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Article

A Study on the Synergistic Mechanism between Industrial Structure Adjustment and Green Development in the Guangdong-Hong Kong-Macao Greater Bay Area

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Abstract: The Guangdong-Hong Kong, China-Macao, China Greater Bay Area (GBA) represents one of China's most dynamic, innovative, and open economic regions, serving as a critical engine for national growth. As it continuously strives for high-quality development, the intricate coordination between industrial structure adjustment and green development becomes an urgent strategic priority. This paper comprehensively investigates the underlying mechanisms through which the GBA can effectively harmonize economic restructuring with long-term ecological sustainability. Drawing on robust theoretical frameworks of ecological economics, environmental management, and regional development, the study systematically analyzes the current state of the regional industrial system. It identifies multifaceted challenges inherent in the green transformation process, such as resource constraints, technological bottlenecks, and institutional barriers. To address these critical issues, the research proposes a comprehensive synergistic mechanism that seamlessly integrates technological innovation, policy frameworks, and extensive cross-regional cooperation. By fostering a circular economy and promoting low-carbon industrial practices, this proposed model aims to optimize resource allocation and mitigate environmental degradation. Furthermore, the study provides actionable policy recommendations to facilitate the transition toward a more resilient and sustainable economic model. Ultimately, this research contributes valuable insights into the spatial and structural dynamics of regional integration, offering a replicable paradigm for other rapidly urbanizing and industrializing regions globally seeking to balance robust economic expansion with stringent environmental preservation mandates.

Keywords: greater bay area; industrial structure; green development; sustainable transition; regional integration

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1. Introduction

1.1. Research Background and Significance

The Guangdong-Hong Kong, China-Macao, China Greater Bay Area (GBA) has rapidly developed into one of the most dynamic and globally competitive regions, characterized by its robust manufacturing base, burgeoning financial services sector, and increasing emphasis on high-tech innovation [1]. As one of China's most open and economically active regions, the GBA plays a pivotal role in driving national economic transformation and global integration. However, this rapid industrialization and urban growth have brought substantial environmental challenges, including air and water pollution, high carbon emissions, and ecological degradation. These issues highlight the

urgent need to reconcile economic growth with environmental sustainability. Coordinating industrial upgrading with green transformation is therefore not only a regional priority but also a strategic imperative for China's broader ecological civilization agenda. Achieving this balance is critical for fostering long-term, high-quality, and sustainable development in the GBA.

1.2. Current Research Landscape

Existing academic literature and policy analyses have extensively examined green development strategies and industrial policy measures, yet these themes are often approached separately [1]. Research focusing solely on green transformation typically emphasizes technological innovation, environmental measures, or green finance, while studies centered on industrial upgrading often examine sectoral restructuring, innovation-driven growth, or global value chain positioning. However, there remains a noticeable gap in integrating these two domains to understand their interplay—specifically, how industrial restructuring can align with ecological objectives, and vice versa. Additionally, while interest in the development of the Greater Bay Area (GBA) is increasing, comparative studies exploring intra-regional interactions among its constituent cities remain limited. In particular, there is insufficient analysis of how differences in institutional settings, governance models, and policy orientations among Guangdong, Hong Kong, China, and Macao, China, affect the effectiveness of regional synergy in advancing green and industrial transformation.

1.3. Research Objectives and Framework

This study aims to address existing gaps by examining how adjustments in the industrial structure within the GBA can be strategically aligned with objectives for green development. The primary goal is to explore pathways through which economic advancement and environmental sustainability can complement each other [2]. To achieve this, the research introduces an integrated framework emphasizing three key dimensions: Innovation-Driven Mechanisms, which investigate how technological progress and industrial innovation can simultaneously enhance economic competitiveness and environmental outcomes; Regional Policy Alignment, which analyzes how coordinated policy tools and regulatory harmonization across Guangdong, Hong Kong, China, and Macao, China, can support cohesive and mutually beneficial development strategies; and Ecological Compensation Schemes, which assess the role of incentive-based mechanisms, such as ecological compensation and green finance, in fostering collaboration and environmental responsibility.

