

The Relationship between Fast Fashion Growth and Environmental Degradation: The Role of Sustainability Using ARDL Model An Empirical Study of China's Apparel Sector (1990-2022)

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Received: 22.08.2025 Accepted: 16.12.2025 Published: 02.03.2026

Abstract:

This study aims to analyze the dynamic relationship between the growth of the fast fashion economy in the apparel sector and the deterioration of environmental quality in China over the period 1990–2023, highlighting the importance of environmental sustainability within this vital industry. The research employs the Autoregressive Distributed Lag (ARDL) model to examine both the short- and long-run relationships between economic growth variables—such as the scale of fast fashion production—and environmental degradation indicators, including carbon dioxide emissions, water pollution, and natural resource consumption.

The results reveal a strong and statistically significant positive correlation between the increase in fast fashion production and the deterioration of environmental indicators, confirming that the rapid industrial expansion of this sector has exacerbated pollution and resource depletion problems in China. According to 2025 statistics, China accounts for approximately 60% of global fast fashion production, generating revenues exceeding USD 86 billion in 2022 and producing around 22 million tons of textile waste annually, with a recycling rate of about 25%, reflecting growing efforts to foster a circular economy.

The study underscores the importance of integrating environmental sustainability practices by improving resource-use efficiency, promoting the circular economy, enforcing stricter environmental policies, and increasing sustainable consumer awareness to reduce the environmental footprint of the fast fashion industry. Furthermore, it demonstrates that implementing sustainability strategies and clean technologies within China's five-year

development plans constitutes a fundamental pillar for achieving a balance between economic growth and environmental protection.

Keywords: Fast fashion, apparel industry, fashion industry, environmental degradation, environmental sustainability.

JEL Classification : Q53, Q56, L67, C32, Q01

1-INTRODUCTION

In recent years, discussions related to global warming and climate change issues have gained remarkable importance within political and scientific discourses, as these phenomena represent a central focus of environmental and social campaigns worldwide. (Sherwin, 2024) Among the prominent factors contributing to the intensification of global warming, discarded clothing waste in developing countries ranks among the foremost. (Gazzola, 2020) These countries suffer from weak and underdeveloped infrastructure for effectively and safely managing and treating such waste. (Zhang, 2022) This has led to the accumulation of massive amounts of fast fashion waste that is heavily consumed in the Global North. (Gao, 2024)

The environmental problem is exacerbated by the export of large quantities of used clothing and textile waste to these countries, where they are often disposed of improperly through uncontrolled burning or dumping in open landfills. This results in the emission of harmful greenhouse gases such as carbon dioxide and methane, as well as the release of toxic pollutants that negatively affect human health and local ecosystems. (Liu, 2017) These textile wastes are considered a major source of air and water pollution, in addition to their adverse impact on biodiversity. (Zhu, 2025)

The textile and fashion industries lie at the heart of the Sustainable Development Goals and the European Commission's Green New Deal, accounting for 2% of global GDP and employing millions of people, while also ranking among the world's largest polluters. (Li, 2023) The industry generates more than 1.2 billion tons of carbon dioxide emissions, 22 million tons of microfibers, and 21 billion tons of waste, 20% of which consists of highly toxic wastewater from dyeing houses. Further surveys reveal that efforts to "slow down fashion" and "close the loop" are being undermined by green washing practices. Only 1% of textiles are effectively recycled. (Alam, 2024) An estimated 25% of newly produced garments remain unsold, while 35% of micro plastics entering the oceans originate from synthetic textiles. Additionally, approximately 100 cubic meters of water per person are consumed for textile-related purposes. Global clothing consumption has increased by 400% compared to twenty years ago. This surge in consumption has led to greater energy use in production processes, material circulation, and handling throughout the product lifecycle, all of which significantly contribute to environmental degradation. The textile industry is considered the second most polluting industry worldwide after the oil sector, accounting for approximately 1.2 billion tons of greenhouse gas emissions—an amount exceeding the combined emissions from international aviation and maritime shipping. (Sherwin, 2024) By 2050, the fashion industry is expected to account for up to 25% of the global carbon budget. Therefore, there is an urgent need to address the adverse environmental impacts of the fashion industry by adopting a circular economy approach as a sustainable solution aimed at reducing waste and improving resource-use efficiency. Within the framework of its 14th Five-Year Development Plan (2021–2025),



the Chinese government is actively promoting these practices to mitigate negative environmental effects and achieve sustainable growth (Niinimäki, 2024).

The fast fashion industry in China represents one of the major economic sectors catering to the growing global demand for affordable clothing and rapid production, with new collections released weekly to satisfy consumers' constantly changing preferences. (Shen, 2022) In 2024, China's textile and apparel exports exceeded USD 301 billion, with an annual production of more than 19.36 billion garments. This sector serves as a major driver of China's economic growth; however, it simultaneously poses a significant environmental challenge.

Studies indicate that the fast fashion industry is responsible for approximately 8% of global greenhouse gas emissions, representing a major challenge that exceeds the combined emissions from international aviation and maritime transport. (Ma, 2025) .In China, billions of liters of water are consumed annually in cotton cultivation, fabric manufacturing, and dyeing processes, which represent the second-largest sources of industrial water pollution. These activities contribute an estimated 17%–20% of total industrial water contamination, mainly through the discharge of liquid waste containing hundreds of toxic chemicals, around 30 of which are highly persistent and difficult to remove from the environment.

1-1-Study Problem:

The fast fashion industry in China is one of the country's core economic sectors that has experienced rapid growth over the past decades. China currently dominates approximately 60% of global fast fashion production, generating annual revenues exceeding hundreds of billions of dollars. However, this tremendous economic expansion has been accompanied by serious environmental challenges, reflected in the deterioration of environmental quality due to the intensive consumption of natural resources and the rising levels of pollution caused by manufacturing processes and textile waste disposal. China ranks among the world's largest polluters in the textile sector, particularly in terms of greenhouse gas emissions, water pollution, and industrial effluents.

This situation necessitates the integration of rigorous scientific analysis to explore the causal relationship between the growth of the fast fashion economy and environmental degradation, employing advanced econometric models such as the Autoregressive Distributed Lag (ARDL) model, which allows for distinguishing between short-run and long-run effects. Moreover, these circumstances call for an assessment of existing governmental policies and interventions aimed at mitigating environmental impacts and redirecting this sector toward more sustainable pathways, especially through the adoption of circular economy practices and clean technologies.

Accordingly, the research problem arises from the need to examine the extent to which the rapid growth of the fast fashion industry influences environmental degradation indicators in China, and how quantitative analysis of this relationship can support the development of effective environmental strategies that balance the requirements of economic growth with the necessity of preserving the environment for future generations.

This study seeks to address several key questions centered on China's experience in the fast fashion industry and its environmental implications. The main research questions are as follows:



- *To what extent does the accelerated growth of China’s fast fashion sector contribute to the deterioration of environmental quality at both local and global levels, particularly concerning rising carbon emissions, increased water pollution, and the aggravation of textile waste problems?*
- *How do intensive manufacturing policies, large-scale production techniques, and the adoption of integrated supply chain models in China influence natural resource consumption and environmental sustainability within the fashion industry?*
- *How are China’s national policies and governmental plans responding to the rapid transformations in the fast fashion sector, and have the Five-Year Development Plans effectively managed environmental impacts and promoted sustainability within the industry?*
- *To what degree can quantitative economic analysis methods, such as the ARDL model, explain the causal relationship between fast fashion-driven economic growth and environmental degradation indicators in both the short and long term?*

1-2-Study assumptions:

- The study posits that the growth of the fast fashion sector in China is positively and statistically significantly correlated with environmental degradation indicators, particularly the increase in carbon emissions, the escalation of water pollution levels, and the worsening problem of textile waste.
- It is hypothesized that the implementation of intensive manufacturing policies, large-scale production technologies, and integrated supply chain models in China leads to greater consumption of natural resources and negatively affects environmental sustainability efficiency within the fashion industry.
- The study assumes that China’s developmental plans and environmental policies contribute to improving the management of the environmental impact of fast fashion; however, implementation challenges may limit the achievement of a real balance between economic growth and environmental protection.

