

Effects of the Carbon Border Adjustment Mechanism on Enterprises' Export Capabilities

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Received July 10, 2023; Revised August 12, 2023; Accepted August 20, 2023

Abstract In 2021, the EU proposed the Carbon Border Adjustment Mechanism (CBAM) to handle CO₂ emissions in international commerce and mitigate climate change's effects on the global economy. The CBAM modifies tariffs on imported commodities to prevent low-carbon nations from profiting from the efforts of other countries to reduce emissions, thereby leveling the playing field between nations with and without carbon pricing. This study investigates the effects of the CBAM on the global economy and export capacity. Data from the World Trade Organization, the Organisation for Economic Co-operation and Development, Taiwan Economic Journal, and the World Bank from 1990 to 2021 were analyzed using artificial intelligence techniques to identify factors related to society, the environment, infrastructure, government efficiency, macroeconomics, trade finance, and innovation technology that significantly affect CO₂ emissions per capita. A positive correlation was observed between CO₂ emissions and gross domestic product; economic development tends to increase CO₂ emissions. The prevalence of diabetes is identified as a significant factor in the European Union and elsewhere. In addition, high CO₂ emissions, exacerbating climate change, can affect the production and availability of food as well as indirectly cause health concerns such as diabetes. However, sustainable development can cause CO₂ emissions to stabilize or decrease in certain cases. In addition, the analysis revealed that Japan, the United States, and Australia have screened CO₂ emission factors and pay attention to the environment and energy-saving technology. Agricultural land is also a key target for reducing emissions, and carbon tariffs can be used to incentivize the reduction of greenhouse gas emissions in the agricultural sector. The results of this study have practical value and can guide decision-makers, including governments, businesses, scholars, and stakeholders, in balancing functional and performance indicators during decision-making.

Keywords: Carbon Border Adjustment Mechanism, CO₂ emissions, Corporate Social Responsibility, Diabetes prevalence

Cite This Article: Yen-Hui Kuo, "Effects of the Carbon Border Adjustment Mechanism on Enterprises' Export Capabilities." Journal of Business and Management Sciences, vol. 11, no. 4 (2023): 245-253. doi: 10.12691/jbms-11-4-4.

1. Introduction

Unusual and unexpected climatic disasters, such as extended periods of extreme heat and drought, are increasingly prevalent worldwide and have had devastating secondary effects, such as riverbeds drying up and becoming impassable for ships. These disasters have resulted in problems such as food and energy shortages, which have negatively affected people's lives and elevated climate change to a serious threat [1]. Extreme weather conditions are projected to become more frequent soon because of these problems, making people more susceptible to health problems and compromising their capacity to survive. Global CO₂ emissions must be lowered in response, but for decarbonization to be successful, businesses must also expand, innovate, and reduce the prices of certain technologies.

Acknowledging climate change as a global problem necessitating cooperative action, nations have begun to

prioritize reducing CO₂ emissions. The Kyoto Protocol was signed in 1997 at the third session of the United Nations Framework Convention on Climate Change (UNFCCC). To counteract global warming, the Kyoto Protocol mandates that nations reduce greenhouse gas emissions. Since then, the United Nations has held monthly conferences to reduce greenhouse gas emissions through global action.

Despite the tense geopolitical climate at the end of 2022, the 27th session of the Conference of the Parties (COP) of the UNFCCC managed to reach a revolutionary agreement to provide loss and damage funds to countries vulnerable to and severely affected by climate disasters and to establish new funding channels and special funds to assist developing countries.

1.1. Climate Action Plan

Climate action plans are in place in many nations to reduce greenhouse gas emissions. The European Union

(EU) suggested a new industrial strategy as well as policies and plans to protect biodiversity and the circular economy. The strategy bolsters a range of environmental sustainability measures, with the end goal of creating a climate-neutral economy, preserving and restoring biodiversity, and reducing pollution to ensure the stability of the EU's economy. The European Green Deal of 2021 aims to reduce emissions by at least 55% by 2030, compared with 1990 levels, and to achieve carbon neutrality by 2050 [2]; these goals were informed by regional politics, low-carbon policies, and post pandemic economic recovery policies [3].