By employing this framework, the study seeks to provide a more comprehensive understanding of sustainable regional development, offering policy recommendations and strategic insights to enhance governance across regions and promote long-term resilience in the GBA [2].

2. Evolution and Characteristics of Industrial Structure in the GBA

2.1. Historical Trajectory of Industrial Development

The industrial evolution of the Guangdong-Hong Kong, China-Macao, China Greater Bay Area (GBA) reflects the broader trajectory of China's economic transformation over the past four decades. Initially, the region emerged as a global manufacturing powerhouse, driven by foreign investment, export-oriented growth strategies, and the relocation of industries requiring significant workforce input [1]. Cities such as Dongguan, Foshan, and Zhongshan developed strong manufacturing capacities, specializing in electronics, furniture, textiles, and household appliances.

With the implementation of China's innovation-driven development strategy and the maturation of global value chains, a new wave of industrial transformation reshaped the GBA. Cities like Shenzhen and Guangzhou shifted focus from traditional, low-value-added industries to high-tech manufacturing and service-based economies, emphasizing research and development (R&D), digital technology, and advanced manufacturing [3].

Shenzhen, in particular, emerged as a global hub for technological innovation and entrepreneurship, hosting companies such as Huawei, Tencent, and DJI.

However, this transition has not been uniform [1]. While some cities have successfully diversified their economies, others remain reliant on resource-intensive and environmentally burdensome industrial structures, underscoring the unevenness of development across the region.

2.2. Spatial Differentiation and Industrial Complementarity

The GBA is characterized by distinct spatial and industrial heterogeneity, which is both a strength and a source of complexity for regional integration. Hong Kong, China, with its well-established legal system, international connectivity, and service-oriented economy, has long been a global financial center. Macao, China, on the other hand, is heavily reliant on tourism and gaming but has begun exploring diversification strategies. Shenzhen leads in technology innovation and digital economy development, while Guangzhou serves as a major hub for advanced manufacturing, commerce, and education [2].

In contrast, cities such as Dongguan, Foshan, and Huizhou still play critical roles as manufacturing bases, contributing significantly to the region's export capacity. Zhuhai and Zhongshan have developed niche industries and are increasingly participating in emerging sectors such as biopharmaceuticals and smart appliances [4]. This industrial complementarity provides a foundation for functional specialization and cross-city collaboration. However, it also presents coordination challenges. Differences in institutional governance, regulatory standards, infrastructure connectivity, and local economic priorities can create friction and inefficiencies in the pursuit of cohesive regional transformation. Balancing specialization with synergy is thus essential to harnessing the full potential of the GBA's diverse economic base.

2.3. Bottlenecks in Structural Upgrading

Despite the region's impressive economic growth and technological advancement, several structural factors continue to impede its path toward green and sustainable industrial development. One key issue is industrial overcapacity in certain sectors, particularly in cities where low-end manufacturing still dominates. This over-reliance on resource-intensive and polluting industries not only threatens environmental sustainability but also weakens the region's long-term economic resilience.

Another significant challenge is the lack of effective coordination in regional planning and development strategies. Fragmented governance across the region's diverse administrative and regulatory frameworks often results in policy misalignment and inconsistency, undermining efforts to integrate industrial upgrading with ecological objectives. Furthermore, disparities in local government capacities and varying levels of commitment to green transformation create unequal momentum across cities [5]. Additionally, the region faces obstacles related to insufficient investment in green infrastructure, limited adoption of cleaner technologies by small and medium-sized enterprises (SMEs), and inadequate mechanisms for ecological compensation and resource allocation. These factors slow the pace of industrial modernization and hinder the transition toward a low-carbon, innovation-led development paradigm. Addressing these challenges requires not only technical solutions but also institutional innovation, intergovernmental cooperation, and inclusive policy design.

