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Research on the Impact of Technical Trade Barriers on Export of Chinese Electromechanical Products to U.S. Market and Potential Countermeasures

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ABSTRACT:*Technical trade barriers (abbreviated TBT), as a new type of trade barrier with high concealment, are favoured by developed countries. A large portion of electromechanical products manufactured in China was exported to developed counties, among all, U.S. market covered a tremendous portion. However, the technical trade barriers adopted by U.S. industrial associations exceeded the conventional international standards, and hence, severely weakens the competitiveness of Chinese electromechanical products. Therefore, investigating the impact of adopted technical trade barriers on exports of Chinese electromechanical products to U.S. market plays a crucial role for policy makers inrefining corresponding policies for regional electromechanical enterprises, stimulates the continuous improvement of contemporary regional electromechanical product standards made by regional industrial associations, and facilitates the long-run development of regional electromechanical manufacturing and exporting enterprises.*

This paper begins by summarizing contemporary situation and conducting an in-depth analysis on the causes of technical barriers encountered by Chinese electromechanical enterprises when they export their products to U.S. market. Followed by the extensive evaluation of positive and negative impacts of TBTadopted by U.S. industrial associations. Lastly, countermeasures related to the export of Chinese electromechanical products are proposed from three perspectives, namely, government-level, industrial-level and enterprise-level. The motivation of this paper is to minimize the adverse effects of TBT in short-run by employing appropriate stimulating policies and appropriate supervision of industrial associations. Moreover, in the long-run, turning the unfavourable situations into opportunities by boosting up the core competitiveness of Chinese electromechanical products is the ultimate objective of this paper.

KEY WORD*: technical trade barriers, export of electromechanical products; positive and negative effects, countermeasures*

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I. INTRODUCTION

Under the context of rapid economic globalization and trade liberalization, the competition surrounded with the international trade is becoming increasingly fierce. Meanwhile, in recent decades, the utilization of traditional trade barriers was gradually replaced by new trade barriers, such as technical trade barriers, which aims to protect the domestic industry and enterprises by avoiding the retaliation from its trading partners. To date, technical trade barriers are frequently adopted by developed countries due to its unique characteristics involving concealment, flexibility and rationality. However, nowadays, the related trade disputes which surrounded with the technical trade barriers are increasing simultaneously.

The U.S. market is a crucial targeting market for Chinese exporting enterprises. However, since 2017, the trade frictions between China and U.S. have been escalating. A series of conventional and non-conventional trade barriers was imposed by U.S. industrial associations to suppress the exports of high-tech products manufactured in China. Followed by the Office of the United States Trade Representative imposed an additional 25% tariff on the listed products, which estimated to be approximately $50 billionfinancialloss to Chinese exporting enterprises. In 2019, such amount was increased by another 25%. At the same duration, a series of non-conventional trade barriers were issued to suppress the development of Chinese high-tech enterprises. The export of electromechanical products was deeply affected by thesenon-conventional barriers.

In recent years, the electromechanical industry in China has experienced a rapid growing stage, and become the largest exporter of electromechanical products in the world. In 2022, the export of electromechanical products of Chinese electromechanical enterprises reached 1,986.04 billion U.S. dollar, achieved an increment of 29.1% in contrast to year 2021. United States was the largest targeting market for

Chinese electromechanical enterprises, which contributed 17.6% of the entire market share. However, the strengthening of trade protectionism brings more uncertainties to Chinese electromechanical industry which is highly relying on exporting. Therefore, studying the technical trade barriers plays a crucial role in promoting the export of Chinese electromechanical products, and ultimately stimulating the upgrading and transformation of the entire electromechanical industry. Moreover, it also helps to facilitate the improvement of regional supporting policies and regulate the standards set by regional government agencies as well as industrial associations.

II. LITERATURE REVIEW

Although the total tradevolume of Sino-US electromechanical products has increased in the past 10 years, the growth rate of the trade volume, however, is gradually decelerating(Wenqi, 2019). As specified by Yanhui Guo (2022), U.S. market is still the potential market for Chinese electromechanicalenterprises. The standards set by U.S. federal agencies and industrial associations, on the other hand, have driven the continuous optimization of export structure of Chinese electromechanical products and the development of modern technology. The major forms of various technical trade barriers implemented in the market of Europe and America includes technical regulations, evaluation procedures, product inspection systems, green barriers and information & technology barriers (Conghui and Yu, 2020). The technical trade barriers implemented by U.S. industrial associations against the Chinese electromechanical products mainly involves the health inspection and quarantine, regulations on packaging and labelling, and the so-called "third-party evaluation" standards(Bing and Bufang, 2021). Moreover, it is worth to note the focus of technical trade barriers implemented by U.S. industrial associations are mainly lying on the labor-intensive products as well as high-tech products (Jianye and Yao, 2022). As indicated by Xiuxiu Zheng *et al.*(2022),the problems encountered by Chinese government in dealing with technical trade barriers is lying on the poor information transmission between the government agencies and regional enterprises, the issued policies are deviated from the actual demands of these exporting enterprises. In addition to that, the Chinese industrial associations should also responsible for the encountered technical trade barriers due to its outdated technical standards, terriblecommunication with enterprises and over-rigid response mechanisms (Yanhui, 2022).

