Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 25, No. 2, 2026

A Study on the Current Status and Optimization Strategies for Exports in Hebei Province's Steel Industry

Yuhan Jiang *

Business School, University of Shanghai for Science and Technology, 516 Jungong Road, Yangpu District, Shanghai 200093, China

* **Corresponding author**: (Email: 19895900956@163.com)

Abstract: The international steel market has become increasingly volatile, with fluctuating demand, trade protectionism, and tighter environmental requirements reshaping export competition. As China's largest steel-producing province, Hebei plays a central role in national steel production and exports, yet its export structure still reflects the legacy of an extensive development model. Using customs and provincial data for 2020–2024, this paper examines the scale, trade modes, product structure, and destination markets of Hebei's steel exports. The results show that export value recovered after the pandemic but remained concentrated in general trade and in flat-rolled and long products, while high-value-added products accounted for a small share. Asia remained the dominant market, followed by Latin America, Europe, and Africa. Four constraints are identified: a one-dimensional product structure, insufficient technical standards, rising environmental costs, and cutthroat price competition. The paper proposes four optimization strategies: market monitoring and diversification, technology benchmarking, green supply chain development, and brand differentiation.

Keywords: Hebei Province; Steel Industry; Export Structure; Green Trade Barriers; Industrial Upgrading.

1. Introduction

The steel industry is a vital foundation of the national economy and a key pillar for building a modern, powerful nation. It plays a crucial role in a country's economic and social development, is closely linked to numerous upstream and downstream industries, and exerts a significant driving force on economic growth. China's industrialization and rapid economic growth have driven the booming development of the steel industry. China's steel production ranks among the world's highest; in 2024, China's crude steel output reached approximately 1.005 billion metric tons, accounting for about 53 percent of global production. Currently, China ranks first among all countries in both crude steel production and net steel exports.

However, as early as 2008, the State Council had already pointed out that industries such as steel, cement, and automobiles in China had long been characterized by unhealthy economic growth patterns and imperfect institutional mechanisms, and issued a series of recommendations and notices regarding structural adjustments in these sectors. Subsequently, the State Council explicitly designated China's steel industry as one in urgent need of rectification. Consequently, the Chinese steel industry is viewed by the outside world as "big but not strong"—that is, while production volumes are high, the industry lacks a competitive edge. Even though China's steel production and export volumes rank among the world's highest, improvements are still needed in product technology, quality, and export methods. At the same time, structural overcapacity in China's steel sector has led to a slump in the industry's development. Although export volumes remain among the highest in the world, export prices for steel products have continued to decline. The period of high profit margins has largely ended, with export profits for most steel enterprises significantly squeezed and some even incurring losses. There is severe overcapacity in low-value-added steel products, and inventory levels remain persistently high. At the same time, high-value-added steel products are not being supplied effectively. The export structure of China's steel industry faces serious challenges, and there is an urgent need to transform the current export landscape and restore the industry's prosperity.

Hebei Province is a major steel-producing province in China, and the province's steel exports play a highly representative role in the grand narrative of China's steel industry exports. Along with the rapid and high-quality development of China's market economy, Hebei's steel industry has also achieved outstanding results; its export value ranks among the highest of all provinces. Since 2001, when Hebei's steel production reached 19.70 million metric tons, the province has consistently ranked first in China for many consecutive years, with its products demonstrating strong market competitiveness. In 2024, the value of Hebei's steel exports reached $4.446 billion, accounting for about 6.3% of the nation's total steel exports. It is evident, therefore, that the challenges facing China's steel industry on the export front are also issues that the Hebei steel industry must seriously consider and address. Moreover, the challenges facing the Hebei steel industry are more specific, more pronounced, and more severe. As the steel industry is a pillar industry of Hebei Province, it significantly impacts the province's overall socioeconomic development. Consequently, it is essential to study the current state of exports in the Hebei steel industry and explore strategies for optimization.

2. Literature Review

Within the national economic system, the steel industry serves as a key strategic pillar industry, holding a pivotal and irreplaceable position. However, the steel industry currently faces a complex and ever-changing business environment as well as severe and challenging market conditions. This not

only poses numerous obstacles to the industry's own stability and sustainable development but also has a profound impact on the scale and direction of China's steel exports. As a major hub of the steel industry, Hebei Province has been particularly hard-hit in terms of its steel export trade.

Zhu Rongjie (2021), after in-depth research, pointed out that the steel smelting production process is extremely lengthy, consumes enormous amounts of energy, and has a negative impact on the ecological environment that cannot be underestimated. Furthermore, as "carbon peaking and carbon neutrality" have become urgent requirements of our times, it is imperative for the steel industry to advance pollution reduction and carbon emission reduction. In light of this, selecting representative cities in Hebei Province as case studies to thoroughly explore pathways for the coordinated control of air pollutants and carbon dioxide in the steel industry is of great significance for promoting simultaneous reductions in both air pollutants and carbon dioxide across the entire sector [1].

Shi and Zhang (2020) review the evolution of China–US trade frictions and discuss response strategies for affected industries, including the use of cross-border e-commerce to expand export channels and the use of WTO rules to safeguard legitimate trade interests [2].

Ma et al. (2022), using steel enterprises in Hebei Province as the core research sample, elaborated in detail on their current development status, conducted an in-depth analysis of the numerous obstacles encountered by enterprises in their internationalization process, and identified a practical and feasible path for the international transformation of Hebei's steel enterprises. Building on this, the study further proposes a practical path for Hebei's steel enterprises to enter the international stage through measures such as improving technological efficiency, optimizing the structure of product exports, facilitating the transfer of production capacity overseas, selecting appropriate marketing strategies, and accelerating digital transformation [3].

