

Provincial Green Governance And Business Operational Resilience: Evidence From Vietnam

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Abstract: *In the context of the green transition, this paper examines the impact of provincial environmental governance on business operational resilience in Vietnam during the 2022–2024 period. Utilizing data from the Provincial Green Index (PGI) and the White Book on Vietnamese Enterprises, the study employs descriptive statistics and comparative analysis across six economic regions. The findings reveal a robust congruent development trend, with the national average PGI score increasing by nearly 70%—from 14.83 to 25.07 points—alongside the steady expansion of the business sector. Detailed regional analysis indicates that Business Support Policies and Services (CT4) and Pollution Reduction and Climate Change Resilience (CT1) serve as the primary drivers of this positive correlation. The research confirms that green governance acts as a catalyst rather than a cost barrier, effectively reducing operational risks and reinforcing investor confidence. This study provides significant empirical evidence suggesting that enhancing provincial green governance capacity is essential for fostering a resilient business ecosystem in the Net Zero era.*

Keywords: *Green governance, Provincial Green Index (PGI), Business resilience, Sustainable development.*

I. INTRODUCTION

As global climate change emerges as an existential threat to human progress, the philosophy of economic growth has undergone a paradigm shift from resource-intensive models toward sustainable development and the green economy. In Vietnam, the commitment to achieving Net Zero emissions by 2050 at COP26 serves as more than a political pledge; it has become the compass for macroeconomic policy. However, the success of this transition depends not only on central mandates but also on the green governance capacity of local governments—the entities that directly shape the business environment and influence the survival of the private sector. The introduction of the Provincial Green Index (PGI) in 2022 by the Vietnam Chamber of Commerce and Industry (VCCI) exemplifies the effort to quantify local environmental governance quality. Nevertheless, a critical question remains at the intersection of theory and practice: Does a robust local green governance system act as a "magnet" for new entrants and sustain existing firms, or does it impose compliance costs that stifle economic vitality?

The nexus between environmental governance and competitiveness has been a subject of decades-long academic debate. Palmer et al. (1995) argued that stringent environmental regulations force firms to reallocate resources from production to non-profit activities (e.g., waste treatment), leading to increased marginal costs and diminished competitiveness. Echoing this view, Jaffe et al. (1995) noted that high environmental standards in the U.S. exerted downward pressure on the productivity of resource-intensive industries in the short term.

Conversely, Porter and van der Linde (1995) proposed the "Porter Hypothesis," suggesting that well-designed environmental regulations stimulate technological innovation. This allows firms to optimize processes and reduce waste, thereby enhancing long-term efficiency. In emerging markets like China, Wang and Liu (2023) demonstrated that environmental regulation drives Total Factor Productivity (TFP) by compelling firms to upgrade obsolete technologies. Research by Chai et al. (2020) published in *Frontiers in Public Health* further evidenced that strict environmental regulations (based on the AQI) reduce labor costs and improve corporate performance. Their findings suggest that environmental improvements enhance worker health, thereby mitigating toxicity-related costs and optimizing operations.

Furthermore, Horváthová (2010) utilized a meta-analysis to show that studies employing panel data frequently find a positive impact of environmental compliance on financial performance. Finally, Zhu and Sarkis (2004) asserted that legal compliance serves as a springboard for firms to participate in global green supply chain management, improving both economic standing and brand reputation. Locally, Nguyen and Nguyen (2024) emphasized that Corporate Social Responsibility (CSR) positively influences performance indicators such as ROA and ROE. Tran (2023) highlighted the reciprocal relationship between environmental law enforcement

and the efficiency of SMEs, identifying these enterprises as key players in addressing environmental pressures. Bich Ngoc (2025) affirmed that while the green transition imposes cost pressures, the synergy between green and digital transformations offers opportunities to foster sustainable development and meet international market demands.