1.2. Carbon Border Adjustment Mechanism

In 2021, the EU proposed the Carbon Border Adjustment Mechanism (CBAM) to handle CO₂ emissions in international commerce and mitigate climate change's effects on the global economy. To prevent low-carbon nations from profiting from the efforts of other countries to reduce emissions, the CBAM modifies tariffs on imported commodities. Instead of sending carbon-intensive industries to locations outside of Europe, the mechanism introduces a tax on imported coal, liquefied natural gas, and steel goods, which can help reduce CO₂ emissions worldwide. Carbon leakage occurs when businesses and activities from nations with high carbon prices move to nations with less stringent environmental regulations and lower carbon costs.

To prevent carbon leakage, many countries have implemented the CBAM or other policies that balance the trade competitiveness with carbon reduction. This is particularly the case for non-EU countries, which generally have less stringent legal systems and business regulations, as the movement of carbon-intensive industries abroad could result in the transfer of pollution, thereby negatively affecting the EU and the global climate. The purpose of implementing the CBAM is to ensure that all countries have equal responsibility in reducing emissions.

2. Purpose

Terrorism, rising geopolitical tensions, and political instability have contributed to a decrease in investment and trade, among other major economic and political problems affecting the global population. In addition, governments are struggling with mounting debt. Inflation has skyrocketed because of the COVID-19 pandemic, extreme climatic events, and the oil crisis, all of which are straining an already fragile economy. Decreased agricultural yields and sustained price increases may result from failure to address extreme climatic events in a timely matter, the effects of which can be compounded by major conflicts, such as the war in Ukraine.

The ability of carbon taxes to slow climate change has been widely acknowledged. The EU has advocated for a carbon border tax on imported products to create a fair playing field for competition and help the EU achieve net-zero carbon emissions [4]. The CBAM levies taxes on imported products depending on their CO₂ emissions to encourage low-carbon manufacturing and reduce

emissions throughout the EU. Because the CBAM might raise prices for imported products, which would counter the interests of countries that sell to the EU, some nations may reject it as a form of economic protectionism. Some nations also feel that basing the CBAM on CO₂ emissions is discriminatory against certain countries and violates the principles of free trade, which were created by the World Trade Organization (WTO) to promote fair competition and eliminate barriers to trade, such as tariffs and other levies (Table 1).

The objective of governmental regulation of enterprises is to stimulate commerce and ensure people's safety and health, protect the environment, and facilitate sustainable development. However, when rules become too complicated or disparities between nations emerge, corporate operational expenses increase, and international commerce suffers [5]. This study examines the link between carbon taxes and five key factors: climate change, trade and finance, the environment and agriculture, social development, and public sector management. The results can encourage countries to reduce carbon emissions in accordance with EU standards, promote global carbon reduction objectives, guide governments in developing carbon taxes, and help businesses select clean technologies and financial investment strategies [6].

3. Methodology

A total of 64 regions has implemented carbon pricing, covering approximately 21.5% of carbon emissions worldwide [7]. For example, the EU, China, Singapore, South Korea, Canada, Japan and the United States (California) use carbon pricing information as the basis for carbon trading and carbon fees, indicating that carbon pricing is essential for achieving net-zero carbon emissions. Carbon fees have become crucial worldwide and have caused the production costs to increase. Businesses pass on these costs to consumers, thereby increasing prices. This study explores the effects of the CBAM on the endogeneity of national policies and provides empirical evidence that taxes continue to play a key role in international trade.

Because of globalization in the latter half of the 20th century, products have formed a global value chain from design, manufacturing, and assembly to marketing. International trade and economic agreements tend to regionalize, and companies may struggle to control globalization and anti-globalization efforts and ensure the competitiveness of their products [8]. This study investigates the effects of the CBAM on companies' export capabilities and gross domestic product (GDP). This study also analyzes whether The global follows the CBAM to encourage international advocacy among decision-makers. By using artificial intelligence technologies such as an artificial neural network (ANN), this study identifies variables that affect CO₂ emissions (metric tons per capita). The variables are related to trade finance, climate change, the environment and agriculture, energy and mining, health and population, social development, and macroeconomics. In addition, this researcher considers the need for the government to continue to develop the CBAM based on data on public

sector management, another variable, which distinguishes this study from the rest of the literature.