Ma (2024) analyzes the current status of Hebei's steel exports, identifies problems in export structure and market development, and proposes targeted countermeasures [4]. Liu et al. (2020) examine the environmental and economic effects of trade barriers and note that research has focused mainly on economic impacts and trade liberalization, with relatively few studies linking trade barriers to environmental outcomes [5]. Bahmani-Oskooee and Kanitpong (2019) show that exchange-rate movements have asymmetric effects across industries, underscoring the sensitivity of commodity trade to exchange-rate changes [6]. Johnson et al. (2023) evaluate decarbonization strategies for the Indian steel industry and show that technology choice and energy structure significantly affect both emissions and costs [7]. Kawabata (2017) examines the distribution of excess capacity in the global iron and steel industry, with particular attention to China [8]. Recent studies extend this literature in two directions. Shi et al. (2023) show that de-capacity policies raised capacity utilization in the Chinese steel industry through equipment upgrading, mergers and restructuring, technological innovation, and environmental regulation [9], while Ren and Zhang (2024) find that the overcapacity-cutting campaign significantly and persistently improved capacity utilization among listed steel firms [10]. A second strand examines the trade effects of carbon border measures. Zhao et al. (2024) estimate that the EU Carbon Border Adjustment Mechanism (CBAM) could reduce Chinese steel export volume by 32 percent and export profits by 58 percent [11]; Li et al. (2023) show that lowering embodied carbon intensity and using green certificates can substantially reduce the resulting cost burden [12]; and Tian et al. (2024) find that large steel enterprises are more exposed to CBAM than small ones, with a higher domestic carbon price offsetting part of the impact [13]. Pan (2024) and Yin et al. (2025) review the low-carbon transition and policy responses of China's steel sector [14, 15]. In summary, existing studies focus mainly on national-level steel trade, environmental performance, or enterprise internationalization, and relatively few combine export scale, trade modes, product structure, and market distribution in a single provincial analysis. This paper addresses that gap for Hebei Province by analyzing 2020–2024 customs data and proposing targeted optimization strategies.

Hebei is one of China's major steel-producing and exporting provinces, so studying its export performance has both theoretical and practical value for regional industrial upgrading.

3. Definitions of Related Concepts and Theoretical Foundations

3.1. The Concept of the Steel Industry

The steel industry is a key pillar of the national economy and a core raw materials sector with rich and multifaceted implications. Broadly speaking, it encompasses the mining and beneficiation of minerals such as iron, chromium, and manganese—which serve as the raw material foundation at the front end of the industrial chain; the ironmaking industry transforms these raw materials into pig iron, while the steelmaking industry further refines it into crude steel, the steel processing industry uses methods such as casting, rolling, forging, and extrusion to transform crude steel into steel products that meet diverse needs; the ferroalloy smelting industry produces additives required for steelmaking; and the steel wire and products industry uses steel as a base to produce various steel wire products. It also involves non-metallic industrial sectors such as coking, refractory materials, and carbon products, which provide critical support for all stages of steel production. In a narrow sense, the sector primarily focuses on ferrous metal smelting and rolling, that is, the direct metal conversion process from ironmaking and steelmaking to steel processing. Its production processes are closely interlinked, from mineral extraction and beneficiation to the output of finished steel products. Major products include pig iron, crude steel, finished steel, and ferroalloys; these products, serving as the "staple of industry," lay a solid foundation for the nation's industrialization and economic development. In the steel industry, pig iron is a primary product, produced by smelting iron-bearing raw materials at high temperatures in a blast furnace. With a carbon content of 2%–4.3%, it is hard and brittle and serves as the main raw material for steelmaking. Crude steel has completed the smelting process but has not undergone plastic processing; it is classified into three categories: electric furnace steel, converter steel, and other steels. Steel products are the primary form of end products. Based on chemical composition, they include high-quality carbon structural steel and carbon structural steel, among others, each serving different purposes to meet the needs of various sectors. Ferroalloys serve as deoxidizers and alloying additives in steelmaking—such as ferrosilicon, ferromanganese, and

ferrochrome—which deoxidize the steel, regulate its properties, and facilitate the production of high-quality steel products.

3.2. Key Characteristics of the Steel Industry

(1) Resource-dependent industries. The steel industry is highly dependent on natural resources such as iron ore and coal; the reserves, quality, and distribution of these resources directly impact the scale of production and exports, export costs, and product quality. At the same time, the steel industry consumes vast amounts of water and electricity, raising issues related to resource conservation and environmental protection. When considering the steel industry's exports, the effective protection and utilization of resources must not be overlooked.

(2) A foundational industry. The steel industry provides key materials for industrial production and social infrastructure; sectors such as construction and manufacturing are indispensable to steel, and the steel industry meets the fundamental needs of various industries. The level of development of the steel industry is an important indicator of a country's degree of industrialization and comprehensive national strength, playing a foundational supporting role in national economic and social development.

(3) A Cyclical Industry. The steel industry is closely linked to macroeconomic conditions and exhibits significant cyclicality. During periods of economic prosperity, various sectors experience rapid growth, leading to a substantial increase in demand for steel; during economic downturns, demand from related industries declines accordingly, resulting in overcapacity in the steel industry.

(4) An industry characterized by economies of scale. Economies of scale refer to an economic phenomenon in which unit costs continuously decrease as production volume increases. In the initial construction phase, the steel industry requires substantial capital investment to purchase equipment, build facilities, and attract talent and technology; only after reaching a certain scale of production can the initial investment yield a full return. As a technology-intensive and asset-intensive industry—and one typically characterized by high industrial concentration—the production processes and technical requirements of the steel industry necessitate the formation of a certain scale to achieve economies of scale.

3.3. Theoretical Foundation

(1) The analysis draws on three bodies of theory. Comparative advantage, developed by David Ricardo, holds that countries benefit from specializing in goods in which they have a lower relative opportunity cost, even without an absolute advantage [16]. The theory explains why Hebei has specialized in steel production, but it also cautions that static cost advantages can trap a region in low-value-added segments; this is the "comparative advantage trap" discussed in Section 4.4. Porter (1990) shifts the focus from factor endowments to firm strategy, industrial clusters, and differentiation, while global value chain research shows that upgrading depends on the governance of buyer-supplier relationships [17, 18]. Green development theory emphasizes the coordination of economic growth and environmental protection and is directly relevant to the carbon and environmental requirements now facing steel exports. Copeland and Taylor (2004) provide the analytical link between trade openness and environmental outcomes [19]. Supply-side structural reform provides the policy framework for reducing overcapacity, upgrading product structure, and extending the industrial chain. Together, these perspectives inform the analysis of export structure, environmental constraints, and upgrading strategies in Sections 4–6.

