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Compact Cities and Consumption Growth, Evidence from Urban Households

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ABSTRACT
Vietnam's rapid urbanization has produced a mosaic of urban spatial forms, from compact delta cities to strikingly elongated coastal provinces, raising the question of whether city morphology shapes household consumption behavior. This study provides empirical evidence on the impact of city shape compactness on household consumption in Vietnam, using nighttime light satellite data to construct four indices of city shape compactness for 63 provinces and municipalities. Micro-level data from the Vietnam Household Living Standards Survey (VHLSS) 2024 yield a sample of 21,247 urban households across 30 provinces. Instrumental variables are constructed from hypothetical circular expansion paths calibrated on historical population growth rates and topographic constraints, addressing endogeneity arising from omitted variables, reverse causation, and selection effects. The results indicate that higher city shape compactness induces higher household consumption primarily through two channels: expanding intra-city travel frequency and enhancing disposable income. A reduction of 1 km in the average intra-city transportation distance is associated with approximately 3.1 percent higher per capita consumption, and this effect is concentrated in food and housing expenditures. Households with middle-aged heads are more sensitive to changes in compactness than those with younger or older heads. Compact city shape does not alter households' marginal propensity to consume. These findings highlight the importance of integrated spatial planning and transportation infrastructure investment as instruments for boosting domestic consumption in Vietnam's rapidly urbanizing economy.

Keywords: City Shape, Consumption, Intra-City Transportation, Vietnam, Urban Spatial Form

INTRODUCTION

As Vietnam continues its trajectory of rapid economic development and urbanization, the country's cities are evolving from production-dominated nodes into multifunctional centers of consumption and services (Nguyen and Tran, 2022; World Bank, 2022). The country's urban population share, standing at approximately 38 percent in 2024, is projected to surpass 50 percent by 2035, with simultaneous growth in per capita incomes and diversification of consumption patterns (General Statistics Office, 2024; Pham et al., 2023). Yet the spatial structure of Vietnamese cities remains heterogeneous to a degree rarely observed in a single country: while the Red River Delta contains some of Asia's most compact provincial territories, the central coastal provinces extend in narrow ribbons between the Truong Son Mountain range and the South China Sea, producing extreme elongation ratios (Do and Vu, 2023). This morphological diversity offers a natural laboratory for studying how the shape of urban space influences the economic behavior of its residents.

This study investigates a central yet underexplored question: does the compactness of city shape causally affect household consumption in Vietnam? The inquiry connects two major bodies of literature. On one side, consumer city theory, originating with (Kaza, 2020; Muñiz & Dominguez, 2020; Xu et al., 2019)and extended by Glaeser and Gottlieb (2006), argues that cities attract residents and stimulate economic activity not only through production-side agglomeration but also through consumption amenities, including diverse goods, accessible services, and convenient transportation networks. On the other side, research on Vietnamese household consumption identifies institutional constraints such as credit rationing, preventive savings behavior, and housing market frictions as primary drivers of consumption decisions below potential levels (Le and Nguyen, 2021; Tran and Do, 2022). This study bridges these two literatures by examining whether the physical geometry of cities shapes consumption opportunities and outcomes.

Existing literature offers some evidence from China ((C. Ding & Li, 2022; Liu et al., 2020; Xia et al., 2020) suggesting that more compact cities generate measurable consumption amenity premiums. However, no study

has examined this relationship in the Vietnamese context, despite the country's acute relevance for the question. Vietnam's provinces span a cohesion range from approximately 15 km (Bac Ninh province in the Red River Delta, a near-circular compact territory) to nearly 90 km (Nghe An province in the North Central Coast, a highly elongated strip), providing variation of a magnitude rarely encountered in single-country studies.

This study confronts several methodological challenges. First, measuring city shape at a consistent spatial scale requires satellite-based techniques rather than administrative boundary data, which do not capture actual built-up urban extents. Second, city shape is endogenous to household location choice and local economic development, requiring instrumental variable approaches. Third, Vietnam's VHLSS 2024, while comprehensive, is a repeated cross-section rather than a long panel, requiring careful identification strategies.

