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Research on the Upgrading of Manufacturing Industry Structure in Emerging Countries under the Background of Climate Change: An International Comparison Perspective

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Abstract: Climate change has consistently commanded a central and pressing role in the development of countries and worldwide. The industrial structure upgrading of the manufacturing industry in emerging countries has gained significant attention due to its implications for economic growth and climate change. Through case studies and comparative analysis, this paper aims to thoroughly analyze and compare the industrial structure upgrading procedures between developed and developing countries, focusing on addressing climate change and reducing carbon emissions. The principal barriers encompass limitations in accessing advanced technologies due to insufficient research and development (R&D) investment, unreasonable energy consumption structure, infrastructural constraints and incoherent policy frameworks. The study proffers strategic imperatives to bridge the chasm between developed and developing countries. These encompass prioritizing targeted initiatives and augmenting R&D investments for innovation and technology acclimatization, countering infrastructure bottlenecks with substantial investments in energy and transportation networks, and fortifying policy frameworks to harmonize economic growth aspirations with sustainability objectives. By enhancing the understanding of how industrial structure upgrading can support climate change mitigation and sustainable development in developing nations, this study provides valuable advice for future policymaking and government actions.

Keywords: industrial structure upgrading, manufacturing industry, climate change, carbon emissions, emerging countries

1. Introduction

Climate change involves persistent changes in temperature and meteorological patterns. Presently, the Earth's surface temperature registers a 1.1°C escalation compared to the late 1800s; temperatures have also hit record highs in the decade between 2011 and 2020. Climate scientists confirmed that human activities have been the chief catalyst of climate change over the last two centuries. Important causes of this phenomenon are principal greenhouse gases such as carbon dioxide and methane. The generation of greenhouse gases predominantly emanates from sectors encompassing energy, industry, transportation, construction, agriculture, and land utilization [1].

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Among those sectors, the manufacturing industry is vital to a country's economic development, catalyzing job creation, technical improvement, and overall industrial growth [2]. However, it has also been identified as a major source of greenhouse gas emissions and environmental degradation [2]. In particular, carbon-intensive firms in the energy and manufacturing sectors are increasingly compelled to respond due to the mounting regulatory, customer, and societal pressure to reduce total CO_2 emissions, given the negative impact of these emissions on the environment [3].

Despite notable corporate action regarding climate change, somewhat paradoxically, it is worrying that, global CO_2 emissions from the energy and industry sectors continue to rise, even in many developed countries [4]. What is worse, certain countries exhibit disproportionate emission levels while emissions inciting climate change traverse global borders. The seven leading emitters, including China, the United States, India, the European Union, Indonesia, the Russian Federation, and Brazil, collectively accounted for approximately half of the global greenhouse gas emissions in 2020 [1]. Recent reports indicate that emerging countries, highly dependent on income from fossil fuel-related activities and energy-intensive products, are witnessing a rise in carbon intensity resulting from their reliance on outdated technologies and inefficient production processes [5].

The industrial structure upgrading of the manufacturing industry in emerging countries is necessary. It has garnered significant attention due to its implications for sustainable economic growth and competitiveness and in light of the urgent need to mitigate climate change and reduce carbon emissions [3]. The upgrading of the manufacturing structure refers to a shift from heavy chemical industries to high-value, low-energy, and low-carbon industries like machinery and high-end manufacturing. This transition helps restrain the expansion of energy-intensive industries and reduces the growth rate of carbon emissions [6].

Considering the environmental factor, this study examines the industrial structure of manufacturing industries in selected developed and developing countries, elucidating their strengths and challenges. Through case studies, comparative analysis, and quantitative data, the paper conducts an in-depth evaluation of industrial structure upgrading in those countries. The paper will first outline key factors intricately tied to industrial structure upgrading. Subsequently, the study will analyze the drivers facilitating successful modernization and industry upgrading in developed countries, aiming to pinpoint similarities and disparities in the experiences of developed and emerging nations. Finally, the research will conclude by proposing valuable recommendations for the future industrial structure upgrading of the manufacturing industry in developing countries.