(2) The concept of green development emphasizes the close coordination and unity between economic development and environmental protection, pursuing a win-win outcome for economic, social, and ecological benefits. The core elements of this concept include sustainable development, low-carbon development, a circular economy, and ecological development. This concept was proposed to address issues such as excessive resource consumption, environmental pollution, and ecological degradation associated with traditional development models, and aims to promote high-quality economic and social development through a green transition. Guided by this philosophy, Hebei Province's steel industry has accelerated the phasing out of outdated production capacity, actively developed green and low-carbon technologies, and promoted the structural optimization and upgrading of the steel industry. At the same time, the "Dual Carbon" policy—a major strategic decision to address climate change in China and promote green development—has further clarified the specific direction for the steel industry's green transition. Furthermore, the green development philosophy and the "Dual Carbon" policy provide crucial guidance for the export trade of Hebei Province's steel industry. As global demand for green, low-carbon products continues to grow, Hebei's steel industry should actively respond by developing green products and enhancing the added value of various products to strengthen its competitiveness in the international market. At the same time, in light of trade barriers—such as carbon tariffs—implemented by some countries and regions, Hebei's steel industry should make comprehensive preparations in advance. By pursuing green transformation and technological upgrades, it can mitigate trade risks and lay a more solid foundation for the healthy development of its export trade.

(3) Supply-side structural reform is one of the key strategies of China's economic reform. Its core objective is to address the imbalance between supply and demand by optimizing the economic structure and improving the quality and efficiency of the supply system, thereby promoting high-quality economic development. In short, it involves starting from the production side to optimize resource allocation, improve the quality of products and services, and meet market demand. As a traditionally energy-intensive and high-emission industry, supply-side structural reform is of great importance to the steel industry in Hebei Province. The steel industry in Hebei Province has long faced issues such as overcapacity, a monotonous product structure, and outdated technology. Through supply-side structural reform, the industry can accelerate the phasing out of outdated production capacity, optimize its product structure, and promote technological innovation, thereby enhancing its market competitiveness.

(4) From the perspective of export trade, supply-side structural reform requires the steel industry in Hebei Province to place greater emphasis on export quality and the value-added of exported products, which aligns with the new demands of the contemporary international market for steel products. At the same time, supply-side structural reform also emphasizes the need to optimize and extend the steel industry chain, driving the sector toward intelligent, green, and high-end development. For the steel industry in Hebei Province, this undoubtedly represents an opportunity in the new era.

4. Analysis of the Current State of Export Trade in Hebei Province's Steel Industry

This section draws on customs export data for Hebei Province for 2020–2024, supplemented by data from the National Bureau of Statistics and the Development Research Center of the State Council. Export values are measured in U.S. dollars. Trade-mode data cover general trade, processing trade, and overseas contracting projects; product-level analysis uses seven HS categories (7202, 7208, 7210, 7216, 7217, 7223, and 7225). Because the trade-mode and market tables report major channels and markets separately, their totals may differ from aggregate export values; the residual is reported as "other" in the tables.

4.1. Analysis of the Scale of Export Trade

After decades of vigorous development, the steel industry in Hebei Province has made significant progress. From ancient times through the early years of the People's Republic of China, Hebei Province, drawing on a heritage of iron smelting spanning more than 3,000 years, struggled to transition to a modern steel industry amid turbulent times. From the founding of the People's Republic of China through the early years of reform and opening-up, the province's steel output remained extremely low, at just over 3,000 metric tons. After nearly three decades of tenacious perseverance, Hebei's steel industry has experienced unprecedented growth. Private steel enterprises have rapidly emerged, driving the industry's rapid expansion and establishing the province as a backbone of the national steel sector. During this period, numerous enterprises actively invested in research and development, propelling Hebei's steel industry toward high-end production. Since the 18th National Congress of the Communist Party of China in 2012, the province's steel industry has undergone continuous optimization and consolidation, transitioning toward a green industry while advancing technological innovation.

Benefiting from Hebei's industrial foundation as a major steel-producing province—with numerous large steel enterprises and vast production capacity—the province possesses strong export capabilities while meeting domestic demand. As shown in Figure 4-1, compared with several other steel-producing provinces (Sichuan, Henan, and Shanxi), Hebei's steel export value has remained at a high level. In 2024, the value of Hebei's steel exports reached as high as $4.446 billion, accounting for about 6.3% of the nation's total steel export value.

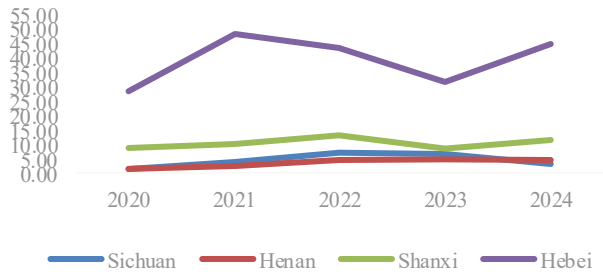


Figure 4-1. Export Values of Selected Steel-Producing Provinces, 2020–2024 (USD 100 million)

Source: General Administration of Customs.

4.2. Trends in Export Volume and Value

As shown in Figure 4-2, from 2020 to 2024, the export value of Hebei Province's steel industry exhibited a pattern of development marked by fluctuations. Due to the impact of the COVID-19 pandemic, which restricted various economic activities, both domestic and international markets for various products experienced a sharp decline in supply and demand. Consequently, exports from Hebei Province's steel industry were severely impacted in 2020, with export volumes declining significantly and export value dropping to as low as $2.82 billion. With the gradual economic recovery in the post-pandemic era, various industries have been adjusting, and exports from Hebei Province's steel industry have also shown signs of recovery. At the same time, countries around the world have been implementing policies to stimulate market demand. Given the interdependence among various industries, both the volume and value of exports from Hebei Province's steel industry increased to some extent in 2021, with export volume reaching 5.0387 million metric tons and export value rising to $4.805 billion. From 2022 to 2024, as international market demand continued to recover, Hebei's steel industry actively expanded into international markets such as the Association of Southeast Asian Nations (ASEAN) and the European Union (EU), establishing closer export trade relationships with multiple countries and regions. However, at the same time, protectionist tendencies emerged internationally, leading to the introduction of a series of trade policies detrimental to globalization. Some countries imposed high tariffs on steel products and erected trade barriers, which inadvertently increased the difficulty of exporting steel from Hebei.

