Category 3 (mineral fuels, lubricants and related materials), a typical representative of energy commodities, has increased significantly from 12.67% in 2015 to 20.28% in 2023. This increase is not only one of the most significant changes among all import categories, but also highlights the increasing importance of energy in China's import structure. Meanwhile, category 7 (machinery and transport equipment), which has long accounted for a large share of China's imports, has decreased significantly from 24.55% in 2015 to 17.13% in 2023. This trend reflects China's gradual reduction of import dependence in this sector, while also providing room for import growth in other commodity categories.

This shift is the result of the combined effects of several internal and external factors. Fluctuations in the international energy market and uncertainties in global demand have led to a significant increase in China's import requirements for fossil fuels and lubricants. This trend was exacerbated, particularly during the COVID-19 pandemic, by global supply chain disruptions and short-term domestic energy capacity shortages, as well as sharp international energy price fluctuations. On the other hand, the decline in imports of category 7 (machinery and transport equipment) reflects the significant improvement in China's domestic production capacity. By accelerating local production and strengthening independent development, China effectively reduced its reliance on imported machinery and equipment during the pandemic.

Total Import and Export Trends: The trend in trade value can reflect China's resilience in an environment of adverse external shocks. During the period under review, China's annual import and export values maintained a strong upward trend. Although there were fluctuations in individual import categories, the overall growth trend did not slow down significantly. Between 2020 and 2021, the import and export value of trade simultaneously experienced a significant jump. This growth not only shows the ability of the Chinese economy to recover quickly from the initial impact of the pandemic, but also reflects China's continued central position in the global trade structure. At the same time, China's flexible trade strategy in dealing with supply chain disruptions has ensured continued growth in total import and export values.

GDP and Trade Correlation: The trends in China's GDP and export/import trade value are generally highly correlated, with both showing a steady growth trend over the observation period. However, there was a divergence between the two through 2018 and 2020. During this period, China's GDP growth slowed but remained stable, while export growth stagnated and import values even declined. This anomaly suggests that the dual impact of the US-China trade war and the COVID-19 pandemic has put unprecedented pressure on China's trade. Due to the ongoing trade war, China's export products are subject to higher tariffs, which has significantly suppressed export growth. The decline in import value partly reflects the contraction in global demand, and is also closely related to the restructuring of the domestic economy and the reduction of import dependence for certain goods. The divergent performance during this period highlights the need to strengthen the resilience of China's trade in the face of global economic uncertainty.

CONCLUSION

The analysis of China's import and export dynamics from 2015 to 2023 shows the remarkable resilience of China's trade structure in the face of external shocks, demonstrating its central position in global trade. Despite the double pressure of the US-China trade war and the COVID-19 pandemic, China's export composition has shown a high degree of stability. The main categories, SITC 7 and SITC 8, continue to dominate the global supply chain, demonstrating the

competitive advantage and market adaptability of China's manufacturing industry. In contrast, the composition of imports shows greater sensitivity and adjustment. The significant increase in the share of SITC 3 reflects the profound impact of fluctuations in the global energy market on China. The decline in the import share of SITC 7 indicates that China has made important progress in industrial upgrading and supply chain optimization, reducing its dependence on imports of key commodities and increasing its independent production capacity.

In terms of export/import trade value, China's rapid recovery from the crisis and continued growth in trade value underline its unassailable position in the global trading system. This resilience is not only due to China's significant advantages in terms of manufacturing and supply chain management, but also to its flexible policy adjustments and rapid response to the demands of the global market. At the same time, the correlation between GDP and total export/import trade value further illustrates the important role of foreign trade in driving China's economic growth. However, the divergence between 2018 and 2020 also reminds us that the US-China trade war and global crises may have long-term effects that require continued attention.

In the future, a more detailed analysis with smaller timestamps, such as quarterly or monthly data, could be conducted to capture more specific trends both during and after the COVID-19 pandemic. Extending the study period to include years beyond the pandemic would allow a more comprehensive understanding of its long-term impact on trade dynamics. In addition, incorporating the impact of other economic factors, such as inflation rates, exchange rates and shifts in product prices, would provide a more comprehensive view of the reasons for changes in the composition of trade.