2. Literature Review

On December 12, 2015, global leaders at the United Nations Climate Change Conference in Paris achieved a milestone, termed the historic Paris Agreement, to address the exigencies posed by climate change. Presently, the accord boasts participation from 194 nations, entailing commitments for emission reduction and collaborative adaptation strategies. The Paris Agreement sets long term goals of reducing greenhouse gas (GHG) emissions across all sectors to limit global warming to 1.5°C [7]. According to May et al., manufacturing utilizes 37% of the primary energy globally [8]. Data from the World Bank has also shown that, by 2014, manufacturing industries and construction contributed 20% (of total fuel combustion) of CO2 emissions. Among the list, developing countries with large manufacturing sectors, such as China and India, are the top carbon emitters. The manufacturing carbon emissions of these two countries account for 31% and 26.4% of the national total carbon emissions, respectively. Given the substantial contributions of emerging countries to global emissions, May et al. suggest that it is crucial to prioritize energy-aware and optimized production methods while also improving firms' technological, business, infrastructure, and structure to effectively address the challenges posed by increased global competitiveness and environmental impacts [8].

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In response to the significant potential for cost-effective reductions in industrial energy usage and GHG emissions, governments have introduced various policies and initiatives to enhance energy efficiency within the manufacturing sector. While countries have begun individualizing climate mitigation efforts, entities exacerbating distress have a greater responsibility to prioritize substantive action [7]. For example, Song et al. found that, in China, further environmental regulation for future enhancements, such as tax incentives for R&D, would help promote the development of green products. It would also offer a conceptual framework and decision-making guidance for promoting and advancing such innovation in the country's industrial development [9]. Such findings suggest potential policy measures emerging countries can adopt to address climate change and carbon emissions while promoting environmentally responsible manufacturing practices and upgrading their industrial structures.

While current literature has offered valuable insights into industrial structure upgrading in the manufacturing industry, a research gap exists between developed and developing countries regarding policy efficiency comparability in climate change and carbon emissions. Most studies have concentrated on developed or emerging nations separately, with few studies analyzing the distinctions, similarities, and policy implications arising from a comparative examination. By conducting a thorough comparative analysis of industrial structure upgrading strategies and policies between developed and emerging nations, this research seeks to bridge this gap while suggesting existing policies in developed countries that could be used by developing countries to address the challenges they face.

3. Method

This paper will utilize case studies and comparative analysis as methodological approaches to investigate the industrial structure upgrading of the manufacturing industry in both emerging and developed countries.

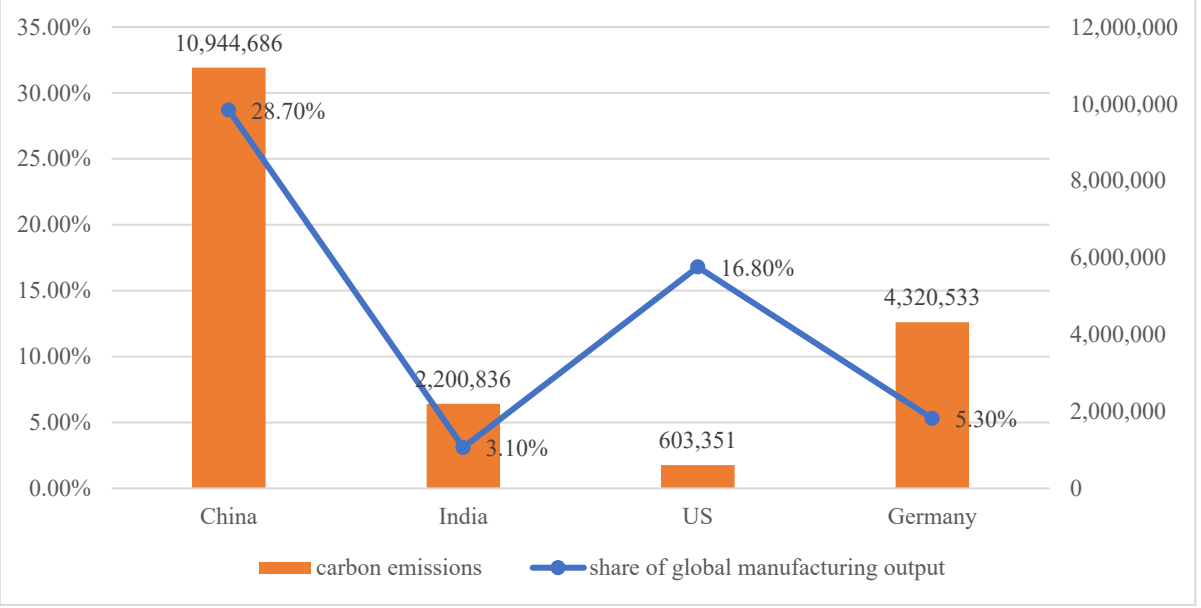

Figure 1: Share of global manufacturing output (%) and carbon emissions (kt) in four nations (Photo credit: Original).

