ASSESSING THE ECONOMIC IMPACTS OF TRANSPORT CONNECTIVITY IMPROVEMENTS IN THE MEKONG RIVER DELTA: A SPATIAL COMPUTABLE GENERAL EQUILIBRIUM APPROACH

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TÓM TẮT

Nghiên cứu này đánh giá tác động kinh tế của việc cải thiện kết nối hạ tầng giao thông tại Đồng bằng sông Cửu Long, vùng kinh tế quan trọng của Việt Nam nhưng đang đối mặt với chi phí logistics cao và sự phân mảnh không gian giữa các địa phương. Nghiên cứu sử dụng mô hình cân bằng tổng thể khả toán không gian (SCGE) với năm gốc 2024 nhằm phản ánh các tương tác không gian và hiệu ứng lan tỏa liên vùng. Mỗi tỉnh được xem như một vùng kinh tế liên kết, trong đó chi phí vận tải liên vùng được tích hợp như các rào cản thương mại không gian. Trong bối cảnh hạn chế dữ liệu cấp tỉnh, nghiên cứu áp dụng chiến lược hiệu chỉnh dựa trên tỉnh mẫu kết hợp nội suy có kiểm soát từ các nguồn thống kê chính thức. Các kịch bản mô phỏng được xây dựng dựa trên việc giảm chi phí vận tải. Kết quả cho thấy cải thiện kết nối giao thông tạo ra tác động tích cực nhưng không đồng đều giữa các vùng, phản ánh sự tồn tại của hiệu ứng lan tỏa và tái phân bổ không gian. Nghiên cứu nhấn mạnh vai trò của yếu tố không gian trong hoạch định chính sách hạ tầng vùng.

ABSTRACT

This study assesses the economic impacts of transport connectivity improvements in the Mekong River Delta, a key economic region of Vietnam facing high logistics costs and spatial fragmentation between localities. A Spatial Computable General Equilibrium (SCGE) model calibrated for a 2024 base year is employed to capture spatial interactions and interregional spillover effects. Each province is modeled as an interconnected economic region, with interregional transport costs incorporated as spatial trade frictions. Given the limitations in provincial-level data availability, an anchor–interpolation strategy is employed, combining official national statistics with controlled interpolation for the remaining regions. Simulation scenarios are designed to reflect alternative transport connectivity improvements through proportional reductions in transport costs. The results indicate that such improvements generate positive but heterogeneous impacts across regions. This reflects the existence of spillover effects and spatial reallocation. The study emphasizes the role of spatial factors in regional infrastructure policy planning.

1. Introduction

The Mekong River Delta (MRD) is a key economic region of Vietnam, playing a crucial role in agricultural production, fisheries, and domestic trade. However, the region faces numerous challenges related to high logistics costs, insufficiently integrated transport infrastructure, and spatial fragmentation among provinces. A substantial body of literature suggests that investment in and improvement of transport infrastructure can reduce transport costs, expand market access, and stimulate regional economic growth (Banister & Berechman, 2001; OECD, 2018).

In analyzing the impacts of infrastructure development, conventional approaches such as regression analysis or before–after evaluations often struggle to fully capture spillover and reallocation effects across regions. Computable General Equilibrium (CGE) models partially address these limitations by simultaneously representing multiple markets within the economy, yet they typically overlook spatial dimensions, particularly transport costs and interregional interactions. To overcome these shortcomings, the Spatial Computable General Equilibrium (SCGE) model has been developed, allowing transport costs and interregional trade flows to be explicitly incorporated into the analytical framework (Bröcker & Schneider, 2002; Kim et al., 2017).

In Vietnam, empirical studies applying SCGE models to assess infrastructure impacts at the regional level remain limited, especially in the context of the Mekong River Delta. Moreover, inconsistencies and gaps in provincial-level statistical data—particularly in recent years—pose significant challenges to the construction of detailed regional models. This situation calls for an approach that is both theoretically rigorous and empirically feasible under data constraints.

Against this backdrop, the present study aims to assess the impacts of transport connectivity improvements on regional economic growth in the Mekong River Delta using an SCGE model calibrated to a 2024 base year. The contributions of this paper are threefold: (i) developing a parsimonious SCGE model with a sectoral structure suited to provincial-level data availability; (ii) proposing a data calibration strategy based on anchor provinces combined with controlled interpolation; and (iii) providing simulation-based evidence to support policy discussions on regional transport infrastructure development.

2. Literature Review

2.1. Transport infrastructure and regional economic growth

Transport infrastructure is widely regarded as an important determinant of regional economic performance through its effects on transport costs, market accessibility, and productivity. Banister and Berechman (2001) argue that transport investments generate economic benefits primarily when they are embedded in appropriate spatial and institutional contexts that allow regions to exploit improved connectivity. Similarly, the OECD (2018) emphasizes that enhanced transport connectivity can strengthen regional competitiveness and contribute to reducing spatial disparities.