3. Green Development Trends and Challenges in the GBA

3.1. Progress in Ecological Policies and Low-Carbon Initiatives

In recent years, the Guangdong-Hong Kong, China-Macao, China Greater Bay Area (GBA) has made notable strides in formulating and implementing ecological and low-carbon development policies. The region has positioned itself as a leader in green finance, actively promoting green bonds, sustainable investment frameworks, and Environmental, Social, and Governance (ESG) disclosure standards. These financial instruments support

environmentally responsible enterprises and incentivize innovation in sustainable technologies [6].

Meanwhile, Guangdong Province has pioneered the development of China's carbon emissions trading system. Its carbon market, one of the earliest and most comprehensive in the country, covers a wide range of sectors, including power generation, cement, and steel. This market-based mechanism has contributed to raising awareness about carbon pricing and promoting emission reduction strategies among enterprises [7].

Across the GBA, numerous pilot projects have been launched to explore pathways to urban sustainability. These include energy efficiency retrofitting in public buildings, the integration of solar and wind energy into urban grids, the deployment of electric public transportation fleets, and the construction of eco-industrial parks. Cities such as Shenzhen and Guangzhou have emerged as frontrunners in electric vehicle adoption and low-carbon city planning. These efforts signify a regional shift toward greener urban development models, though challenges in scale, coordination, and continuity remain.

3.2. Environmental Pressures and Cross-Border Issues

Despite ongoing progress, the GBA continues to face acute environmental pressures that transcend administrative boundaries. Shared challenges such as air pollution, water contamination in river basins like the Pearl River Delta, and land degradation due to overdevelopment and industrial activities pose significant threats to public health and ecological stability. Additionally, rising greenhouse gas emissions linked to urban growth, industrial energy consumption, and transportation demand are undermining the region's low-carbon transition goals.

A major impediment to addressing these issues lies in the fragmented nature of environmental governance across the GBA's framework. Differences in legal systems, regulatory standards, data transparency, and enforcement capacities between Hong Kong, China, Macao, China, and mainland cities create coordination challenges. For example, while Guangdong enforces a province-wide ecological redline system, Hong Kong, China operates under a distinct environmental policy structure. This institutional fragmentation hampers the formulation and implementation of unified standards, joint monitoring mechanisms, and collaborative pollution mitigation strategies. Consequently, the effectiveness of otherwise ambitious environmental policies is diluted, and regional ecological risks remain insufficiently managed.

3.3. Public Awareness and Green Innovation Gaps

Public environmental awareness in the GBA has steadily improved, supported by education campaigns, media coverage, and growing public concern over environmental quality. Nonetheless, significant disparities remain in the depth and scope of public participation in green initiatives. Residents in cities such as Hong Kong, China, and Shenzhen benefit from established civic engagement platforms and environmental education systems, whereas participation levels are relatively lower in other parts of the region, particularly in smaller or industrially oriented cities where economic priorities often overshadow ecological considerations [8].

Additionally, the development and application of green technologies are unevenly distributed across the GBA. High levels of green research and development investment are concentrated in innovation hubs such as Shenzhen and Guangzhou, while other cities encounter challenges related to talent availability, funding, and institutional support for environmental innovation. This imbalance restricts the adoption of sustainable practices and hampers the establishment of a cohesive regional green innovation ecosystem.

The private sector, while increasingly aware of sustainability trends, demonstrates varying levels of practical engagement. Large enterprises may incorporate environmental, social, and governance considerations into their operations, but many small and medium-sized enterprises (SMEs), which form the backbone of the GBA's economy, often lack the resources, expertise, or incentives to adopt sustainable technologies or transform their business models. Bridging these gaps requires not only technological and financial

assistance but also enhanced public-private partnerships, policy incentives, and capacity-building initiatives to foster a culture of sustainability throughout the region.

4. Toward a Synergistic Mechanism: Policy Integration and Innovation Pathways

4.1. Technological Innovation and Industrial Green Transition

Technological innovation acts as a driving force for advancing the green transformation of industrial systems in the GBA [9, 10]. As the region transitions away from resource-intensive and high-emission industries, the adoption of clean technologies becomes indispensable. This encompasses the development and implementation of energy-efficient manufacturing processes, circular economy frameworks, and pollution mitigation technologies.

