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Economic transformation and sustainable growth in emerging economy cities: Evidence from Hanoi city, Vietnam

Nguyen Thi Dong[1]
[1]Academy of Policy and Development (APD), Vietnam
Email ID: dongnt@apd.edu.vn

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ABSTRACT

This study examines the impact of economic structural transformation on sustainable growth in Hanoi, an emerging economy undergoing a significant shift from traditional sectors to the modern service sector. The results show that the increase in the service sector's share, along with attracting foreign direct investment and improving innovation capacity, has a statistically significant positive impact on economic and social growth, and maintains a stable long-term co-integration relationship. However, the environmental impact is differentiated, with service-based industries contributing to reduced environmental pressure, while increased industrialization and urbanization could degrade air quality if appropriate control policies are lacking. The study confirms that structural transformation towards service-oriented development, coupled with innovation and sustainable urban governance, is a key direction for Hanoi to achieve green and inclusive growth in the future

Keywords: Economic restructuring; Sustainable growth; Service-oriented economy; VECM model; Co-integration; Innovation; FDI; Emerging cities; Green development; Hanoi..

1. INTRODUCTION

Over the past three decades, emerging economies have undergone profound changes in their development models, with structural economic transformation being seen as a key driver of long-term growth and improved labor productivity. A World Bank report (2017) affirms that structural transformation, particularly the shift of labor and resources from the agricultural sector to industry and services, plays a central role in generating sustainable growth in middle-income countries. McMillan and Rodrik (2011) also emphasize that the redistribution of resources between economic sectors is a crucial factor determining the rate of productivity growth in developing economies.

Along with globalization and technological innovation, major cities in emerging economies have become key spaces for structural transformation. The United Nations Report on World Urbanization (UN-Habitat, 2022) indicates that cities now generate over seventy percent of global GDP, and are the most active hubs for modern industrial, service, and innovative activities. The Organization for Economic Cooperation and Development (OECD) (2021) argues that urban areas play a central role in sustainable development due to their ability to effectively utilize high-quality human resources, large market sizes, and more complete innovation ecosystems compared to rural areas.

In emerging economies in Asia, numerous studies have shown a strong link between structural transformation and sustainable growth. Henderson and Turner (2020) argue that the shift towards high value-added service industries is an inevitable trend as urbanization reaches maturity. Ghani and O'Connell (2014), in a World Bank study, emphasize that cities like Bangalore, Jakarta, Bangkok, and Manila all demonstrate the significant impact of a new economic structure - based on modern services and technology industries - on total factor productivity growth. Furthermore, the United Nations Sustainable Development Goals Report (2023) affirms that structural transformation can only be truly sustainable when linked to environmental protection, emission reduction, and narrowing urban inequality.

In this context, Hanoi - the economic, political, and cultural center of Vietnam - is undergoing a strong structural transformation, reflecting the general trend of cities in emerging economies. Since 2010, Hanoi's economic structure has shifted towards a significant increase in the proportion of the service sector and high-tech industries, in line with the recommendations of international organizations on sustainable urban development models (Asian Development Bank, 2022). At the same time, Hanoi is facing major challenges regarding the environment, population pressure, and the need to innovate its growth model. A report by the United Nations Development Programme (2021) emphasizes that Vietnamese cities, especially Hanoi and Ho Chi Minh City, need to accelerate their structural transformation towards green and sustainable development to avoid falling into the middle-income trap.

Although numerous international studies have analyzed economic structural transformation at the national level (Herrendorf, Rogerson, and Valentinyi, 2014; Duarte and Restuccia, 2020), there is a lack of research focusing on the urban level in emerging economies, particularly quantitative analysis of the impact of structural transformation on sustainable growth in the Vietnamese context. Therefore, this study aims to fill this academic gap by assessing the characteristics of Hanoi's economic structural transformation over the past decade and

analyzing its impact on sustainable growth across three pillars: economic, social, and environmental.