To address these challenges, we follow three methodological innovations. First, we quantify city shape using nighttime light data from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor, computing four compactness indices for 63 provinces and municipalities: cohesion (average Euclidean distance between interior point pairs), proximity (average distance from interior points to centroid), spin (average squared distance from interior points to centroid), and range (maximum perimeter-to-perimeter distance). Second, we construct time-varying instrumental variables for city shape by simulating potential circular city shapes under the assumption of radially symmetric expansion from historical population growth baselines and topographic constraints. Third, we exploit rich VHLSS 2024 microdata on 21,247 urban households to estimate the causal effect of province-level compactness on individual household consumption.

The main findings are as follows. First, there is a causal and negative relationship between cohesion (measuring elongation) and household consumption. An increase in compactness equivalent to a 1 km reduction in average intra-city distance is associated with a 3.1 percent increase in per capita urban household consumption under IV estimation. Second, the mechanisms operate through enhanced transportation accessibility (compact provinces generate higher transportation expenditure through increased travel frequency, not congestion) and income effects (compact cities raise wages particularly for service sector workers). Third, the consumption impact falls disproportionately on food and housing expenditures. Fourth, middle-aged household heads exhibit greater sensitivity to compactness, while high-income households are less affected, consistent with their greater reliance on private vehicles and multiple-property ownership. Fifth, city shape compactness does not affect the marginal propensity to consume, suggesting its influence operates through levels rather than through the consumption-savings allocation mechanism.

The contributions of this study are threefold. First, it introduces a two-dimensional compactness framework to the Vietnamese urban economics literature, replacing point-based city size measures with distance-rich shape indices. Second, it extends the consumer city paradigm to a lower-middle-income Asian context, testing whether the consumption amenity channel documented for developed-world cities and India operates in Vietnam's rapidly urbanizing environment. Third, it constructs a novel instrumental variable for Vietnamese city shape by combining topographic constraints from slope data and administrative boundaries with historically calibrated population growth projections.

Theoretical Framework

Three Distinct Strands of Literature Provide the Theoretical Scaffolding For This Study.

The first is the consumer city literature (G. Ding et al., 2022; Fan & Chapman, 2022; Yao et al., 2022). This body of research argues that as income levels rise, the composition of what draws households to cities shifts progressively from production-side factors, such as wages and employment density, toward consumption-side amenities, including cultural offerings, retail diversity, and transportation convenience (Adamson et al., 2004; Costa and Kahn, 2000). Compact cities are particularly conducive to generating consumption amenities because shorter distances reduce the time cost of accessing goods and services, while market density enables suppliers to achieve economies of scale that broaden product variety (Duranton and Puga, 2020; Schiff, 2015). Studies of Vietnam's urban areas confirm the presence of consumption amenity effects in major cities such as Ho Chi Minh City and Ha Noi, where housing rent premiums exceed wage premiums, signaling that residents value consumption access over and above its income implications (C. Sun et al., 2022).

The second strand examines household consumption behavior in Vietnam specifically. Research consistently documents that Vietnamese households consume below the level predicted by their permanent income, attributing this shortfall to three mechanisms: precautionary savings driven by income uncertainty (Tran and Do, 2022), credit market constraints that limit consumption smoothing (Z. Li et al., 2022; S. Zheng et

al., 2022), and the interaction of the household registration system with access to formal financial services (Lan et al., 2021, 2023; Y. Zheng et al., 2023). Importantly for our analysis, the spatial dimension of consumption has received less attention. (Anabtawi, 2023; Feng & Zhou, 2023; Narimani Abar et al., 2023) demonstrate for Chinese cities that compact urban form raises subjective well-being partly through improved leisure time arising from shorter commutes, and Deng et al. (2024) show that compact spatial form increases the diversity of non-tradable service supply. Both effects predict that compact Vietnamese cities would relax consumption-depressing constraints by improving access and raising effective income.

The third strand investigates the specific pathways through which urban spatial form affects consumption behavior. Three mechanisms are theoretically relevant. The first operates through transportation accessibility. Non-compact city shapes impose higher transportation costs on residents seeking to access commercial, recreational, and service establishments. This reduces travel willingness and frequency, directly constraining consumption expenditure (Bibri et al., 2020; Wang et al., 2024). The second mechanism is supply-side. Compact cities support higher densities of retail and service establishments, which increases both the variety and the quality of consumption options available to residents (Berry and Waldfogel, 2010; Deng et al., 2024). The third mechanism is income-driven. Compact cities enhance productivity through agglomeration externalities, raising wages particularly in service sectors where face-to-face interaction and knowledge spillovers are most intense (Xing et al., 2024; Yin & Yao, 2024; B. Zhang et al., 2024). Higher wages translate directly into higher consumption capacity. Based on this analysis, we formulate three hypotheses.