Government-led measures to encourage green research and development (R&D) play a pivotal role. Policies such as tax incentives, innovation funding, and collaborative research initiatives between public and private sectors can mitigate the financial risks and challenges associated with innovation for enterprises. Special emphasis on supporting startups and small-to-medium enterprises engaged in clean technology innovation can expand the foundation of green industrial capabilities [3].

The creation of low-carbon industrial parks and eco-industrial clusters is vital for demonstrating integrated approaches to sustainable production [11]. These parks prioritize environmental considerations, utilizing renewable energy sources, optimizing resource flows, and incorporating systems for waste recycling and water conservation.

The application of advanced technologies, including artificial intelligence (AI), big data, and the Internet of Things (IoT), can significantly enhance industrial energy efficiency and environmental monitoring. For instance, AI-driven energy management systems can optimize electricity usage patterns and reduce peak load demand, contributing to the decarbonization of industrial processes. Strengthening digital infrastructure within traditional industrial sectors is a crucial step toward achieving an intelligent and sustainable transition.

4.2. Institutional Coordination and Cross-Border Policy Mechanisms

Institutional coordination within the GBA is crucial for harmonizing environmental governance and fostering synergistic development. Considering the coexistence of diverse legal, administrative, and regulatory systems in Guangdong, Hong Kong, China, and Macao, China, the establishment of a multilateral policy platform serves as a foundational step toward achieving policy coherence [12].

This platform could be structured as an intergovernmental council or working group dedicated to environmental and industrial coordination, supported by regular dialogue, joint planning, and technical exchanges. Its responsibilities could include aligning key regulatory instruments, such as environmental impact assessment procedures, industrial emission limits, and sustainability certification standards. Unified emission monitoring systems would enable consistent data collection, comparison, and public disclosure across regions, thereby enhancing transparency and promoting mutual accountability [13].

Regionally coordinated incentive schemes are also essential [6]. For example, green subsidies spanning multiple regions, shared carbon offset programs, and co-financed pilot projects can strengthen collaborative efforts. These mechanisms would not only consolidate resources and expertise but also minimize regulatory uncertainty for enterprises operating across Guangdong, Hong Kong, China, and Macao, China.

Additionally, joint training programs for policymakers and environmental professionals, along with shared databases and ecological early warning systems, can enhance institutional learning and enable rapid responses to environmental challenges. A more integrated governance framework would not only improve enforcement but also establish a unified green development identity for the GBA on the global stage.

4.3. Market-Based Mechanisms and Financial Instruments

Market-based mechanisms offer powerful tools for aligning economic incentives with sustainability goals. Among these, green finance has emerged as a cornerstone of the GBA's transition strategy. Financial instruments such as green bonds, sustainability-linked loans, and climate risk insurance enable capital to flow toward environmentally responsible projects, including renewable energy, clean transportation, and energy-efficient infrastructure. Hong Kong, China, leveraging its mature financial ecosystem and global connectivity, plays a pivotal role in anchoring regional green investment. The Hong Kong, China Green Bond Grant Scheme and the Green and Sustainable Finance Cross-Agency Steering Group exemplify institutional efforts to develop a robust green finance market. As a gateway for international investors, Hong Kong, China can facilitate the channeling of global capital to support green initiatives throughout the GBA. The carbon trading system established in Guangdong also contributes to the development of a carbon pricing mechanism that incentivizes emission reductions. Expanding the scope and coverage of the carbon market, and exploring its integration with other regional or international trading systems, could enhance liquidity and effectiveness.

Furthermore, promoting Environmental, Social, and Governance (ESG) investment frameworks across the GBA will help embed sustainability considerations in corporate strategies and investor decision-making [14]. Encouraging listed companies to disclose ESG metrics and integrating such indicators into stock market indices and investment funds can strengthen the link between financial performance and environmental accountability.