The negative impact of technical trade barriers on export of electromechanical products is obvious. As pointed out by Chinese scholar Junyong (2022), the main problem encountered by Chinese electromechanical manufacturing and exporting enterprises is lying on certain aspects of their technical standards and regulations which is far away from conventional international standards. And hence, it is difficult to mitigate the negative effect of technical trade barriers. According to the finding of Jing Liu (2019), it is believed that negative effect of technical trade barrier to the export of electromechanical products is lying on the increment of overall production cost, and hence, reducing the price competitiveness in the targeting market. Moreover, the establishment of technical trade barriers will exacerbate the trade conflict between countries(Guangyu and Zhaoyu, 2018). Robert Grundke and Christoph(2019) concluded that every time the export of developing countries is adversely affected by U.S. technical trade barriers, it will suffer from severe financial losses, through their empirical studies. In addition to that, for developing countries, the inability to comply with product standards as specified in technical trade barriers may hinder their long-run economic development if they are heavily depending on their exports.

A coin has two sides and so does technical trade barriers, these settings may also have positive effects on exporting enterprises of electromechanical products. As indicated by the findings of Wei Xu and Hai Bu (2018), when the adverse impact of technical trade barriers on export enterprises is larger than the risk of technological upgrading and transformation, enterprises will choose technological innovation and transformation to avoid the adverse impact of technical trade barriers. Through the corresponding investigation of microeconomic data, it is possible to conclude that the encounter of technical trade barriers has certain degree of positive impact on manufacturing and exporting enterprises and leads to the spur of new technologies in three major aspects, namely, enterprise profitability, research and development capability, and the number of talented research staffs. Moreover, it is able to observe the heterogeneity in these positive impacts among enterprises with different features on their exporting (Junwei and Yang, 2021). There is evidence to support the fact that technical trade barriers will stimulate the information flow between two countries (*i.e.*, exporting country and importing country, which implements the technical trade barriers), leading to the promotion of economies of scale, reduction in transaction costs, and formation ofa long-run trade stimulation effect(Yuchen and Yunte, 2016). Last but not least, it is believed that technical trade barriers, which have adverse effect on the development of Chinese electromechanical manufacturing and exporting firms, will trigger the contemplation of the entire industry and associated associations, make these enrolled enterprises pay more attention to the safety standards of manufactured products and establish appropriate corporate culture of humanistic care, strengthen its core competitiveness and stimulate the formation of legal awareness (Junyong, 2020).

Several countermeasures have been proposed by Chinese scholars in tackling the technical trade barriers, although these countermeasures are not straightforwardly related to the export of electromechanical products, they can be served as an excellent starting point. As proposed by Sheng Wang (2018), government agencies should establish a specialized technical trade barrier prevention and control agency to monitor the technical trade barriersissued by the targeting market. At the same time, the agency should also be dedicated in building up a policy consulting service platform for enterprises when they have any concerns regarding to the technical trade barriers. Moreover, it is crucial for government to push the related industrial associations in the establishment and continuous refinement of the related technical rules and regulations as well as industrial standards to improve their guidance related to the technological innovation of enterprises (Hong and Ke, 2020). For manufacturing and exporting firms, they should, under the guidance of the government agencies, absorb foreign technology spillover capabilities through overseas direct investment, and fill the technological gap of domestic isolated innovation environment(Li, 2020).

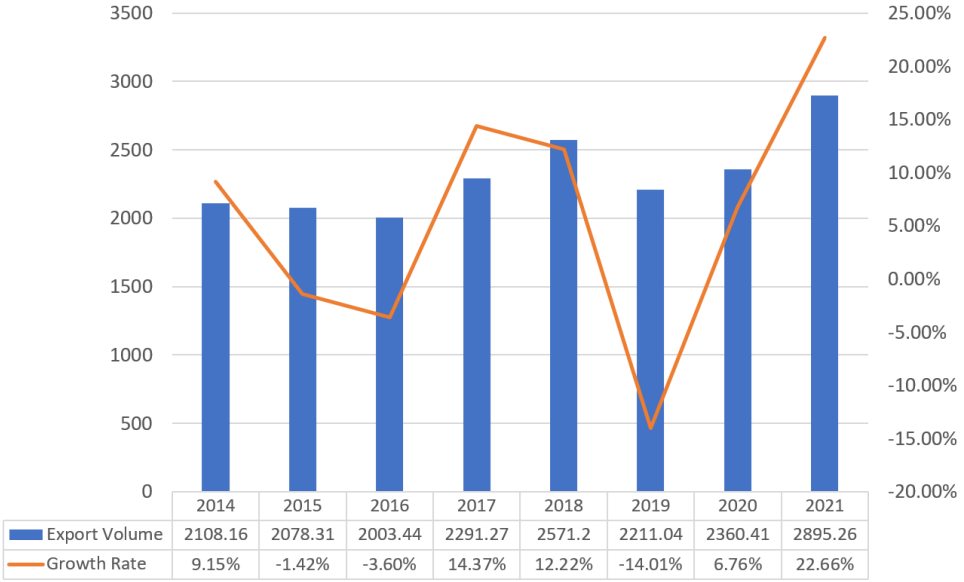
III. CURRENT SITUATION AND CAUSES OF TECHNICAL TRADE BARRIERS

3.1 Current Situation

According to the data obtained from the National Bureau of Statistics of China, the totalexport volume of electromechanical products in China has increased from 0.12 trillion U.S. dollars in 2001 to 2.49 trillion U.S. dollars in 2020, achieved an increment of approximately 20 times, and has become the world's largest exporter of electromechanical products.According to UN Comtrade data, since 2015, the exports of electromechanical products manufactured in China to the United States have accounted for more than 50% of the total export volume, and hence, it is the largest targeting market for Chinese electromechanical enterprises.