3.1. New Trade Theory

According to the new trade theory (NTT), increases in the cost of trade (such as the costs of CO₂ emissions) lead to decreases in trade volume or changes in the structure

and composition of raw materials in international trade and play a crucial role in determining international trade patterns. Although numerous studies explore the factors that affect international trade, such as production location, market size, and operating costs, the effects of government tax policies on trade, especially tax systems that help

Table 1. Positions toward the CBAM by country.

Area	Nation	Position	Explanation
Europe	Germany	Neutral	Because the main heavy industries in Germany are export oriented, attitudes toward the CBAM are more conservative than those of other EU countries; worries about possible trade wars have also been expressed.
	The Netherlands	Support	Accepting the CBAM will facilitate global carbon reduction.
	Italy	Support	Funds collected through the CBAM are planned to be invested in a national restoration and sustainable development plan to reduce the high carbon emissions produced by the agriculture, forestry, and animal husbandry industries.
	France	Support	France is the main advocate of the CBAM in the EU. The French government believes that countries should be taxed on the basis of their carbon emissions and that the CBAM will help EU industries compete fairly with other regions; France has attempted to persuade other EU countries to adopt the CBAM.
	Spain	Support	Spain's agriculture, forestry, and animal husbandry industries produce high levels of carbon emissions, making the CBAM crucial.
North America	The United States	Opposed	The CBAM will have a major impact on the global economy, trade, and international relations. The EU should first use other carbon reduction methods, such as carbon reduction conventions. To protect its rights and interests, the United States developed a carbon tariff bill that can be introduced at any time.
Asia	China	Opposed	Climate change should not be used as a geopolitical bargaining chip, or as a tool used to attack other countries or erect barriers to trade.
	Japan	Opposed	The CBAM will affect the development of Japan's steel industry. A border carbon tax may also be imposed on imported products.
	South Korea	Opposed	The CBAM should not be an obstacle to international trade and should comply with WTO regulations prohibiting discrimination against foreign producers.
	India	Opposed	The CBAM is a protectionist measure and discriminatory against developing countries and should implement the CBAM and WTO norm compliance analysis.

Source: this study.

change production energy input, have been overlooked. These policies can affect international trade patterns [9]. High tax rates can increase a company's operational costs, weaken the competitiveness of products on the international market, reduce investment and innovation, and result in companies relocating to countries with lower tax rates. Conversely, certain tax incentives provided by the government can encourage companies to export, thereby enhancing their export capabilities [10].

Countries have responded differently to the EU's CBAM and imposed various tax rates (Table 1). The complexity and dynamic nature of international tax law increases the complexity and uncertainty of tax obligations, increases the legal costs of international trade, and weakens export capabilities [11]. Government tax policies can indirectly affect exchange rates, and changes in exchange rates affect products' export prices, which can affect their competitiveness in foreign markets [12]. Therefore, government policies affect the size and competitiveness of domestic and foreign markets, thereby affecting enterprises' export capabilities. When formulating carbon emission taxes, governments should consider how countries upstream and downstream in the product supply chain formulate carbon taxes rather than considering domestic carbon taxes alone. Empirical evidence indicates that only by jointly formulating carbon taxes can consumers and companies both benefit [13].

3.2. Environmental Economics

Carbon taxes can facilitate regional economic development, strengthen efforts to protect the environment, and improve social welfare policy [14]. Compliance with

carbon emission regulations is a corporate social responsibility (CSR), but it increases production costs and reduces competitiveness. For this reason, low-carbon production technology must be authorized through the WTO and the Agreement on Trade-Related Aspects of Intellectual Property Rights [15]. The right combination of policy and environmental economics can accelerate energy transformation [5]. Thus, a carbon tax is a crucial measure for the government to incentivize the development of green, emission-reducing technology [16], to ensure a reliable and affordable energy supply, and to achieve the seventh goal of the 2030 Sustainable Development Agenda [17].

3.3. Global Value Chain

The amount of foreign investment a nation receives is affected by its trade policies and integratedness into global value networks [18]. Increases in trade costs, such as those due to carbon taxes, change how the global population

participates in the creation of goods and services and can cause some factories to move [19]. Because rising carbon prices causes businesses to pare down activities that contribute to carbon emissions, governments establishing carbon tax quotas must ensure carbon tax caps remain within a narrow range [20]. However, during the COVID-19 epidemic, numerous consumers procured goods and services through shipping facilitates in the global value chain located in tax- or cost-effective zones [21]. Businesses often join international supply chains to procure affordable materials and access new consumer markets [22].