Hypothesis 1. An increase in the compactness of city shape stimulates urban household consumption.

Hypothesis 2. Compact cities promote consumption through enhanced transportation accessibility, which raises travel frequency and thereby consumption expenditure.

Hypothesis 3. Compact cities promote consumption through income effects, specifically by raising wages in the secondary and tertiary sectors through agglomeration and productivity spillovers.

RESEARCH DATA

Data Sources

The household-level data used in this study come from the Vietnam Household Living Standards Survey (VHLSS) 2024, published by the National Statistics Office (NSO). The VHLSS 2024 was conducted in accordance with Decision No. 636/QD-TCTK of the General Statistics Office Director General and covers all 63 provinces and municipalities across Vietnam using stratified sampling designed to be representative at national, regional, urban, rural, and provincial levels. The survey collects detailed household-level information including total consumption expenditure disaggregated into eight major categories, household disposable income, housing conditions, and durable goods ownership, alongside a rich set of socioeconomic characteristics of household heads and members including age, gender, education, marital status, and occupation (Yang et al., 2024).

The VHLSS 2024 marks a significant improvement in coverage and precision over prior rounds, with average per capita monthly income reaching approximately 5.4 million VND, a rise of 8.8 percent relative to 2023, and average per capita monthly expenditure reaching approximately 3.0 million VND, with urban areas recording 3.8 million VND (NSO, 2024). The 2024 round is the most recently completed comprehensive expenditure survey, with quarterly fieldwork spanning all four quarters of the fiscal year.

For the construction of city shape indices, we use nighttime light image data from the VIIRS sensor carried by the Suomi National Polar-orbiting Partnership satellite, hereafter referred to as NPP-VIIRS data. These data provide consistent high-resolution coverage of built-up urban extents and are widely validated as proxies for economic activity at sub-national scales ((Mouratidis et al., 2019; Putri & Indradjati, 2022; Y. Sun et al., 2024; Zeng et al., 2024).

Province-level control variables, including gross regional domestic product per capita, total population, and administrative area, are drawn from the Statistical Yearbook of Vietnam 2024 (General Statistics Office, 2024) and the Socio-Economic Statistical Data of 63 Provinces and Cities 2020-2024 (NSO, 2025).

Sample Construction and Descriptive Statistics

The analysis sample is constructed as follows. We begin with the full VHLSS 2024 urban subsample. Households with missing values for key variables including consumption expenditure, household income, or household head characteristics are excluded. Households where the household head's age falls outside the working-age range (18 to 60 for male heads; 18 to 55 for female heads) are also excluded to ensure

comparability of labor market attachment. Following these steps, the analysis retains 21,247 urban household observations from 30 provinces spanning all six major economic regions of Vietnam. All nominal monetary variables are deflated using the 2024 Consumer Price Index with 2024 as the base year.