Despite a rich foundation of international theory and empirical evidence, research on the impact of local green governance in Vietnam still contains significant gaps. Most existing studies, such as those by Le et al. (2022) or Pham et al. (2022), focus on the Provincial Competitiveness Index (PCI) generally, without isolating the specific role of environmental governance. Given that the PGI was only launched in 2022, there is a dearth of large-scale quantitative research using panel data to evaluate how specific PGI sub-indices affect the dynamics of new and existing business populations across 63 provinces. In particular, the link between governmental green support policies and long-term business resilience in the post-pandemic recovery context remains under-explored.

Therefore, this paper aims to empirically analyze the influence of local green governance—measured through the PGI framework—on market entry dynamics and the operational sustainability of the Vietnamese business sector. The study moves beyond aggregate PGI scores to examine four key sub-indices: (1) minimizing environmental pollution and the negative impacts of climate change; (2) ensuring compliance with minimum environmental standards; (3) promoting green practices; and (4) incentive policies and support services for environmental protection. Through comparative analysis, the research expects to provide scientific evidence that green governance serves as a "driver" rather than a "barrier" to business ecosystem development. The findings will contribute academically to the literature on green institutional economics and offer vital policy recommendations for provincial governments to enhance sustainable competitiveness in the era of digital and green economies.

Beyond this introduction, the article is structured as follows: Section 2 details the Data and Research Methodology; Section 3 presents the Research Results; and Section 4 provides the Conclusion.

II. DATA AND RESEARCH METHODOLOGY

2.1. Data

To analyze the nexus between local green governance and the vitality of the private sector, this study utilizes an empirical analysis method based on a provincial-level secondary dataset. The research focuses on benchmarking and analyzing the fluctuating trends of business indicators under the influence of environmental governance pillars, an approach that facilitates the direct identification of highlights and bottlenecks in local green policy implementation while providing a comprehensive overview of Vietnam's current economic-environmental landscape. The data for this research is synthesized from the two most authoritative administrative and survey sources in Vietnam. Primary corporate data is extracted from the White Book on Vietnamese Enterprises, published annually by the General Statistics Office (GSO) since 2019. This source provides the total number of active enterprises at the end of each year, serving as a proxy for investor expectations and confidence in the green business environment, thereby ensuring that the study reflects the actual health of the business ecosystem across all 63 provinces without statistical noise. Complementing the corporate data, environmental governance metrics are sourced from the Provincial Green Index (PGI), first launched by the Vietnam Chamber of Commerce and Industry (VCCI) in 2022. This integrated index is constructed from surveys of thousands of domestic and foreign-invested firms regarding the quality of local environmental management. Rather than relying solely on aggregate scores, this study conducts a granular analysis of the four specific components: CT1, which evaluates efforts in reducing environmental pollution and natural disasters; CT2, which measures compliance with minimum environmental standards; CT3, focused on the promotion of green practices; and CT4, which examines policies and services designed to support businesses in environmental protection.

2.2. Research Methodology

The research methodology is implemented through three logical stages. Initially, descriptive statistics are employed to delineate the national distribution of PGI scores and business scale, establishing a baseline for the broader economic-environmental context. Subsequently, a group analysis is conducted by categorizing the 63 provinces into distinct tiers based on their green governance performance. This comparative framework allows for a rigorous assessment of the disparities between top-performing and lagging groups, specifically regarding the growth rates of new business registrations and the ratios of active enterprises. Through this multi-step analytical approach, the study identifies specific mechanisms through which provincial governance influences the sustainability and operational resilience of the private sector.

III. RESEARCH RESULTS

3.1. The Provincial Green Index (PGI)

The PGI consists of four sub-indices derived from 45 indicators that measure environmental governance quality aimed at aligning environmental protection with economic development. These indices evaluate policies and support services that encourage businesses to adopt behaviors exceeding minimum legal or international standards. Each sub-index has a maximum score of 10, totaling a possible 40 points for the aggregate PGI. Higher scores reflect a more successful balance between economic growth and environmental stewardship.

To assess shifts in national environmental governance quality from 2022 to 2024, this paper utilizes the annual national average PGI, calculated as the mean score of all 63 provinces. According to the VCCI PGI Data, the national average scores for 2022, 2023, and 2024 are 14.83, 21.59, and 25.07, respectively. These figures indicate a significant upward trajectory in nationwide environmental governance quality, with 2024 seeing a nearly 10-point increase compared to the index's inception in 2022.