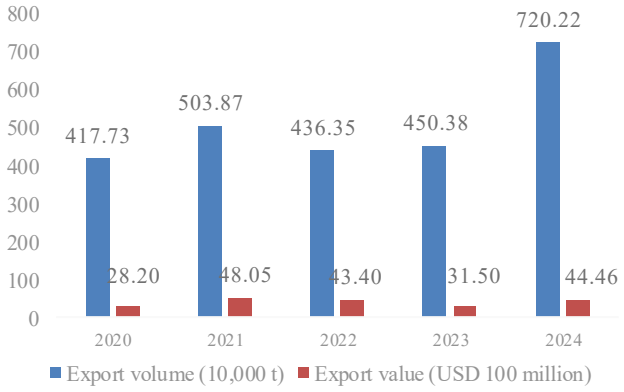


Figure 4-2. Steel Export Volume and Value in Hebei Province, 2020–2024

Data sources: General Administration of Customs; National Bureau of Statistics.

4.3. Export Trade Patterns

4.3.1. General Export Trade

Table 4-1. Export Value of Steel by Trade Mode, 2020–2024 (USD million)

Year	General Trade	Processing Trade	Overseas	Other	Total
2020	2311.69	12.51	10.63	485.17	2820.00
2021	3244.21	114.19	37.11	1409.49	4805.00
2022	3288.66	366.48	28.28	656.58	4340.00
2023	2608.48	90.00	13.80	437.72	3150.00
2024	4040.45	78.59	6.33	320.63	4446.00
Total	15493.49	661.77	96.15	3309.59	19561.00

Analysis of the data shows that general trade exports in Hebei Province's steel industry exhibited distinct phased characteristics during the 2020–2024 period. In 2020, the value of general trade exports in the province's steel industry reached 2,311.69 million U.S. dollars, indicating that general trade exports possess a certain level of market competitiveness. From 2021 to 2022, as the global economy recovered, export value rose from $3,244.21 million to $3,288.66 million, driven by cost and production capacity advantages. However, in 2023, as international trade protectionism intensified and non-tariff barriers—such as anti-dumping measures—gradually increased, export value fell again to $2,608.48 million. In 2024, general trade exports rose to $4,040.45 million. When compared to national steel export trends, the fluctuations are closely correlated. In competition with other provinces strong in steel production, Hebei's gaps in technological innovation, product value-added, and resource-logistics integration have gradually become apparent, necessitating urgent change. General trade is the primary export method for Hebei Province's steel industry. Under this trade model, steel enterprises in Hebei independently produce steel products and then export them directly to international markets, allowing them to exercise greater control over every stage of the process—including production, pricing, and sales. As the province's steel industry continues to optimize its technology and gradually improve product quality, enterprises are becoming increasingly competitive in the international market. Consequently, they are more inclined to choose the general trade method—which offers greater autonomy—to export their products and thereby directly participate in international market competition.

4.3.2. Processing and Export Trade

Data shows that from 2020 to 2024, the total value of export trade under the processing-trade arrangement for the steel industry in Hebei Province was $661.77 million. This represents another major export channel for Hebei's steel products, second only to general export trade. Although processing-trade is not the dominant trade method, it plays an indispensable role in sectors such as welded steel pipes. In terms of export scale, the processing-trade sector has generally exhibited a trend of growth amid fluctuations. In 2020, due to the impact of the global pandemic, unstable international market demand, and the introduction of domestic policies related to steel production capacity, Hebei Province's steel processing-for-export trade faced severe challenges, with the trade value dropping to as low as $12.51 million. As the global economy gradually recovered, the scale of processing-for-export trade saw significant growth in 2022, reaching $366.48 million. At the same time, the Belt and Road Initiative has also brought many new opportunities for the steel industry's processing trade exports in Hebei Province. However, during the 2023–2024 period, amid the tug-of-war between globalization and deglobalization, some Western countries enacted numerous tariff and non-tariff policies that affected the processing trade exports of Hebei Province's steel industry.

4.3.3. Export Trade via Overseas Contracting Projects

Compared to general trade and processing trade under export-processing arrangements, export trade via overseas contracting projects in Hebei Province's steel industry accounts for a relatively small share of total export trade because such exports depend on the number and scale of overseas engineering projects undertaken by provincial firms. The export value of overseas contracting projects in the province's steel industry followed an upward-then-downward trend, peaking in 2021 at $37.11 million. Overseas contracting exports in Hebei Province's steel industry refer to a comprehensive commercial activity in which steel enterprises and related engineering units within the province—possessing the appropriate qualifications and capabilities—organically integrate multiple aspects such as steel product manufacturing, engineering and technical services, and the supply of supporting facilities, with the core objective of undertaking overseas engineering projects to export these services to international markets. This export model helps expand international market share, promote technological innovation in the steel industry, and enhance employees' multidisciplinary skills.

4.4. Export Trade Structure

After collating data on the categories of export products in Hebei Province's steel industry from the Information Network of the Development Research Center of the State Council, it was found that the variety of steel products is extensive, making it difficult to analyze each category individually. Therefore, this paper selected seven major commodity categories in the steel industry frequently mentioned on the Information Network of the Development Research Center of the State Council (with codes 7202, 7208, 7210, 7216, 7217, 7223, and 7225).

As shown in Figure 4-3, export values differ substantially across product categories. The categories with relatively high export values are 7208 (flat-rolled products of iron or non-alloy steel, width 600 mm or more, hot-rolled, not clad, plated or coated), 7210 (flat-rolled products of iron or non-alloy steel, width 600 mm or more, clad, plated or coated), 7216 (angles, sections and profiles of iron or non-alloy steel), 7217 (wire of iron or non-alloy steel), and 7225 (flat-rolled products of other alloy steel, width 600 mm or more). In contrast, 7202 (ferroalloys) and 7223 (wire of stainless steel) recorded very low export values. Categories 7208, 7210, 7216, and 7225 are

basic steel materials used in infrastructure and finished-goods production, so their high export values are consistent with Hebei's role as a supplier of primary and intermediate products. Category 7217 also recorded high values in 2020–2022 but declined sharply thereafter. Overall, the product mix remains concentrated in flat-rolled and long products, while more differentiated alloy and downstream products account for a small share. Hebei's steel industry should therefore guard against a "comparative advantage trap" in which large volumes of standard products generate thin export margins.