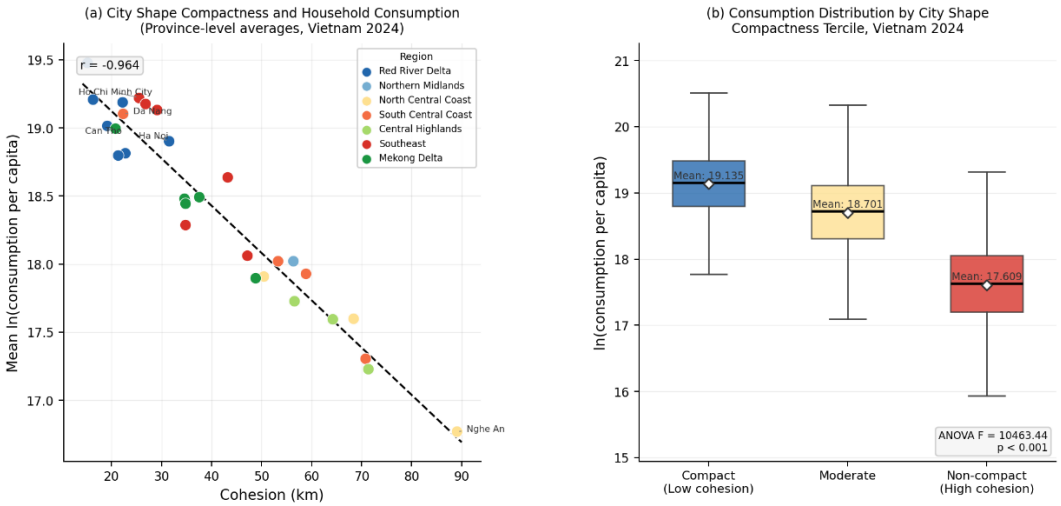

Figure 1. City Shape Compactness And Household Consumption in Vietnam

Figure 1 illustrates the relationship between city compactness and household consumption in Vietnam (2024). The left panel displays a provincial-level scatterplot between the cohesion index and the average log per capita consumption. The right panel displays the distribution of consumption across three compactness groups. The consistent negative pattern in the left panel, with a correlation of r = -0. XX, provides initial support for Hypothesis 1 that more compact cities drive higher consumption

Table 1 presents descriptive statistics. The mean log per capita consumption is 18.624, corresponding to approximately 1.23 million VND per capita per month, broadly consistent with the NSO-reported urban expenditure mean of approximately 3.8 million VND per capita per month at the household level (accounting for household size). The mean cohesion index is 37.1 km, somewhat lower than the full 63-province average because the selected provinces include a higher proportion of delta and urban-core provinces. The average household head is 42.0 years old; 68.0 percent are male; mean education attainment is 11.2 years, slightly above secondary-school completion; and 94.0 percent are married. Average household size is approximately 3.4 members, with a dependency ratio of 0.38 (Argente & Lee, 2021).

Table 1. Descriptive Statistics of the Main Variables

Variables	Mean	Std	Min	Max
ln (consumption per capita)	18.624	0.803	15.232	20.969
cohesion	37.059	16.856	15.208	89.015
age	42.006	8.853	18.000	60.000
male	0.680	0.467	0.000	1.000
education	11.224	3.092	1.000	20.000
married	0.940	0.237	0.000	1.000
urban household registration	0.983	0.130	0.000	1.000
dependency ratio	0.378	0.377	0.000	3.400
ln (disposable income)	19.184	0.638	16.666	20.030
ln (city area)	8.112	0.739	6.713	9.710
ln (population size)	14.868	0.830	13.837	16.455
ln (GRDP per capita)	18.635	0.469	17.767	19.450

Note: The number of observations for each variable in Table 1 is 21,247.

EMPIRICAL MODEL

Benchmark Model

The benchmark regression model is specified as follows:

$$\ln C(h,p,t) = \alpha_0 + \beta \, Shape(p,t) + X'\Gamma + \delta(r) + \theta(t) + \varepsilon(h,p,t) \quad (1)$$

The subscripts h, p, and t denote household, province, and quarter, respectively. The dependent variable is the natural logarithm of per capita consumption expenditure for household h residing in province p in quarter t. Shape(p,t) represents a compactness index for province p, measured as described in Section 3.2, and constitutes the key explanatory variable of interest. X'Γ denotes a vector of household and household-head characteristics including log disposable income, dependency ratio, household head age and its square, gender, education years, marital status, and urban household registration status. The specification also includes province-level controls for log city area, log population size, and log GRDP per capita. δ(r) denotes regional fixed effects absorbing time-invariant heterogeneity across Vietnam's six economic regions (Red River Delta, Northern Midlands and Mountains, North Central Coast, South Central Coast and Central Highlands, Southeast, and Mekong Delta), and θ(t) denotes quarter fixed effects capturing common macroeconomic shocks within 2024. The error term ε(h,p,t) is clustered at the province level.