The relationship between carbon taxes and competitiveness in international trade is complex. This study enhances the NTT model by exploring relevant policy, with a particular emphasis on taxation. Most studies treat taxes as an exogenous variable and ignore countries' political influence on firms' export capacities in the context of global value chains. In addition to taxation, labor, innovation in pro-environmental technology, exchange rates, and other factors strongly affect trade competitiveness.

3.4. Sample

The CBAM decreases the risk of carbon leakage by levying taxes on imported products based on how much carbon is emitted during their production to create the conditions for fair competition among domestic and foreign producers. This study outlines the EU's CBAM tax on high-carbon leakage products, for which importers

are required to pay fees. Tables 2 and 3 summarize the 43 products that the EU's CBAM aims to regulate and their corresponding taxation rules, which are based on data from the Ministry of Finance. The product specific CBAM regulations strongly affected The global exports to the EU and the rest of the world from 2016 to 2022.

The data for this study are sourced from the WTO, the Organisation for Economic Co-operation and Development, the Taiwan Economic Journal, and the World Bank (Table 2). The data span 1990 to 2021 and are analyzed using artificial intelligence techniques to identify factors (1,441 in total) related to society, the environment, infrastructure, government efficiency, macroeconomics, trade finance, and innovation technology (independent variables) that significantly affect CO₂ emissions per capita (the dependent variable). The research sample comprises 60% randomly selected training data, 20% validation data, and 20% testing data.

Table 2. Data Profile

Variables	Source
Diabetes prevalence	International Diabetes Federation, Diabetes Atlas.
CO ₂ emissions from solid fuel consumption (% of total)	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.
CO ₂ emissions (metric tons per capita)	Climate Watch. 2020. GHG Emissions. Washington, DC: World Resources Institute. Available at: https://www.climatewatchdata.org/ghg-emissions . See SP.POP.TOTL for the denominator's source.
Mortality rate, infant, boys (per 1,000 live births)	Estimates developed by the UN Inter-agency Group for Child Mortality Estimation (UNICEF, WHO, World Bank, UN DESA Population Division) at www.childmortality.org .
Electricity production from hydroelectric sources (% of total)	IEA Statistics © OECD/IEA 2014 (http://www.iea.org/stats/index.asp), subject to https://www.iea.org/t&c/termsandconditions/
Share of women in labor force (% of female population ages 15+) (national estimate)	International Labour Organization. "Labour Force Statistics database (LFS)" ILOSTAT. Accessed December 6, 2022. https://ilostat.ilo.org/data/ .
Government expenditure per student, primary (% of GDP per capita)	UNESCO Institute for Statistics (http://uis.unesco.org/). Data as of February 2020.
Bird species, threatened	United Nations Environmental Program and the World Conservation Monitoring Centre, and International Union for Conservation of Nature, Red List of Threatened Species.
Logistics performance index: Quality of trade and transport-related infrastructure (1=low to 5=high)	World Bank and Turku School of Economics, Logistic Performance Index Surveys. Data are available online at: https://lpi.worldbank.org/ . Summary results are published in Arvis and others' Connecting to Compete: Trade Logistics in the Global Economy, The Logistics Performance Index and Its Indicators report.
Burden of customs procedure	
Household final consumption expenditure per capita growth (annual %)	
Gross value added at factor cost (GVA) (current US\$)	
Merchandise imports from low- and middle-income economies in Sub-Saharan Africa (% of total merchandise imports)	
Food imports (% of merchandise imports)	
Merchandise imports by the reporting economy, residual (% of total merchandise imports)	
Tariff rate, most favored nation, simple mean, all products (%)	World Bank staff estimates using the World Integrated Trade Solution system, based on data from United Nations Conference on Trade and Development's Trade Analysis and Information System (TRAINS) database and the World Trade Organization's (WTO) Integrated Data Base (IDB) and Consolidated Tariff Schedules (CTS) database.
Binding coverage, all products (%)	World Bank staff estimates using the World Integrated Trade Solution system, based on data from World Trade Organization.
Unemployment with advanced education (% of total labor force with advanced education)	World Bank, World Development Indicators database. Estimates are based on data obtained from International Labour Organization, ILOSTAT at https://ilostat.ilo.org/data/ .
Trademark applications, nonresident, by count	World Intellectual Property Organization (WIPO), Statistics Database at www.wipo.int/ipstats/ . The International Bureau of WIPO assumes no responsibility with respect to the transformation of these data.
Life expectancy at birth, male (years)	(1) United Nations Population Division. World Population Prospects: 2022 Revision. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.