The research hypothesizes that the application of quantitative economic analysis methodologies, particularly the Autoregressive Distributed Lag (ARDL) model, can reveal the causal relationships between the industrial growth variables of the fast fashion sector and environmental degradation indicators in both the short and long term.

1-3-Research Objective:

This study aims to explore and analyze the dynamic relationship between the growth of China’s fast fashion industry and environmental quality degradation using the Autoregressive Distributed Lag (ARDL) model over the period 1990–2022. The study seeks to achieve the following specific objectives:

- To measure and determine the extent of the impact of fast fashion production growth on environmental degradation indicators, such as greenhouse gas emissions, water pollution, and the increase in textile waste.
- To analyze the causal relationships between economic and environmental variables and distinguish between short-run and long-run effects using the ARDL model.



- To evaluate the effectiveness of China's environmental policies and national regulations during the study period in mitigating the negative environmental impact of the fast fashion industry.
- To propose integrated recommendations based on the findings to enhance sustainability practices within the apparel manufacturing sector in support of balanced and sustainable development.

1-4-Study Methodology:

This study adopts a quantitative analytical approach using the Autoregressive Distributed Lag (ARDL) model, which is an effective tool for analyzing dynamic relationships between economic and environmental variables over multiple time periods. The independent variables include the growth rate of the fast fashion industry—measuring the annual increase in production or sales volume—along with raw material consumption, which represents the quantity of primary inputs used in production, and the growth rate of gross domestic product (GDP). Carbon dioxide (CO₂) emissions are employed as the main indicator of environmental quality and serve as the dependent variable.

The analysis relies on official data and environmental and industrial reports covering the period 1990–2022. The ARDL model is particularly advantageous because it accommodates variables with mixed orders of integration, specifically I(0) and I(1), without requiring all variables to be integrated of the same order. Moreover, it allows for the distinction between short-run and long-run effects on the dependent variable, providing a more comprehensive understanding of the causal dynamics within the model.

1-5-Study Plan:

The study is divided into two main parts, in addition to the results and recommendations :

**Theoretical framework and a review of the most relevant previous economic studies .*

**Measurement of the impact of the growth of the fast fashion and apparel industry on environmental quality in China.*

2-Theoretical framework and key previous economic literature

2-1-Overview of the fast fashion industry and its global impact

The fast fashion industry ranks among the fastest-growing sectors in the global apparel market, with a projected market value of approximately USD 162.76 billion in 2025 and a compound annual growth rate (CAGR) of 10.04%, expected to reach USD 317.98 billion by 2032. This expansion is primarily driven by the production of diverse clothing collections at low prices and ultra-fast production speeds that meet the rising consumer demand for constant renewal and trend responsiveness. ([Armstrong, 2015](#))

The fast fashion industry produces approximately 80–100 billion clothing items annually, representing a doubling of global apparel consumption compared to previous decades. The Asia-Pacific region leads the global market, with annual sales exceeding USD 32 billion, driven by China's dominant share of around 60% of worldwide production. This dominance is supported by massive e-commerce platforms like Shein and Temu, which introduce thousands of new products daily, accelerating production-consumption cycles. ([United Nations, 2025](#))

The fast fashion industry constitutes one of the primary contributors to global environmental degradation, accounting for approximately 10% of total carbon dioxide emissions—surpassing the combined emissions from international aviation and maritime shipping. It ranks as the second-largest consumer of water worldwide after agriculture, depleting vast quantities of natural resources through clothing production, dyeing, and finishing processes, which drive elevated pollution rates and environmental deterioration (Primadasa, 2024)

A report indicates (Atstja, 2021)A global report indicates that the fast fashion industry generates approximately 92 million tons of textile waste annually, with a recycling rate of less than 1% of this volume. The majority accumulates in landfills or is incinerated, releasing dangerous pollutants into the air, soil, and water sources, while exacerbating the micro plastic crisis from synthetic fibers such as polyester.

From a consumption perspective, producing a single cotton T-shirt requires approximately 2,700 liters of water—equivalent to the amount one person needs for drinking over two and a half years. The fast fashion industry consumes more than 215 trillion liters of water annually, equivalent to 86 million Olympic-sized swimming pools, placing immense pressure on water resources in various regions worldwide, particularly in producing countries.(Faibil, 2023)

Table no.1- Global Fast Fashion Industry in 2025

Year	Market Value (Billion USD)	CAGR (%)	Garments Produced (Billion)	Water Consumption (Billion m ³)	Textile Waste Recycling Rate (%)	Source
2015	80	8.5	60	100	0.5	McKinsey. (2024)
2020	110	9.8	85	125	0.8	Uniform Market. (2025).
2025	150.82	10.7	100	141	<1	McKinsey. (2024)
2030*	230	8.9	130	170	5	Market Projection. (2024)

Source: McKinsey (2024)

The table illustrates the evolution of the fast fashion industry from 2015 to 2030, focusing on economic and environmental dimensions.

Market Value for Sustainable Economic Growth:

It reflects the market value increase from USD 80 billion in 2015 to USD 150.82 billion in 2025, with projections reaching USD 230 billion by 2030, demonstrating clear expansion in the fast fashion apparel market. This growth underscores the rising global demand for such clothing, driven by rapid production policies and consumer-friendly pricing..(Colucci, 2021)

Compound Annual Growth Rate (CAGR):

The table shows the industry maintaining a relatively high growth rate, starting at 8.5% in 2015, reaching 10.7% in 2025, with a projected slight decline to 8.9% by 2030—an indicator of continued sector expansion despite economic and environmental pressures.

Number of Garments Produced:

Production increased from 60 billion pieces in 2015 to 100 billion in 2025, projected to reach 130 billion by 2030, reflecting heightened consumer consumption and rapid wardrobe renewal trends that reinforce fast production and disposal cycles.

Water Consumption:

Annual water usage rose from 100 billion cubic meters in 2015 to 141 billion in 2025, expected to hit 170 billion cubic meters by 2030. This substantial consumption is linked to cotton cultivation and manufacturing processes requiring vast water volumes, exerting pressure on water resources and posing major sustainability challenges.

Recycling Rate:

Despite rising production, recycling rates show minimal progress: 0.5% in 2015, less than 1% in 2025, projected to reach 5% by 2030. This highlights an urgent need for improved waste recycling systems and reuse technologies to reduce environmental impact.

These indicators embody the challenges facing the fast fashion industry, which—despite substantial economic growth—confronts escalating environmental crises related to natural resource consumption, waste generation, and carbon emissions. This reality calls for adopting a more sustainable production model, emphasizing technological innovation, improved waste management, and shifts in consumer behavior toward environmentally conscious product choices.

Projections beyond 2030 underscore the need for integrated actions by all stakeholders to ensure a sustainable balance between industry growth and environmental protection.