The research aims at two main objectives: (1) analyzing the current state and trends of economic structural transformation in Hanoi during the period from 2010 to 2023; and (2) assessing the impact of structural transformation on the city's sustainable growth, thereby providing policy suggestions to promote sustainable development for a central urban area of an emerging economy like Vietnam. With this approach, the research not only contributes to the existing academic gap but also has important practical implications for urban policy planning and development governance.

2. THEORETICAL FOUNDATION

2.1. Economic structural transformation and classical theoretical foundations

Structural economic transformation is built on the foundation of classical development theories, emphasizing the shift of resources from low-productivity sectors to higher-productivity sectors. Lewis's (1954) model indicates that the shift of surplus labor from agriculture to industry will generate growth through changes in marginal productivity. This view is reinforced by Kaldor's (1966) arguments, who argued that industrialization is the "engine of growth," with spillover effects facilitating an increase in total factor productivity. Meanwhile, Romer's (1990) endogenous growth theory expands the approach by emphasizing the role of knowledge, innovation, and technological progress in the structural transformation process. Recent studies such as those by Herrendorf, Rogerson, and Valentinyi (2014) further affirm that structural transformation is an inevitable trend in the development process, especially in emerging economies.

2.2. Economic structural transformation in the urban context of emerging economies.

In emerging economies, urban areas are the centers where structural transformation is most intense. According to the United Nations (UN-Habitat, 2022), cities are not only population centers but also "main drivers of growth" due to the concentration of high-quality human resources, advanced infrastructure, and efficient production and service networks. Henderson and Turner (2020) argue that as urbanization reaches maturity, the economic structure of cities will shift strongly towards high value-added service sectors such as finance, information technology, logistics, and creative services. Studies by Ghani and O'Connell (2014) also show that in cities in India, Indonesia, Thailand, and the Philippines, this shift increases productivity and improves the efficiency of resource allocation. This explains why cities in emerging economies often experience a faster rate of structural transformation than the national average.

2.3. Sustainable growth and the three pillars of urban development.

Sustainable urban growth is approached based on three pillars: economic, social, and environmental. The United Nations Sustainable Development Goals report (2023) emphasizes that urban development is only considered sustainable when it ensures productivity growth linked to stable job creation, improved social welfare, and minimized negative environmental impacts. The Organization for Economic Cooperation and Development (OECD) (2021) argues that a sustainable urban growth model needs to combine technological innovation, green service development, and efficient resource utilization. At the same time, the Asian Development Bank (2022) points out that cities in Vietnam, Thailand, and Malaysia are facing significant challenges regarding environmental pollution, population growth, and infrastructure pressure, requiring long-term sustainable development strategies.

2.4. The relationship between economic structural transformation and sustainable growth.

International studies have demonstrated a strong correlation between economic structural transformation and sustainable growth in emerging economies. McMillan and Rodrik (2011) argue that the shift of resources from low-productivity to high-productivity sectors promotes overall growth, thereby laying the foundation for sustainable development. Zhang et al. (2021) analyze that innovation plays a crucial mediating role connecting structural transformation with green growth, particularly in rapidly developing cities. However, the United Nations (UN -Habitat, 2021) warns that if structural transformation occurs without control, cities may face serious environmental pollution, increased urban inequality, or excessive reliance on the informal service sector.

From an urban development perspective, economic restructuring offers opportunities to improve productivity, innovate technology, and attract high-quality investment, but it also demands sustainable urban governance. World Bank studies (2017; 2023) emphasize that to ensure sustainability, cities need to link structural transformation with environmental governance, improve green infrastructure, and enhance urban resilience. This is particularly important for Hanoi - a central urban area of Vietnam - where the structural transformation is happening rapidly but still faces significant challenges regarding the environment, transportation, and population distribution.

2.5. Theoretical framework of the research

Based on the above arguments, the study constructs a theoretical framework based on two main groups of content: (1) theories of economic structural transformation, emphasizing the shift of resources between economic sectors and the impact of innovation; and (2) theories of sustainable growth in urban spaces, emphasizing the interaction between economy, society, and environment. Synthesizing these two groups of theories allows the study to more clearly analyze the mechanisms through which economic structural transformation affects sustainable growth in emerging economies. This approach ensures coherence and relevance to Hanoi's development characteristics from 2010 to 2023, while also providing a solid foundation for building the research model and discussing the results in the following sections.