Nevertheless, the economic impacts of transport infrastructure are not spatially uniform. Regions with central locations or stronger economic bases often benefit more from improved connectivity due to agglomeration effects, whereas peripheral regions may experience substantial gains only when transport costs are sufficiently reduced or when critical network bottlenecks are alleviated. These heterogeneous effects underscore the importance of analytical frameworks that explicitly account for spatial interactions.

2.2. CGE and SCGE approaches in infrastructure analysis

CGE models have been extensively applied to policy evaluation because of their ability to capture economy-wide interactions within a consistent theoretical framework. However, traditional CGE models generally lack an explicit spatial structure and therefore fail to account for interregional transport costs and spatial spillovers.

SCGE models extend the CGE framework by incorporating spatial interactions through transport costs and interregional trade linkages. Early work by Bröcker and Schneider (2002) demonstrates that embedding transport infrastructure within a spatial general equilibrium setting provides a more comprehensive assessment of regional development impacts. Subsequent studies, including Kim et al. (2017) and Haddad et al. (2015), further show that SCGE models are particularly well suited for analyzing infrastructure investments, as they can capture both direct effects and indirect reallocation effects across regions.

2.3. Research gaps

Despite the growing international literature on SCGE applications, regional-level empirical studies in Vietnam remain limited, particularly for the Mekong River Delta. Existing research often relies on non-spatial approaches or focuses on individual provinces without explicitly accounting for interregional interactions. In addition, data constraints at the provincial level limit the feasibility of highly disaggregated spatial models. This study addresses these gaps by applying a parsimonious SCGE framework tailored to the data conditions of the Mekong River Delta, thereby contributing new empirical evidence on the spatial economic impacts of transport connectivity improvements.

3. Methodology

3.1. SCGE framework

This study employs a Spatial Computable General Equilibrium (SCGE) model to analyze the economic impacts of transport connectivity improvements in the Mekong River Delta. The SCGE framework extends the traditional CGE model by explicitly incorporating spatial dimensions through interregional transport costs, allowing the analysis of direct, spillover, and reallocation effects among regions (Bröcker & Schneider, 2002; Kim et al., 2017; Koike et al., 2015; Koike et al., 2025).

In the model, each province is treated as a distinct economic region characterized by aggregate production and consumption activities. Regional production is represented by a Cobb–Douglas production function:

$$Y_r = A_r . K_r^{\alpha r} . L_r^{1-\alpha r} \quad (1)$$

where Y_r denotes total output in region r, K_r and L_r represent capital and labor inputs, A_r is a region-specific technology parameter, and αr is the capital share parameter.

Final demand in each region is modeled as a fixed proportion of regional income:

$$C_r = \theta_r . Y_r \quad (2)$$

where C_r denotes total final consumption in region r, and θ_r is the consumption share of regional income.

3.2. Data and sectoral structure

The model is calibrated to a 2024 base year, which represents the most recent period with relatively complete and officially published statistical data available at the time of the study. Each regional economy is represented by four aggregated sectors: agriculture, forestry and fisheries (AGR); industry and construction (INDCON); services (SERV); and product taxes less subsidies (TAX). This level of aggregation is consistent with Vietnam's statistical classification and balances analytical clarity with data availability at the provincial level.

Key input data include gross regional domestic product (GRDP) at current prices, population, employment, and realized investment. These data are compiled from the Statistical Yearbook of Vietnam and provincial statistical yearbooks for provinces with publicly available and comprehensive datasets.

3.3. Anchor–interpolation strategy

Given the uneven availability of provincial-level data, the study adopts an anchor–interpolation strategy commonly used in CGE applications under data constraints (Robinson et al., 2001; Lofgren et al., 2002). An Giang and Kien Giang are selected as anchor provinces due to the availability of detailed statistical yearbooks for 2024. For the remaining provinces, sectoral shares and investment ratios are interpolated based on GRDP per capita, reflecting relative levels of economic development.

In addition, qualitative evidence from the Mekong Delta Annual Economic Report (AMDER, 2024) is used as a supplementary reference to guide bounded adjustments to sectoral structures. These adjustments are applied conservatively to ensure that regional characteristics are reasonably reflected without compromising the internal consistency of the base-year dataset.

3.4. Transport costs and simulation scenarios

Interregional transport costs are incorporated as spatial trade frictions that increase the effective price of goods traded across regions:

$$P_{rs} = P_r . (1 + \tau_{rs}) \quad (3)$$

where P_{rs} is the effective price of goods produced in region r and consumed in region s, P_r is the producer price in region r, and τ_{rs} denotes interregional transport costs.