.(D’Adamo, 2021)

Table no.2- Key Global Fast Fashion Industry Statistics (2025)

Indicator	Value
Global Fast Fashion Market Size	billion 150.82\$
Projected Market Size by 2032	billion 291.1\$
Compound Annual Growth Rate (CAGR)	(2032-2024) %10.7
Annual Garments Produced	Approximately 100 billion globally
Annual Water Consumption	billion cubic meters 141
Contribution to Global CO2 Emissions	Approximately 10%
Textile Waste Generated Annually	million tons 92
Percentage of Textile Waste Recycled	Less than 1%
Water Usage per Cotton Shirt Produced	liters 2700
Market Share in Apparel Industry	globally %30-20
Largest Consumer Region	Asia-Pacific (\$32 billion in sales)
Leading Fast Fashion Companies (Market Share)	Shein (18%), H&M, Zara

Source: McKinsey (2024)



The table presents a set of key indicators for the global fast fashion industry in 2025, which can be explained in detail as follows:

- **Global Market Value:** The table indicates that the fast fashion market size reached approximately USD 150.82 billion in 2025. This figure reflects the growing demand for rapidly produced, low-cost clothing, underscoring the industry's continuous expansion despite environmental challenges.
- **Future Projections:** The market is expected to reach approximately USD 291.1 billion by 2032, maintaining a compound annual growth rate (CAGR) of 10.7%, signaling investor confidence and sustained consumer demand for this category.
- **Annual Production Volume:** Approximately 100 billion garments are produced globally each year, reflecting rapid collection renewal and consumer demand for variety.
- **Water Consumption:** The indicator shows the fast fashion industry uses around 141 billion cubic meters of water annually, exerting significant pressure on natural resources, particularly in production hubs like Asia.
- **Carbon Emissions:** The industry contributes about 10% of global carbon dioxide emissions, underscoring fast fashion's substantial role in exacerbating climate change.
- **Textile Waste:** The sector generates nearly 92 million tons of textile waste annually, with recycling rates below 1%, intensifying environmental challenges.
- **Market Share:** Major companies like Shein, H&M, and Zara account for around 18% of the global fast fashion market, indicating concentration among a limited number of key players.
- **Largest Consumer Markets:** The Asia-Pacific region dominates, representing sales of USD 32 billion, highlighting its growing role in the fast fashion industry.

The table confirms that the fast fashion industry is not merely a commercially expanding activity but represents a major environmental and social challenge requiring sustainable practices to preserve natural resources and balance economic growth with environmental protection.

Table no.3- Global Environmental Impacts of Fast Fashion in 2025

Environmental Impact	Details	Figure
Water Consumption for Clothing Production	1 cotton shirt = 2700 liters of water	Equivalent to 2.5 years of drinking water for one person
Textile Waste Quantity	Fast fashion clothing waste	92 million tons annually
Recycling Rate	Percentage of clothing waste recycled	Less than 1%
Carbon Dioxide Emissions	Fast fashion industry's contribution	10% of global emissions
Annual Water Usage	Fast fashion industry	215 trillion liters
Projected Market Size	Global fast fashion market	\$150.82 billion (2025)

Source: McKinsey (2024)

The table presents the key environmental indicators of the fast fashion industry and its negative impacts on the environment, which can be explained as follows:

- **Water Consumption for Clothing Production:**
Producing a single cotton T-shirt requires approximately 2,700 liters of water—equivalent to the amount one person needs for drinking over roughly two and a half years. This figure highlights the immense pressure on water resources used in cotton cultivation and apparel manufacturing.
- **Global Textile Waste Volume:**
The fast fashion industry generates around 92 million tons of clothing waste annually, representing a massive volume of waste often disposed of through unsustainable methods that cause widespread environmental pollution.
- **Clothing Waste Recycling Rate:**
The recycling rate stands at less than 1% of total clothing waste generated, indicating a major problem in waste management within this sector and leading to accumulation in landfills or harmful incineration.
- **Carbon Dioxide Emissions:**
The fast fashion industry accounts for approximately 10% of global carbon dioxide emissions, positioning it as one of the major sources of greenhouse gases contributing to global warming.
- **Annual Water Usage Volume:**
The apparel sector consumes around 215 trillion liters of water annually, reflecting massive depletion of water resources, particularly in production regions reliant on cotton farming and fabric processing.
- **Projected Market Size:**
Estimates show the global fast fashion market reaching USD 150.82 billion in 2025, underscoring the industry's vast scale despite the environmental challenges it faces.
These indicators demonstrate that the fast fashion sector imposes a significant environmental burden, necessitating the adoption of more sustainable production and consumption practices to mitigate negative impacts and ensure natural resource continuity.

2.2 Importance of Fast Fashion in the Chinese Economy

The fast fashion apparel industry plays a pivotal role in the Chinese economy, ranking among the vital sectors that significantly contribute to GDP and employment for millions of workers. According to 2025 statistics:

First, China's fast fashion industry reaches approximately USD 252 billion, with a compound annual growth rate (CAGR) estimated at 2.7% during 2025–2030, indicating sustained sector expansion and intensive investment in both domestic and international markets. (Wang, 2023)

Second, China controls approximately 60% of global fast fashion production, serving as the primary supplier to worldwide fashion retailers. It leverages advanced technology, digital production lines, and effective e-commerce marketing, solidifying its position as a regional and global powerhouse in the sector.

Third, This industry ranks among the most important sources of employment, providing millions of jobs particularly in urban and rural areas, contributing to income improvement and unemployment reduction, with women's participation exceeding 60% of the workforce.

Fourth, The Chinese government seeks to balance economic growth with sustainable development through strategies aimed at reducing waste, promoting the circular economy, lowering pollution levels, and enhancing efficiency in natural resource consumption while adopting eco-friendly materials.(Meskini, Sustainability, , 2024)

Fifth, data analysis reveals a substantial increase in e-commerce revenues within the fast fashion apparel sector, where digital platforms such as Shein and Temu command a significant market share, generating billions in annual sales through innovations in marketing and logistics.

Table no.4- Statistics on the Significance of the Fast Fashion Apparel Industry in the Chinese Economy 2025-2030

Indicator	Statistic / Figure
China Apparel Market Size (2025)	Approximately \$252 billion (Projected for 2030)
CAGR for China Market (2025-2030)	2.7% annual growth
China’s Share of Global Fast Fashion Production	About 60% of global fast fashion output
Market Valuation of Shein (2024)	Exceeds \$60 billion
E-commerce Fashion Market in China (2025)	Estimated at \$714 billion
Female Workforce Participation in Fast Fashion	Over 60% of total workforce
China’s Textile Waste Recycling (Target for 2025)	25% of textile waste recycled

Statista (2025)

China's fast fashion industry has emerged as a critical economic driver, yet it faces significant environmental challenges that necessitate effective sustainability-oriented policies to preserve China's competitive position while fulfilling global environmental and social responsibility commitments.

Table no.5- Environmental and Social Impacts of the Fast Fashion Industry in China

Environmental Indicator	Statistic/Detail	Source
Textile Waste Generated in China	Over 26 million tons annually	Textile Insights 2025
Textile Waste Recycling Rate in China	Approximately 20% recycled textiles; less than 1% clothing recycled into new garments	China Briefing 2025
Water Consumption by Textile Industry	Around 93 billion cubic meters per year (equivalent to consumption by 5 million people)	China Water Risk 2021
Industrial Water Pollution from Textile Manufacturing	17-20% of China's total industrial water pollution	China Water Risk 2021

CO2 Emissions from Fast Fashion	Fast fashion contributes to 10% of global carbon emissions	Earth.org 2025
Global Textile Waste	92 million tons annually worldwide	UniformMarket 2025

Source: Author's elaboration

Table no. 05 illustrates the volume of apparel waste generated by China's fast fashion industry, estimated at approximately 26 million tons annually. This substantial waste volume reveals the acute environmental challenges associated with waste management, particularly given the limited recycling rate of approximately 20% of total textile waste, and a significantly lower rate for clothing-to-clothing recycling that does not exceed 1%. This reflects the urgent need to develop advanced recycling technologies and strengthen circular economy policies in China.