Figure 1 traces the total export volume (in 100 million USD) of electromechanical products manufactured in China to U.S. market from 2014 to 2021. As indicated in Figure 1, it is possible to observe the upward trend of export volume of electromechanical productsto U.S. market, however, the export volume decreased in contrast to prior year in 2015, 2016 and 2019. The underlying reason on the decrement of export volume is lying on the change of the international economic environment. The global economywas slow down since 2015, followed by the trade conflict between China and U.S. escalated. The electromechanical industry in China not only needed to bear the unfavourable situation of reduced foreign demand, but also needed to respond to the trade protection measures implemented by U.S. federal agencies and industrial associations. The situation worse off in 2019, it was caused by the level-up of Sino-US trade conflict, the export volume of electromechanical products was significantly decreased from $257.12billion (2018) to $221.10 billion (2019), resulting in a reduction rate of 14.01%. In 2021, the export growth rate exceeded 22%, setting a new high in this eight-year horizon. As predicted by (Bing, 2021), the export volume of electromechanical products manufactured in China to U.S. market will continue to grow in the subsequent 5 years.

Figure 1: Export Volume of Electromechanical Products from China to U.S. Market (in 100 million USD)

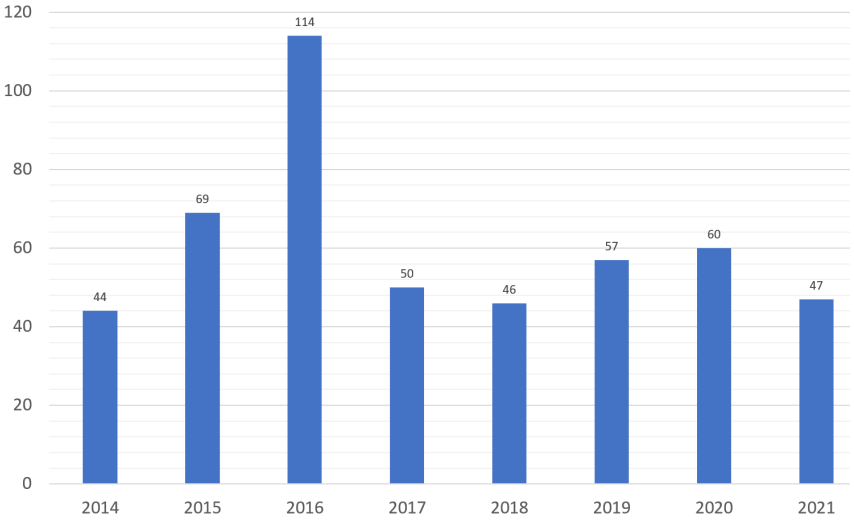


	2014	2015	2016	2017	2018	2019	2020	2021
Export Volume	2108.16	2078.31	2003.44	2291.27	2571.2	2211.04	2360.41	2895.26
Growth Rate	9.15%	-1.42%	-3.60%	14.37%	12.22%	-14.01%	6.76%	22.66%

Source: National Bureau of Statistics of China (2022)

With the increment of total export volume of Chinese electromechanical products to U.S. market, the corresponding reported number of electromechanicalexports, which encountered with technical trade barriers in U.S. market from 2014 – 2021, is described in Figure 2. As specified in Figure 2, the highest number of reported technical trade barriers was occurred in year 2016, which was 114 cases, and for the remaining years, the number was fluctuated around an average number of 55 cases. As the main exporting market for Chinese electromechanical products, it involved a huge amount of trade volume, and hence, the adopted trade barriers adversely affected Chinese electromechanical enterprises.

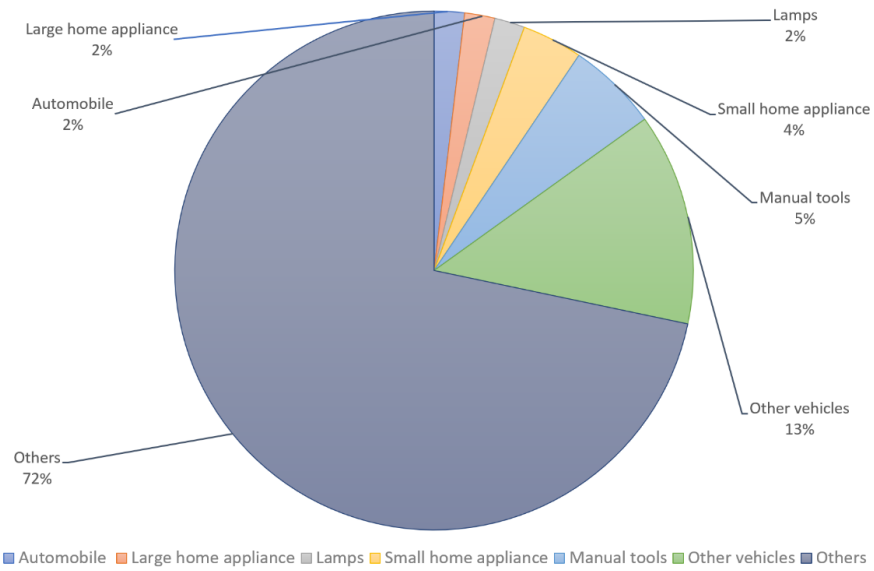
Figure 2: No. of Reported Issues of TBT on Exporting Electromechanical Products to U.S. market



Source: National Bureau of Statistics of China (2022)

In terms of product structure, the U.S. CPSC (Consumer Product Safety Commission) detained a total of 119 batches of substandard consumer goods manufactured and imported from China in 2021, covering five major categories of the products. Among them, 53 batches are belonging to electromechanical products, which ranked first among five major categories. As indicated in Figure 3, the manual tools, small home appliance, lamps, and other electromechanical products, which accounts for 83% of the recalled electromechanical product categories, they are mainly belonging to labor-intensive products. It is possible to conclude that the recalled electromechanical products, encountered with the U.S. technical trade barriers, are mainly labor-intensive products, and hence, such factor should be considered when taking potential countermeasures.

