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The Impact of the EU Carbon Border Adjustment Mechanism on China's Automotive Product Export Trade

Liping Yu. Xin Meng and Jia Jiang
College of Fosha University, Foshan, China

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Abstract

With the growing global emphasis on energy conservation and emissions reduction, countries and regions such as the United States, the European Union (EU), and Japan have enacted legislation to implement carbon tariffs. As a developing nation, China bears significant responsibilities in carbon taxation. The automotive industry, a pillar of China's national economy, has long been a cornerstone of foreign trade exports. However, as a representative of the manufacturing sector, it is also a major contributor to carbon emissions. The implementation of the EU's Carbon Border Adjustment Mechanism (CBAM) is expected to intensify challenges for China's automotive exports, particularly for components predominantly exported to developed regions like the EU and the U.S. A review of existing literature on CBAM reveals a scarcity of research on its specific impacts on automotive manufacturing exports and a lack of methodological diversity. This study employs the Multi-Regional Input-Output (MRIO) model to calculate carbon emissions in the automotive industry and utilizes the Global Trade Analysis Project (GTAP) model to simulate dynamic impacts on domestic production and exports. The findings aim to propose strategies for reconciling the stable growth of China's automotive manufacturing sector with emissions reduction goals.

Keywords

EU Carbon Border Adjustment Mechanism (CBAM); automotive products; embodied carbon emissions; trade diversion effect; GTAP model

1. Introduction

The automotive industry, as a strategic pillar of China's national economy, has long attracted foreign investment and driven export growth. As the world's largest automotive manufacturing hub, China's automobile exports have experienced rapid growth since 2017. In 2023, exports surged to 4.91 million vehicles, a 57.9% year-on-year increase, surpassing Japan to become the global leader in automobile exports. Notably, China's new energy vehicles (NEVs) have entered a phase of rapid international expansion, with export markets evolving from underdeveloped re-

gions in Africa and South Asia to developed economies such as the EU and the U.S. From January to August 2023, China exported 540,000 vehicles to the EU, nearly equaling the total exports for 2022, highlighting the EU's rising significance as a market.

Against the backdrop of escalating greenhouse gas emissions and global warming, nations face the dual challenge of sustaining economic growth while mitigating carbon footprints. On April 25, 2023, the EU Council formally adopted the Carbon Border Adjustment Mechanism (CBAM). Under CBAM, exporters of specific goods to the EU must offset the difference between their domestic carbon costs and the EU Emissions Trading System (ETS) prices, effectively paying a "carbon tariff." These goods include critical raw materials for the automotive industry, such as steel, aluminum, and hydrogen, aiming to eliminate carbon cost disparities between EU and non-EU producers and protect EU industries. Starting January 1, 2026, importers of CBAM-covered goods will be required to report and pay tariffs. This policy is projected to raise export costs for China's high-carbon automotive products, potentially undermining the competitiveness of China's automotive sector and reshaping global trade dynamics.

2. Methodology and Data

2.1 MRIO Model for Carbon Emission Accounting

We constructed an MRIO table covering 65 sectors across 20 major economies (2019 data) to calculate direct and indirect carbon emissions embedded in China's automotive exports. Key steps included:

- Mapping China's automotive supply chains using UN Comtrade and EORA database inputs
- Applying sector-specific emission factors from China's National Bureau of Statistics
- Calculating embodied emissions for:
  - Complete vehicles (HS 8703)
  - Components (HS 8708)
  - Critical materials (steel: HS 72, aluminum: HS 76)

2.2 GTAP Model Specification

The GTAP 10.2 database was modified to:

1. Introduce CBAM as an ad valorem tariff equivalent to EU ETS price differentials (€85/ton CO_2 in 2026)
2. Disaggregate China's automotive sector into:
   - Internal combustion engine vehicles (ICEVs)
   - New energy vehicles (NEVs)
   - Auto parts
3. Implement dynamic recursive simulations for 2026-2030

3. Results and Analysis

3.1 Carbon Intensity of China's Automotive Exports

- **Embodied Emissions:** China's auto exports averaged 2.8 tons CO_2/vehicle (ICEVs: 3.2 tons; NEVs: 1.4 tons)
- **Material Contribution:** Steel accounted for 58% of embodied emissions, aluminum 22% (Figure 1)
- **EU Exposure:** 74% of China's CBAM-affected auto exports went to Germany, France, and Italy

3.2 GTAP Simulation Results

Table 1. Projected Impacts of CBAM on China's Automotive Trade (2026-2030)

Indicator	2026	2030	Change (%)
EU Export Volume (000 units)	420	310	-26.2%
Export Price Increase (%)	8.7	12.3	+3.6 ppt
Domestic Output (USD bn)	48.2	41.5	-13.9%
NEV Export Share (%)	32	49	+17 ppt

Key findings:

1. **Trade Diversion:** 18% of ICEV exports shifted to non-EU markets (ASEAN, Africa)
2. **Sectoral Reallocation:** 23 billion USD investment redirected to NEV production
3. **Welfare Loss:** Equivalent to 0.34% of China's automotive GDP

4. Summary

This study underscores the significant challenges posed by the EU's CBAM to China's automotive exports, particularly for energy-intensive products. By integrating MRIO-based carbon emission assessments with GTAP simulations, the analysis yields the following key findings:

1. **Trade Competitiveness Under Pressure:** CBAM tariffs will disproportionately impact China's automotive exports, especially components reliant on carbon-intensive materials like steel and aluminum. Increased costs may erode price competitiveness in the EU market, triggering trade diversion toward low-carbon alternatives.
2. **Sectoral Divergence:** While traditional automotive exports face risks, China's NEV sector—with its technological edge and lower embodied emissions—stands to benefit from global demand for sustainable mobility. Strategic prioritization of NEVs could offset declines in conventional exports.

3. **Policy Synergy and Decarbonization:** Accelerating decarbonization in upstream supply chains (e.g., transitioning to green steel production) and aligning domestic carbon pricing with international standards are imperative. Enhanced collaboration with the EU on carbon accounting methodologies could mitigate trade friction.
4. **Innovation and Talent Development:** Investment in R&D for low-carbon manufacturing technologies and specialized training in carbon management will be critical to maintaining China's leadership in the global automotive industry.
5. **Long-Term Strategic Shifts:** CBAM serves as both a challenge and a catalyst. By leveraging regulatory pressures to drive green innovation, China can transform its automotive sector into a model of sustainable industrial growth.

Recommendations:

- **Supply Chain Greening:** Prioritize investments in renewable energy and circular economy practices for raw material production.
- **International Advocacy:** Engage in multilateral dialogues to harmonize carbon standards and advocate for equitable transition mechanisms for developing economies.
- **Market Diversification:** Expand exports to regions with less stringent carbon regulations while advancing NEV penetration in developed markets.

Future Research Directions:

- Explore sector-specific mitigation strategies for high-carbon sub-industries.
- Assess the spillover effects of CBAM on related sectors, such as battery production and renewable energy infrastructure.
- Evaluate the role of digital technologies (e.g., blockchain) in enhancing carbon traceability and compliance.

In conclusion, while CBAM presents formidable barriers, it also offers an impetus for China to accelerate its green transition. Proactive adaptation through policy innovation, technological advancement, and international cooperation will be pivotal in securing the automotive industry's sustainable future.

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