Table no.6- Water Consumption and Industrial Water Pollution Impact in China's Fast Fashion Sector(2025)

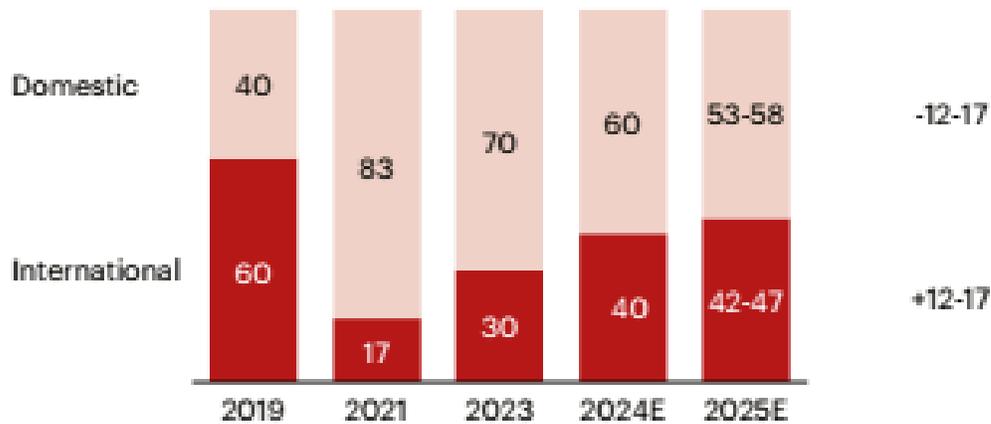
Indicator	Global Value	China Value	Source
Carbon Dioxide Emissions (CO2)	1.5 billion tons annually	1.2 billion tons annually	Global Industry Report 2025
Water Consumption	200 billion cubic meters per year	93 billion cubic meters per year	UniformMarket 2025

Source: Author's elaboration

Table no.6 highlights water consumption in the fast fashion sector, where total consumption reaches approximately 93 billion cubic meters annually, equivalent to the water consumption of roughly five million individuals. This reflects severe environmental pressure on water resources in China, particularly in cotton cultivation regions and areas engaged in chemical textile processing. Additionally, the data indicates that 17% to 20% of industrial water pollution in China originates from apparel manufacturing processes, where hazardous chemicals are employed in dyeing and finishing operations, thereby exacerbating environmental and health challenges.(Claxton, 2020).

Furthermore, the fast fashion industry contributes approximately 10% of total global carbon dioxide emissions.(Li, 2017)This positions it among the industrial sectors with the most significant impact on climate change, necessitating effective measures to reduce emissions and promote sustainable production practices.Based on these data, it is evident that China's fast fashion industry presents a substantial environmental challenge that requires the adoption of protective measures, including strengthening regulatory oversight of industrial enterprises, developing cleaner production technologies, and incentivizing recycling initiatives alongside partnerships with the private sector and civil society to safeguard natural resources and ensure their sustainability.

Figure no1-Chinese Consumer Spending on Personal Luxury Goods in Mainland China (Domestic vs. International) 2023-2025



Source: (Meskini, Sustainability, 2024)

Figure no1 presents the dynamics of Chinese consumer spending on personal luxury goods in mainland China, illustrating how the distribution of this expenditure has shifted between domestic and international markets during the period from 2019 through projections for 2025. The economic implications of **Figure no1** highlight how luxury goods consumption patterns in China have transformed in response to the global environment (the pandemic followed by the recovery phase). This reflects the effectiveness of government policies in promoting domestic spending and enhancing the attractiveness of the internal market. It also demonstrates the growing role of the Chinese consumer in the global luxury goods market, where the balance between domestic and international purchasing has become more dynamic in accordance with economic and social changes.

These findings illustrate the resilience of the luxury goods market in the face of major variables, as well as the importance of monitoring the motivations and trends of Chinese consumers as a globally influential factor in the luxury market.

2-3-Environmental Sustainability Challenges in China's Fast Fashion Apparel Sector

China's fast fashion apparel sector constitutes one of the vital economic pillars; however, it faces severe environmental challenges that necessitate the adoption of sustainable and integrated strategies. First, this sector is characterized by intensive consumption of natural resources, particularly water and energy, where massive quantities of water are depleted through the cultivation of natural fibers, such as cotton, and multiple manufacturing processes, thereby exerting environmental pressures on local ecosystems. (Liu, 2025)

Second, the fast fashion industry generates substantial quantities of textile waste that exceed the capacity of current recycling systems, with clothing recycling rates reaching less than 1%, necessitating the development of robust infrastructure to promote the circular economy and reduce waste accumulation in landfills.

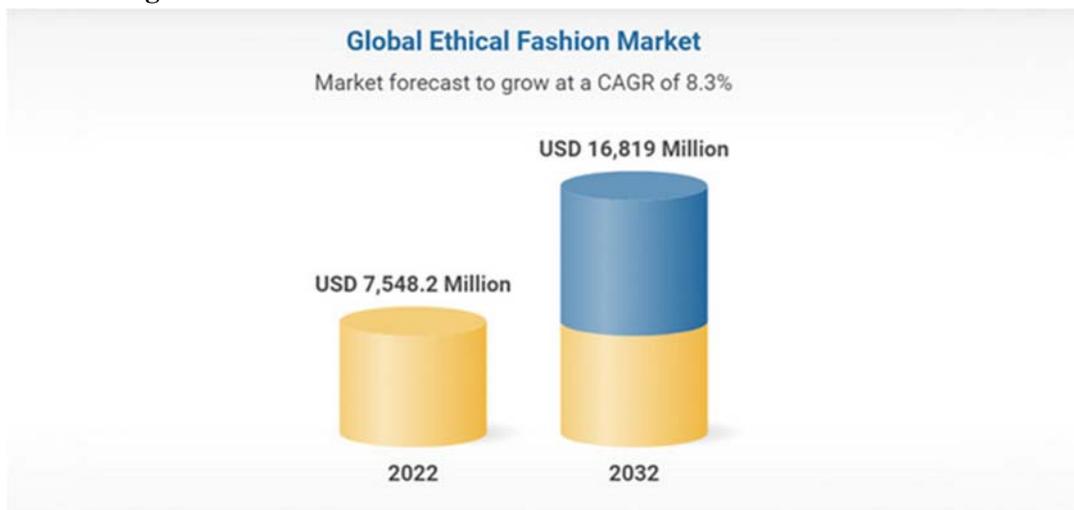
Third, dyeing and chemical coloring processes cause industrial water pollution at rates reaching 20% of total industrial water pollution, thereby exacerbating the environmental crisis and threatening the safety of water resources, wildlife, and human populations.

Fourth, this industry contributes a significant proportion of greenhouse gas emissions, which amount to approximately 10% of global emissions, thereby constituting a substantial burden on international efforts to combat climate change.(Asante, 2022)

Fifth, the industry faces challenges related to the use of non-environmentally friendly chemical and synthetic materials, necessitating a transition to the use of eco-friendly materials and technologies within production processes.