Many researchers are devoting time and energy to developing analytical tools and predictive models to predict trends. Artificial intelligence is highly capable of processing complicated situations, making it an effective tool for evaluating data on government policy. Although neural networks are rarely used, their usefulness is becoming more widely acknowledged. This study investigates interactions among elements of the CBAM. The geographical correlation features of the global commerce with the EU are analyzed through analysis of variance (ANOVA), and t tests are run independently to supplement the ANOVA results.

4. Results

This study investigates the effects of the EU's CBAM on The global export capacity and GDP development in comparison with other countries' responses to the CBAM. Because the political and economic landscapes of nations are dynamic, we first use ANN and other artificial intelligence technologies to identify and prioritize the factors that are closely related to CO₂ emissions and the CBAM. The development of government policy relies on research into a variety of areas, including trade finance, climate change, the environment and agriculture, health, demographic and social development, and public sector management. We manually filter the data and then use ANOVA to determine how different nations reacted to the CBAM and how The global commerce with the EU is affected by geography. The results of this research can be used as a resource for policymakers, company owners, and other interested parties.

4.1. Artificial Neural Network, ANN

The purpose of this research is to develop risk models that can make reliable predictions without the restrictions of overly simplistic assumptions and in cases of a lack of relevant data. This is accomplished by training an optimization application network on input and target variables and then using the trained network to predict the output values of fresh input variables in a feedback framework. The adjusted R² value of 0.99996 indicates that approximately 99.0% of the variation in the dependent variable is explained by the regression fit, as demonstrated by the empirical results. A statistically significant relationship is observed between 64 examined factors and CO₂ emissions. Australia, China, the EU, Japan, and the United States are the top ten export destinations for The global, and each of these regions has a different impact on The global exports.

Japan, the United States, and Australia have screened CO₂ emission factors, indicating their attention to the environment and energy-saving technology (Table 3). The factors related to agricultural land are also screened in China, the United States, and Australia, which are large countries.

Deforestation, tillage, fertilizer consumption, and animal management on agricultural land contribute to global warming [23]. Therefore, those working to reduce emissions should prioritize the agricultural sector. For example, the cost of imported commodities might increase

if a country imposes a carbon tax but imports a large quantity of agricultural products from a country with less stringent emissions standards [24]. If exporting nations perceive a lower demand for their agricultural products, they may have to adjust agricultural policy. Carbon tariffs, if applied to both the country of import and the country of export, may be an effective tool for reducing agricultural greenhouse gas emissions. If put into action, this strategy may reduce emissions from farmland and thereby mitigate some of the worst effects of climate change.

Financial institutions can help reduce CO₂ emissions by aiding with finance and investment in areas such as renewable energy, green buildings, and transportation, all of which require substantial investment and resources [25]. Green finance and socially responsible investment are two new areas in the financial sector that might help the green economy grow [26]. Eight and six finance-related factors in China and the United States, respectively, are identified, indicating that the opening of carbon emission trading markets can increase interest among investors in companies with a smaller carbon footprint and stronger focus on environmental sustainability through CSR and environmental protection, thereby indirectly affecting CO₂ emissions (Table 3). To better reflect the importance of environmental, social, and governance issues in the financial industry and to encourage responsible and sustainable financial practices, governments should consider green finance and sustainable investment when formulating and promoting environmental policies.

A positive correlation is observed between CO₂ emissions and GDP, as revealed by Table 3, which demonstrates that six GDP factors are identified, four of which are in the United States. This indicates that as economic development accelerates, CO₂ emissions also tend to increase. This is because economic activities such as energy production, industrial manufacturing, and transportation typically generate considerable amounts of CO₂ [27]. However, as a country's economy advances, emphasis on sustainable development usually increases, which can cause CO₂ emissions to stabilize or decrease in certain cases.