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Appendix

Table 3. Import Percentage Composition

Year	Import Category									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2015	3.13	0.35	12.90	12.67	0.47	9.89	8.33	24.55	22.67	5.04
2016	3.22	0.39	13.17	11.95	0.44	9.99	8.10	24.91	23.49	4.33
2017	3.07	0.40	14.89	14.24	0.43	10.74	7.64	23.32	22.34	2.93
2018	3.15	0.38	13.32	17.09	0.37	10.63	7.34	22.58	22.10	3.05
2019	4.01	0.38	14.29	17.42	0.46	10.63	6.96	21.34	22.30	2.20
2020	4.90	0.31	15.20	13.60	0.53	10.38	8.44	21.34	24.72	0.58
2021	4.72	0.30	16.47	15.72	0.56	9.85	8.09	19.42	23.04	1.83
2022	4.86	0.26	14.88	19.85	0.48	9.87	7.31	17.73	21.92	2.84
2023	5.05	0.31	16.48	20.28	0.53	9.38	6.60	17.13	20.62	3.61
min	**3.07**	**0.26**	**12.90**	**11.95**	**0.37**	**9.38**	**6.60**	**17.13**	**20.62**	**0.58**
max	**5.05**	**0.40**	**16.48**	**20.28**	**0.56**	**10.74**	**8.44**	**24.91**	**24.72**	**5.04**
mean μ	**4.01**	**0.34**	**14.62**	**15.87**	**0.47**	**10.15**	**7.65**	**21.37**	**22.58**	**2.93**
median M	**4.01**	**0.35**	**14.88**	**15.72**	**0.47**	**9.99**	**7.64**	**21.34**	**22.34**	**2.93**
st. dev σ	**0.82**	**0.05**	**1.26**	**2.84**	**0.06**	**0.44**	**0.60**	**2.64**	**1.07**	**1.25**
σ/μ	**0.20**	**0.15**	**0.09**	**0.18**	**0.13**	**0.04**	**0.08**	**0.12**	**0.05**	**0.43**
2015~2019	**0.88**	**0.03**	**1.39**	**4.75**	**-0.01**	**0.74**	**-1.37**	**-3.21**	**-0.37**	**-2.84**
2020~2023	**0.15**	**0.00**	**1.28**	**6.68**	**0.00**	**-1.00**	**-1.84**	**-4.21**	**-4.10**	**3.03**

Table 4. Export Percentage Composition

Year	Export Category									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2015	2.87	0.16	0.70	1.42	0.03	6.03	18.80	39.00	30.88	0.10
2016	3.28	0.19	0.72	1.48	0.03	6.12	18.33	39.51	30.26	0.07
2017	3.14	0.18	0.78	1.79	0.04	6.81	18.31	39.87	29.06	0.02
2018	2.99	0.17	0.83	2.14	0.05	7.32	18.28	40.25	27.93	0.04
2019	2.95	0.16	0.78	2.15	0.05	7.04	18.27	39.35	29.21	0.04
2020	2.78	0.11	0.70	1.42	0.06	7.06	18.83	40.09	28.80	0.16
2021	2.39	0.09	0.76	1.47	0.08	8.06	17.97	40.44	28.64	0.11
2022	2.10	0.09	0.71	1.84	0.10	8.92	16.69	42.55	26.90	0.09
2023	2.22	0.11	0.68	1.85	0.10	7.81	16.27	44.16	26.68	0.12
min	**2.10**	**0.09**	**0.68**	**1.42**	**0.03**	**6.03**	**16.27**	**39.00**	**26.68**	**0.02**
max	**3.28**	**0.19**	**0.83**	**2.15**	**0.10**	**8.92**	**18.83**	**44.16**	**30.88**	**0.16**
mean μ	**2.75**	**0.14**	**0.74**	**1.73**	**0.06**	**7.24**	**17.97**	**40.58**	**28.71**	**0.08**
median M	**2.87**	**0.16**	**0.72**	**1.79**	**0.05**	**7.06**	**18.28**	**40.09**	**28.80**	**0.09**
st. dev σ	**0.39**	**0.04**	**0.05**	**0.28**	**0.03**	**0.87**	**0.84**	**1.59**	**1.31**	**0.04**
σ/μ	**0.14**	**0.29**	**0.07**	**0.16**	**0.50**	**0.12**	**0.05**	**0.04**	**0.05**	**0.50**
2015~2019	**0.08**	**0.00**	**0.08**	**0.73**	**0.02**	**1.01**	**-0.53**	**0.35**	**-1.67**	**-0.06**
2020~2023	**-0.56**	**0.00**	**-0.02**	**0.43**	**0.04**	**0.75**	**-2.56**	**4.07**	**-2.12**	**-0.04**