Chart 1: National Average PGI Fluctuations (2022–2024)

Year	Max PGI	Mean PGI	Min PGI	The number of localities exceeding the mean
2022	17.67	14.83	12.52	30
2023	26.00	21.59	17.02082	35
2024	28.99	25.07	20.71	29

Source: VCCI

Based on the empirical data, a significant breakthrough and uniform growth trend in environmental governance quality is evident nationwide. The most striking highlight is the systematic elevation of the baseline, where the national mean score surged from 14.83 in 2022 to 25.07 in 2024, representing an increase of nearly 70%. This trend demonstrates a fundamental shift in provincial priorities, moving from the marginalization of environmental concerns toward concrete policy actions aimed at greening the economy.

The disparity between top-tier and lagging groups reveals further significant dynamics. The leading group, represented by the maximum values, has continually set new records, reaching 28.99 in 2024 and establishing benchmarks that far exceed the baseline levels of 2022. Conversely, the trailing group, or the minimum values, provides perhaps the most positive indicator of progress; the minimum score recorded in 2024 was 20.71, a figure substantially higher than the national average from just two years prior. This suggests that even the weakest-performing provinces today are outperforming the national average of the initial study period.

While 2023 witnessed an explosion in performance with 35 provinces exceeding the average—indicating a widespread competitive movement—the landscape shifted in 2024. Although the overall national score continued to rise, the number of provinces performing above the mean dropped to 29. This phenomenon suggests that the top-tier provinces are accelerating at such a rapid pace that they have significantly raised the national average floor. Consequently, remaining provinces must exert substantially greater effort to prevent a widening governance gap and avoid being marginalized in the national green development race.

To understand whether this breakthrough stems from specific pillars or a holistic improvement across all dimensions, we examine Table 2: Changes in PGI Sub-indices from 2022 to 2024.

Table 2: Changes in PGI Sub-indices from 2022 to 2024.

Year	Value of Indicator	CT1	CT2	CT3	CT4
2022	Max PGI	6.85	6.74	5.35	2.59
	Min PGI	3.07	4.03	2.98	1.39
	Mean PGI	3.72	5.07	4.10	1.94
	The number of localities exceeding the mean	16	31	30	31
2023	Max PGI	7.71	7.89	7.07	6.02
	Min PGI	4.12	3.85	3.28	4.04
	Mean PGI	6.56	5.73	4.20	5.10
	The number of localities exceeding the mean	39	43	23	27
2024	Max PGI	7.83	7.95	7.66	8.50
	Min PGI	4.38	3.91	3.93	4.28

Mean PGI	6.67	6.77	5.30	6.32
The number of localities exceeding the mean	38	35	23	32

Source: VCCI

An analysis of the fluctuations in Table 2 reveals a breakthrough trend and a clear shift in policy focus. Between 2022 and 2024, the mean values of all sub-indices recorded positive growth, reflecting synchronized efforts across localities to adapt to new green standards.

The most spectacular breakthrough occurred in Sub-index 4 (CT4): Policies and Support Services. From a very low average of 1.939 points in 2022, SI4 recorded a record growth of 226.01% (+4.383 absolute units) to reach 6.322 points in 2024. This shift indicates that governance focus has evolved from mere pollution control to proactively supporting businesses in adopting clean production—marking a new phase in provincial-level economic greening efforts.

Next is the improvement in CT1: Pollution Reduction and Climate Change Resilience, which grew by a steady 79.33% over three years. Notably, the largest leap occurred between 2022 and 2023 (+76.26%), demonstrating rapid policy responsiveness by localities immediately following the PGI's debut to tighten environmental standards and enhance resilience against climate shocks.

CT2: Ensuring Compliance with Environmental Standards maintained stable performance and reached the highest average score in the system by 2024 (6.772 points, up 33.46%). The proportion of localities exceeding the average peaked in 2023 (68.25%), indicating that compliance with minimum environmental laws has become a universal standard, relatively well-implemented across most provinces.