Diabetes prevalence was a key variable for the EU and the globe overall (Table 3). Neither scientific research nor the literature identifies a direct causal relationship between CO₂ emissions and diabetes. "CO₂ emissions" refers to the amount of CO₂, which is only one of the greenhouse gases related to global climate change. Diabetes is a metabolic disease related to the production and use of insulin in the body. Although the two seem to have no direct correlation, studies demonstrate that excessive CO₂ emissions may lead to climate change, which can affect food production and supply and indirectly cause health problems such as diabetes. For example, climate change may affect people's dietary and exercise habits and thus their health [28].

Financial institutions play a role in reducing carbon emissions by providing financial support and investment in renewable energy, green buildings and transport. Emerging green finance and socially responsible investment can stimulate growth in the green economy. The opening up of carbon trading markets can increase investor interest in companies with a lower carbon footprint and a strong focus on environmental

sustainability through CSR and the protection of the environ-ments.

While there is no direct causal relationship between CO₂ emissions and diabetes, excessive CO₂ emissions can contribute to climate change, which indirectly affects factors such as food production, supply, and people's

dietary and exercise habits, potentially leading to health problems like diabetes. Although scientific research and literature do not establish a direct link, studies suggest that excess CO₂ emissions can indirectly have an impact on health due to climate change. Addressing CO₂ emissions is crucial to mitigate these potential health effects.

Table 3. ANN variables

Australia	China	Europe	Japan	United States
Adjusted savings: consumption of fixed capital (% of gross national income [GNI])	Arable land (% of land area)	Diabetes prevalence (% of population aged 20 to 79 years)	CO ₂ emissions from solid fuel consumption (% of total)	Agricultural land (square kilometers)
Agricultural land (square kilometers)	Current education expenditure, secondary (% of total expenditure in secondary public institutions)	The time required to obtain electricity (days)	Electricity production from renewable sources, excluding hydroelectric sources (kilowatt hours)	CO ₂ intensity (kilograms per kilogram of oil equivalent energy use)
Alternative and nuclear energy (% of total energy use)	External health expenditure per capita (current US\$)	Lead time to export, median case (days)	Reserves and related items (BoP, current US\$)	Discrepancy between expenditure estimate of GDP (constant LCU)
Chemicals (% of value added in manufacturing)	Grants and other revenue (% of revenue)	Unemployment with advanced education (% of total labor force with advanced education)	Discrepancy between expenditure estimate of GDP (current LCU)	
Men employed in agriculture, (% of male employment) (modeled International Labour Organisation estimate)	Gross capital formation (constant 2015 US\$)		Energy use (kilograms of oil equivalent per capita)	
Food imports (% of merchandise imports)	HFC gas emissions (thousands of metric tons of CO ₂ equivalent)		Exclusive breastfeeding (% of children aged under 6 months)	
GNI per capita growth (annual %)	ICT service exports (BoP, current US\$)		Foreign direct investment, net outflows (% of GDP)	
Intentional homicides, men (per 100,000 men)	International tourism, receipts for travel items (current US\$)		Grants and other revenue (current LCU)	
Net secondary income (net current transfers from abroad) (current LCU)	Merchandise exports (current US\$)		Industrial design applications, nonresident, by count	
Nurses and midwives (per 1,000 people)	Merchandise exports to low- and middle-income economies in East Asia and Pacific (% of total merchandise exports)		Intentional homicides, men (per 100,000 men)	
Other greenhouse gas emissions, composition of hydrocarbons (HFC), perfluorocarbons (PFC), and sulfur hexafluoride 6 (SF ₆ ; thousands of metric tons of CO ₂ equivalent)	Net official flows from United Nations agencies, UNDP (current US\$)		Manufacturing exports (% of merchandise exports)	
Personal remittances, paid (current US\$)	Portfolio investment, net (BoP, current US\$)		Market capitalization of listed domestic companies (% of GDP)	
Population aged 50–54 years, men (% of male population)	PPG, official creditors (NFL, current US\$)		Merchandise exports to low- and middle-income economies in Latin America and the Caribbean (% of total merchandise exports)	
The prevalence of stunting, height for age (% of children aged under 5 years)	PPG, other private creditors (NFL, current US\$)		Merchandise imports by the reporting economy, residual (% of total merchandise imports)	
Primary education, teachers (% women)	Primary completion rate, women (% of relevant age group)		Physicians (per 1,000 people)	
Real interest rate (%)	Share of tariff lines with international peaks, primary products (%)		Proportion of population spending more than 10% of household consumption or income on out-of-pocket health care expenditures (%)	
Tariff rate, applied, simply mean, primary products (%)	Stocks traded, total value (% of GDP)		Proportion of time spent on unpaid domestic and care work, women (% of the 24-hour day)	
Tariff rate, applied, weighted mean, primary products (%)	Total alcohol consumption per capita, women (liters of pure alcohol, projected estimates, women aged 15+ years)		SF ₆ gas emissions (thousands of metric tons of CO ₂ equivalent)	
Water productivity, total (constant 2015 US\$ GDP per cubic meter of total freshwater withdrawn)	Total debt service (% of GNI)		Tariff rate, trade most-favored-nation-treatment, simply mean, primary products (%)	
The proportion of women aged 15+ years living with HIV (%)			Taxes on goods and services (current LCU)	