3. RESEARCH METHODOLOGY

3.1. Approach

This study employs a quantitative approach combined with empirical analysis to assess the impact of economic structural transformation on sustainable growth in Hanoi from 2010 to 2023. This approach builds upon the theoretical framework presented earlier, emphasizing the role of structural shift, innovation, and the interaction between the three pillars of sustainable growth: economic, social, and environmental. Reports from the World Bank, the United Nations, and the Organization for Economic Cooperation and Development recommend that the analysis of structural transformation in urban areas should be based on long-term data series to clarify trends and spillover effects. Therefore, the study selects time series data to reflect the fluctuations of indicators over time.

This approach allows for the direct measurement of the impact of structural transformation on sustainable growth, while controlling for the role of other important factors such as urbanization, foreign direct investment, labor productivity, and innovation. This method is widely used in international studies analyzing cities in emerging economies to ensure the objectivity and reliability of empirical results.

3.2. Research model

The research model was developed to identify the relationship between economic structural transformation and sustainable growth in Hanoi. Based on studies by McMillan and Rodrik, Henderson and Turner, as well as the United Nations guidelines for sustainable urban analysis, the overall research model comprises three groups of dependent variables and one group of principal explanatory variables, specifically as follows:

Main explanatory variable: Economic restructuring is reflected in changes in the proportion of the three economic sectors (agriculture, industry, and services), the level of labor mobility, and the contribution of high value-added industries.

The dependent variable reflects sustainable growth: (1) Economic growth: including gross regional product, labor productivity and capital efficiency. (2) Social growth: including sustainable employment, average income and urban quality of life. (3) Environmental growth: including air quality, emission levels, waste management and efficient resource use.

The model utilizes a dynamic regression structure with lags to reflect the long-term and short-term impacts of structural transformation on the three pillars of sustainable growth. The application of a dynamic model accurately reflects the nature of structural transformation - a gradual process with ripple effects over time.

3.3. Hypothesis system

Based on theories and results from international studies, the research hypothesis system is constructed as follows:

Hypothesis 1: Transforming the economic structure towards increasing the proportion of high-tech industries and high value-added services has a positive impact on Hanoi's economic growth.

Hypothesis 2: Economic restructuring contributes to improving the quality of employment and enhancing social indicators, thereby positively impacting the city's social growth.

Hypothesis 3: Economic restructuring can put pressure on the urban environment if there is no appropriate greening strategy; therefore, the impact of structural transformation on environmental growth may be bidirectional depending on the management mechanism.

Hypothesis 4: Innovation and investment in high-tech industries act as intermediaries, amplifying the positive impact of structural transformation on sustainable growth.

Hypothesis 5: Urbanization and foreign direct investment have a moderating effect on the relationship between structural transformation and sustainable growth in Hanoi.

This system of hypotheses helps to comprehensively assess the impact of structural transformation, while also allowing for the testing of different mechanisms of interaction between the pillars of sustainability.

3.4. Data analysis methods

Research data was collected from the Hanoi Statistical Yearbook, reports from the World Bank, the Organization for Economic Cooperation and Development, the United Nations, and the Asian Development Bank. The data series includes economic, social, and environmental indicators for the period from 2010 to 2023.

The study used the following quantitative analytical methods:

Analyze trends and structures to describe the changes in the economic structure of Hanoi.

Stationarity testing and cointegration analysis aim to assess the long-term link between structural transformation and sustainable growth.

Dynamic regression models using vector autoregression or error-corrected vector autoregression models are used to quantify the impact of structural transformation in the short and long term.

Random effects analysis and impulse response functions are used to explain the mechanisms by which structural transformation impacts economic, social, and environmental variables.

The data analysis methodology described above allows for a comprehensive and objective assessment of the impact of economic structural transformation on Hanoi's sustainable growth, while also providing a solid foundation for the research results and discussion.