Figure 3: The Recalled Percentage of Product Structure of Electromechanical Products(2021)



Source: U.S. CPSC 2021

3.2 Technical Trade Barriers on Imported Electromechanical Products

As the initiator of technical trade barriers, a sophisticated system has been established by U.S. federal agencies and industrial associations which consists of three aspects, namely, technical regulations, technical standards and conformity assessment procedures.

The technical regulations adopted in U.S. are generally associated with the specification of production processes and manufacturing procedures. The motivation is ensuring the consumer safety, protecting the ecological system and for national security concerns. These technical regulations are issued by various governmental agencies and private institutions. It is worth to note, once such technical regulations are established, it must be followed thereafter by exporters from entering the U.S. market, otherises the products will be forbidden to enter the market, making them clearly mandatory.In addition, the U.S. market has an extremely detailed regulatory enforcement system to ensure the implementation of its technical regulations. The U.S. federal government have established various agencies with specificduties to conduct rigorous reviews on the production and transportation process of imported products, ensuring the implementation of established technical regulations.

The technical standards are referring to the product guidelines recognized by designated institutions (governmental and industrial), the constraints on product labelling and packaging, as well as industrial terminologyinvolved in the production and manufacturing process of electromechanical products. The number of technical standards established inU.S. is enormous.According to the research findings of Yanhui (2022), there are currently over 40,000 standards formulated by unofficial organizations in United States, and over 50,000 official technical regulations and standards formed by U.S. federal agencies.Moreover, there are numerous and scattered standard bodies in United States, with over 300 standard bodies for the classification of electromechanical products, for instance, the American Society of Mechanical Engineers (ASME).Furthermore, the standards of each state in U.S. vary from each other, they may not adopt the international standards, in some occasions, the state technical standards may even conflict with the international version.

The conformity assessment proceduresare the supervision and review of the production process and quality of products. Only the products comply with the corresponding conformity assessment procedures will be issued with conformity certification marks. For instance, majority of U.S. market adopts the FCC conformity assessment program and UL certification for electromechanical products. It requires electromechanical products imported from China to pass the corresponding tests and obtain the UL certification. In addition, some evaluation standardseven lack national unified certification, known as the "third-party evaluation" standard, are also employed in U.S. market, which is believed to be ambiguous evaluation method. Some Chinese electromechanicalmanufacturing and exporting enterprises are forced to obtain such testing results for their products from various laboratories in order to fulfill quality certification requirements proposed by either U.S. federalagencies or industrialassociations, and hence, increasing the overall cost from the perspective of electromechanical manufacturing enterprises located in China.

3.3 Analysis of the Causes of Technical Trade Barriers on Electromechanical Products

The causes of technical trade barriers on Chinese electromechanical products can be broadly classified into two categories, namely, internal causes and external causes.

The internal causes are referring to the ones embedded in exporting country, which can be further analysed from three aspects. From government perspective, there are deficiencies on providing early warnings of technical trade barriers to electromechanical enterprises. To date, there is no dedicated government agencies on collecting and reporting information associated with technical trade barriers, and the construction of information distribution online platform for technical trade barriers does not catch sufficient attention. Existing websites, such as China Technical Trade Measures Network and China TBT Research Centre are outdated due to insufficient maintenance. According to the annual report on Chinese technical trade measures (2022), the proportion of electromechanical enterprises in China obtaining information related to technical trade barriers through domestic TBT/SPS websites is 9.48%, while the proportion of obtaining information through TBT/SPS consultation points is only 5.92%. Therefore, when the U.S.federal agencies or industrial associations raise its technical trade barriers, the regional enterprises canrespondvery passively.

The corresponding regional industrial associations have failed to play its role in technical standard formulation.The formulation of industrial standards in U.S. is independently completed by corresponding associations of strong autonomy. On contrary, the modification and introductionof standards and evaluation procedures requires government approval at all scales. As a result, these associations are usually of low efficiency. In addition to that, the standard formulation of regional electromechanical industry is relatively outdated in contrast to international standards. The revision of Chineseelectromechanical industrial standards occurs every ten years, which is far lagging behind the international standards that revisits every five years. Meanwhile, the regional electromechanical industrial standards are more inclined to local producers rather than consumers (unlike the corresponding industrial standards made by U.S. electromechanical associations).

From the perspective of the regional electromechanical enterprises, the major problem is lying on its products lack of technological innovation. To date, the exports of electromechanical products to U.S. market are mainly labor-intensive ones, and these products are likely to be affected by technical trade barriers. Over the past 10 years, the export of electromechanical products to U.S. market formed a relatively fixed trading pattern, that is, majority of the exported electromechanical products are labor-intensive products. The comparatively low labor cost in China makes the products have price advantage in U.S. market. However, the yearly increasing exporting volume cannot conceal the fact that majority of the electromechanical manufacturing and exporting enterprises in China only capable of producing the low-value-added products, and developing core competitive technology becomes more prominent task for these firms. In addition to that, most of the enterprises overly focus on the production while ignoring the changes in U.S. market policies and standards. And when they encountered with the technical trade barriers, most of the enterprises are not inclined to take any legal actions against the recall incident.

The internal causes are referring to the ones associated with importing country. U.S. has advanced technology and accompanied with high product requirements. Therefore, for electromechanical products, in contrast to UL certification adopted in U.S., CCC certification (employed in China) has lower requirements for fire prevention and flame retardancy of electromechanical products.Moreover, a large number of indicators specified in CCC certification comes directly or indirectly from international standards, while UL certification in the United States is separated from international standards. As a consequence, suppose the regional industrial associations have not updated their technical standards according to actual situations, it is difficult to meet the requirements of the U.S. market.