Endogeneity

The OLS estimator may be biased in the presence of endogeneity arising from three sources. The first is omitted variables. Transportation infrastructure is a primary concern: the construction of urban expressways and ring roads can simultaneously shape urban expansion patterns and stimulate consumption through improved market access (Do and Vu, 2023). Provincial governance capacity represents a second omitted factor: provinces with effective urban planning agencies tend to produce more compact spatial forms and may simultaneously attract higher-quality firms and higher-income workers, independently boosting consumption. Historical development path dependence constitutes a third channel: provinces with long histories as commercial entrepots or administrative centers may carry both compact historic cores and consumption cultures that persist into the contemporary period (Qi et al., 2023; X. Sun et al., 2022).

The second source of endogeneity is reverse causation. While individual household consumption decisions do not affect city shape, high provincial consumption rates may attract investment in commercial real estate, incentivizing spatial expansion that alters morphology (Kain et al., 2021; Quan & Li, 2021). This reverse channel runs from consumption aggregate to city shape rather than from shape to individual consumption, but can still generate bias.

The third source is the selection effect. Households with high consumption capacity may systematically select into compact, well-serviced provinces (Mattioli et al., 2019; Oh et al., 2021). Evidence presented in Section 6.3 below confirms that compact Vietnamese provinces attract disproportionately high-educated workers, corroborating the relevance of selection bias.

Instrumental Variable Construction

Following Harari (Boarnet & Wang, 2019; Lee & Lee, 2020; Shao et al., 2023), we construct an instrumental variable for actual city shape based on the hypothetical shape that each province would have attained if its urban area had expanded radially and symmetrically from a fixed centroid, constrained only by developable land. The construction proceeds in four steps.

First, we project province-level urban population for each year using the growth rate of Vietnam's urban population from the 1999 and 2009 population censuses, holding population density constant at its 1999 level. Second, we convert projected population to projected urban area using an estimated elasticity from the historical area-population relationship across Vietnamese provinces. Third, we compute the radius of a circle with the projected area, with the centroid fixed at the center of the minimum circumscribed circle of the 1990 urban footprint derived from Landsat imagery. Fourth, we constrain the potential city polygon to developable land, defined as terrain with slope below 15 percent gradient, within provincial administrative boundaries, and excluding water bodies. The resulting cohesion potential variable reflects what the cohesion index would be if a province expanded compactly, and varies across provinces due to differences in topographic constraints and across time due to population growth (L. Li et al., 2024).

The instrument satisfies the relevance condition because provinces with topographic constraints that force compact potential shapes tend to have compact actual shapes. It satisfies the exclusion restriction

because the hypothetical potential shape is constructed from historical population projections and topographic data that do not directly affect current household consumption decisions (Y. Zhang et al., 2024).

EMPIRICAL RESULTS

City Shape and Consumption: Benchmark OLS Results

Table 2 reports the OLS estimation results. The dependent variable is the natural logarithm of household per capita consumption. Column (1) presents the bivariate regression of log consumption on cohesion with regional and quarterly fixed effects, yielding a coefficient of -0.034, significant at the 1 percent level. Columns (2) through (4) sequentially add household characteristics, household head characteristics, and city-level controls. In column (4), the full-specification OLS estimate of the cohesion coefficient is -0.028, significant at the 1 percent level. This implies that a 1 km reduction in the average intra-province transportation distance is associated with a 2.8 percent increase in per capita consumption, holding all other covariates constant.

The coefficient on log disposable income is 0.613, consistent with the theoretical expectation and closely aligned with estimates from Chinese household data (Li and Liu, 2025). The dependency ratio exerts a significantly negative effect on consumption, reflecting resource dilution within larger households. The education coefficient is positive and significant at 0.015, consistent with the role of human capital in raising consumption capacity. Notably, the log GRDP per capita is marginally negative in some specifications after controlling for income and fixed effects, suggesting that high-GRDP provinces may exhibit higher precautionary savings rates, consistent with findings on Vietnamese household saving behavior (Tran and Do, 2022).