This specification is consistent with small-scale SCGE models that explicitly incorporate transport costs as spatial trade frictions in interregional equilibrium analysis (Koike et al., 2015; Koike et al., 2025).

The allocation of goods across regions follows a simplified Armington-type specification:

$$Q_{rs} = \frac{(P_{rs})^{-\sigma}}{\sum_k (P_{ks})^{-\sigma}} \cdot Q_s \quad (4)$$

where Q_{rs} represents the quantity of goods supplied from region r to region s, Q_s is total demand in region s, and σ is the elasticity of substitution across sources.

Regional equilibrium is satisfied when:

$$Y_r = C_r + I_r + \sum_s Q_{rs} \quad (5)$$

Simulation outcomes are evaluated as percentage changes in total regional output relative to the baseline:

$$\Delta Y_r(\%) = \frac{Y_r^{\text{scenario}} - Y_r^{\text{baseline}}}{Y_r^{\text{baseline}}} \text{ x } 100 \quad (6)$$

3.5. Model assumptions and limitations

The SCGE model employed in this study is subject to several simplifying assumptions that are common in small-scale spatial general equilibrium applications. First, production technologies are assumed to follow Cobb–Douglas functional forms with region-specific but time-invariant parameters, implying constant returns to scale and no endogenous technological change. Second, capital and labor are treated as region-specific and immobile across regions in the short run, which is appropriate for analyzing short- to medium-term impacts of transport connectivity improvements.

Third, interregional trade is modeled using an Armington-type specification, assuming imperfect substitutability between goods originating from different regions. While this approach captures spatial differentiation in production, it does not explicitly model firm-level heterogeneity or endogenous location choices.

Finally, the model adopts a comparative-static framework calibrated to a 2024 base year, and therefore does not capture dynamic adjustment processes over time. As a result, the findings should be interpreted as relative impact assessments rather than long-term growth forecasts. These assumptions reflect a deliberate trade-off between analytical tractability and data availability, consistent with previous parsimonious SCGE studies (Bröcker & Schneider, 2002; Haddad et al., 2015; Koike et al., 2015).

4. Results and Discussion

Table 1 presents the economic structure of the Mekong River Delta regions in 2024, expressed as sectoral shares of total output.

Table 1. Economic structure by region in the Mekong River Delta

Unit: (%)

Region	AGR	INDCON	SERV	TAX
Can Tho	0.366	0.191	0.396	0.047
Vinh Long	0.364	0.185	0.406	0.045
Dong Thap	0.365	0.188	0.402	0.046
An Giang	0.362	0.179	0.417	0.042
Ca Mau	0.362	0.178	0.418	0.042

Source: Authors' compilation from GSO (2024), provincial statistical yearbooks, and interpolation results.

The results in Table 1 show a broadly similar structural composition across regions, with services accounting for the largest share, followed by agriculture and industry–construction, reflecting the region's dual role as both an agricultural base and an emerging service-oriented economy. Product taxes represent a relatively small but stable share across all regions, supporting the consistency of the baseline calibration.

Table 2 reports the baseline equilibrium output by region obtained from the SCGE model for the base year 2024.

Table 2. Baseline output by region

Unit: billion VND (current prices)

Region	Province/City (aggregated)	Baseline output
CT	Can Tho	235,831.4
VL	Vinh Long	235,831.4
DT	Dong Thap	234,423.3
AG	An Giang	227,190.2
CM	Ca Mau	231,096.1

Source: Authors' calculations based on the SCGE baseline equilibrium (2024).

The results in Table 2 indicate notable differences in baseline economic scale across regions, with Can Tho and Vinh Long exhibiting higher total output levels. At the same time, Ca Mau shows a relatively smaller economic size. These baseline values serve as reference points for assessing relative changes in regional output under alternative transport connectivity scenarios.

Following Equation (6), simulation outcomes are measured as percentage changes in total regional output relative to the baseline equilibrium. Table 3 summarizes these relative changes across regions and scenarios.

Table 3. Percentage change in total output by region and scenario

Unit: (%)

Region	Basel-ine	Scenar-io_A	Scena-rio _B	Scena-rio_C
AG	0.0	-0.847	-0.544	-0.28
CM	0.0	0.722	-0.439	1.81
CT	0.0	0.991	-0.009	-0.408
DT	0.0	0.215	0.104	-0.238
VL	0.0	-0.888	0.758	-0.379

Source: Authors' calculations using SCGE model.

The results in Table 3 indicate heterogeneous regional responses across scenarios, with some regions experiencing output gains while others face modest declines, depending on the configuration of transport cost reductions. These patterns highlight the presence of spatial spillover and reallocation effects, suggesting that the economic impacts of transport connectivity improvements are unevenly distributed across the Mekong River Delta.