In addition to that, the U.S. industrial associations have strong awareness of environmental protection. In recent years, many regulations and standards on energy efficiency of electromechanical products have been released. For instance, the California Energy Commission (CEC) announced new "Title 20 Electrical Energy Efficiency Regulations", which set the minimum energy and water consumption levels for electronics and household appliances.In 2022, the U.S. Department of Energy also implemented strict energy-saving standards for multiple electromechanical products, which aims to improve the product quality, promote energy saving, and protect the environment. Conversely, the green ecological indicators for electromechanical products in CCC certification (utilized in China) have not been fully included in the assessment system, and the related environmental awareness of these enrolled enterprise is still weak. Moreover, it is inevitably to note the proportion of exports of electromechanical products from China to the U.S.market accounts for over 70% of the bilateral trade volume between China and United States. In order to protect the domestic companies, the technical trade barriers have been deliberately adopted by the government agencies via upgrading the corresponding standards and making certain voluntary product certificationsmandatory.

IV. POSITIVE AND NEGATIVE IMPACT OF TECHNICAL TRADE BARRIERS

4.1 Positive Impact of Technical Trade Barriers

A coin has two sides and so does technical trade barriers, these rules may have positive effects on exporting enterprises of electromechanical products in the long-run, including the promotion of technological innovation in Chinese electromechanical enterprises, establishing the standard awareness among electromechanical enterprises and industrial associations, and generating trade facilitation influence.

Under the trade of electromechanical products between China and the United States, labor-intensive products are comparative advantage for Chinese enterprises, and hence, U.S. market chooses to import such products from China instead of manufacturing it domestically. By doing so, it will generate trade deficit for U.S. and the related regional enterprises will be adversely affected. Therefore, the technical trade barriers have been imposed on the import of electromechanical products. As a result, in order to export the products to U.S. market, Chinese electromechanical enterprises have to comply with various quality certifications and technical standards. These measures will inevitably generateadditional cost for Chinese enterprises and ultimately make the price of products no longer competitive in U.S. market. The increment of such cost will ultimately push the enterprises to accelerate their technological innovation process by refining the production procedures, developing its core technology, and reducing the negative impact on human beings and environment. In addition to that, the proportion of exports of capital and technology-intensive products will increase, and the overall export structure will be more balanced, thereby promoting export structure adjustment, transformation and upgrading. The above changes will leave a positive impact on Chinese electromechanical enterprises' response to U.S. technical trade barriers.

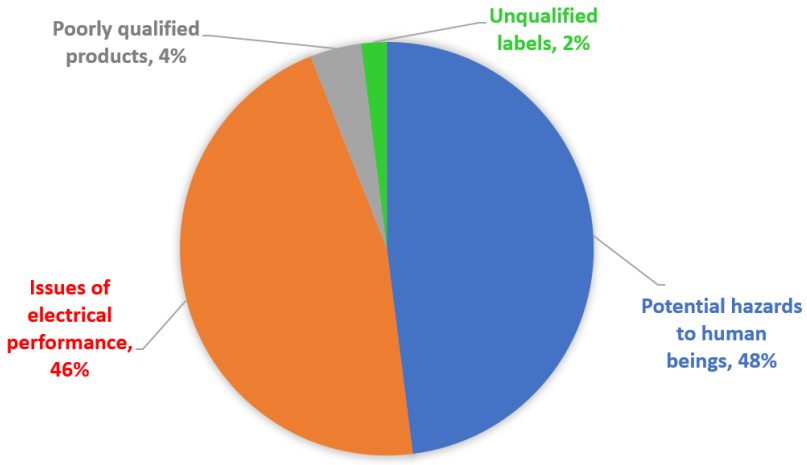
The technical trade barriers set by the U.S. federal agencies and industrial associations are a double-edged swordfor Chinese electromechanical industry. In short-run, many firms unable to fulfill high technical standards and cannot enter the U.S. market. However, in the long-run, it may improve the trade conditions of the exports of electromechanical products to U.S. market. The underlying reason is that with the increment of quality requirements of imported products, Chinese enterprises will continuously refine their production

procedures and ensure their products fulfill the requirements ofindustrial standards.As a consequence, due to the improvement in the quality of Chineseelectromechanical products, U.S. market will be more willing to accept these products in the long-run. Moreover, as long as Chinese electromechanical products ultimately passing through the technical barriers, it will greatly enhance the global reputation of Chinese electromechanical products, and hence, stimulating the willingness of international consumers on choosing products manufactured in China.

The development of electromechanical industry initiated early in U.S., and hence, the industrial associations and enterprises in U.S. have strong awareness of technical standards. After decades of continuous refinement, they have a matured system for technical standards.Based upon its technological advantages, U.S. may adopt its standards on evaluating the imports. Unfortunately, the electromechanical products manufactured in China are still at early stage of development, and hence, the standards made by U.S. associations always hinder the products from entering the U.S. market due to unacceptable product performance and safety concerns. Figure 4 summarizes four reasons on the recall of Chinese electromechanical products announced by U.S. Consumer Safety Commission in 2021. As specified in Figure 4, two major reasons are lying on the potential hazards to human-beings (48%) and issues of electrical performance (46%). These two reasons reflect that majority of the Chinese electromechanical manufacturing and exporting firms lack sufficient awareness of their end consumers and environment considerations.