Finally, CT3: Promoting Green Practices—which reflects the role and commitment of local governments—showed the slowest improvement (increasing only 29.27% from 4.103 to 5.304). The percentage of observations above the mean for SI3 remained consistently low (around 36.5%), revealing a deep divide in green leadership mindset. While a few localities surged ahead due to decisive leadership, the majority are undergoing a slow transition.

In summary, the 2022–2024 period reflects a substantive transformation. The surge in SI4 and the stability of SI1 and SI2 provide empirical evidence that provinces are moving toward "depth" in environmental governance. However, the persistent disparity in leadership roles (SI3) warrants careful consideration in subsequent quantitative analyses.

3.2. Green Governance and Business Resilience

To evaluate the relationship between green governance and business resilience, this article utilizes data on active enterprises, enterprises reporting business results, and labor force size. The analysis examines these correlations across Vietnam's six economic regions: The Red River Delta, the Northern Midlands and Mountains, the Central Coastal region, the Central Highlands, the Southeast, and the Mekong Delta. By comparing regional shifts in green governance and business activity, the study clarifies the impact of environmental management on the operational sustainability of the enterprise sector.

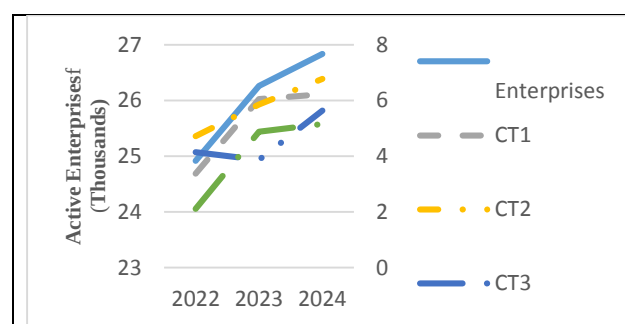


Figure 1.a. Central Highland

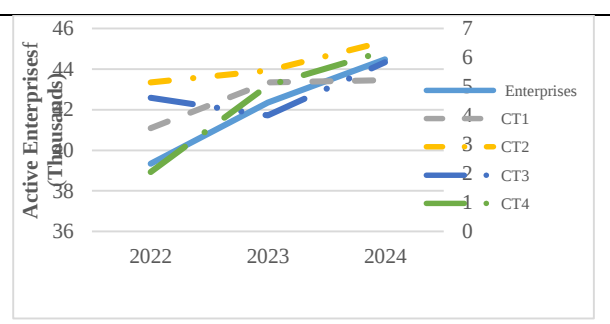


Figure 1.b. Northern Midlands and Mountains

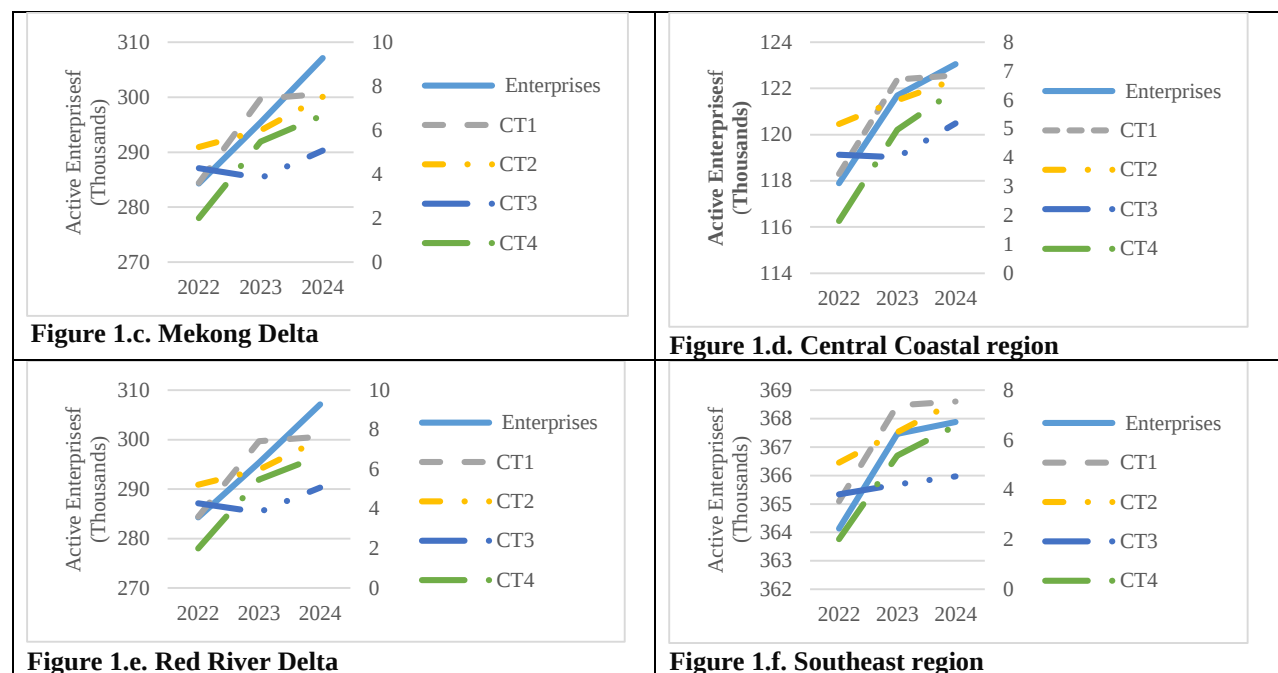


Figure 1. The Relationship between Green Governance and Business Resilience

Regarding the regional analysis, we first examine the Central Highlands (Figure 1.a), which possesses the smallest business population compared to other regions—approximately 11 and 13 times fewer enterprises than the Red River Delta and the Southeast, respectively. During the 2022–2024 period, statistical data for this region reflects a congruent development trend, where the expansion of productive forces occurred in tandem with significant improvements in provincial environmental governance capacity. The data reveals a distinct and stable positive correlation between business scale and the Provincial Green Index (PGI), as the number of active enterprises rose from 24,914 to 26,836 units (a 7.71% increase) while the overall PGI score surged from 14.23 to 23.47 points (a 64.9% increase). Among the four components, CT1 and CT4 served as the primary drivers of this correlation. Notably, CT1 in the Central Highlands was the largest contributor