First, a systematic approach will be employed to conduct the case studies. It will first identify a selection of emerging countries, including China and India. Statistical data unequivocally underscores

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China's preeminence, accounting for 28.7% of global manufacturing output in 2022. India, the second-largest developing nation on this roster, commands a 3.1% share in global manufacturing output. Furthermore, the investigation will encompass developed economies, including the United States and Germany. The United States wields a 16.8% stake in the global manufacturing landscape. Germany's manufacturing output constitutes 5.3% of the global share [10]. It merits noting that these four nations also feature prominently among the leading emitters in 2020. As Figure 1 shows, data from the World Bank incontrovertibly establishes China as the preeminent emitter, contributing a substantial 10,944,686 kt of carbon emissions. India contributes 2,200,836 kt of carbon emissions. In contrast, the two highly industrialized nations contribute 603,351 kt and 4,320,533 kt of carbon emissions, respectively. The choice of these countries is to represent different stages of industrial development and varying approaches to industrial structure upgrading.

Second, the comparative analysis focused on four key dimensions: innovation, energy structure, infrastructure construction and policy framework. It will examine the financial resources governments allocated to support research and development, the technological advancements driving industry transformation, and the energy structure and infrastructure construction of countries related to sustainability and productivity. The study will also analyze the selected countries' policy frameworks and regulatory measures, and identify similarities and differences. The analysis will provide insights into the effectiveness of different approaches to industrial structure upgrading.

4. Result

4.1. Research and Development

Research and development (R&D) traditionally focus on developing new products and processes. Governments are responsible for recognizing the importance of advanced technologies in reducing carbon emissions, and motivating industry and business to participate in the exchange of knowledge and technology actively. This is especially important in the dynamic manufacturing landscape, where technological leaps occur frequently. The execution of R&D necessitates an infusion of resources (especially financial support), policy impetus, and a substantial capital reservoir. In these areas, developing countries are underinvested or more challenged than developed countries.

According to the OECD, in 2021, the U.S. and Germany allocated 3.457% and 3.133% of GDP to R&D, respectively. These figures underscore the pronounced lead held by these nations over developing countries regarding cultivated R&D capabilities and substantial investments in technological innovation, which catalyze enhanced productivity, innovation, and competitive edge. Exemplifying this, Germany's 'Industry 4.0' initiative, a cornerstone of its national high-tech strategy, expounds heightened investments in digital technology research and development. This strategic approach engenders interconnected products, value chains, and business models that transcend economic domains, thereby fostering a convergence of technologies [11]. According to Xin et al., periods of U.S. economic expansion have witnessed increased allocations of environmental research and development (ER&D) across industries, resulting in environmental benefits. The cyclical nature of this trend is underscored by heightened R&D expenditures correlating with augmented Innovative Environmental Technologies Research (IETR) patents, coupled with a concurrent reduction in carbon emissions during economic booms [12].

However, developing countries do not yet have the same extent of innovation incentives. Limited funding for R&D is a significant constraint in developing countries, which hinders their ability to keep pace with advanced technology. Data from the OECD and the World Bank shows that, developing countries exhibit lower gross domestic spending on R&D compared to developed nations. As a prominent representative of emerging economies, China's social R&D investment has experienced a remarkable surge, amounting to 2.7864 trillion yuan in 2022. Moreover, the R&D

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expenditure relative to GDP has increased to 2.44%, reflecting a notable rise of 0.53% compared to ten years ago [13]. While China has made significant progress in R&D endeavors over the past decade, a substantial step is still needed to reach the levels of developed countries. A particularly pressing concern is observed in India, where the allocation of resources towards domestic R&D is below the threshold of 1% of its GDP. Data has even shown a downward trend in Figure 2, declining from 0.74% in 2012 to 0.66% in 2018. This situation raises pertinent questions about India's capacity to foster innovation and technological advancement in manufacturing industries, which help reduce carbon emissions.