4. RESEARCH RESULTS AND DISCUSSION

4.1. Descriptive statistical analysis and trend analysis

To provide an initial assessment of Hanoi's economic structural transformation and sustainable development, this study utilizes a series of data from 2010-2023 and compiles them into Table 1 below. This table reflects the fluctuations of economic, social, and environmental indicators, thereby providing a foundation for testing the model and hypotheses presented in the previous section.

Table 1. Descriptive statistics and trends of the indicators (2010-2023)

No	Target	2010	2023	Absolute change	Rate of change (%)	CAGR (%)
1	GDP (billion VND)	350,000	1280000	930000	265.71	10.36
2	Agricultural share (%)	10.5	4.0	-6.5	-61.90	-6.47
3	Industrial share (%)	30.0	27.1	-2.9	-9.67	-0.81
4	Service proportion (%)	59.5	69.0	9.5	15.97	1.16
5	Workers (thousand people)	2200	2490	290	13.18	0.94
6	Percentage of service sector workers (%)	55.0	68.0	13.0	23.64	1.56
7	Labor productivity (million VND/person)	159.1	513.0	353.9	222.40	8.88
8	FDI (million USD)	450	3000	2550	566.67	14.05
9	Innovation Index (0-100)	28.0	55.0	27.0	96.43	5.11
10	Average AQI index	95	72	-23	-24.21	-2.05
11	CO_2 emissions (million tons)	6.50	7.80	1.30	20.00	1.38
12	Household waste (kg/person/day)	0.90	1.25	0.35	38.89	2.54
13	Urbanization rate (%)	70.0	78.5	8.5	12.14	0.86

(Source: General Statistics Office, Ministry of Finance)

The results in Table 1 show that Hanoi's economic structural transformation is evident, with significant changes in the proportion of economic sectors. The agricultural sector's share decreased from 10.5 percent in 2010 to 4.0 percent in 2023, reflecting a rapid contraction of this sector within the overall urban economy. The industrial sector's share remained relatively stable, fluctuating slightly around 27 percent, while the service sector increased significantly from 59.5 percent to 69.0 percent. This establishes a trend towards the service-oriented economy - a typical characteristic of emerging economies at the medium development stage.

Alongside the changes in the industrial structure, other economic indicators also show a strong growth trend. The gross domestic product (GDP) increased from VND 350 trillion to VND 1,280 trillion, reflecting a high and stable average annual growth rate. Corresponding to this growth, labor productivity increased proportionally over time, showing the effectiveness of shifting labor to higher value-added sectors. The proportion of labor in the service sector increased from 55 percent to 68 percent, and the total workforce in the city also increased slightly, reinforcing the view that structural transformation plays a role in improving the efficiency of labor allocation.

Foreign direct investment increased from US$450 million to US$3 trillion, demonstrating a significant rise in the city's investment attractiveness, particularly in high-tech and service industries. This is consistent with the increase in the innovation index from approximately 28 to over 55 points in 2023, reflecting an improvement in the economy's innovation capacity and aligning with the hypothesis that innovation plays a mediating role in structural transformation.

From an environmental perspective, the air quality index has shown an improvement, decreasing from an average value of 95 to 72. However, other indicators such as CO_2 emissions and average per capita household waste have tended to increase. This reflects the fact that although some pollution control efforts have yielded certain results, the environmental pressure on urban areas remains significant due to increased energy consumption and waste generation driven by urbanization and rising living standards. The increase in the urbanization rate from 70 percent to 78.5 percent further highlights the growing pressure from urban population, requiring improved urban governance capacity and investment in sustainable infrastructure.

Overall, the results describing the period 2010-2023 show that Hanoi is transforming its economic structure towards reducing dependence on agriculture, strengthening the role of services, improving labor productivity, and increasing foreign investment attraction. These advances have helped the city achieve strong economic growth, while also creating an important foundation for social growth such as job creation, improved income, and enhanced innovation capacity. However, the initial results

also reveal that environmental challenges have not been fully addressed, highlighting the need for close integration between structural transformation and green development strategies to ensure long-term sustainability.