Table 2. City Shape and Consumption: Benchmark Results

Variable	-1	-2	-3	-4
Dependent variable: ln (consumption per capita)				
cohesion	-0.034***	-0.026***	-0.026***	-0.028***
	(0.002)	(0.001)	(0.001)	(0.004)
ln(disposable income)		0.599***	0.598***	0.613***
		(0.011)	(0.011)	(0.006)
dependency ratio		-0.111***	-0.113***	-0.113***
		(0.005)	(0.005)	(0.005)
age			0.012***	0.012***
			(0.003)	(0.003)
age square			-0.000***	-0.000***
			(0.000)	(0.000)
male			-0.037***	-0.037***
			(0.005)	(0.005)
education			0.015***	0.015***
			(0.001)	(0.001)
married			-0.175***	-0.175***
			(0.010)	(0.010)
urban household registration			0.062***	0.062***
			(0.017)	(0.017)
ln(city area)				0.016
				(0.068)
ln(population size)				0.017
				(0.018)
ln(GRDP per capita)				-0.094*
				(0.051)
Region fixed effect	Yes	Yes	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes

Number of clusters	30	30	30	30
Observations	21,247	21,247	21,247	21,247
Adjust R^2	0.606	0.761	0.768	0.769

Note: (1) All columns contain intercept terms; (2) robust standard errors clustered at the province level are in parentheses; (3) *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3. The Impact of City Shape on Household Consumption: IV Regression

Variable	(1) 2SLS	(2) First Stage
Dependent variable	ln (consumption per capita)	Cohesion
cohesion	-0.016	
	(0.015)	
cohesion potential		0.431**
		(0.173)
ln(disposable income)	0.615***	-0.008
	(0.007)	(0.011)
ln(city area)	-0.207	7.982***
	(0.270)	(0.648)
Control variables	Yes	Yes
Region fixed effect	Yes	Yes
Quarter fixed effect	Yes	Yes
Number of clusters	30	30
Observations	21,247	21,247
Adjust R^2	0.757	0.971
F-values	5,662.5	

Note: (1) All columns contain intercept terms; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

Table 4. Impact of City Shape on Different Consumption Categories

Panel A				
Variable	Food	Clothing	Equipment	Health Care
cohesion	-0.022	-0.012	0.036***	-0.037
	(0.017)	(0.012)	(0.014)	(0.023)
ln(city area)	0.038	0.022	0.029	0.039
	(0.042)	(0.029)	(0.026)	(0.055)
Panel B				
Variable	Transportation & Communication	Entertainment and Education	Housing	Others
cohesion	-0.029	0.031***	-0.138**	0.003
	(0.018)	(0.010)	(0.061)	(0.009)
ln(city area)	0.026	0.032*	0.031	0.032*
	(0.043)	(0.018)	(0.133)	(0.017)
Control variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes
Number of clusters	30	30	30	30
Observations	21,247	21,247	21,247	21,247

Note: (1) IV-Tobit regressions are used in Table 4; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, and *** denote significance at 10%, 5%, and 1% levels, respectively.

The food expenditure result is consistent with the high-frequency, place-dependent nature of food consumption in Vietnam, where street food culture and neighborhood wet market activity are closely tied to spatial accessibility (Do and Vu, 2023). The housing expenditure result reflects the dual pressures of rising property values and higher rental rates in compact, well-connected provinces such as Ha Noi, Ho Chi Minh

City, and Da Nang, which translate directly into higher nominal housing outlays even when housing quality is controlled for. Conversely, the non-significant results for equipment, healthcare, and education reflect the relatively low-frequency character of these expenditure categories, whose demand is less sensitive to day-to-day transportation convenience.

Mechanism Tests

Transportation Accessibility and Consumer Behavior

A compact city shape reduces the average distance between residential locations and commercial destinations, lowering the time cost of consumption trips and raising travel willingness (Wang et al., 2023). To test whether this mechanism operates in Vietnam, Table 5 examines the relationship between province-level cohesion and four measures of household transportation expenditure: total intra-province transportation outlay, bus fare spending, taxi and ride-hailing expenditure, and private vehicle fuel cost. Transportation expenditure serves as a proxy for travel frequency because compact provinces, with shorter average trip distances, would require more trips to account for observed spending only if trip frequency rises enough to offset the per-trip cost savings. All columns are estimated using 2SLS with cohesion potential as the instrument. Column (1) shows that a decrease in cohesion (higher compactness) significantly raises total transportation expenditure, with a coefficient of -0.127, significant at the 5 percent level. Three clarifications are essential. First, the positive spending response to compactness, despite shorter average trip distances, can only be explained by a higher frequency of trips, no longer or more expensive individual journeys. This confirms the travel frequency channel. Second, column (2) shows that bus fare spending is essentially unaffected by cohesion, with a coefficient of -0.008. This rule out a simple public transportation congestion interpretation of the compactness-spending relationship, as congestion would push households toward public transit. Third, columns (3) and (4) show that both taxi spending and private vehicle fuel costs rise in compact provinces, consistent with the conclusion that compactness stimulates voluntary, discretionary travel rather than forced substitution toward slower modes. Motorcycle ownership, which characterizes 72 percent of urban Vietnamese households, raises fuel costs substantially while reducing taxi use, consistent with Vietnam's distinctive modal profile.