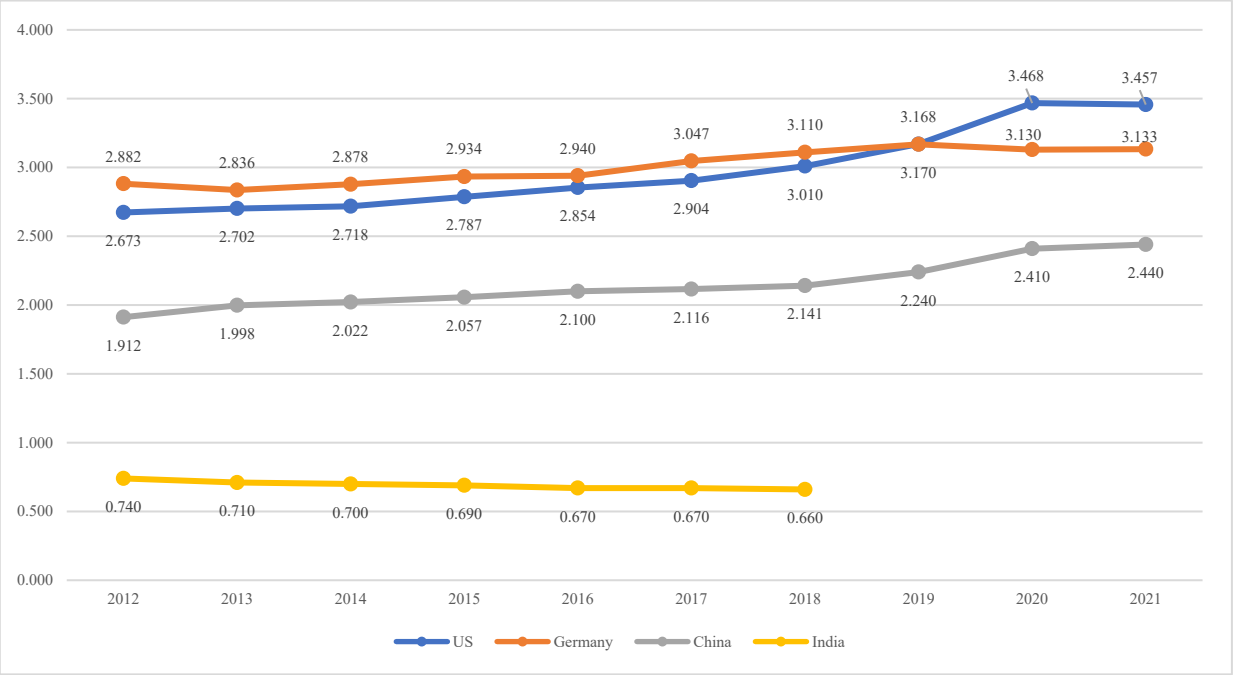

Figure 2: Gross domestic spending on R&D (% of GDP) (Photo credit: Original).

4.2. Energy Consumption Structure

The manufacturing industry is inherently reliant on a consistent energy supply, the composition of which significantly influences the extent of carbon emissions generated. The empirical findings emphasize that non-renewable energy sources remain primary contributors to greenhouse gas emissions. A 1% increase in renewable energy consumption corresponds to a noteworthy 0.193% reduction in carbon emissions. Such observation underscores the pressing significance of energy transition within the manufacturing industry - prioritizing the adoption of renewable energy sources as a pivotal measure to mitigate the carbon footprint associated with energy consumption [14].

Data provided by the IEA indicates that the U.S. is heavily dependent on oil products, which account for 50.73% of total energy consumption. This disproportionate dependence on fossil fuels has resulted in substantial carbon emissions, consequently contributing to the escalating challenges of climate change. Similarly, Germany's energy landscape is characterized by oil products accounting for 44.92% of energy consumption, complemented by a 22.62% utilization of natural gas. Although the combustion of natural gas still releases greenhouse gases, it is comparatively cleaner than coal and oil in terms of carbon emissions.

Manufacturing in developing countries is heavily based on traditional fossil energy consumption, which seriously increases carbon emissions and environmental pollution. Over the past three decades, China has consistently relied substantially on coal, constituting an average of 40.14% of its total

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energy consumption. Additionally, the consumption of oil products, amounting to 20.93%, contributes notably to its overall carbon footprint. In contrast, India has a diversified its energy mix, with biofuels and waste contributing to 36.92% of its energy consumption, as depicted in Figure 3. This marks a relatively cleaner energy source compared to conventional fossil fuels. However, the consumption of oil products and coal persists at 30.24% and 15.78%, presenting persistent challenges regarding carbon emissions.