4.2. Analysis of Variance

The results in Table 4 indicate that Japan, Australia, and the United States pay a considerable amount of attention to CO₂ emissions due to solid fuels, and Japan pays particular attention to the added value created by its products. In addition, these countries pay attention to the supply of power. In terms of labor, both Japan and the United States attach importance to gender equality in the workplace. In terms of education, Japan, Australia and other countries pay great attention to women's right to higher education. In terms of international trade, China has tariff barriers, and Japan screens out all product-binding tariffs; this difference between nations has been a focal point of negotiations and agreements. The United States and Japan applied most-favored-nation treatment in imposing tariffs; household consumption expenditure in the United States and Japan also significantly affect the growth of China's GDP.

5. Discussion

Carbon tariffs are imposed on goods imported from countries with less stringent carbon regulations compared with the importing country. The purpose of carbon tariffs is to level the playing field between countries and to incentivize the reduction of greenhouse gas emissions. The ANN analysis revealed that Japan, the United States, and Australia have screened CO₂ emission factors and pay attention to the environment and energy-saving technology. Agricultural land is also a key target for reducing emissions, and carbon tariffs can be used to incentivize the reduction of greenhouse gas emissions in the agricultural sector. Financial institutions can help reduce CO₂ emissions by providing funding and investment, and emerging fields such as green finance and socially responsible investment can facilitate the development of the green economy. A positive correlation is observed between CO₂ emissions and GDP; economic development tends to increase CO₂ emissions. However, sustainable development can cause CO₂ emissions to stabilize or decrease in certain cases. The prevalence of diabetes was filtered out through analysis for both the EU and global CO₂ emissions, but excessive CO₂ emissions may indirectly cause health problems such as diabetes through climate change.

The ANOVA reveals that Japan, Australia, and the United States are highly focused on the environment, especially in terms of controlling CO₂ emissions. Japan is also concerned with the added value created by the CBAM in its products and, like Australia, places emphasis on ensuring an adequate energy supply. Both Japan and the United States prioritize gender equality in the workplace. China has trade barriers, whereas Japan and the United States screen all products for binding coverage, a key issue in treaty negotiations.

6. Conclusion

The skies aircraft fly through are bumpier today than four decades ago, scientists have found, after producing a

new analysis showing that the climate changed has increased as CO₂ emissions [29]. In conclusion, this research paper has explored the relationship between excessive CO₂ emissions, diabetes prevalence, and their impact on health. The results highlight the serious health problems that can result from rising CO₂ emissions and the need to address this problem. By identifying the potential link between CO₂ emissions and the prevalence of diabetes, this study contributes to the increasing amount of research on the health impacts of environmental pollution. More importantly, this paper focuses on the interdependence of long-term development, economic growth and protection of the environment. It highlights the importance of striking a balance between economic progress and sustainable practices to ensure the well-being of present and future generations. This recognition is critical for decision-makers and stakeholders when formulating strategies and policies that can promote sustainable development.