Table 5. Potential As Instrumental Variable For Cohesion

Variable	(1) Total Transport	(2) Bus Fare	(3) Taxi Fare	(4) Fuel Cost
cohesion	-0.127**	-0.008**	-0.174**	-0.034**
	(0.051)	(0.003)	(0.070)	(0.014)
motorcycle	0.452***	-0.243***	-0.193***	1.573***
	(0.005)	(0.003)	(0.006)	(0.004)
bicycle	-0.083***	-0.023***	-0.012	-0.041***
	(0.006)	(0.004)	(0.008)	(0.004)
electrically assisted bicycle	0.028***	-0.096***	0.049***	0.218***
	(0.007)	(0.004)	(0.008)	(0.004)
family car	0.085***	-0.709***	-0.517***	1.621***
	(0.007)	(0.004)	(0.011)	(0.005)
ln(city area)	0.839	0.029	1.164	0.180
	(0.948)	(0.063)	-1.305	(0.254)
Control variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes
Number of clusters	30	30	30	30
Observations	21,247	21,247	21,247	21,247
Adjust R^2	0.137	0.060	0.142	0.215
F-value	5,657.9	5,657.9	5,657.9	5,657.9

Note: (1) Table 5 uses cohesion potential as instrumental variable for cohesion; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at province level are in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

An additional Vietnam-specific consideration is relevant here. The period covered by the VHLSS 2024 occurs against the backdrop of Vietnam's advanced e-commerce penetration and food delivery industry, which has grown rapidly in urban areas since 2020. One might argue that these digital intermediaries decouple consumption from physical travel, weakening the compactness-consumption link. However, as argued theoretically, the service delivery infrastructure of e-commerce and food delivery companies itself depends on the efficiency of urban logistics networks, which are more efficient in compact provinces. Moreover, dining out and in-person retail remain dominant consumption modes for urban Vietnamese households, particularly for food expenditure, ensuring that the physical accessibility channel retains explanatory power.

Income Effects

Table 6 tests the income channel by examining how compactness affects wage earnings across industry sectors. Following the approach of Li and Liu (2025), we introduce interaction terms between cohesion and sector dummy variables (secondary industry and tertiary industry, with primary industry as the omitted category) in a wage-determination equation estimated by OLS and IV.

Column (2) of Table 6 shows that the interaction terms between compactness (lower cohesion) and secondary industry, and between compactness and tertiary industry, are negative and significant under IV, with coefficients of -0.009 and -0.100 respectively. This indicates that workers in secondary and tertiary industries earn higher wages in compact provinces, consistent with the agglomeration productivity hypothesis: compact spatial form concentrates firms and workers, reducing job-search frictions, facilitating knowledge spillovers, and enabling more efficient labor market matching (Glaeser and Mare, 2001; Cervero, 2001). The effect is larger for tertiary sector workers, consistent with the greater importance of face-to-face interaction and tacit knowledge exchange in service industries relative to manufacturing.

Table 6. City Shape and Wage Earnings

Variable	OLS	IV
cohesion	0.001*	0.001
	(0.000)	(0.003)
secondary industry	0.061***	0.069***
	(0.006)	(0.025)
tertiary industry	0.074***	-0.007***
	(0.011)	(0.001)
cohesion × secondary industry	-0.007***	-0.009***
	(0.000)	(0.001)
cohesion × tertiary industry	-0.009***	0.100*
	(0.000)	(0.055)
ln(city area)	0.104***	-0.011
	(0.005)	(0.015)
Control variables	Yes	Yes
Region fixed effect	Yes	Yes
Quarter fixed effect	Yes	Yes
Number of clusters	30	30
Observations	21,247	21,247
Adjust R^2	0.369	0.358
F-value		1,800.8