Sustainable fashion is not merely a trend in today's apparel landscape—it is a priority for consumers and companies alike.(Mattos, 2018) Over decades, while the sustainable fashion market is still in its nascent stages today, it is growing at a tremendous rate. Studies indicate that companies are not only investing more heavily in sustainable strategies, but consumers are also valuing brands with a better environmental footprint.(Dissanayake, 2016) where they are spending more money with environmentally friendly retailers. Today's statistics demonstrate that the sustainable and ethical fashion landscape is growing at an exceptional rate. The ethical fashion sector reached \$7,548.2 million in 2022, and by 2027, this market is expected to grow at a compound annual growth rate (CAGR) of 8.1% during the forecast period, reaching a value of \$11,122.2 million by 2027 and \$16,819 million by 2032

Figure no2-Sustainable and Ethical Fashion Market 2022-2032



Source::Research and markets 2024

The report indicates that direct investments in sustainable fashion have been fueled by various factors. Consumers have become more aware of the problems associated with traditional manufacturing processes.

Figure no3- Global Sustainable Apparel Market Forecast 2023-2033

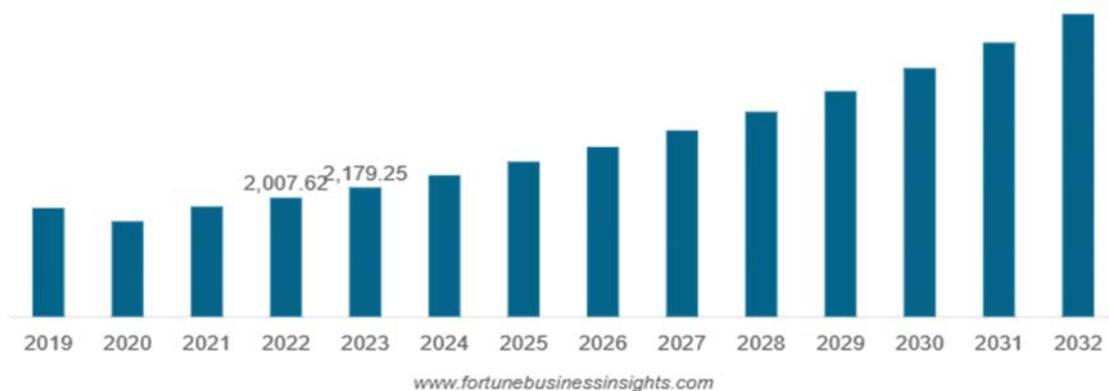


Source :(Gao, 2024)

This report draws attention to increased awareness of environmental safety and recycling as a fundamental driver of this industry. Notably, the study also found that certain regions are gaining traction faster than others, with two-thirds of customers in India willing to pay more for sustainable fashion. The global recycled fashion market size reached \$7,596.84 million USD in 2023, and the market is expected to grow from \$8,253.97 million USD in 2024 to \$16,701.28 million USD by 2032.

Figure no4- Recycled Fashion Market Size in the Asia-Pacific Region

Asia Pacific Upcycled Fashion Market Size, 2019-2032 (USD Million)



Source (United Nations, 2025)

Consumer demand for sustainable and ethical fashion has risen over the past two years, particularly among younger generations. These consumers prioritize environmentally friendly practices and are attracted to the creativity and individuality that recycled clothing offers. Each upcycled piece is often unique, fulfilling the desire for personal and distinctive fashion.



Additionally, designers and brands are increasingly incorporating upcycling into their business models. For example, Loro Piana, the Italian company offering high-quality textiles, recently launched a new sustainable collection, "Loro-Re-Cashmere for All," which includes signature pieces made from a blend of recycled and virgin cashmere. This collection circularly utilizes existing waste materials and creates timeless and gender-neutral pieces, demonstrating the luxury industry's commitment to responsible resource utilization.

2-4- The most important economic literature of the past:

***Centobelli, P. (2022).** "Slowing the fast fashion industry: An all-round perspective." The study aimed to analyze the comprehensive impact of the fast fashion industry on the environment, focusing on several dimensions: climate change, environmental quality degradation, biodiversity loss, and depletion of natural resources. The study also aimed to highlight the importance of adopting sustainability practices to mitigate the negative impacts of this industry, which produces massive quantities of clothing at high speed with intensive resource consumption. The findings indicated that the fast fashion industry contributes significantly to greenhouse gas emissions and consumes large quantities of water and toxic chemicals that pollute aquatic environments. The study also highlights that intensive production causes biodiversity degradation through the depletion of land and natural resources. The study emphasizes the necessity of adopting sustainable strategies such as using environmentally friendly materials, improving resource efficiency, and recycling products to reduce negative environmental impacts and achieve a balance between economic development and environmental preservation. (Centobelli, 2022)

***The study conducted by researcher Pătruți (2024)** in the *Management Dynamics in the Knowledge Economy* journal addressed the challenges facing the fast fashion industry in achieving environmental, economic, and social sustainability. The study aimed to identify the barriers affecting the adoption of sustainable practices within this industry, with a focus on the environmental dimension manifested in the intensive use of natural resources and the production of massive quantities of waste. The findings revealed that the fast fashion industry contributes significantly to water and energy depletion and generates waste that pollutes the environment, necessitating the adoption of circular economic models that reduce waste and promote resource reuse. The study emphasizes that adopting such environmental practices not only contributes to environmental protection but also achieves improvements in operational efficiency and long-term profitability, thereby enhancing companies' competitiveness within the global market.

This research provides a theoretical and analytical framework that assists policymakers and researchers in understanding the structural problems that hinder the implementation of sustainability in the fast fashion industry, and recommends the necessity of strengthening regulatory and institutional support to achieve genuine and sustainable transformation. (Pătruți, 2024)

***The United Nations report (2025)** entitled "The Fashion Industry Can Lead to Environmental Disaster," published on the United Nations website, indicates that the fast fashion industry is among the largest water-consuming industries globally, as this industry consumes approximately 215 trillion liters of water annually, equivalent to 86 million Olympic-sized swimming pools. This industry also contributes approximately 10% of total

global carbon dioxide emissions, thereby exceeding the combined emissions of both air and maritime transport. The report focuses on the substantial environmental impact of this sector, warning of the accumulation of massive quantities of produced waste, which reaches 92 million tons annually, with expectations of increasing to 134 million tons by 2030 if effective measures are not taken.

The report emphasizes the necessity of adopting sustainable production and consumption practices, and strengthening legislative and regulatory frameworks by governments to mitigate this dangerous environmental impact, thereby promoting the transition to a circular economy in the fashion sector. (United Nations, 2025).

***In a study conducted by Miskini and colleagues (2024)** in the Energy & Environment journal, the environmental and economic challenges facing the fast fashion industry in the context of the COVID-19 pandemic were examined. The study confirmed that this industry utilizes massive natural resources and produces large quantities of waste resulting from the rapid consumption and production of clothing.

The findings indicated that adopting sustainability practices such as the circular economy and using environmentally friendly materials contributes positively to improving operational efficiency and long-term profitability. Furthermore, the transition to sustainable practices enhances consumer loyalty among those who prefer eco-friendly products, thereby providing companies with a competitive advantage in the market. The study highlighted that the greatest challenge lies in the initial transition costs and the difficulty of integrating sustainability practices into traditional business models, necessitating institutional and political support to facilitate this transition and enhance its economic and social impact.