4.2. Testing the stationarity of data series

To ensure the reliability of the dynamic regression model and cointegration analysis, the first step of the study was to test the stationarity of the data series for the period 2010-2023. The test was performed using the unit cell test with the hypothesis that the data series are non-stationary at the five percent significance level.

The test results are summarized in Table 2 below.

Table 2. Results of the Stationarity Test (ADF) of the variables in the model

Variable	Significance level	ADF Statistical Value	Critical value 5%	Conclude
GDP (billion VND)	5%	-1.92	-2.99	Don't stop
Agricultural share (%)	5%	-3.45	-2.99	Stop
Industrial share (%)	5%	-2.10	-2.99	Don't stop
Service proportion (%)	5%	-1.85	-2.99	Don't stop
Labor productivity	5%	-1.77	-2.99	Don't stop
Workers (thousand people)	5%	-1.55	-2.99	Don't stop
FDI (million USD)	5%	-1.70	-2.99	Don't stop
Innovation Index	5%	-3.15	-2.99	Stop
Average AQI	5%	-1.48	-2.99	Don't stop
CO_2 emissions	5%	-2.22	-2.99	Don't stop
Household waste	5%	-1.90	-2.99	Don't stop
Urbanization rate	5%	-1.72	-2.99	Don't stop

(Source: General Statistics Office, Ministry of Finance)

The results in Table 2 show that only two variables, the agricultural weight and the innovation index, reached stationarity with ADF statistical values less than the critical value of 5 percent. This reflects the reality that variables reflecting innovation capacity and agricultural structure tend to fluctuate in clearer cycles and are more likely to converge towards long-term trends.

The remaining variables are not stationary, especially economic variables such as GDP, service sector share, FDI, and labor productivity. This is consistent with the continuous growth of Hanoi's economy over the past decade, where indicators tend to increase over time without fluctuating around a fixed value. Environmental variables such as AQI, CO_2 emissions, and household waste also show non-stationary nature, reflecting the continuous change due to the impact of urbanization and the expansion of production and services.

With these results, the next step in the study is to test stationarity at first-order differences. Additional test results (not presented in tables) show that most variables become stationary at first-order differences, confirming that the data are suitable for cointegration testing and dynamic regression models such as error-adjusted models.

The nonstationarity of socio-economic variables is common in studies of long-term growth. Therefore, determining that variables are stationary at first-order differences is a crucial condition for examining cointegration to assess the long-term relationship between structural economic transformation and sustainable growth in Hanoi.

4.3. Analyzing the cointegration relationships between variables

After determining that most variables in the model become stationary at first-order differences, the study proceeded to perform cointegration tests to determine whether a long-term relationship exists between structural economic transformation and the pillars of sustainable growth. Cointegration tests help assess the long-term degree of cointegration between variables, consistent with the nature of structural transformation - a process that has a prolonged impact and creates cumulative effects over time.

The study used the Johansen cointegration test with a five percent significance level. The results are summarized in Table 3.

Table 3. Results of Johansen colinker test

Cointegration test variables	Trace Statistics	Critical value 5%	Conclude
GDP - Service sector share - FDI - Innovation	52.41	47.21	There are colinked
Social growth - Service sector share - Innovation	41.33	29.68	There are colinked

AQI - Industrial and Urbanization Rate	18.77	15.41	There are colinked
CO_2 - Labor - Services	13.10	15.41	Non-coordinated
Waste - Services - Innovation	21.25	15.41	There are colinked

(Source: Author's data processing results)

The test results in Table 3 show significant cointegrations between the group of economic structural transformation variables and the pillars of sustainable growth. Specifically, the group of variables including GDP, service sector share, foreign direct investment flows, and innovation index achieved Trace statistical values higher than the critical threshold of five percent, allowing us to conclude that a long-term relationship exists between these variables. This indicates that the increase in the service sector share and the level of innovation, along with attracting foreign investment, is intrinsically linked to Hanoi's economic growth in both the short and long term.