The electromechanical industry in China has gradually shifted from "quantity oriented" to "quality oriented" development. With the continuous level-up of technical trade barriers in United States, Chinese enterprises and industrial associations are gradually learning from these standards, and gradually placing greater emphasis on green production and consumer safety concerns. It has positive effect on improving the awareness of technical standards ofChineseelectromechanical enterprises and industrial associations. In reality, the regional electromechanical enterprises do pay more attention to environmental standards and reducing the pollution in their production, packaging, and recycling processes in recent years. Moreover, electromechanical enterprises also pay more attention to safety standards. They strive to improve product quality and establish a strict reviewing system to supervise the quality of electromechanical products.

Figure 4: Reasons for CPSC's Recall of Electromechanical Products Manufactured in China (2021)



Source: U.S. CPSC 2021

4.2 Negative Impact of Technical Trade Barriers

U.S. industrial associations have established technical trade barriers on imported Chinese electromechanical products in order to protect the domestic electromechanical industry and reduce the corresponding unemployment rate. Raising the entry requirements of U.S. market will definitely have tremendous negative impact on Chinese electromechanical exports in short-run, which triggers quantitative inhibitory effects. The system of technical trade barriers in U.S. market consists of technical regulations, standardsand conformity assessment procedures. This system is completely independent of international standards, which is believed to be sophisticated and fragmented, with roughly 100,000 official and unofficial technical standards have different degree of restrictive effects. In recent years, U.S. industrial associations have added significant amount of protection measures related to energy-efficiency and environmental protection on electromechanical products, which aims to supress the exports of developing countries. For instance, in May 2019, a proposal was enforced to clarify the testing program for voltage distributors, which aims to constrain the additional unit load and additional reference temperature of electromechanical products. In July 2021, the

California Energy Commission set minimum energy and water consumption levels for electronic and household appliances in the new "Title 20 Electrical Energy Efficiency Regulations". On contrary, the related industrial standards for Chinese electromechanical products are still lying on the product functions, and the corresponding settings on environmental protections and energy efficiency is far from that as specified in U.S. standards. As a consequence, the electromechanical products manufactured by Chinese firms hard to meet the environmental requirements, and will be banned from entering the U.S. market. As indicated in Table 1, the total number of technical barriers to trade (TBT) notifications was gradually increasing in the past five years from 71 issues to 129 issues. Although the weightage of TBT notifications on electromechanical products was declined from 70.42% to 36.43%, the number of TBT notifications on electromechanical products was gradually increasing in the past five-year duration.

Table 1: No. of TBT Notifications on Electromechanical Products and Corresponding Weightage

Year	No. of TBT notifications on electromechanical products	No. of TBT notifications on products imported from China	Weightage of TBT notifications on electromechanical products
2017	50	71	70.42%
2018	46	109	42.20%
2019	57	121	47.11%
2020	60	124	48.39%
2021	47	129	36.43%

Source: U.S. CPSC 2021

The most obvious manifestation of losses caused by the establishment of technical trade barriers is the increment in associated costs. The proportion of technology-intensive products of electromechanical exports to U.S. is still in relatively low proportion, making it difficult to achieve high level of added value. Once the cost increases, due to the imposed technical trade barriers, the revenue of the exporting electromechanical enterprises will be further diluted and the entire industry will fall into a difficult condition. Generally speaking, the increment of associated cost induced by the adoption of technical trade barriers is mainly coming from three aspects: production cost, operating cost, and external cost.

Majority of Chinese electromechanical enterprises have not mastered any core competitive technologies, meanwhile, many raw materials are still relying on foreign imports. In recent years, U.S. federal agencies and industrial associations have continuously raised technical trade barriers and attempted to restrict the export of core components to Chinese electromechanical manufacturing firms, resulting in an increment of production costs. Moreover, the technical trade barriers increase the operating cost of Chinese electromechanical products. The setting of trade barriers triggers strict requirements for product certification. As the production standards of electromechanical products in China are relatively outdated, and the industrial associations have not established the unified standards that following either the U.S. or international standards. In order to export the products to U.S. market, majority of the electromechanical firms have to spend time and efforts to familiar withU.S. product standards and refine the corresponding technology, which may lead to additional production costs. In addition to that, the testing results provided by regional institutions are not recognized by U.S. industrial associations, and hence, the test have to be repeated at designated certification agencies located in United States, this additional cost will also be counted in the production cost. Finally, the technical trade barriers increase the external cost for Chinese electromechanical products. The external cost refers to the related cost caused by the recall of exported electromechanical products. It is manifested as the inability of the exported products to meet various standards set by U.S. industrial associations, and lead to the recall of products. Table 2 summarizes the recall of Chinese electromechanical products announced by CPSC from 2016 to 2021. A recall states that the exported batch of electromechanical products cannot enter the U.S. market, it will be either resale to other country, ship back to China or destructed in United States. Either way will generate huge external cost to Chinese electromechanical enterprises.

Table 2: The Recall of Exported Electromechanical Products by CPSC (United States) from 2016 to 2021

Year	No. of recall of electromechanical products
2016	58
2017	22
2018	31
2019	27
2020	41
2021	22

Source: U.S. CPSC 2021

According to the "Annual Report on Chinese Technical Barriers to Trade Measures (2020)", in 2019 alone, Chinese electromechanical enterprises suffered a direct financial loss of 5.57 billion Chinese yuan due to

U.S.technical trade barriers, ranking the first among all targeting markets ofelectromechanical exports. Although, Chinese electromechanical industry is continuouslyintroducing new technologies to improve product quality, the associated research and development expenses will also level up the production cost. In order to maintain the same level of revenue, these enterprises have to increase the selling prices, and ultimately, weakening the price advantages of Chinese electromechanical products in U.S. market. In addition to that, U.S. is the first market to integrate the labor rights with the technical trade barriers, which involve regulations prohibiting the products made by prisoners, implementing minimum wage standards, and abolishing compulsory labor. By doing so, it may further dilutes the price advantages of Chinese electromechanical products in U.S. market, as majority of the exported products are belonging to the labor-intensive products.