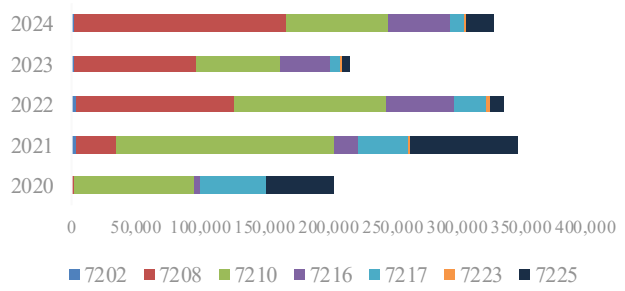


Figure 4-3. Export Value of Major Steel Product Categories in Hebei Province, 2020–2024 (USD 10,000)

Source: Information Network of the Development Research Center of the State Council.

4.5. Export Market Analysis

4.5.1. Traditional Markets

Table 4-2 reports the regional distribution of Hebei's steel exports, and Table 4-3 reports selected country markets within each region. Asia is the largest market, followed by Latin America, Europe, and Africa. South Korea, Vietnam, Thailand, Saudi Arabia, and the United Arab Emirates are the main Asian destinations, while Brazil, Peru, and Panama account for most of the Latin American total.

Table 4-2. Regional Distribution of Steel Exports, 2020–2024 (USD 100 million)

Region	2020	2021	2022	2023	2024
Asia	18.95	30.72	27.68	20.75	28.85
Latin America	3.51	7.30	4.92	4.24	5.98
Europe	1.67	4.04	4.03	2.84	3.30
Africa	3.25	4.67	5.14	2.72	5.37
Other countries and regions	0.82	1.32	1.63	0.95	0.96
Total	28.20	48.05	43.40	31.50	44.46

Source: General Administration of Customs.

Note: Other countries and regions include unlisted markets. Totals match Figure 4-2.

Based on Tables 4-2 and 4-3, this study finds that Hebei Province's major steel trading partners have remained relatively stable. Although the primary target markets have remained relatively stable, the rankings of these markets in terms of steel export value have been constantly shifting.

Asia is the primary destination for Hebei Province's steel exports, including countries such as South Korea and Vietnam. In 2024, the value of steel exports from Hebei Province's steel industry to the Asian region reached $2.885 billion. This is due to the Asian market's inherent advantages, such as short shipping distances and low transportation costs. Furthermore, between 2020 and 2024, rapid economic growth in some Asian countries led to a large number of infrastructure projects—such as bridges, roads, and industrial parks—which drove demand for steel from Hebei Province's steel industry. Industry reports suggest that energy-sector investment in several Latin American countries has also supported steel demand. In 2024, the value of steel exports from Hebei Province's steel industry to Latin America reached $598 million. Countries across Europe have very high requirements for the quality and environmental standards of steel products. Exports to Europe include both standard and higher-grade products, and the market's quality and environmental requirements are stringent. This explains why the European market serves as a target market for Hebei's steel exports; in 2024, the value of steel exports from Hebei's steel industry to Europe reached $330 million. Unlike other rapidly developing regions, African countries have a weak industrial base. However, from 2020 to 2024, Hebei Province's steel exports to the African market showed a fluctuating growth trend. This is because African countries have been vigorously promoting infrastructure development in recent years, resulting in enormous demand for various types of steel raw materials and steel products.

Table 4-3. Major Country Markets for Hebei's Steel Exports, 2020–2024 (USD 100 million)

Country/Region	2020	2021	2022	2023	2024
Asia					
South Korea	2.52	6.40	4.79	4.08	4.00
Vietnam	2.49	3.31	4.08	2.52	4.36
Thailand	1.78	2.20	1.62	1.02	1.41
Saudi Arabia	1.35	0.81	1.51	1.33	2.43
United Arab Emirates	0.95	1.52	1.13	1.57	3.16
Latin America					
Brazil	0.49	1.65	1.00	1.09	1.17
Peru	0.97	1.16	0.82	0.45	0.54
Panama	0.06	0.08	0.13	0.16	0.18
Europe					
Belgium	0.14	0.98	0.46	0.55	0.83
Portugal	0.15	0.56	0.50	0.10	0.20
Italy	0.38	1.06	1.13	0.37	0.61
Africa					
Morocco	0.01	0.10	0.08	0.00	0.02
Ghana	0.44	0.36	0.31	0.16	0.22
Nigeria	0.80	1.13	1.23	0.53	0.65

Note: Countries are grouped by region; regional totals are reported in Table 4-2. Source: General Administration of Customs.

4.5.2. Market Competitive Landscape

From a domestic perspective, the steel industry in Hebei Province faces intense competition in global steel trade. Coastal provinces such as Jiangsu and Shandong, leveraging their geographical advantages and high-end industrial structures, hold significant market shares in Southeast Asia, Europe, and the United States. Although Hebei Province's steel industry possesses certain economies of scale and the advantage of a complete supporting industrial chain, its export mix remains concentrated in standard steel products. Rapid economic development has led to a sharp increase in pressure in the low- to mid-end markets, necessitating further adjustments to the structure of Hebei's steel exports. Internationally, Hebei's steel exports are primarily directed toward traditional markets, concentrated in regions such as

Asia, Latin America, and Europe. The Asian market serves as the core export region for Hebei's steel industry, with relatively stable demand in Southeast Asia and East Asia—including Thailand, Vietnam, South Korea, and Japan—but it currently faces risks and challenges posed by significant increases in local production capacity and low-price competition in the international market. The Latin American market holds considerable growth potential; however, it is currently caught in the tug-of-war between globalization and deglobalization. Influenced by trade protectionist policies, export fluctuations in this region are quite pronounced. At the same time, given the European market's substantial demand for high-end steel products and the stringent environmental standards in the international market, Hebei's steel industry must implement supply-side reforms and enhance its green, low-carbon technology capabilities to boost its competitiveness in the global marketplace.