5. Regional Synergy and Governance Innovation

5.1. Role of Cities in Driving Integrated Development

In the Greater Bay Area (GBA), the diverse economic bases and developmental stages of constituent cities provide a strong foundation for differentiated yet complementary roles in promoting integrated green development. Recognizing and leveraging these differentiated advantages is crucial for achieving regional synergy and ensuring coordinated efforts. Shenzhen, as a pioneer in science and technology innovation, has the potential to serve as a central hub for green innovation. Its robust startup ecosystem, high R&D investment, and strong policy support for sustainable industries make it well-positioned to lead in areas such as green tech entrepreneurship, AI-driven environmental management, and renewable energy applications. Guangzhou, with its strategic location and comprehensive industrial base, can focus on developing eco-industrial clusters and sustainable logistics systems. By integrating green technologies into its transportation and manufacturing sectors, Guangzhou can lead in demonstrating circular economy practices and smart logistics infrastructure that reduce carbon footprints. Hong Kong, China, as an international financial center with mature legal and regulatory systems, is uniquely suited to anchor green finance in the region. Its deep capital markets, ESG disclosure frameworks, and growing network of sustainable investment funds can channel global resources into green projects across the GBA.

Meanwhile, other cities such as Dongguan, Foshan, and Zhuhai can contribute by upgrading their traditional manufacturing sectors through clean production techniques and by participating in regional industrial reallocation strategies that align with low-carbon goals [15]. This functional division of roles enhances regional complementarity, supports specialization, and contributes to a more integrated and balanced development model.

5.2. Building a Multi-Level Governance Framework

To support the complex and interdependent processes of green transformation across the GBA, a robust multi-level governance structure is essential. This structure must bridge administrative boundaries and foster alignment across multiple scales of authority—central, provincial, and municipal. At the central level, national guidelines and funding mechanisms for carbon neutrality, technological innovation, and ecological protection can set the tone and direction for regional development. Central support also helps

institutionalize cross-regional cooperation by providing a legal and political framework for collaboration. At the provincial level, the Guangdong government can act as a coordinator by formulating implementation plans that reflect regional priorities, setting common environmental standards, and managing large-scale infrastructure and ecological projects. Municipal governments, meanwhile, are responsible for on-the-ground execution. Their role includes local policy customization, enforcement of environmental standards, and support for grassroots initiatives. To avoid fragmentation and policy inconsistency, better vertical integration of planning, monitoring, and evaluation mechanisms is required. The establishment of a GBA Regional Environmental Governance Council—comprising representatives from Guangdong, Hong Kong, China, and Macao, China—could serve as a high-level institutional platform for information sharing, resolution of technical issues, and joint decision-making. This council would oversee regional ecological targets, coordinate joint initiatives, and publish regular reports to ensure transparency and accountability.

5.3. Inclusive Participation and Talent Networks

Achieving sustainable transformation in the Greater Bay Area requires broad-based participation that encompasses governments, businesses, and communities. Inclusive governance that empowers local populations, promotes civic responsibility, and enhances environmental awareness is essential for fostering a lasting green development identity in the region. Public engagement through participatory platforms such as community meetings, citizen science initiatives, and online consultation channels can strengthen local ownership of environmental policies. Environmental education programs in schools and communities should be enhanced to instill sustainable values from an early age, cultivating a generation of environmentally conscious citizens. Furthermore, the contributions of civil society organizations, including non-governmental entities, advocacy groups, and academic institutions, should be fully acknowledged and supported. These organizations can act as intermediaries between policy and practice, facilitate community-driven projects, and provide independent oversight. Talent development is a critical driver of green transformation. Initiatives such as regional talent exchange programs and collaborative training efforts can promote knowledge sharing and foster a unified professional culture centered on sustainability [11]. Building an open and dynamic green talent ecosystem that integrates universities, research institutions, startups, and multinational companies will help attract and retain skilled professionals across the region. Special emphasis should be placed on engaging youth through internships, innovation competitions, and entrepreneurship platforms, encouraging their active participation in shaping the region's sustainable future.