A further important aspect examined in this research paper is the role of CSR in promoting long-term development. The study recognizes that companies have a responsibility beyond profit and that they should actively participate in initiatives aimed at addressing environmental challenges. By incorporating CSR into their operations, companies can contribute to sustainable development goals while also enhancing their reputation and competitiveness. Furthermore, the paper discusses the potential of a CBAM in promoting low-carbon businesses. CBAM serves as a tool to incentivize companies to reduce their CO₂ emissions by imposing tariffs on imports based on their carbon footprint. This mechanism not only encourages environmentally friendly practices within businesses, but also creates a level playing field by ensuring that international trade does not disadvantage companies adhering to sustainable practices.

However, there are still gaps in knowledge and areas that require further research. Future studies should focus on assessing the economic and trade implications of CBAM and its potential effectiveness in different industries and regions. Additionally, more research is needed to explore the broader environmental and health impacts of excessive CO₂ emissions and diabetes prevalence, as well as the specific mechanisms through which they are interconnected. By address remaining gaps, future research can provide valuable information that will inform policy decisions, guide sustainable development efforts and contribute to society's overall well-being. It's key to continuing to explore and deepen our understanding of the complex relationships between CO₂ emissions, health and sustainable development in order to prepare for a more sustainable and healthier future.

Acknowledgements

This article is the outcome of an international trade and environmental policy research project. We would like to express our sincere gratitude to all those who contributed to this research. Firstly, we would like to thank all the participants from the Department of Finance at Yunlin University of Science and Technology, who voluntarily dedicated their time and shared their experiences.

Secondly, we are grateful to all participants in the Customs Service, Ministry of Finance, who dedicated their time and shared their experiences, without whom this study would not have been possible. We would also like to thank our families for their unwavering support and understanding throughout this highly rewarding research process during this challenging year.

Statement of Competing Interests

No potential conflict of interest was reported by the authors.

Table 4. T tests.

Country	Variable	F	Sig	Country	Variable	F	Sig
United States	Binding coverage, all products	12.441	0.004**	Japan	Binding coverage, all products	12.441	0.004**
	Bird species, threatened	13.714	0.003**		Bird species, threatened	13.714	0.003**
	CO ₂ emissions from solid fuel consumption	5.422	0.038*		CO ₂ emissions from solid fuel consumption	5.189	0.042**
	Expenditure per student, primary	5.358	0.039*		Household final consumption expenditure	11.278	0.006**
	Household final consumption expenditure	7.606	0.017*		Share of women in labor force	12.648	0.004**
	Share of women in labor force	12.925	0.004**		Life expectancy at birth, male	12.978	0.004**
	Life expectancy at birth, male	12.928	0.004**		Logistics performance	34.286	0***
	Logistics performance	34.286	0***		Mortality rate, infant, boys	12.757	0.004**
	Mortality rate, infant, boys	32.474	0***		Ratio of female to male enrollment in higher education	12.524	0.004**
	Ratio of female to male enrollment in higher education	12.298	0.004**		Tariff rate, most favored nation, simple mean, all products	5.104	0.043**
China	Tariff rate, most favored nation, simple mean, all products	8.783	0.012*	Trademark applications, total	6.232	0.028**	
	Burden of customs procedure	8.361	0.013*	CO ₂ emissions from solid fuel consumption	5.189	0.042*	
	Logistics performance	34.286	0.000***	Electricity production from hydroelectric sources	7.906	0.016*	
Australia	Bird species, threatened	13.714	0.003**	Gross value added at factor cost	10.958	0.006**	
	CO ₂ emissions from solid fuel consumption	4.979	0.045*	Logistics performance	34.286	0.000***	
	Share of women in labor force	11.482	0.005**	Ratio of female to male tertiary enrollment	9.94	0.008**	
	Life expectancy at birth, male	12.657	0.004**	Trademark applications	5.347	0.039*	
	Logistics performance	34.286	0***	CO ₂ emissions from solid fuel consumption	4.979	0.045*	
	Merchandise imports from developing economies in Sub-Saharan Africa	5.254	0.041*	Electricity production from hydroelectric sources	6.864	0.022*	
	Mortality rate, infant, boys	31.015	0***	Logistics performance	34.286	0.000***	

The values in the table are coefficients for all variables (the corresponding p values are in parentheses); * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

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