V. POTENTIAL COUNTERMEASURES TO TECHNICAL TRADE BARRIERS

From the analysis as specified in section 4, it is possible to observe the technical trade barriers set by U.S. government agencies as well as industrial associations may lead to constraints and restrictions on exports of Chinese electromechanical enterprises in short-run. However, it is inevitable to conclude that the technical trade barriers may bring some favourable effects to these enterprises and industrial associations in long-run. Several potential countermeasures have been proposed in this section to mitigate the negative effects brought by U.S. technical trade barriers from the perspective of government agencies, industrial associations and enterprises.

5.1 Improving Technical Standards and Regulations, Establishing Early Warning Mechanism

The underlying reason, which explains why the export of electromechanical products are frequently affected by U.S. technical trade barriers, is lying on the fact that majority of related standards utilized in China are deviated from the standards adopted in United States. Therefore, it is essential for regional government agencies as well as industrial associations to learn and understand the technical regulations and conformity assessment certification system of the U.S. electromechanical industry. Based on that, it is ideal for government agencies to collaborate with the industrial associations in periodic revision of correlated technical standards and regulations, aiming to be in line with the U.S. and other advanced international standards. After the formation of regional technical standards and regulations, government representatives and industrial superintendents should actively inspect enterprises to ensure they are complying with the standards and regulations. Appropriate incentives, like subsidies and/or tax reduction, should be provided to enterprises strictly follow the production standards, and the punishment should be imposed on firms violating the regulations.

In contrast to the developed countries with matured electromechanical industry, regional electromechanical enterprises usually lack of sufficient awareness and understanding towards the human-beings-associated and environment-oriented technical standards and regulations. In short-run, appropriate protection measures should be developed by government agencies to protect the legitimate rights of exporting electromechanical firms when facing the lawsuits filed by U.S. associations.

Moreover, asymmetric information is believed to be one of the major reasons for the obstruction of export of regionalelectromechanical products. In most occasions, the exporting enterprises cannot predict the upcoming uncertainties in advance. In response to this situation, adedicatedinstitution, may it be government-level or industrial-level, should be established to monitor the technical trade barriers made by associated markets. After detecting any technical trade barriers, such institution should appropriately estimate the impact of the technical trade barriers via big data analysis, and generate the report on the online platform, so that government, industrial associations and exporting electromechanical enterprises may quickly access to the report and develop corresponding countermeasures in time. Such monitoring and reporting mechanism is termed as the early warning mechanism.

The online service platform should be continuously maintained, so that all involved entities may obtain the information instantly. In addition to that, the government agencies and industrial associations may provide policy consulting services for small to medium scale enterprises. For instance, they may organize periodic briefing to convey the information and potential countermeasures related to technical trade barriers to electromechanical enterprises and obtain the instant feedback from firms related to technical trade barriers. The most ideal version of early warning mechanism should perfectly integrate the government agencies, industrial associations and exporting enterprises.

5.2 Enhancing Core Competitiveness and Matching Corresponding Technical Standards

Technological innovation is believed to be the foundation for Chinese electromechanical products to overcome the negative effect brought by technical trade barriers. To date, majority of exported electromechanical products are belonging to labor-intensive products with relatively low technical contents, these products usually hard to meet various standards in U.S. market. Moreover, in order to weaken the cheap labor advantage of Chinese electromechanical manufacturing and exporting firms, the introduction of labor standards in recent year's technical trade barriers further dilute the core competitiveness of Chinese products in

U.S. market. In order to improve this situation, the most crucial task for enterprises is lying on enhancing the core competitiveness via technological innovation. Although such action may add extra financial pressure to the enterprises, due to the additional research and development expenses in short-run, this move will continuously enhance the core competitiveness of the electromechanical firms in the long-run. Moreover, the entire electromechanical industry and manufacturing firms should pay close attention to various standards related to human-beings and environment. In recent years, U.S. market has increasingly emphasized on the feature of green energy, low-carbon emission, energy conservation, and human beings' safety. Green development is likely to be the future trend for electromechanical industry. Therefore, the electromechanical industry and enterprises must follow this trend by strictly controlling the production process, improving the product quality, and ultimately matching the advanced technical standards so as to reshape the impression of exported electromechanical products and further strengthen their core competitiveness. Enhancing the core competitiveness has another layer of meaning, in addition to imposed technical trade barriers, U.S. federal agencies also attempted to block the high-tech components, which is crucial for the manufacturing of electromechanical products, from entering the Chinese electromechanical firms. Therefore, being capable of developing the core technologies, rather than relying on foreign imports, plays a crucial role.

There are two countermeasures can be taken by regional electromechanical industry – absorbing the advanced technology of developed countries and increasing the proportion of research and development talents among employees. At present stage, the regional electromechanical industry is deemed as a production, assembly, and distribution center in the global supply chain, the major competitiveness is lying on cheap labor cost. Such position in the global supply chain is low-value-added and not sustainable in the long-run, as the entire industry does not own any core technologies. Therefore, the best strategy can be taken by regional electromechanical industry is to attract famous internationalelectromechanical corporations to set up overseas factories and operate in China. By introducing direct investment, the regional electromechanical industry can absorb advanced technology of these overseas branches. Meanwhile, for large electromechanical enterprises, they should also accelerate the pace of "going global", make direct investments in the developed countries. By doing so, it will change the impression of the firm and sound its reputation. Moreover, the corresponding technical standards, which are adopted in developed countries, can also be employed as a reference in establishing the Chinese version of technical standards.