5. Problems in the Export Trade of Hebei Province's Steel Industry

5.1. The Export Structure of Steel Products Is One-Dimensional

Hebei ranks among the top provinces in steel production, and its crude steel output—much of it low-value-added—accounts for roughly one-fifth to one-quarter of the national total. Most of these low-value-added steel products are produced by the influx of small and medium-sized private steel enterprises. These enterprises suffer from certain issues regarding irrational production and export structures; with profit maximization as their primary objective, they tend to cut corners in areas such as raw material selection, technological investment, environmental protection, and the selection of export destinations. This is detrimental to the sustainable development of Hebei's steel industry. Under these circumstances, it is extremely difficult to rely on the "invisible hand" of the market to regulate the export structure and scale of Hebei's steel industry. At the same time, there is a certain degree of lag in the formulation of government policies, which ultimately results in an irrational production and export structure for the province's steel industry. Furthermore, the province's steel exports are primarily concentrated in traditional sectors such as sheet steel, steel pipes, bars, and wire rods. In 2024, the export value of steel plates was relatively high, accounting for a significant proportion of total steel exports and becoming the main component of exports. Although the scale of pipe exports was not as high as that of steel plates, they still held a certain market share in niche markets such as oil and natural gas transportation. Meanwhile, bars and wire rods are generally used in reinforced concrete structures in the construction industry, making them categories with relatively high export values as well. This high concentration on these categories means that other types of steel products—especially those with high added value and high-tech content—account for a very small proportion of total exports.

5.2. Technical Standards for Export Products Need Improvement

In Hebei's steel industry, small and medium-sized private enterprises account for a relatively large share, and they generally suffer from insufficient investment in technology and innovation. First, the products manufactured by Hebei's steel industry are mostly low-value-added items that do not require excessive technical or financial investment; consequently, the province's investment in steel industry technology remains relatively low. In countries with more developed steel industries, technological upgrading accounts for a substantially larger share of sales revenue, enabling them to produce high-quality, high-value-added products. Although China has massive steel production, a large proportion of its output consists of low-value-added steel products, and it still imports a significant share of certain high-grade steel products. As globalization deepens, demand in the international market for steel products is increasingly focused on high-quality, high-value-added items. However, the technical standards of steel products produced in Hebei Province fall far short of these requirements, which will inevitably lead to significant difficulties for this major Chinese steel-producing province in exporting its steel products.

In the realm of high-value-added products, Hebei's steel industry lags significantly behind international advanced standards. The province relies primarily on imports for such products, reflecting shortcomings in its technical standards system—specifically manifested in outdated production processes, an imperfect quality control system, and a low level of intelligent manufacturing. As evidenced by the production models of some steel enterprises in Hebei Province, the industry's awareness of standardization remains relatively weak, with operations still focused primarily on meeting basic production requirements. At the same time, the testing and certification system for the province's steel products is not yet fully developed, and there is a lack of cooperation with third-party certification bodies that meet international standards. There is also a certain degree of disconnect between upstream and downstream enterprises in terms of standard alignment, which hinders efficient collaboration along the province's steel industry supply chain.

5.3. Environmental Constraints on Steel Exports

The steel industry is characterized by high energy consumption and high pollution emissions, and Hebei's steel sector ranks among the highest in the country in this regard. Annual steel pollution emissions are enormous, leading to severe pollution problems in Hebei. In recent years, the province's steel industry has faced numerous challenges in exports, with environmental issues emerging as a key factor constraining its development. Given the region's historically severe air pollution, pollution issues in the steel industry—a major energy- and resource-consuming sector—have become increasingly prominent, drawing significant attention from all sectors of society. In response, the government has taken decisive action to overhaul the steel industry and other heavy industries through a series of stringent measures, such as shutting down non-compliant polluting enterprises, mandating the installation of environmental protection equipment, and enacting various environmental standards and policies, with the aim of alleviating environmental protection concerns. At the export level, recent evidence indicates that the EU CBAM could reduce Chinese steel export volume by about one-third and export profits by more than half, while lowering embodied carbon intensity would substantially reduce the cost burden [11–13].

However, in the actual implementation of environmental policies, investment in energy conservation and emissions reduction among various steel enterprises in Hebei Province

has shown a polarized trend. To meet environmental requirements and maintain their existing operations, large steel enterprises are willing to invest heavily in purchasing and installing environmental protection equipment. However, with the overall steel market currently in a slump and environmental facilities being prohibitively expensive, these major steel enterprises must shoulder high environmental costs while also grappling with challenges such as low market demand and falling product prices, resulting in a sharp increase in pressure to survive in the market. In stark contrast, many small, privately-owned steel enterprises—constrained by limited capital, weak technical capabilities, and an inability to cope with significant market fluctuations—often produce steel products that are highly homogeneous and offer low added value, placing them at a disadvantage in the face of intense market competition. In this sluggish market environment, in order to survive, they can only rely on increasing output and cutting costs to maintain their operations; they lack the surplus funds to invest in environmental protection facilities, and the use of environmental protection equipment in their production processes is virtually nonexistent.

This vast disparity in environmental investment directly results in a significant gap in production costs between large and small steel enterprises. The environmental costs incurred by large steel enterprises are ultimately passed on to product prices, which makes their products less price-competitive in international export markets; conversely, small steel enterprises, with their low environmental costs, can offer relatively lower prices and thus capture a portion of the market share. Over time, this situation is highly prone to a Gresham's-law-type crowding-out effect, in which lower-cost, less environmentally compliant products displace cleaner ones. This has placed steel enterprises that strictly adhere to environmental standards in a dilemma: on the one hand, they continue to invest heavily in pollution control and emissions reduction to meet environmental requirements; on the other hand, the sluggish steel market makes it difficult to fully recoup these high environmental costs through product sales, significantly eroding their profitability. Some enterprises, unable to bear the burden, even face the risk of bankruptcy.

5.4. Cutthroat Price Competition in Steel Exports

Within the export landscape of Hebei Province's steel industry, low-price competition has become a prominent issue that cannot be ignored. From the perspective of the industry's internal structure, Hebei Province has a large number of steel enterprises of varying sizes. On the one hand, many small and medium-sized steel enterprises, lacking advanced technological innovation capabilities, primarily focus on low-value-added products, resulting in a high degree of product homogeneity. In order to secure a share of the limited international market, these small and medium-sized steel enterprises often resort to the most direct strategy of price competition, squeezing their profit margins and using low prices as their selling point. Typically lacking a sound cost accounting system, these enterprises neglect long-term investments in environmental protection and R&D, focusing solely on capturing immediate market share—a trend that drives export prices down repeatedly.