This study provides an important analytical framework for understanding the relationship between sustainability and profitability in the fast fashion sector, and calls for the necessity of launching supportive policies to promote sustainable production practices. (Meskini, 2024)

***In a study published in 2024** entitled "The carbon footprint of fast fashion consumption and production" (Li et al., 2024), the carbon footprint of clothing consumption in the fast fashion sector was assessed using a Life Cycle Assessment (LCA) model, with a focus on jeans as a case study product. The findings revealed that the carbon footprint of consuming one pair of jeans in the fast fashion consumption pattern amounts to 2.50 kg of carbon dioxide equivalent per use, which is approximately 11 times higher compared to traditional fashion. The research reported that approximately 91% of this footprint originates from fiber production and jeans manufacturing, with significant contribution from rapid international air transport, which substantially increases carbon emissions compared to maritime transport associated with traditional fashion. The study also found that developed countries record the highest individual footprint from fast fashion consumption compared to developing countries, at 53% higher.

The study provides an analytical model that enables assessment of the carbon footprint of consumption in the fast fashion sector, proposing strategies to mitigate these emissions such as promoting second-hand clothing circulation, which can reduce emissions by up to 90%. The study calls for advancing the circular economy in the clothing industry as a sustainable solution to reduce negative environmental impacts. (Li, 2024)

2-5- Research Gap:

Despite the substantial volume of studies that have addressed the impact of the fast fashion industry on the environment and sustainability, significant gaps remain in understanding the dynamic relationship between fast fashion consumption and long-term environmental fluctuations. Most previous studies have focused on assessing partial environmental impacts such as the carbon footprint of production or waste outcomes, without comprehensive integration of consumer behavior, product life cycle, and logistical factors associated with supply chains. These studies have also lacked in-depth analyses of the economic and social challenges facing the adoption of sustainable practices in different countries or regions.

In this context, my research aims to bridge this gap by adopting a comprehensive analytical methodology that links fast fashion consumption with changes in environmental footprint over time, in addition to examining barriers and opportunities in adopting the circular economy and sustainable practices, with focus on local characteristics and mutual interactions among economic, environmental, and social factors. Through this integration and expanded analysis, the research seeks to provide insights based on more precise and comprehensive data that support the development of effective and sustainable policies for the fast fashion industry.

3- Measuring the Impact of Fast Fashion Industry Growth on Environmental Quality in China

This section aims to analyze the impact of fast fashion industry growth in China, measured through expected annual growth in clothing production or sales, alongside raw material consumption—which includes the quantity of primary materials used in production processes—and GDP growth rate on environmental quality. Environmental quality was measured using the carbon dioxide emissions indicator, with the study focusing specifically on the fashion and apparel sector, particularly the fast fashion industry, during the period extending from 1990 to 2022.

The study employed the Autoregressive Distributed Lag (ARDL) model to assess the short-term and long-term relationship between carbon dioxide emissions and the expansion of fast fashion industry growth, based on comprehensive annual data for this period. The study also examined the impact of fast fashion industry growth expansion, raw material consumption, and economic growth rate as separate independent variables on carbon dioxide emissions as the dependent variable.

The study period and country were selected based on the availability of reliable data, taking into account the role of the fast fashion industry in the Chinese economy, as this industry represents one of the vital sectors that contributes prominently to GDP and reflects significant developments in the country's industrial and commercial activity over the past three decades.

Table no.6- variable descriptions and sources.

	Variables	Variables symbol	Musuring unit	Source
Dependent	Carbon dioxide emissions	CO2	T/J	The global economic



Independent	FastFashionGrowth	FFG	Thousands of tonne	International energy agency
	RawMaterialConsumption	RMC	Constant 2010 dollars	World bank
	Gross domestic product p/c	GDPPC	Constant 2010 dollars	World bank

Source: Author’s elaboration

3-1- Model formulation:

"To analyze the relationship between carbon dioxide emissions, the expansion of growth in the fast fashion industry in China, alongside raw material consumption and economic growth rate, the following equation was adopted:"

$$CO_2 = f(\text{Fast Fashion Growth, Raw Material Consumption, GDP PC,})$$

3.1.1 - Results and Discussion:

The Autoregressive Distributed Lag (ARDL) model is acknowledged as one of the most efficient econometric methodologies, particularly when compared to alternative approaches. Its robustness makes it ideally suited for analyzing the effects of independent variables on a dependent variable across both short- and long-term horizons.

3.1.2 - Unit Root Test Results:

Prior to conducting the ARDL bounds test for any variable, it is imperative to assess the variable’s unit root properties. All variables must exhibit stationarity either at level I(0), first difference I(1), or a combination thereof, in order to ensure the validity of the F-statistic evaluation. The stationarity status of the series is rigorously examined using both the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test to accurately determine their order of integration.

Table no. 8 - result of the augmented dickey fuller (ADF) and Phillips Peron (PP) unit root tests.

	ADF			PP			
	T-statistic	p-value	Critical value	T-statistic	p-value	Critical value	
CO2	5.636589	0.0005	3.562351	5.553355	0.0005	3.535433	I(1)
LNG exports	4.162564	0.0207	3.56775	4.533554	0.0136	3.527221	I(1)
GDPPC	4.174752	0.0019	2.975231	4.098662	0.0152	3.523253	I(1)
PL gaz	5.052356	0.0004	2.978542	4.886524	0.0023	3.563451	I(1)

Source: Author’s elaboration using Eviews 12 software.

The results of the Augmented Dickey-Fuller (ADF) test, as presented in Table 8, demonstrate that all five variables achieve stationarity at their first differences, denoted as I(1). Consequently, the implementation of the Bounds Testing approach is justified for this study,

with the Autoregressive Distributed Lag (ARDL) model identified as the most appropriate technique to explore the interrelationships among the variables.

3-1-3-Lag Order Selection Criteria:

After confirming that all variables are integrated of the same order, the next step involved determining the optimal lag length. This selection was based on six distinct information criteria, considering lag lengths ranging from zero to two. The maximum lag length was restricted to two due to the relatively small sample size, ensuring model parsimony and reliability in the estimation process.

Table no.9 - Lag Order Selection Criteria Results

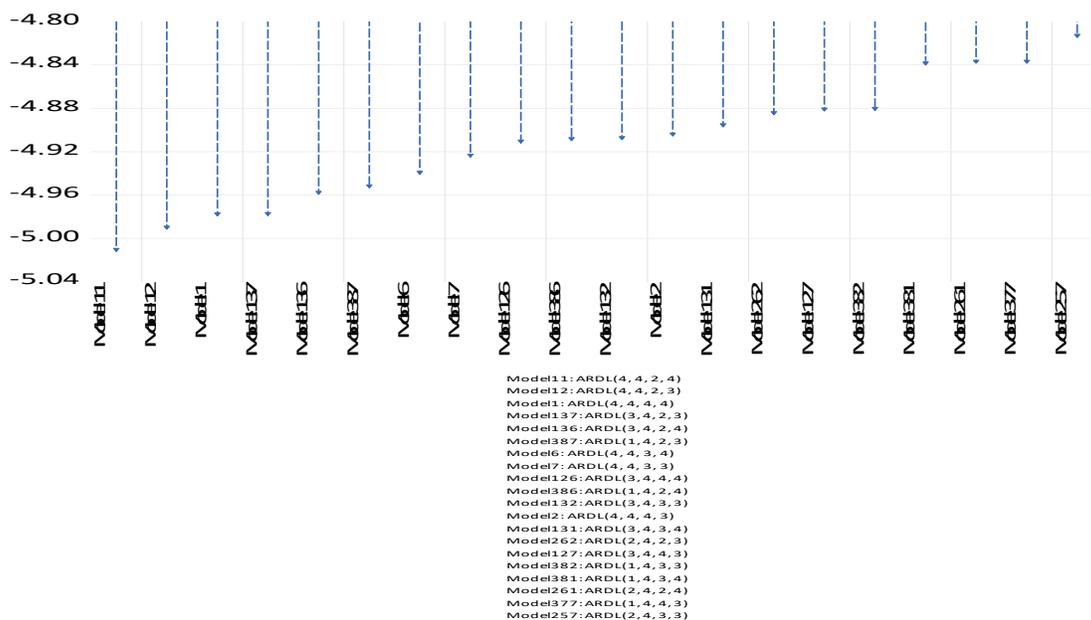
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1034.129	NA	2.01e+2478.1325268.4338873.24403			
1	-820.6954190.5225*	3.35e+18*	56.75246*	62.12356*	62.32543*	
2	-958.453337.825634.17e+1886.95767		64.4568662.75230			

Source: Author’s elaboration using Eviews 12 software.