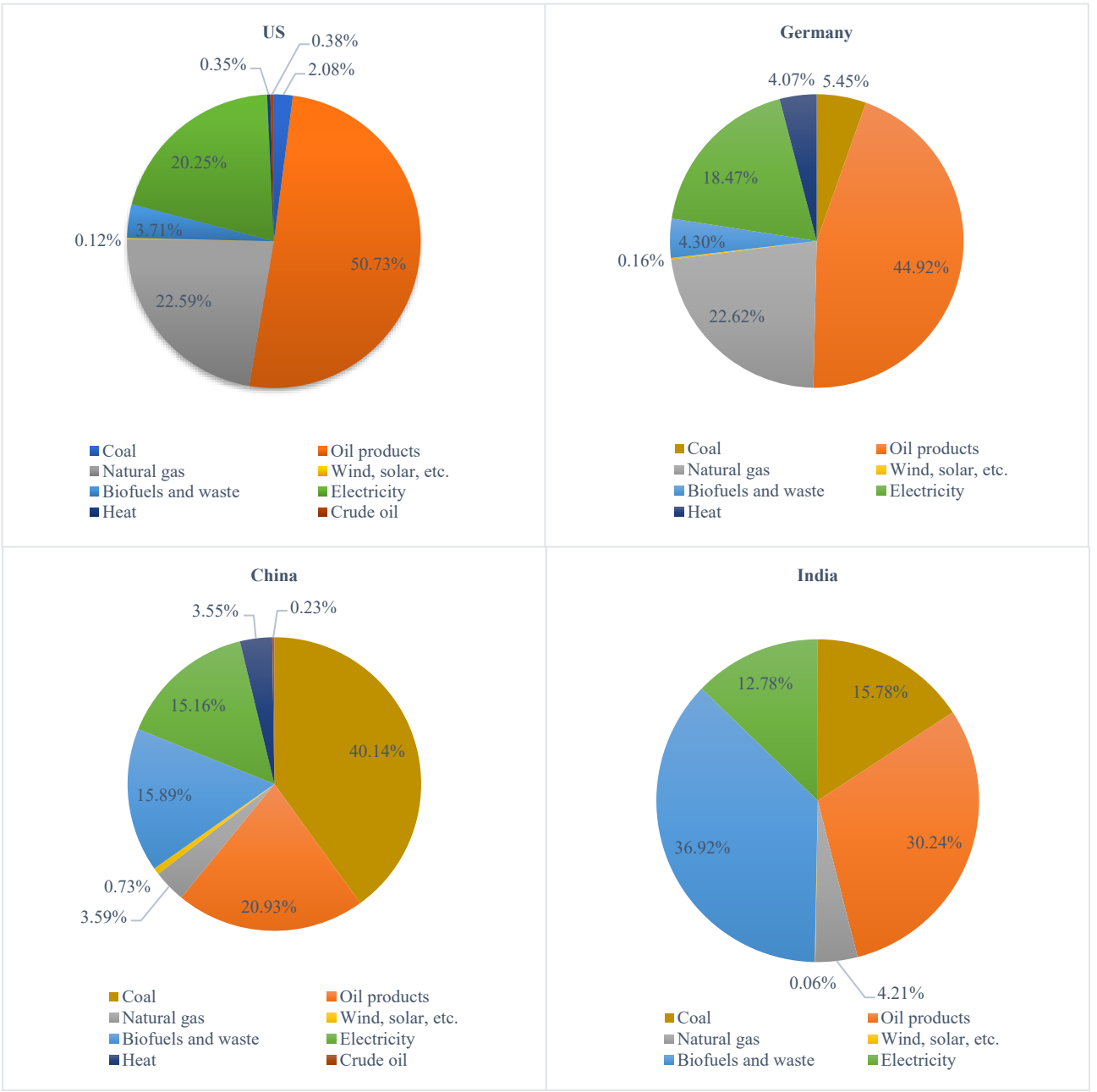

Figure 3: Energy consumption structure of countries (Photo credit: Original).

4.3. Infrastructure Construction

Efficient and reliable infrastructure is essential to achieve energy structure transition and sustainable development of the manufacturing sector. Improved infrastructure can reduce the production and

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transaction costs of enterprises, promote factor flows and knowledge spillovers within regions, and facilitate the upgrading and transformation of manufacturing enterprises. There is no doubt that developed countries have much better and more accessible infrastructure than developing countries.