Another countermeasure should be taken by regional electromechanical industry is to increase the proportion of research and development talents among employees. Electromechanical enterprises should erect appropriate corporate culture which allows employees to maximize their potentials in research and development. The experienced employees should be allocated with sufficient funding to learn required skills in professional institutions. In addition to that, the enterprises may attract talents in the discipline by providing high paying positions. With the increment of proportion of specific talents, Chinese electromechanical industry can undergo constant transformation by reducing the production of labor-intensive based products and moving towards high-tech electromechanical products.

5.3 Optimizing the Structure of Exporting Products to Match the Demands of U.S. Market

Chinese exporting electromechanical products have one obvious problem, that is, over-concentration of export structure on certain categories of the products. Therefore, it is highly vulnerable to technical trade barriers imposed by the U.S. federal agencies as well as their industrial associations. As specified before, majority of the electromechanical products exported to U.S. market are belonging to labor-intensive products with relatively low technological contents, and making it difficult to meet the technical standards. Hence, Chinese electromechanical enterprises should optimize the structure of exporting products to match the demands ofU.S. market.

In order to optimize the export structure and effectively alleviate the negative restrictions brought by technical trade barriers, large electromechanical manufacturers in China should establish advanced elimination mechanism. In recent years, U.S. market has constantly upgraded its technical trade barriers by combining them with environmental protection regulations. Therefore, electromechanical enterprises must independently promote the construction of elimination mechanism, establish relatively sound management, assessment, and supervision mechanism, eliminate backward production capacity, prohibit the production of products generating heavy pollution, and accelerate industrial transformation and upgrading. At the same time, production is carried out in strict accordance with U.S. environmental protection standards. Using environmental-friendly processes and equipment, adopting recyclable materials, and reducing energy consumption will significantly boost up the proportion of "green" product exports.

At the same time, electromechanical enterprises should also strengthen their comparative advantages by increasing the proportion of export of competitive products, and improving the export structure based on the demand of the U.S. market. It is well-known that U.S. market relies heavily on the exports of electromechanical

equipment and metal products. Therefore, electromechanical enterprises should focus on improving the product quality of these products and increasing their proportion in their exports.

VI. CONCLUSION

Nowadays, the technical trade barriers are frequently adopted by U.S. federal agencies and industrial associations to hinder the import of labor-intensive electromechanical products from China. The technical trade barriers have characteristics of hidden, flexible and reasonable, which is believed to be superior than conventional trade barrier, and hence, have tremendous negative impact on Chinese electromechanical products from entering U.S. market in short-run. At present stage, China is world's largest exporter of electromechanical products, and the U.S. market is the largest targeting market for the exports of electromechanical products. In 2021, exports of electromechanical products from China to U.S. market reached 289.53 billion U.S. dollars, and the amount is expected to expand in the next five years. In order to protect its domestic market, U.S. federal agencies and industrial associations set technical trade barriers, the number of TBT notifications and recalls of Chinese electromechanical products has remained high in the past five years.

Through analyzing the relevant data on Sino-US trade in electromechanical products and studying the U.S. technical trade barriers, involving technical regulations, standards and conformity assessment procedures, it is able to observe that the export of Chinese electromechanical products hindered by technical trade barriers is mainly caused by both internal and external factors. The internal factors involve the imperfection of early warning system and related information platform, the entire industry lacks core technological competitiveness and sufficient attention on the formulation of technical standards. The external factors include the prevalence of trade protection policies, advanced level of electromechanical technology, high requirements on products, as well as strong awareness of human-beings' safety and environmental protection.

To Chinese electromechanical industry and enterprises, the impact of technical trade barriers is two-sided. In short-run, the technical trade barriers will have tremendous negative impact on the export of Chinese electromechanical products. The escalated technical trade barriers, which is also integrated with the environmental standards and standards related to the safety of human-beings, make certain portion of electromechanical products difficult to enter the U.S. market. Even the remaining electromechanical products managed to enter the U.S. market, due to the increment of associated costs, the revenue for these enterprises are severely diluted. In addition to that, the increment of costs will drive up the selling price in U.S. market, which weakens the competitive advantage of Chinese electromechanical products, and reduces the corresponding market share. In the long-run, technical trade barriers set by U.S. federal agencies and industrial associations will generate certain positive effect on Chinese electromechanical industry. The technical standards will force electromechanical enterprises to accelerate their transformation by improving the quality of the product, refining the contemporary manufacturing process, and closely adhering to the most advanced version of international standards. In addition to that, when the Chinese electromechanical industry successfully breaks through its technological limitations, the corresponding export volume and producer surplus will be significantly increased, as a consequence, the trade conditions as well as welfare of employees will be improved accordingly. Last but not least, the awareness of the technical standards will be ameliorated.

In order to leverage the advantages of Chinese electromechanical industry and mitigate the negative effects brought by technical trade barriers, the following countermeasures should be taken by regional government agencies, industrial associations, as well as enterprises. Government agencies should fully understand the technical regulations and conformity assessment and certification system advocated by American electromechanical industrial associations, and formulate technical standards and regulations that are compatible with regional situations. Meanwhile, the government agencies should also collaborate with industrial associations to establish a sound early warning online platform to promptly convey information associated with technical trade barriers to electromechanical enterprises. The industrial associations should focus on core technology research and development, strengthen the training of high-tech talents, and refine technical standards that match those of developed countries. All electromechanical enterprises should optimize the export structure and strictly comply with technical standards, and enhance its core competitiveness via industrial transformation.

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