Based on the LR, FPE, AIC, and SC selection criteria, the optimal lag length was determined to be one. Following this selection and subsequent diagnostic assessments of the ARDL model, the Bounds testing procedure was conducted, succeeded by the estimation of the Error Correction Model (ECM). Utilizing the Automatic Lag Length Selection Test within the ARDL framework, the Akaike Information Criterion (AIC) was employed to identify the optimal lag structure. Figure 05 illustrates the ARDL estimation process with automatic lag selection as implemented in E-Views version 12. The finalized model specification was (2, 4, 3, 4, 4), chosen based on its minimization of the AIC value.

Figure no.5 - Akaike Information Criteria.

Akaike Information Criteria (top 20 models)



Source: Author's elaboration using Eviews 12 software.

Figure no.5 clearly demonstrates that the ARDL (2, 4, 3, 4, 4) model represents the most appropriate specification for our analytical framework.

3-2-Estimation of the ARDL model.

3-2-1-ARDL Bounds Test for Cointegration.

The bounds test is utilized to determine the existence of a long-run equilibrium relationship among the variables within the ARDL framework. According to the null hypothesis of no cointegration, if the calculated F-statistic is below the lower critical bound, this indicates the absence of a long-term relationship among the variables. Conversely, if the F-statistic exceeds the upper critical bound, it signifies the presence of a cointegrating relationship and thus confirms long-run equilibrium. If the F-statistic falls between the lower and upper bounds, the test results are considered inconclusive.

Tableno.10 - Result of ARDL bound test

Test statistic	14.54533					
f-statistic						
	10%		5%		1%	
Sample size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
30	2.39	3.39	4.05	4.33	4.28	5.87
asymptotic	2.58	3.57	2.57	3.49	3.48	4.28

Source: Author's elaboration using Eviews 12 software.

Table 10 reveals that the calculated F-statistic of 14.54533 surpasses the critical values at both I(0) and I(1) levels across the 1%, 5%, and 10% significance levels. This outcome confirms the existence of a cointegrating relationship among the variables in the model. Consequently, it is appropriate to estimate an Error Correction Model (ECM) to examine both the short-run and long-run effects of Fast Fashion Growth, Raw Material Consumption, and GDP per capita on carbon dioxide emissions.

3-2-2-Cointegrating ARDL Model Estimate.

The Autoregressive Distributed Lag (ARDL) model was applied to examine both the short-term dynamics and long-term equilibrium relationships among the variables, subsequent to confirming their stationarity and cointegration properties

The Empirical Results of ARDL Estimation

Table no.11 - Error Correction Model (ECM), Short-Run, and Long-Run Regression Results

ECM Regression, short-run				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
FFG	-0.141125	0.032506	-4.255751	0.0032
D(GDPPC)	38.96523	3.755454	14.82352	0.0000



RMC	1713.154	538.3245	2.652342	0.0301
CointEq(-1)*	-1.227900	0.118422	-13.25313	0.0000
R-squared	0.981316	Mean dependent var		3325.172
Adjusted R-squared	0.967957	S.D. dependent var		4152.646
S.E. of regression	905.0346	Akaike info criterion		15.73562
Sum squared resid	9885573.	Schwarz criterion		16.53373
Log likelihood	-214.6667	Hannan-Quinn criter.		17.97754
Durbin-Watson stat	2.655779			

* p-value incompatible with t-Bounds distribution

Long -run

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FFG	0.488290	0.024464	23.74525	0.0000
GDPPC	43.83552	2.442363	12.98262	0.0000
RMC	-4822.7756	1426.417	-5.572006	0.0038
C	-35200.53	4687.506	-12.24593	0.0000

$$FFG = CO2 - (0.4882 * FFG + 43.83552 * GDPPC - 4822.7756 * RMC - 35200.5314)$$

Source: Author’s elaboration using Eviews 12 software.

The Error Correction Model (ECM) results from this study indicate that the coefficient of the lagged error correction term, CointEq(-1), is negative and statistically significant at the 1% level, with an estimated value of -1.227. This finding confirms the presence of a long-run equilibrium relationship between the independent variables and carbon dioxide emissions. The coefficient further signifies that deviations from the long-term equilibrium are corrected at a rapid rate of 122.7% within each period. Additionally, the model demonstrates a robust explanatory power, with adjusted R² values of 0.9813 and 0.9679 in the long and short run, respectively, suggesting that approximately 98% of the variance in the dependent variable is accounted for by the independent variables.

In the short run, ARDL estimation results reveal that the Fast Fashion Growth and Raw Material Consumption exert a significant negative effect on carbon dioxide emissions, whereas GDP per capita is found to have a significant positive impact. Conversely, in the long run, both Fast Fashion Growth and Raw Material Consumption display a statistically significant positive influence on carbon dioxide emissions, alongside GDP per capita which continues to exhibit a substantial positive effect.

3-3-Arch test:

In 1982, Engle introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model to effectively capture volatility clustering observed in time series data. The model comprises conditional equations for both the mean and variance. Specifically, the conditional mean equation is governed by an ARMA (p, q) process, which models the systematic component of

the return series. Meanwhile, the conditional variance depends on the squared residuals from previous periods, thereby accounting for heteroskedasticity in the data.

Table no.12 - Arch test

Heteroskedasticity Test: ARCH			
F-statistic	0.518352	Prob. F(21,7)	0.8857
Obs*R-squared	0.056743	Prob. Chi-Square(1)	0.8422

Source: Author’s elaboration using Eviews 12 software.

Table no.12 indicates that the F-statistic associated with the ARCH test is 0.51, accompanied by a p-value of 0.88. Since this p-value exceeds the 5% significance level, we fail to reject the null hypothesis, thereby confirming the stability of the error term variance in the time series.