For the group of variables reflecting social growth, including social welfare indicators and the proportion of services along with the innovation index, the results also confirm the existence of a cointegration relationship. This reflects that structural factors such as the level of service provision and innovation capacity play an important role in improving the quality of life and creating sustainable jobs in urban areas.

Conversely, the group of variables including CO_2 emissions, labor, and service sector share did not show a cointegration, implying that growth in the service sector does not create a long-term cumulative impact on CO_2 emissions. This may be related to the fact that service industries generally emit less than industrial industries, and therefore the environmental impact is short-term and dependent on other moderating factors such as urban planning, environmental standards, or the level of clean energy use.

The group of variables including AQI, industrial proportion, and urbanization shows a clear co-linked relationship, reflecting the long-term impact of industrial expansion and urbanization on air quality. This is consistent with the practice that the expansion of production and the increase in urban population density often lead to significant pressure on the air environment if not properly controlled.

Finally, the co-linked relationship between household waste, service share, and innovation index shows that service growth is accompanied by improved waste collection and management as innovation capacity and environmental infrastructure are enhanced. This reflects a positive trend in modern cities where technological innovation contributes to improved waste management efficiency.

Overall, the cointegration test results reinforce the argument that economic structural transformation in Hanoi - particularly towards service-oriented development and innovation - has a long-term relationship with sustainable growth in many aspects. This provides a foundation for estimating the dynamic regression model and examining the mechanisms of impact in the next part of the study.

4.4. Estimates of the Dynamic Regression Model (VECM)

Based on the results of stationarity and cointegration tests, the VECM error correction model is used to analyze the relationship between economic structural transformation and sustainable growth. The model allows for simultaneous assessment of short-term impacts (through difference coefficients) and long-term impacts (through error correction coefficients).

The dependent variable in the model is GDP, representing economic growth - a crucial pillar of sustainable development. The explanatory variables include the service sector share, foreign direct investment flows, and the innovation index. These variables are identified as having cointegration in Table 3.

Table 4. Results of the VECM model estimation for the GDP dependent variable

Variables/Parameters	Coefficient	Standard error	Value t	Conclude
Error Correction Factor (ECM)	-0.42	0.11	-3.81	Significant (long-term impact)
Difference in service proportion	0.215	0.084	2.56	Significant (short-term impact)
FDI difference	0.031	0.012	2.65	Significant (short-term impact)
Difference in the Innovation Index	0.144	0.067	2.15	Significant (short-term impact)
Constant	0.028	0.013	2.09	Significant

(Source: Author's data processing results)

The results in Table 4 show that the error correction coefficient (ECM) is negative and statistically significant at the five percent level, implying that GDP growth tends to adjust back to long-term equilibrium at a rate of approximately forty-two percent per cycle when deviations occur. This is important evidence that the long-term relationship between economic structural

transformation and economic growth in Hanoi has remained stable throughout the study period.

In the short term, the change in the proportion of services has a positive and statistically significant impact on GDP growth. This reflects the structural shift towards an increased role of the service sector, which has directly contributed to growth each year, consistent with the trend in emerging economies where services become the main driver of high value-added generation.

Foreign direct investment (FDI) inflows also show a significant short-term impact on GDP growth. The positive coefficient implies that when Hanoi attracts more foreign investment, especially in high-quality service sectors and technology industries, the economy responds positively immediately. This result is consistent with the city's development practices, where FDI projects are often large-scale and quickly become operational.

The innovation index has a positive and statistically significant impact coefficient, indicating that an increase in technological innovation capacity helps improve economic growth in the short term. This shows that technological innovation not only plays a long-term cumulative role but also creates an immediate spillover effect on modern service industries and high-tech manufacturing.

The model's constant coefficients also carry statistical significance, implying that, in addition to structural transformation factors, GDP growth is also influenced by other fundamental factors such as domestic market expansion, increased consumption, and improved total factor productivity.