The U.S. has a highly developed infrastructure network, advanced transportation systems, and a robust energy supply contributing to the efficient movement of goods and resources. Moreover, the U.S. Department of Transportation emphasized the importance of achieving infrastructure modernization in its Strategic Plan F.Y. 2022-2026, as it will not only help achieve safer and more efficient goods transportation and support the U.S. economy but also maintain livability in communities and regions, as well as the resilience of the supply chain [15]. Germany, known for its efficient infrastructure, benefits from a well-connected transportation network, reliable energy infrastructure, and access to capital for businesses [16].

In contrast, developing countries face significant challenges related to limited physical infrastructure, hampering their ability to optimize input factors and enhance competitiveness while reducing carbon emissions. In India, efforts have been made to improve transportation infrastructure in the last decades. However, further development, such as the need for roads, is still needed to address connectivity gaps and bottlenecks that hinder the smooth flow of goods [17]. Over the past decade, China has vigorously promoted the Belt and Road initiative and invested heavily in constructing transportation infrastructure. However, certain rural areas still face accessibility and connectivity challenges [18].

4.4. Policy Framework

The four nations under consideration have all entered the Paris Agreement, signifying their commitment to addressing climate change. In this context, distinct measures have been adopted by each country to combat this global challenge. The Inflation Reduction Act (IRA), signed into law by President Biden in 2022, represents a pivotal and ambitious climate policy in U.S. history. It aims to align U.S. emissions with the commitment to reduce greenhouse gas emissions by 50-52% below 2005 levels by 2030 [19]. While the IRA sets a positive trajectory for emissions reduction and demonstrates a global commitment, the Climate Action Tracker (CAT) analysis indicates that additional policies are required to bridge the gap between current projections and the 2030 target. The estimated emissions decline by 2030 is projected to range from 26-42% below 2005 levels, falling short of the target [19]. The IRA invests $369B in clean energy for decarbonization but also offers concessions to fossil fuels. Furthermore, the US Congress allocated just $1B for global climate finance in 2022, falling short of Biden's pledge, undermining US climate leadership and equity commitment [19].

Germany's new government, in office since December 2021, is accelerating domestic climate policies, aiming for a 65% emissions reduction by 2030 [20]. Despite measures like renewable energy expansion and coal phase-out plans, lags exist in other sectors, and more actions are required for overachievement and a 1.5°C-compatible contribution. Effectively implementing planned measures is crucial. The government's response to the Ukrainian crisis includes positive steps, like renewables expansion, but also counterproductive ones, such as tax reduction on fossil fuels and fast-tracking Liquified Natural Gas (LNG) infrastructure [20]. Proposals like supporting fossil gas extraction and revisiting fossil fuel project financing abroad contradict global sustainability goals.

China's current emissions remain significantly high under existing policies, posing a risk to achieving its NDC targets. Despite progress in renewable energy and end-use sectors, growing energy demand sustains reliance on fossil fuels. The government prioritizes fossil fuels for stability and security, even though emission reduction efforts are insufficient. The economic slowdown in 2022 caused emissions to stabilize, but coal stockpiling continues. Emission levels are projected to peak around 2025 and remain elevated. Despite fossil fuel dependence, China's transition to renewables is

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advancing rapidly and outpacing other countries, with leadership in non-fossil energy investment, renewable capacity, and electric vehicles [21].

According to the CAT, India has made strides in renewable energy, ranking fourth globally in 2022, but coal reliance remains challenging. Despite robust policies promoting renewables, plans for new coal capacity and LNG imports contradict climate goals [22]. With current policies, India is exceeding NDC targets, but stronger targets are still needed. The 2023 National Electricity Plan supports renewables but increases coal capacity, contradicting a 1.5°C-compatible approach. This incongruity is underscored by the heightened demand for electricity engendered by escalating heatwave occurrences, thus accentuating the pressing need for sustainable energy paradigms [22].

5. Discussion

This study has analyzed the responsibility and urgency of developing countries in reducing emissions and climate governance, and examined the constraints or shortcomings of developing countries in manufacturing upgrading in four dimensions based on the perspective of environmental improvement. Next, the paper discusses and provides advice for future policymaking and governments on how industrial structure upgrading can support climate change mitigation and sustainable development in developing nations.