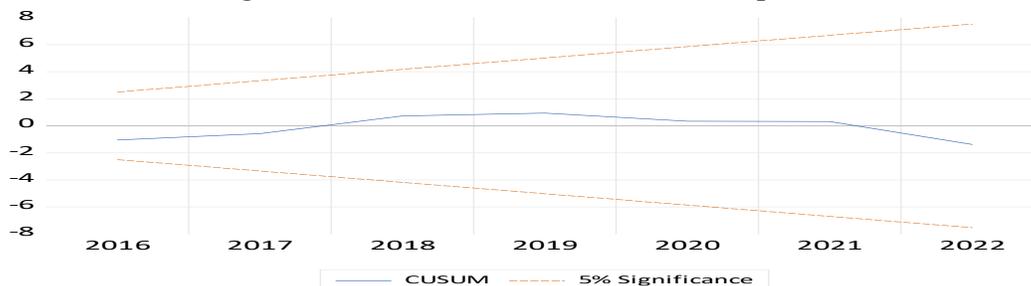
Table no.13 - Breusch-Godfrey Serial Correlation LM Test:

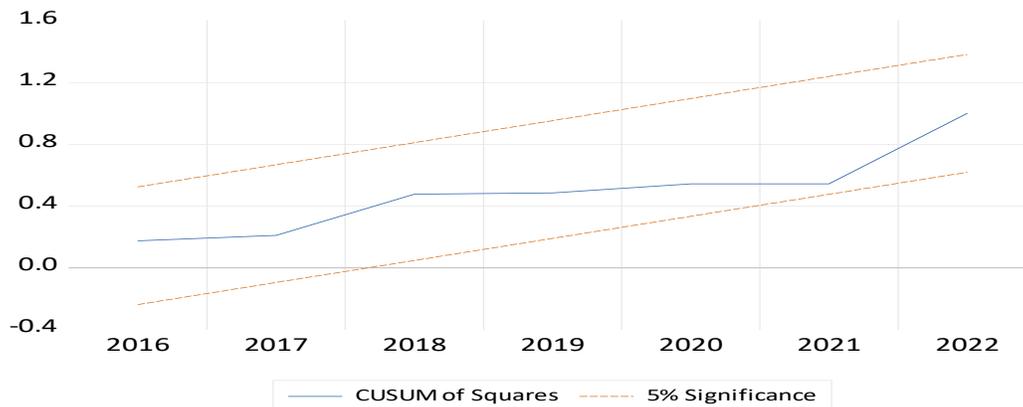
F-statistic	0.527336	Prob. F(21,7)	0.8733
Obs*R-squared	19.04674	Prob. Chi-Square(21)	0.6344
Scaled explained SS	1.094561	Prob. Chi-Square(21)	1.0000

Source: Author’s elaboration using Eviews 12 software.

Table no.13 displays an F-statistic of 0.52 with an associated p-value of 0.87, which exceeds the 5% critical significance level. Therefore, the null hypothesis of no autocorrelation among the error terms is not rejected. To further assess the model’s stability, robustness, and structural integrity, two diagnostic tests were employed: the CUSUM and CUSUM squared (CUSUM SQ) tests. Originally developed by Brown et al., these tests validate parameter constancy over time. As shown in Figure 06, the model’s stability is confirmed by the cumulative sum plots, where the blue lines remain within the critical red boundaries, indicating stable coefficients throughout the error correction model.

Figure no.06 - the Cusum and Cosum of Squares.



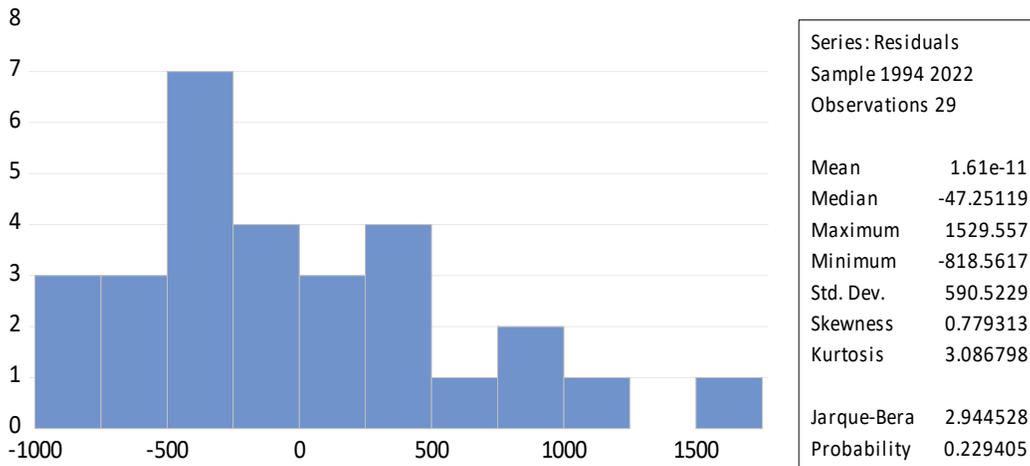


Source: Author’s elaboration using Eviews 12 software.

The figures respectively illustrate the specifications and results of the CUSUM and CUSUM of Squares (CUSUM SQ) tests applied to the developed models. In both plots, the trajectory of the blue lines remains confined within the critical red boundaries, thereby confirming the stability of the variables incorporated in the model throughout the entire study period.

3-4-Normality test:

Figure07: Normality test



Source: Author’s elaboration using Eviews 12 software.

Conclusion:

This study highlights the vital role of the fast fashion industry in the Chinese economy during the period from 1990 to 2022, where the industry witnessed remarkable and accelerated growth reflected in increased clothing production and significant export expansion. China's clothing production reached approximately 19.36 billion pieces in 2023, with exports exceeding 43% of global textiles in 2022, equivalent to more than \$301 billion in exports in 2024. Major companies such as TEMU and Shein are key players, serving global markets with daily shipments of approximately 9,000 tons of goods.



This massive growth has had a clear impact on the environment, as confirmed by the results of the Autoregressive Distributed Lag (ARDL) model used in the study. The findings revealed a long-term cointegration relationship between fast fashion industry growth, raw material consumption, GDP level, and carbon dioxide emissions—providing clear evidence of environmental quality deterioration as a direct result of this rapid industrial growth. The study demonstrated that carbon emissions increase significantly with the expansion of textile production and consumption characterized by energy-intensive and chemical-intensive industrial methods.

The ARDL model emerges in this study as an advanced tool capable of handling time-varying data and analyzing both direct and indirect effects of economic and environmental variables. The model proves its reliability in illustrating how global market confidence in fast fashion brands, coupled with low prices and continuous fashion renewal, contributes to increased demand and consumption, thereby accelerating product cycles and increasing production of waste and environmentally impactful industrial waste.

The study emphasizes the necessity of adopting strict and sustainable environmental policies aimed at reducing the environmental impact of this industry, with focus on the circular economy, recycling, and improving resource use efficiency. Balancing sustainable economic growth with environmental protection requires collaborative strategies that enhance consumer awareness, improve production standards, and impose strict oversight on industrial practices to achieve genuine sustainability in the fast fashion sector, especially in major markets such as China.

With these findings, the study provides comprehensive monitoring confirming that environmental protection can only be achieved through a radical transformation in the fast fashion production and consumption system, while simultaneously ensuring continuity of economic growth—a major challenge requiring integration of research and regulatory efforts at local and international levels.

Recommendations:

- Regulatory frameworks and strict legislation must be developed that obligate the fast fashion sector to reduce carbon dioxide emissions, based on study findings that demonstrated a close correlation between industry growth and environmental quality deterioration.
- Policies should be adopted that incentivize raw material recycling and the use of sustainable fabrics to reduce waste generated by the fast fashion industry—a necessary step to support sustainable development. Educational and awareness initiatives directed at consumers are recommended with the aim of promoting sustainable behaviors and reducing consumption of clothing with harmful environmental impacts, thereby contributing to demand reduction and helping to decrease environmental pressure.
- Support for scientific research must be strengthened to develop manufacturing technologies that reduce energy consumption and harmful chemical usage, based on the urgent need to minimize the environmental impact of the clothing industry.



- Joint coordination between government and the private sector constitutes a fundamental point for implementing effective environmental policies, with establishment of monitoring and follow-up mechanisms to ensure stakeholder compliance with environmental standards.
- Implementation of precise systems for measuring companies' environmental and social performance is recommended, ensuring transparent reporting, which contributes to raising the level of environmental responsibility and reducing emissions.
- These recommendations are characterized by precision and realism, reflecting the study's conclusions while establishing scientific and policy foundations for achieving sustainable environmental development in the fast fashion sector within the context of the Chinese economy.

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