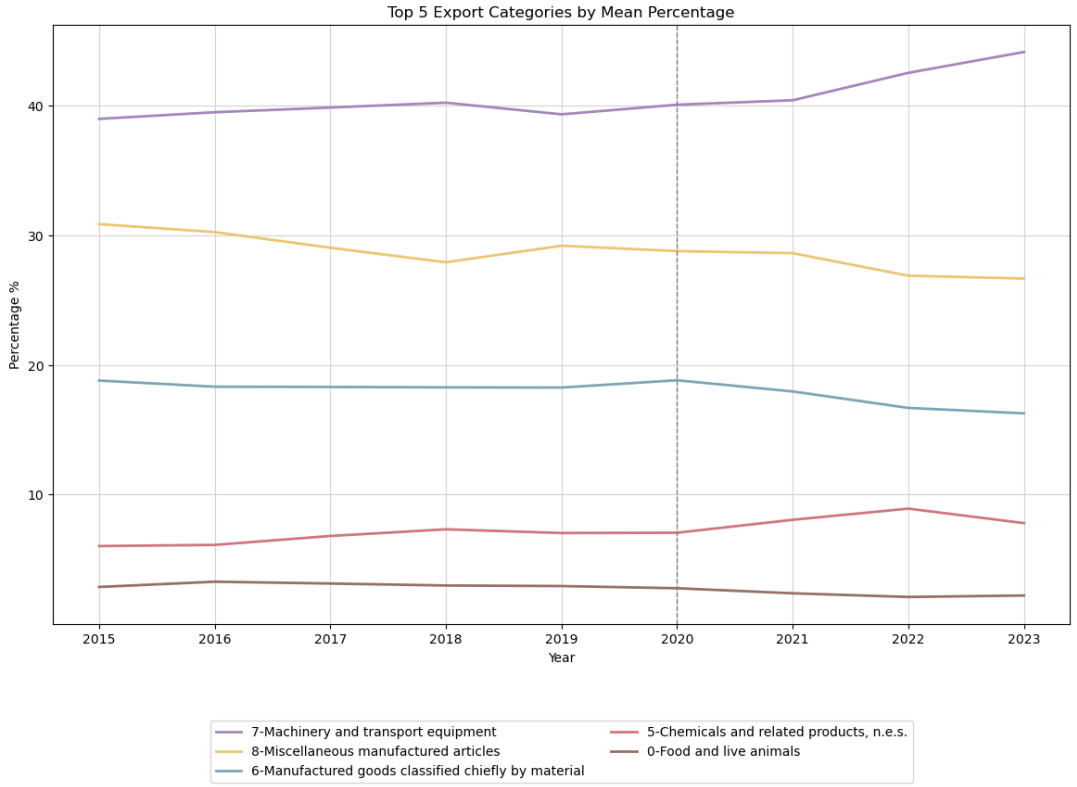

Figure 4. Export Percentages by the Largest 5 Categories

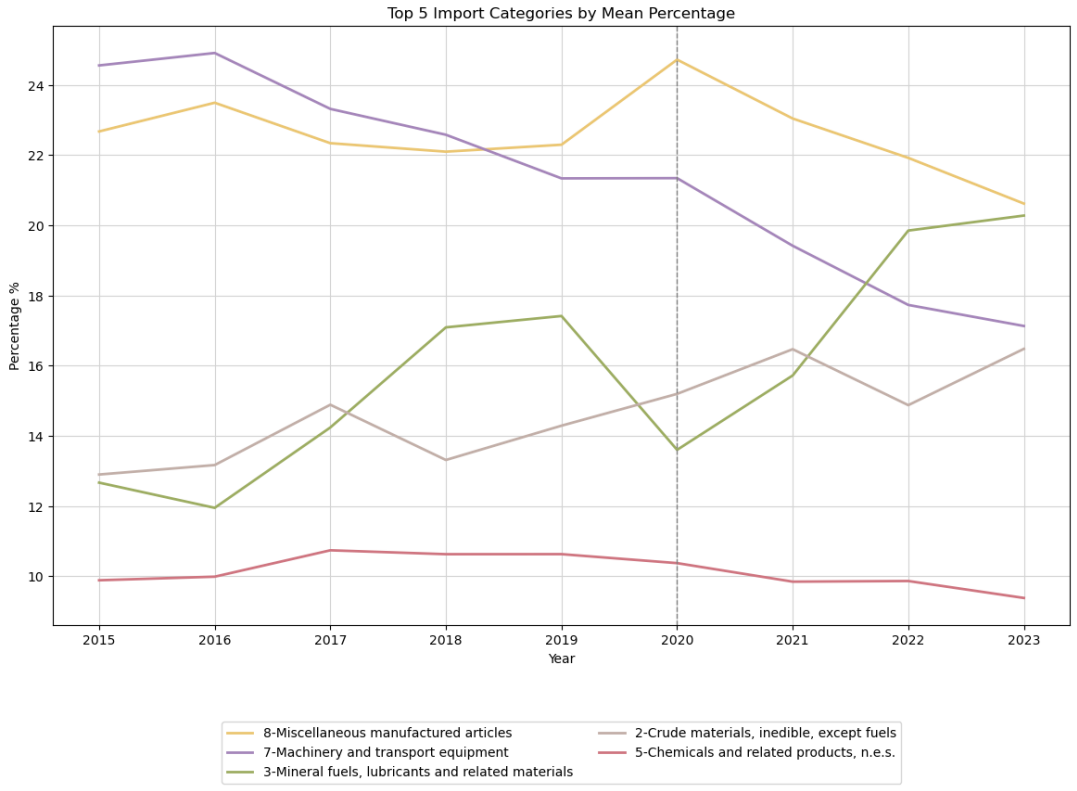

Figure 5. Import Percentages by the Largest 5 Categories