On the other hand, while large steel enterprises possess certain technological advantages, they are also forced to engage in low-price wars to maintain normal production line operations amid an overall market downturn and overcapacity. At the same time, external factors such as exchange rate fluctuations and unstable raw material prices have further intensified this low-price competition. When the RMB appreciates, the prices of steel export products denominated in U.S. dollars rise relatively, reducing their competitiveness; to mitigate this impact, enterprises tend to lower their product prices in local currency; conversely, when raw material prices fall, companies' costs decrease; rather than investing these savings in R&D and upgrades, some companies seize the opportunity to further lower export prices in an attempt to capture a larger market share. This interplay of factors has made the phenomenon of low-price competition in Hebei Province's steel industry increasingly severe, making sustainable development for the sector extremely challenging.

6. Recommendations for Export Trade Strategies

6.1. Closely Monitor Market Demand Trends

In today's increasingly integrated and fiercely competitive global economy, the steel industry in Hebei Province faces numerous challenges in its export trade, and closely monitoring market demand trends is undoubtedly the key to breaking through these challenges. To address this issue, in-depth and precise market research is indispensable. Steel enterprises in Hebei Province need to join forces with relevant industries to establish professional research teams. These teams should be dispatched to major export destinations such as Europe and Latin America to immerse themselves in local downstream industries—such as construction and machinery manufacturing—and gain insights into localized market needs. At the same time, by building a big data monitoring system to integrate international information on the steel industry and applying professional analytical techniques, enterprises can forecast trends in steel market demand and promptly track dynamic changes in factors such as raw material prices, product prices, and product mix, thereby laying a solid foundation for export strategies. At the same time, optimizing the steel product mix is imperative. The industry should target high-end manufacturing, increase investment in the research, development, and innovation of high-value-added steel products, collaborate with research institutions to overcome technical challenges, impose strict high-quality standards on steel enterprises of all sizes, accelerate infrastructure development in emerging markets, and develop steel products tailored to international demand to meet diversified and localized needs.

Furthermore, emphasis should be placed on building a diversified market network, avoiding reliance on any single market and reducing market risks associated with the export of Hebei's steel industry. While continuously consolidating traditional markets such as Southeast Asia and the Middle East, the province's steel industry should also deepen its presence in emerging markets such as Latin America and Eastern Europe to broaden sales channels.

6.2. Strengthen Technology Monitoring and Benchmarking

To address the export trade challenges facing Hebei's steel industry, comparable benchmark companies should be selected globally based on multiple factors, including enterprise scale, product structure, and market positioning. For large state-owned steel enterprises in Hebei,

benchmarking against international steel giants such as ArcelorMittal is recommended to thoroughly study their advanced experience in transnational operations, large-scale production organization, high-end product R&D, and global marketing; For small and medium-sized steel enterprises specializing in specialty steel production, benchmarking against companies with unique expertise in this field—such as Japan's Daido Special Steel and Sweden's Sandvik—can help draw on their practices in materials R&D, quality control, and market segmentation. Conducting regular, comprehensive analyses of benchmark companies—through their annual financial reports, R&D input-output ratios, new product export rates, and customer satisfaction survey results—can provide a deeper understanding of their export operations. By thoroughly understanding the strengths and weaknesses of these benchmark companies, Hebei's steel enterprises can identify the gaps between themselves and these peers, clarify key areas for technological advancement, and implement specific plans to catch up and surpass them.

At the same time, the steel industry in Hebei Province needs to improve its long-term support mechanisms. A dedicated benchmarking fund could be considered, with its size and contribution rate determined through industry consultation, to support technology introduction and sustained benchmarking progress.

6.3. Establish and Improve a Green Supply Chain

Regarding the export challenges facing Hebei's steel industry, the focus should be on green design. The industry can proactively strengthen collaborative innovation with universities and research institutions to collectively integrate environmental protection principles throughout the entire steel product R&D process. It is essential to establish a scientific and sustainable approach to environmental protection and incorporate green production into corporate development strategies and corporate culture, thereby enhancing corporate social responsibility. At the same time, close attention should be paid to leading international green product standards. Detailed rules and regulations tailored to the characteristics of Hebei's steel industry should be formulated, and relevant policies should be introduced to assist enterprises in obtaining internationally recognized certifications, thereby paving a solid path for steel product exports. Green procurement is also key to ensuring a stable and environmentally friendly supply chain. A rigorous green access system for steel suppliers must be established, comprehensively evaluating the environmental credentials of raw material suppliers—such as iron ore and coke—and strictly selecting green partners capable of advancing alongside the industry. Green clauses must be clearly stipulated in daily procurement contracts, and a specialized oversight team should be formed to strictly monitor compliance, ensuring that raw material supplies are both high-quality and environmentally friendly, thereby firmly underpinning the upstream foundation of the steel industry's exports. As they move toward green production, steel enterprises must take bold steps to adopt internationally leading green technologies—such as smelting reduction ironmaking—and take decisive action to phase out outdated production capacity, thereby breathing new life into production processes. Simultaneously, existing equipment should undergo in-depth energy-saving and environmental upgrades to maximize energy utilization and minimize pollution emissions, transforming factories into benchmarks for green manufacturing. This will comprehensively enhance product quality and production efficiency. Leveraging outstanding green competitiveness, the steel industry in Hebei Province will achieve leapfrog development in both the volume and quality of its exports, securing a firm foothold in the international market.