5.1. Technological Collaboration and Increased Investments in R&D

Figure 2 shows that both China and India suffer from insufficient R&D investment. While China has taken a big step towards increasing R&D investment, the overall funding is still far behind that of the US and Germany. This issue is even more pronounced in India, a major manufacturing hub in urgent need of industrial structure upgrading, yet perennially lacking sufficient financial support. Thus, governments in developing countries should continue allocating more financial resources towards R&D programs, as it is an essential driver and pivotal financial guarantee behind industrial innovation and technological development. Such emphasis on R&D and solid financial sources enables the cultivation of an innovation culture, drives the creation of resource-saving and environmentally sustainable technologies, procedures, and materials, and ultimately achieves industrial structure upgrading in the manufacturing sector.

With financial support, governments should prioritize technology transfer and capacity-building initiatives, which help to develop green production methods. Such methods are designed to minimize energy consumption, reduce waste generation and optimize resource use, all contributing to lower carbon emissions. Through capacity-building initiatives, developing countries can gain skills and knowledge to implement energy-efficient practices in their manufacturing processes, for example, sustainable resource management practices. This can help reduce carbon emissions associated with resource extraction and processing through more efficient energy use. Furthermore, developing countries should collaborate with developed countries, such as the US and Germany, international organizations, and private sector groups to promote information sharing and technological diffusion. Access to innovative technologies from experienced countries enables developing countries to accelerate replacing outdated technology and polluting machinery with cleaner, more efficient alternatives. Concurrently, technological collaboration and increased investments in R&D foster enhanced efficiency, productivity, and sustainability, rendering valuable contributions to the industry's and the nation's long-run development.

5.2. Improvement in the Structure of Energy Consumption

A major priority in China and India revolves around restructuring energy systems to reduce reliance on carbon-intensive sources. As previously discussed, coal remains the predominant energy source

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in China, India, and many other developing countries, leading to substantial GHG. In contrast, the US and Germany utilize oil products and natural gas as their primary energy sources. Although natural gas is also a type of fossil fuel, it is relatively cleaner and holds significance as a transitional asset in the ongoing energy transition. Developing countries could draw lessons from their experiences to initiate similar measures.

Governments must prioritize sustainable solutions, such as energy transition, that promote clean technology adoption and efficient manufacturing, and address traditional infrastructure investments for long-term success. The core of energy transition revolves around pursuing high-efficiency output while simultaneously reducing input, consumption, and emissions across various sectors. This involves transitioning from carbon-intensive sources to high-efficiency, eco-friendly alternatives that reduce the environmental impact of industrial activities. By transitioning to renewable energy, industries can significantly reduce their carbon intensity and thus improve their ecological footprint. At the same time, such a paradigm shift would also bring advantages of reducing production costs in the long run and offering a plausible solution to the resource scarcity dilemma.

5.3. Enhancement of Infrastructure

The transition of energy structure and upgrade of manufacturing industry structure require strengthened and enhanced infrastructure. Physical infrastructure, such as transportation networks, constitutes the bedrock of manufacturing, undergirding the flow of materials and goods. For India, and other developing countries where inadequate road infrastructure poses challenges, expanding transportation systems and improving physical infrastructure is paramount to support industrial development and economic growth. Concurrently, developing green transportation systems will effectively curtail transportation emissions. By incentivizing manufacturers to adopt sustainable transport options and enhancing logistics infrastructure, such as using electric or hybrid vehicles and promoting alternative fuels, it will significantly help reduce carbon emissions in the supply chain, benefiting manufacturing and broader society.

In recent years, the information and communication field has actively adopted advanced technologies and vigorously promoted energy conservation, emission reduction, and green transformation work. The energy use efficiency of the information infrastructure has been continuously improved, with remarkable results in green energy conservation work. New infrastructure is not only an important area for energy conservation and carbon reduction, but also an enabler that empowers other industries to enter the path of green and low-carbon development. New infrastructure promotes the use of big data, cloud computing, artificial intelligence and other digital technologies, which can help reduce carbon emissions through energy optimization, cost optimization, risk prediction and decision-making control, helping realize the digital management of carbon assets and the tracking of carbon emissions. While strengthening traditional infrastructure, it is more necessary for developing countries to enhance cyberinfrastructure development and actively seize the opportunities for development in the digital age to promote the transformation and upgrading of manufacturing industries and curb environmental degradation.

5.4. Policy Guidance and Coherence

The Paris Agreement ensures that countries cooperate toward the same goal. Concurrently, it facilitates the exchange of ideas and strategies among countries, emphasizing the leadership responsibility of developed nations to developing countries. While the specific articulation and execution of climate actions remain within the purview of individual countries, the US and Germany benefited from sound political regulations and systems. China, and India exhibit both commendable efforts and room for improvement.