to the PGI increase, surging nearly twofold from 3.37 to 6.22 points. This reflects the region's specific prioritization of mitigating climate change impacts and pollution to secure a sustainable development space for enterprises in agriculture and resource extraction. Meanwhile, CT4 recorded the highest relative growth at 144%, rising from 2.11 to 5.15 points, which aligns with the expansion of business scale and indicates that regional authorities proactively provided support services for new market entrants. CT2 exhibited steady growth of 43.4%, maintaining environmental discipline, while CT3 saw a slight dip in 2023 before rebounding to 5.64 points in 2024, suggesting a strategic reorientation of regional leadership. Ultimately, the green momentum in the Central Highlands stems from a robust contribution of environmental impact mitigation (CT1), highlighting a strategy focused on protecting the core ecosystem as a foundation for long-term business development.

Shifting the focus to the Northern Midlands and Mountains (Figure 1.b), this region maintains a relatively low business concentration, with a total number of enterprises approximately 1.66 times higher than that of the Central Highlands. Similar to the previous region, the 2022–2024 period recorded a congruent growth trend where the business population expanded from 39,341 to 44,487 units (a 13.08% increase) and the PGI score rose from 15.71 to 23.84 points (a 51.75% increase). This confirms that the surge in economic entities did not trigger a decline in green governance quality; instead, environmental improvements provided a supportive framework for expanding productive forces. However, a deeper analysis reveals that this correlation was primarily driven by the breakthrough of CT4, which skyrocketed by 203%, from 2.05 to 6.23 points. This indicates that the PGI rise relative to business growth largely resulted from proactive government efforts in providing support services and guidance for corporate environmental practices. Furthermore, CT2 contributed stable growth, matching the business momentum and demonstrating that environmental discipline remains a crucial component of the regional PGI. In contrast, the relationship between business quantity and indices CT1 and CT3 appeared less cohesive, as CT1 remained nearly stagnant during 2023–2024 despite continued business growth, and CT3 experienced an inverse correlation in 2023. Consequently, for the Northern Midlands and Mountains, the positive nexus between business development and green governance relies predominantly on the leverage of support policies (CT4) rather than direct pollution mitigation efforts.