Figure 1 provides a visual comparison of regional output responses to alternative transport connectivity scenarios relative to the baseline.

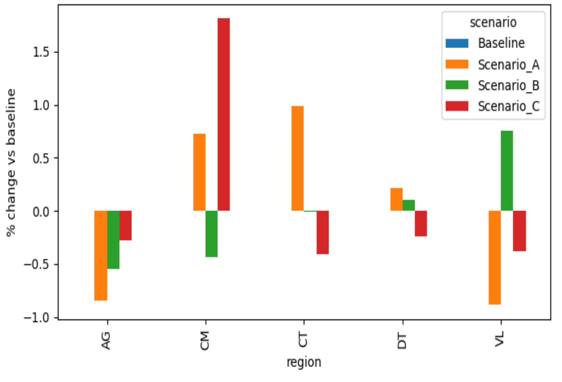

Figure 1. Comparison of regional impacts across scenarios *(Source: Authors' calculations.)*

As illustrated in Figure 1, reductions in interregional transport costs generate positive but heterogeneous economic impacts across the Mekong River Delta. Regions with more central locations and relatively stronger service-oriented economic structures tend to benefit more from corridor-based connectivity improvements, reflecting their higher initial accessibility and stronger integration into regional trade networks. In contrast, peripheral regions experience relatively larger gains under scenarios involving broader, network-wide reductions in transport costs, as improved connectivity enhances market access and reduces spatial disadvantages.

These heterogeneous regional responses are consistent with previous SCGE-based analyses of transport infrastructure investments. Similar patterns have been reported by Bröcker and Schneider (2002) and Haddad et al. (2015), who find that corridor-focused investments often reinforce advantages of economically central regions, while network-wide improvements promote more balanced spatial outcomes. The results also align with recent SCGE studies emphasizing the role of spatial spillovers and reallocation effects in shaping regional competitiveness following transport cost reductions (Kim et al., 2017; Koike et al., 2015; Koike et al., 2025).

Although the present study adopts a more parsimonious model structure compared to international SCGE applications based on highly disaggregated social accounting matrices, the qualitative impact patterns remain robust. This finding supports the growing evidence that simplified SCGE frameworks, when carefully calibrated, can still yield meaningful policy insights in data-constrained regional contexts.

To assess the stability of the simulation results, a qualitative sensitivity analysis was conducted with respect to key model parameters, particularly the elasticity of substitution in interregional trade and the magnitude of transport cost reductions (Appendix A). Consistent with earlier SCGE studies, parameter variations affect the magnitude but not the direction of regional output responses (Haddad et al., 2015; Koike et al., 2025). Importantly, the relative ranking of regional impacts remains stable across plausible parameter ranges, indicating that the main conclusions of the study are robust to moderate parameter uncertainty.

5. Conclusion and Policy Implications

This study applies a Spatial Computable General Equilibrium model to assess the economic impacts of transport connectivity improvements in the Mekong River Delta using a 2024 base-year dataset.

By incorporating interregional transport costs and spatial interactions, the SCGE framework provides a comprehensive tool for evaluating economy-wide and regional effects of transport infrastructure policies in a data-constrained context.

The simulation results suggest that improvements in transport connectivity can enhance regional economic performance, although their benefits are unevenly distributed across space. Central regions tend to gain more from corridor-based investments, whereas peripheral regions benefit more from network-wide reductions in transport costs. These findings imply that infrastructure policies should balance targeted investments in key transport corridors with broader network improvements to promote more inclusive regional development.

From a policy perspective, the study demonstrates the usefulness of SCGE models as decision-support tools for regional planning in the Mekong River Delta. Future research may extend the analysis by incorporating finer sectoral disaggregation, dynamic modeling, or explicit interregional trade flow data as such information becomes available.

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APPENDIX A. SENSITIVITY ANALYSIS

To assess the robustness of the simulation results, this study conducts a sensitivity analysis with respect to the elasticity of substitution in interregional trade (σ), a key behavioral parameter in SCGE models. Following common practice in the literature, σ is varied between 2 and 4. For each value, the main transport connectivity scenarios are re-simulated, and percentage changes in total regional output relative to the baseline equilibrium are compared.

Table A. Sensitivity of regional output changes to substitution elasticity

Unit: (%)

Region	σ = 2	σ = 3 (baseline)	σ = 4
AG	-0.31	-0.28	-0.25
CM	1.65	1.81	1.94
CT	-0.45	-0.41	-0.37

DT	-0.26	-0.24	-0.21
VL	-0.41	-0.38	-0.35

Source: Authors' sensitivity simulations using the SCGE model.

The sensitivity results indicate that variations in the elasticity of substitution affect the magnitude of regional output changes but do not alter their direction or relative ranking. This confirms that the main conclusions of the study are robust to moderate parameter uncertainty.