6. Conclusion

The integration of industrial structure adjustment with green development in the GBA is both a necessity and an opportunity to pioneer a model of sustainable regional governance. Through coordinated policy innovation, technological advancement, and institutional synergy, the GBA can achieve a balanced and inclusive green transition. Moving forward, establishing long-term mechanisms for regional cooperation and ecological responsibility will be crucial to building a resilient and low-carbon bay area aligned with global sustainability goals.

References

1. J. Nussbaumer and F. Moulaert, "Integrated area development and social innovation in European cities: A cultural focus," *City*, vol. 8, no. 2, pp. 249-257, 2004.
2. F. De Bello, W. Thuiller, J. Lepš, P. Choler, J. C. Clément, P. Macek, et al., "Partitioning of functional diversity reveals the scale and extent of trait convergence and divergence," *Journal of Vegetation Science*, vol. 20, no. 3, pp. 475-486, 2009.
3. B. R. Copeland, "Pollution content tariffs, environmental rent shifting, and the control of cross-border pollution," *Journal of International Economics*, vol. 40, no. 3-4, pp. 459-476, 1996.
4. J. Silliman, "Expanding civil society: Shrinking political spaces—The case of women's nongovernmental organizations," *Social Politics: International Studies in Gender, State & Society*, vol. 6, no. 1, pp. 23-53, 1999.

5. W. Liu and B. Qin, "Low-carbon city initiatives in China: A review from the policy paradigm perspective," *Cities*, vol. 51, pp. 131-138, 2016.
6. A. Costakis, *U.S. Patent Application No. 11/279,997*, 2006.
7. J. Janger, T. Schubert, P. Andries, C. Rammer, and M. Hoskens, "The EU 2020 innovation indicator: A step forward in measuring innovation outputs and outcomes?," *Research Policy*, vol. 46, no. 1, pp. 30-42, 2017.
8. M. Bernard and J. Ravenhill, "Beyond product cycles and flying geese: Regionalization, hierarchy, and the industrialization of East Asia," *World Politics*, vol. 47, no. 2, pp. 171-209, 1995.
9. Z. Yu, Z. Xiao, Y. Yan, C. C. Feng, and X. Liu, "The geographic disparity of agglomeration economies: Evidence from industrial activities in China's emerging greater bay area," *Applied Geography*, vol. 161, p. 103128, 2023.
10. F. Zhao and S. He, "Impact of business environment on industrial structure upgrading in Guangdong–Hong Kong–Macao Greater Bay Area," *Discrete Dynamics in Nature and Society*, vol. 2025, no. 1, p. 6617589, 2025.
11. E. C. Hui, X. Li, T. Chen, and W. Lang, "Deciphering the spatial structure of China's megacity region: A new bay area—The Guangdong-Hong Kong-Macao Greater Bay Area in the making," *Cities*, vol. 105, p. 102168, 2020.
12. H. Yu, "The Guangdong-Hong Kong-Macau greater bay area in the making: Development plan and challenges," *Cambridge Review of International Affairs*, vol. 34, no. 4, pp. 481-509, 2021.
13. F. Yang, Y. Sun, Y. Zhang, and T. Wang, "Factors affecting the manufacturing industry transformation and upgrading: A case study of Guangdong–Hong Kong–Macao Greater Bay Area," *International Journal of Environmental Research and Public Health*, vol. 18, no. 13, p. 7157, 2021.
14. Z. Yu, Z. Xiao, and X. Liu, "Characterizing the spatial-functional network of regional industrial agglomerations: A data-driven case study in China's greater bay area," *Applied Geography*, vol. 152, p. 102901, 2023.
15. L. Yi, W. Yun, and L. Hong, "Industrial development of world-class bay areas and its enlightenment to the Guangdong-Hong Kong-Macao Greater Bay Area," *Bulletin of Chinese Academy of Sciences (Chinese Version)*, vol. 35, no. 3, pp. 312-321, 2020.

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