Moving to the Mekong Delta (Figure 1.c), this region holds the fourth-largest business concentration in the country, with a population exceeding 70,000 enterprises. During the 2022–2024 period, the Mekong Delta demonstrated a positive developmental trajectory where the expansion of business scale occurred in parallel with breakthrough improvements in green governance capacity, particularly during the 2022–2023 transition. Statistical data reveals a strong and consistent positive correlation between the growth of productive forces and the overall PGI, as the number of active enterprises in the region rose from 65,290 to 70,679 units (an 8.25% cumulative growth) while the PGI score recorded an impressive surge of 75.5%, rising from 14.11 to 24.77 points. Deep analysis confirms that this positive correlation was primarily driven by the extraordinary progress of CT4 and CT1. Specifically, CT4 recorded the highest regional growth at 220.7%, climbing from 1.88 points in 2022 to 6.03 points in 2024, indicating that the link between enterprises and green governance is firmly built upon policy leverage. Provincial authorities have concentrated heavily on providing support services to help businesses navigate green standards amidst the pressures of economic transition. Simultaneously, CT1 rose from 3.4 to 7.29 points—a 114.4% increase—which, for a region highly vulnerable to climate change, reflects substantive efforts in pollution mitigation and climate adaptation. This core element has sustained PGI growth and instilled confidence within the business community regarding an environment secure from natural disaster risks. Furthermore, CT2 grew by 45.8% to reach 7.32 points, matching the pace of business expansion and ensuring that the increased quantity of firms did not compromise local environmental discipline. Unlike other regions that experienced temporary dips, CT3 in the Mekong Delta improved steadily from 3.83 to 4.9 points, demonstrating the consistent commitment of the leadership toward sustainable development. Ultimately, the relationship in this region is mutually supportive and strategically oriented, successfully combining "software" policy support (CT4) with "hardware" environmental mitigation (CT1) to build a green economic ecosystem adapted to the specific challenges of the Mekong downstream.

Transitioning to the Central Coastal region (Figure 1.d), the 2022–2024 period highlights a transformative development model where institutional improvements and green support services play a pivotal role in shaping the quality of economic growth. The data reveals a distinct and positive correlation between the development of productive forces and green governance capacity. While the number of active enterprises grew steadily from 117,899 to 123,056 units (a 4.37% increase), the overall PGI score recorded an explosive advancement from 14.53 to 24.72 points—a 70.1% surge. This significant disparity in growth rates, with the PGI improving 16 times faster than the business scale, confirms that environmental progress in the Central Coast is not merely a natural consequence of economic expansion but rather the result of proactive and decisive policy interventions.

Deep analysis reveals that this positive correlation is primarily driven by the breakthrough shifts in CT4 and CT1. Similar to the Northern Midlands and Mountains, CT4 in the Central Coast is the fastest-growing component, skyrocketing by 250.3% from 1.81 to 6.34 points. This indicates that the nexus between enterprises and green governance in this region is built upon an "enabling" foundation, where local authorities have maximized resources for support policies, consulting, and service delivery to accompany businesses in their environmental protection journeys. Regarding CT1, in contrast to the stagnation observed in mountainous regions, this index plays a vital role in pulling the overall PGI upward alongside business growth, nearly doubling from 3.44 to 6.85 points. This demonstrates that the relationship between enterprises and the PGI here is reinforced by tangible capacities in pollution mitigation and climate change adaptation—a pressing priority for coastal areas. Additionally, CT2 grew by 29.8%, acting as a stabilizer that ensures sustainable development for the community of newly established firms.