6.4. Accelerate the Development of a Differentiated Brand

Amid the fiercely competitive global steel market today, brand development and differentiated competition strategies are crucial for the Hebei steel industry as it seeks breakthroughs in export trade. Regarding brand development, the Hebei steel industry must rally the efforts of all stakeholders. The Hebei Provincial Government should take the lead in integrating provincial resources, collaborating with enterprises and industry associations to forge a unified “Hebei Steel” brand. By leveraging platforms such as international exhibitions and forums to comprehensively showcase the industry's strengths, and utilizing various media channels to disseminate promotional materials and tell the brand's story, the province can enhance the brand's international visibility and reputation, establishing it as a symbol of quality. At the same time, strengthening corporate brand development is of paramount importance. Each enterprise must build upon its unique characteristics, draw upon its cultural heritage, and cultivate a brand with distinctive appeal. For example, enterprises with technical expertise should emphasize the transmission of traditional craftsmanship to build a professional brand image, integrate brand strategy into the entire production process, and add value to the brand through high-quality products and services. In terms of differentiated competition, product differentiation is a key entry point. By gaining a deep understanding of international market demands, enterprises can develop specialty alloy steels tailored to the high-end manufacturing sectors in Europe and the United States, and focus on infrastructure projects in emerging markets by introducing construction steels adapted to local conditions—thereby opening up sales channels through targeted and differentiated products. Furthermore, service differentiation also significantly boosts exports. By establishing localized service teams covering major global markets—teams that are familiar with local conditions, can respond swiftly to customer needs, and provide one-stop services—companies can build closer relationships with customers. Additionally, by developing personalized service plans tailored to different clients—such as offering customized production and financial services to large clients, and providing convenient processing of small-volume orders to small and medium-sized clients—companies can gain a firm foothold in international markets through differentiated services, propelling Hebei Province's steel industry exports to new heights.

7. Conclusion

As a major steel production and export base in China, Hebei Province's importance to the nation's economic development is self-evident. Through an analysis of the current state of the steel industry's export trade in Hebei Province, this paper identifies certain characteristics in terms of export volume, trade methods, and export structure. In terms of export volume, Hebei Province ranks among the top

in the country; however, in recent years, its growth trend has experienced some fluctuations due to factors such as the domestic and international economic environment and trade frictions. Regarding export structure, although the proportion of high-end products has increased somewhat, the sector remains dominated by mid- to low-end steel products, resulting in relatively low value-added. In terms of trade modes, exports are primarily conducted through general trade; the export approach is relatively monotonous, competitiveness is insufficient, and efforts to tap into emerging markets need to be strengthened.

In response to the challenges facing Hebei Province's steel industry in export trade—such as a one-dimensional export structure, rapidly increasing environmental pressures, and insufficient innovation capacity—this paper proposes a series of optimization strategies. These include strengthening technological innovation, improving product quality and value-added to address trade barriers, increasing investment in environmental protection to promote green production and meet domestic and international environmental requirements, actively expanding into emerging markets, optimizing the export market layout, and reducing over-reliance on traditional markets and trade methods. By implementing these measures, Hebei Province's steel industry can be expected to contribute to its export trade.

In the future, the steel industry's export trade in Hebei Province will continue to face new opportunities and challenges. As the "Belt and Road" Initiative advances further, the demand for infrastructure construction in countries along the route will only increase, providing a vast market for Hebei's steel exports. At the same time, domestic industrial restructuring and technological upgrades will drive the steel industry toward high-end, intelligent, and green development, thereby enhancing the international competitiveness of its products.

However, we must remain vigilant at all times. The trend of rising global trade protectionism is unlikely to change in the short term, and trade frictions continue to occur frequently, impacting the steel industry's exports in Hebei Province. Furthermore, as environmental standards continue to rise, the environmental protection costs for steel enterprises will increase further, placing higher demands on their sustainable development. To achieve sustainable development in Hebei Province's steel export trade, further optimization efforts are needed in the future: First, continue to increase investment in scientific and technological innovation, achieve breakthroughs in key core technologies, and enhance the industry's capacity for independent innovation and product value-added; second, strengthen international cooperation and exchange, actively participate in the formulation of international standards, and enhance the steel industry's influence in the international market; third, further optimize the industrial structure, promote mergers and reorganizations among steel enterprises, increase industry concentration, and strengthen enterprises' risk-resilience; fourth, strengthen talent development by attracting and cultivating a group of high-caliber professionals with an international perspective and innovative capabilities to provide intellectual support for the development of the steel industry.

It is believed that through continuous effort and innovation, the export trade of Hebei Province's steel industry will achieve higher-quality development in the future and make a greater contribution to the province's sustained economic growth.

This study has several limitations. It relies on descriptive customs and provincial data for 2020–2024 and does not estimate causal effects. Firm-level heterogeneity, the specific effects of trade measures, and the relationship between environmental regulation and export competitiveness remain important questions for future research.

The authors thank the editors and anonymous reviewers for their constructive comments and suggestions.

References

[1] Zhu, R. (2021). Study on the coordinated reduction of air pollutants and CO2 in the iron and steel industry of typical cities in Hebei Province [Master's thesis, Tianjin University]. (in Chinese)

[2] Shi, X., & Zhang, Q. (2020). Current situation of China-US trade friction and response strategies of related industries in China. Foreign Economic Relations and Trade, (1), 10–13. (in Chinese)

[3] Ma, Z., Wang, H., & Zhang, J. (2022). Research on the internationalization path of steel enterprises in Hebei Province under the Belt and Road Initiative. Hebei Metallurgy, (8), 74–79. https://doi.org/10.13630/j.cnki.13-1172.2022.0816 (in Chinese)

[4] Ma, X. (2024). Current status and countermeasures of steel export trade in Hebei Province. China Storage & Transport, (12), 127–128. (in Chinese)

[5] Liu, L.-J., Creutzig, F., Yao, Y.-F., Wei, Y.-M., & Liang, Q.-M. (2020). Environmental and economic impacts of trade barriers: The example of China–US trade friction. Resource and Energy Economics, 59, 101144. https://doi.org/10.1016/j.reseneeco.2019.101144

[6] Bahmani-Oskooee, M., & Kanitpong, T. (2019). Asymmetric effects of exchange rate changes on Thailand-China commodity trade: Evidence from 45 industries. The Chinese Economy, 52(3), 203–231. https://doi.org/10.1080/10971475.2018.1548142

[7] Johnson, S., Deng, L., & Gençer, E. (2023). Environmental and economic evaluation of decarbonization strategies for the Indian steel industry. Energy Conversion and Management, 293, 117511. https://doi.org/10.1016/j.enconman.2023.117511

[8] Kawabata, N. (2017). Where is the excess capacity in the world iron and steel industry? A focus on East Asia and China (RIETI Discussion Paper No. 17-E-026). Research Institute of Economy, Trade and Industry.

[9] Shi, S., Li, H., Tang, H., & Liu, Y. (2023). A study of the impact of de-capacity policies on industry capacity utilization paths: Evidence from the Chinese steel industry. PLOS ONE, 18(12), e0295613. https://doi.org/10.1371/journal.pone.0295613