4.5. Hypothesis testing

Based on the VECM model estimation results for the economic and social pillars, the study conducts a hypothesis test. The test results show that most hypotheses are strongly supported by statistically significant coefficients and are consistent with theoretical expectations regarding the role of structural transformation in sustainable urban development.

Regarding the first hypothesis, the study suggests that increasing the service sector's share has a positive impact on Hanoi's economic growth. The coefficient of the service sector's difference in the VECM model is 0.215, with a t-statistic value of 2.56, exceeding the 5 percent significance threshold. This demonstrates that the expansion of the service sector - especially modern service industries such as information technology, logistics, finance, and high-quality education - has the potential to boost GDP growth in the short term. This result also reinforces the theoretical argument about the driving role of serviceization in emerging urban economies.

The second hypothesis suggests that economic structural transformation has a positive impact on the social pillar of sustainable growth. When the model is estimated with the composite social index as the dependent variable, the variables related to service sector transition, the proportion of service labor, and the innovation index all show positive and statistically significant coefficients. The service sector proportion has an impact of 0.162 with $t = 2.28$, while the service labor variable has an impact of 0.210 with $t = 2.56$. The innovation coefficient has a positive value and is significant at the five percent level. These results indicate that the increasing role of the service sector not only impacts economic growth but also contributes to improving job quality, raising incomes, and expanding sustainable social opportunities for urban residents. Therefore, this hypothesis is convincingly confirmed.

The third hypothesis addresses the two-way impact of structural transformation on the environmental pillar, where the direction of impact depends on the nature of the industry and greening policies. Cointegration analysis and impulse response function results show that the shock of increased service sector share tends to slightly improve air quality in the short term, while the shock of increased industrial sector share significantly worsens the AQI index. This reflects the divergent nature between sectors: modern services tend to be more environmentally friendly, while traditional industries - especially energy-intensive ones - put significant pressure on the urban environment. However, to quantitatively and rigorously test this hypothesis, a separate VECM model for the environmental variables needs to be estimated. Since this step has not been fully completed, the study tentatively concludes that there is qualitative evidence supporting the hypothesis, but further testing is needed in the extended section.

The fourth hypothesis suggests that innovation plays a mediating role in the relationship between structural transformation and sustainable growth. Model results indicate that innovation has a positive and significant impact on both the economic and social equations, with corresponding coefficients of 0.144 ($t = 2.15$) in the GDP model and 0.094 ($t = 2.08$) in the social model. This suggests that innovation not only supports but also amplifies the positive impact of structural transformation on the two most important pillars of sustainable growth. However, to formally prove this mediating role, further Sobel testing or Bootstrap analysis is needed, as the current VECM model does not include direct mediating tests. Thus, the study has sufficient evidence to support the hypothesis in its preliminary direction, but further confirmation through advanced analysis is required.

The fifth hypothesis suggests that urbanization and foreign direct investment (FDI) play a moderating role in the relationship between structural transformation and sustainable growth. While FDI inflows have been confirmed to have a significant short-term impact on economic growth with a coefficient of 0.031 and a t-value of 2.65, the model does not include the interaction variable between the service sector and FDI, or between services and urbanization levels. Therefore, the current results show that FDI plays an important role, but there is insufficient data to conclude on its moderating role. To accurately test this hypothesis, further model estimation with the interaction variable or analysis based on high-low urbanization levels is needed.

In summary, hypothesis testing reveals that most of the study's hypotheses are strongly supported by statistical results, particularly in the economic and social pillars.

Some hypotheses related to the environment and mediating or regulating roles require further in-depth quantitative testing. However, the overall results clearly affirm that structural transformation towards service-oriented development, combined with innovation and attracting high-quality investment, is an effective path to promoting sustainable growth in emerging cities like Hanoi.

5. CONCLUSION

This study aims to assess the impact of economic structural transformation on Hanoi's sustainable growth during the period 2010-2023, using a quantitative approach based on the VECM model, trend analysis, and cointegration testing. The results show that the structural transformation in Hanoi is profound and consistent with emerging economies: the agricultural sector has significantly decreased, the service sector has steadily increased, and industry has remained stable but is trending towards high-tech sectors. Thanks to this shift, Hanoi has achieved robust economic growth with rapidly increasing labor productivity and continuously expanding GDP.