Conversely, CT3 experienced a slight dip in 2023 before rebounding strongly in 2024. This fluctuation suggests a high level of calibration in the region's leadership; following a period of stabilizing the business scale from 2022 to 2023, political determination was intensified to achieve a breakthrough in green scores in the final year. Ultimately, the relationship between business expansion and the PGI in the Central Coastal region is a deeply integrated and mutually reinforcing one. The primary momentum stems not only from outward-facing support policies (CT4) but also from the capacity to resolve core environmental and climate issues (CT1). This represents a comprehensive green governance model where as the business scale expands, the policy systems and field-level response capacities are strengthened proportionally.

Advancing to the Red River Delta (Figure 1.e), the political and economic hub of the North, this region maintains a business population eleven times larger than that of the Central Highlands. Data from the 2022–2024 period shows that the number of active enterprises in the region rose from 284,303 to 307,139 units, representing a cumulative growth of 8.03%, while the overall PGI score increased from 15.77 to 26.63 points, a surge of 68.8%. This evidence suggests that the increasing economic density in the Red River Delta is generating "positive pressure," compelling regional authorities to enhance green governance capacity in proportion to the scale of development. This positive correlation is primarily driven by breakthrough shifts in CT1 (Pollution Reduction & Climate Change) and CT4 (Policies & Support Services). Specifically, CT1 rose from 3.61 to 7.65 points—an increase of 111.9%—demonstrating that in a region characterized by rapid industrialization and urbanization,

tangible efforts in direct pollution control serve as the "backbone" that allows the PGI to maintain a growth trajectory congruent with the number of enterprises. Meanwhile, CT4 recorded a record-breaking growth of 232%, climbing from 2.01 to 6.68 points, which indicates that the link between businesses and green governance in the region relies heavily on service-based support, with authorities proactively leading and providing the necessary tools for enterprises to practice green economics. Additionally, CT2 and CT3 saw increases of 43.8% and 32%, respectively, reflecting a decisive adjustment in leadership mindset to keep pace with the momentum of growth on the ground.

Moving to the Southeast (Figure 1.f), the nation's largest economic powerhouse with a business population approximately 13 times that of the Central Highlands, the 2022–2024 data reveals a significant expansion in the active enterprise count from 326,903 to 353,230 units, a cumulative growth of 8.05%. During this same interval, the regional PGI score demonstrated a remarkable leap from 14.88 to 26.68 points, representing an 80% increase. This data confirms that the Southeast is successfully decoupling economic growth from environmental degradation, as the rapid PGI rise—surpassing the rate of business expansion—reflects a sophisticated governance response to the high density of industrial activities. The positive correlation is predominantly anchored by the dramatic breakthroughs in CT4 and CT1. Specifically, CT4 surged by 245%, rising from 1.95 to 6.73 points, which underscores that green governance in this industrial hub is primarily driven by an advanced support ecosystem where authorities provide the specialized services and incentives necessary for large-scale green transitions. Concurrently, CT1 climbed from 3.42 to 7.74 points (a 126% increase), illustrating that direct pollution mitigation and climate resilience have become core pillars in sustaining the regional business environment against the externalities of high-speed urbanization. Furthermore, CT2 and CT3 maintained steady upward trajectories, with increases of 36.4% and 34.2% respectively, signaling that both the regulatory framework and leadership commitment are evolving in synchrony with the region's vast economic scale. In essence, the Southeast model demonstrates a mature integration of green governance, where proactive policy support (CT4) and robust environmental management (CT1) act as critical stabilizers for the country's most concentrated business community.

In conclusion, the comparative analysis across the six economic regions provides compelling evidence that provincial green governance (PGI) and the sustainability of the business sector are fundamentally intertwined in a mutually reinforcing relationship. Far from being a regulatory burden that stifles vitality, high-quality environmental governance—particularly through proactive support services (CT4) and direct pollution mitigation (CT1)—acts as a primary driver for maintaining and expanding the enterprise ecosystem. The consistent upward trajectory of PGI scores alongside business growth across all regions confirms that local authorities are successfully transitioning from a "growth-at-all-costs" mindset to a sustainable development paradigm. While disparities remain, particularly in the depth of green leadership (CT3) and regional resource allocation, the overall trend suggests that a robust green institutional framework reduces operational risks and enhances long-term resilience for firms. Ultimately, these findings affirm that green governance is a competitive advantage in Vietnam's new economic era, where environmental stewardship and business prosperity are no longer a trade-off but a unified trajectory toward the Net Zero 2050 goal.