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To align with its carbon neutrality objective set for 2060, China must judiciously manage its energy demand. This necessitates the establishment of concrete and absolute peaking targets, accompanied by an elevation of energy-related NDC targets. Furthermore, a swifter pace of decarbonization within sectors marked by high emissions is imperative. While China takes the lead as a representative of developing countries and has invested heavily in energy transition, further coherent policies are needed to phase out fossil fuel dependency. Coherent policy implementation also plays a critical role in mitigating geopolitical and security variables that impede progress. These policies hold the key to circumventing barriers to progress by ensuring strategic alignment between the energy transition blueprint and climate requirements.

India's mix of policies promoting renewable energy and new coal capacity highlights the need for policy coherence. India should harmonize policies across sectors to move towards a trajectory that aligns with the Paris Agreement. This involves ensuring that plans for coal capacity expansion do not undermine progress made in renewable energy deployment. It is worth noting that achieving policy coherence plays a key role in coordinating economic growth and emission reduction goals, which is a challenge not only for China and India but also for developing countries in general.

Within the broader context, achieving policy coherence requires policymakers to consider both historical origins and future development, and meticulously contemplate the intricate interrelationships among various sectors and their collective impact on emissions dynamics. A coherent policy framework can help optimize the effectiveness of climate actions while eliminating potential conflicts. By establishing clear guidelines and objectives, governments can provide a roadmap for industries to follow, promoting sustainable practices and reducing their carbon footprint. Such a strategy would, in turn, contribute to long-term economic growth.

6. Conclusion

With a focus on mitigating climate change and fostering sustainable development, this paper scrutinizes industrial structure upgrading in manufacturing sectors across developed and developing nations. The study yields insights into opportunities and challenges inherent in various economic contexts. Among different solutions, it is more critical for developing countries to recognize the challenges they face and learn from the experiences of developed countries.

Firstly, this paper highlighted the importance of advanced technologies and R&D spending for driving innovation and sustainable manufacturing practices. The U.S. and Germany's emphasis on R&D and technology adoption has amplified productivity and sustainable growth. In contrast, developing countries encounter barriers like restricted access to advanced technologies and inadequate R&D investments. Mitigating these hurdles necessitates heightened R&D investments, knowledge exchange, and collaborative initiatives. Over the past decades, China has made considerable strides in bolstering continuous R&D, marked by substantial financial commitments. Conversely, India grapples with a substantial gap.

Secondly, the energy structure is a shared realm for improvement across all four nations. Despite varying extents of transition to renewables, heavy reliance on carbon-emission-related sources persists. Governments, on the one hand, need to advocate consumers use energy sparingly; on the other hand, they must prioritize sustainable solutions, such as energy transition, that promote clean technology adoption and efficient manufacturing.

Thirdly, the significance of infrastructure development becomes evident. Developed nations gain from well-established infrastructure, efficient transportation networks, and capital access. In response, developing countries like China and India must further invest in efficient energy infrastructure and augment transport networks to facilitate manufacturing transportation. Developing countries can also accelerate the building of cyberinfrastructure to promote sustainable manufacturing development while contributing to environmental improvement.

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Lastly, policy frameworks emerge as another pivotal driver of industrial structure enhancement. The results and discussions underscore the criticality of policy coherence for both developed and emerging economies. Leading countries like the U.S. and Germany should harmonize their regulations and incentives and then share their experiences with developing nations such as China and India. By aligning policies across sectors and addressing discrepancies, nations can bolster their endeavors' effectiveness, collectively advancing towards the Paris Agreement goals.

This research holds significance as it fills a gap in the literature by comparing industrial structure upgrading strategies and policies between developed and emerging nations. By highlighting the distinct challenges and opportunities faced by different economic contexts, this paper extends the knowledge base of industrial structure upgrading and its implications for climate change mitigation and sustainable development. The findings can inform policymakers, industry stakeholders, and researchers in developing countries, providing insights into practical approaches to reduce carbon emissions while promoting economic growth. However, the analysis of this paper primarily relied on secondary data sources, limiting the depth and specificity of the findings. Future research could incorporate primary data collection methods to gather more nuanced information. Additionally, the study focused on a selected set of countries, and the findings may be generalizable to only some developing and developed countries. Future research could consider a broader range of countries to capture the diversity of industrial structure upgrading experiences.

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