The VECM model results confirm the positive role of service-based economy in economic growth, demonstrated by a positive and statistically significant coefficient in the short term, and the existence of a long-term co-linked relationship between services, FDI, innovation, and GDP. This proves that structural transformation not only creates immediate impacts but also shapes long-term growth trajectories. With the social pillar, the shift of labor to the service sector and the increase in innovation show a positive impact on employment, income, and overall well-being of urban residents.

The impact on the environmental pillar is twofold: while service-based development shows a trend toward reducing pressure on the environment, the rise of industrialization and urbanization creates significant challenges to air quality and emissions. This reflects the complex nature of urban growth, where socio-economic factors can advance faster than the environment's ability to regulate them.

Overall, the study affirms that economic restructuring towards service-based development, combined with innovation and selective investment attraction, is the foundation for Hanoi's sustainable growth. However, environmental challenges indicate the need for a stronger strategy in urban management and green development.

Based on the analysis results, the study offers several policy implications aimed at promoting structural transformation towards greater efficiency and sustainability in the future.

First and foremost, it is necessary to continue improving the quality of service sector development, especially modern service industries with high knowledge and technology content such as information technology, finance, digital commerce, and logistics. Developing these industries will not only boost economic growth but also contribute to improving job quality and increasing people's income. Forming innovation clusters linked to universities and research institutes will create a knowledge-based service ecosystem; and proactively attracting new-generation FDI in strategic fields such as semiconductors, AI, green technology, and digital technology will help Hanoi become a leading technology center in the country, directly contributing to increased labor productivity and national TFP. Digital transformation and the development of the digital economy must continue to be the top priority pillars of the city. Hanoi must maintain its leading position nationwide in digital government services, smart city platforms, digital enterprises, and e-commerce. The strong development of the digital economy will create new growth drivers for Hanoi and support Vietnam in achieving its high growth targets amidst increasingly fierce global competition.

Secondly, to enhance the spillover effects of foreign direct investment (FDI), FDI attraction policies need to shift from "quantity" to "quality," prioritizing projects with high technological and innovation content, while also incorporating sustainable development requirements into project appraisal. High-tech investment projects should be linked to the domestic business network to enhance technology spillover and improve the endogenous competitiveness of the economy.

Thirdly, regarding the social pillar, Hanoi needs to focus on developing high-quality human resources that meet the requirements of the new economic structure. It should promote vocational training and retraining for displaced workers, while expanding training programs in digital skills, creative skills, and skills adapting to the modern job market. The social security system needs to be strengthened to ensure workers benefit maximally from structural transformation. The city needs to strengthen the linkages between businesses and universities, promote digital and technological skills training, and implement policies to attract international talent and experts to live, work, and conduct research. With the largest education and research system in the country, Hanoi has the potential to become a center for supplying high-quality human resources for the entire Northern key economic region.

Fourth, to mitigate negative environmental impacts, the city needs to strongly promote green policies in industry and services. This includes adopting clean technologies in industrial production, strengthening emission controls, expanding urban green spaces, and investing in high-quality public transportation infrastructure to reduce environmental pressure. Industrialization should go hand in hand with replanning industrial zones according to green standards, restructuring energy-intensive industries, and encouraging the transition to renewable energy.

Finally, Hanoi needs to continue developing a smart and sustainable urban governance system. The combination of service provision, innovation, and digital governance will help improve the efficiency of resource allocation, enhance forecasting and coordination capabilities, and minimize social and environmental costs. Urbanization must be managed in a qualitative rather than quantitative manner, through improving infrastructure, land management, and enhancing the capacity to deliver public services.

Overall, the policy implications outlined above suggest that economic structural transformation, when properly guided and harmoniously integrated with public policy, will become a crucial driving force in helping Hanoi achieve its goals of green, inclusive, and sustainable growth in the coming decades

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