IV. CONCLUSION

The data indicates that green governance is not a barrier but rather a catalyst for expanding business scale. In regions where the PGI shows strong growth, the number of active enterprises has recorded a corresponding increase. This proves that a "clean" business environment with transparent environmental regulations helps firms mitigate operational risks, thereby fostering the confidence necessary to maintain and expand their operations. The positive correlation between the enterprise population and sub-indices such as CT4 reaffirms the collaborative role of the government. When authorities proactively provide guidance on environmental responsibilities, businesses—particularly new entrants—can more easily adapt to stringent market standards, which enhances their survival rates and long-term resilience.

Furthermore, this relationship reflects a new economic paradigm: robust green governance helps localities attract high-quality investment capital and enables domestic firms to integrate more deeply into global supply chains. Today, the sustainability of a business depends not only on capital or market access but also on its compatibility with the local green governance ecosystem. Ultimately, green governance and business development do not represent a trade-off; rather, they form a positive feedback loop. Effective green governance creates a space for sustainable development, while a growing business community, in turn, drives the government to further enhance environmental management capacity to meet practical demands.

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REFERENCES

- [1]. Bich Ngoc (2025). Green transformation pressure forces businesses to innovate [Áp lực chuyển đổi xanh buộc doanh nghiệp đổi mới]. *Environmental Economics Journal*.
- [2]. Chau Loan, & Phung Thi Minh Trang (2021). Thai Nguyen strengthens environmental protection in industrial parks [Thái Nguyên tăng cường bảo vệ môi trường tại các khu công nghiệp]. *Environment Magazine*, (5).
- [3]. Horváthová, R. (2010). Does environmental performance affect financial performance? A meta-analysis. *Ecological Economics*, 70(1), 52-59.
- [4]. Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. (1995). Environmental Regulation and the Competitiveness of U.S. Manufacturing. *Journal of Economic Literature*, 33(1), 132-163.
- [5]. Nguyen Thi Lien Hoa, & Nguyen Thi Kim Ngan (2024). Social responsibility and financial performance of listed commercial banks: Empirical evidence from Vietnam [Trách nhiệm xã hội và hiệu quả tài chính của các ngân hàng thương mại niêm yết: Bằng chứng thực nghiệm tại Việt Nam]. *Journal of Development and Integration*.
- [6]. Nguyen Thi Thanh Tram (2025). The impact of environmental strategy and environmental management accounting on environmental and financial performance: A study of Vietnamese manufacturing enterprises [Tác động của chiến lược môi trường và kế toán quản trị môi trường đến hiệu quả môi trường và hiệu quả tài chính: Nghiên cứu tại các doanh nghiệp sản xuất Việt Nam]. *Economy and Forecast Review*.
- [7]. Palmer, K., Oates, W. E., & Portney, P. R. (1995). Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm? *Journal of Economic Perspectives*, 9(4), 119-132.
- [8]. Pham Chau Thanh, & Pham Minh Tung (2021). Environment and business performance of enterprises [Môi trường và hiệu quả hoạt động kinh doanh của doanh nghiệp]. *Industry and Trade Magazine*, (16), 212-217.
- [9]. Porter, M. E., & van der Linde, C. (1995). Toward a New Conception of the Environment-Competitiveness Relationship. *Journal of Economic Perspectives*, 9(4), 97-118.
- [10]. Tran Van Duy (2023). Small and medium enterprises play an important role in implementing the 2022 Environmental Protection Law [Cộng đồng doanh nghiệp nhỏ và vừa đóng vai trò quan trọng trong thực thi Luật Bảo vệ môi trường năm 2022]. *Industry and Trade Magazine*.
- [11]. Wang, Y., & Liu, K. (2023). The effect of environmental regulation on firm productivity: Evidence from pulp and paper industry in China. *Economic Research-Ekonomska Istraživanja*, 36(1), 264-295. doi.org
- [12]. Zhu, Q., & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, 22(3), 265-289.