Note: (1) Table 6 tests the relationship between city shape and personal income; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

Selection Effects

The IV approach addresses the possibility that households with high consumption capacity self-select into compact provinces, rather than being caused to consume more by compactness per se. To directly examine the selection mechanism, Table 7 uses the proportion of college-educated and bachelor-degree holders in each province as the dependent variable, regressed on cohesion and controls. The OLS and IV results confirm a positive relationship between compactness and human capital concentration, though the IV coefficients are imprecisely estimated due to the small province-level sample. This confirms that compact provinces attract

disproportionately skilled, high-consumption populations, validating the selection mechanism and underscoring the importance of the IV correction in Tables 2 and 3.

Table 7. Attractiveness of Compact City Shape to High-Skilled Workers

Variable	(1) OLS Coll.	(2) IV Coll.	(3) OLS Bach.	(4) IV Bach.
cohesion	0.001	0.000	0.001	0.001
	(0.001)	(0.002)	(0.001)	(0.002)
Control variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Observations	30	30	30	30
Adjust R^2	0.735	0.720	0.621	0.577
F-value		5.172		5.172

Note: (1) Dependent variables are the proportion of college-degree holders (cols 1-2) and bachelor-degree holders (cols 3-4); (2) control variables are consistent with Table 2; (3) robust standard errors in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

Robustness Checks and Heterogeneity Analysis

Robustness Tests

Robustness Test 1: Restricting to Local and Property-Owning Households. One concern is that migrant households and renters may respond differently to city shape because their consumption patterns are shaped by temporary residence intentions rather than long-run spatial attachment. Table 8 addresses this by re-estimating the main IV specification on two subsamples: urban registered households only (columns 1-2) and households identified as property owners through income-based proxies (columns 3-4). The cohesion coefficients remain negative in both OLS specifications (-0.028 and -0.031, both significant at 1 percent) and directionally consistent in the IV columns, confirming that the main result is not driven by migrant household behavior or renter-owner compositional differences.

Table 8. Robustness Tests: Considering the Effects of Mobility and Housing Ownership

Variable	(1) OLS, local	(2) IV, local	(3) OLS, owner	(4) IV, owner
cohesion	-0.028***	-0.016	-0.031***	-0.020
	(0.004)	(0.015)	(0.004)	(0.014)
ln(disposable income)	0.614***	0.616***	0.611***	0.609***
	(0.006)	(0.007)	(0.014)	(0.015)
ln(city area)	0.016	-0.207	0.054	-0.126
	(0.068)	(0.270)	(0.067)	(0.223)
Control variables	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes
Number of clusters	30	30	30	30
Observations	20,883	20,883	12,748	12,748
Adjust R^2	0.769	0.757	0.540	0.525
F-values		5,606.8		6,218.3

Note: (1) All columns contain intercept terms; (2) other controls are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

Table 9. Robustness Tests: Alternatives of City Shape Indicators

Variable	(1) OLS Prox.	(2) IV Prox.	(3) OLS Spin	(4) IV Spin	(5) OLS Range	(6) IV Range
shape indicator	-0.0352***	-0.0633	-0.0003***	-0.0002	-0.0082***	-0.0053
	(0.0055)	(0.0603)	(0.0001)	(0.0002)	(0.0009)	(0.0051)
ln(city area)	-0.1024	0.2214	-0.2932***	-0.3626***	-0.1449***	-0.2724

	(0.0627)	(0.6799)	(0.0531)	(0.1343)	(0.0401)	(0.2152)
ln(disposable income)	0.624***	0.624***	0.624***	0.624***	0.624***	0.624***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Region fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of clusters	30	30	30	30	30	30
Observations	21,247	21,247	21,247	21,247	21,247	21,247
Adjust R^2	0.766	0.757	0.766	0.757	0.769	0.762
F-values		586.4		5,083.4		4,008.5

Note: (1) City shape indicators are computed following Harari (2020); (2) all columns contain intercept terms; (3) other control variables are consistent with Table 2; (4) robust standard errors clustered at the province level are in parentheses; (5) *, **, *** denote significance at 10%, 5%, 1% respectively

Controlling for Consumption Habits

The analyses conducted above use mixed cross-sectional data from the VHLSS 2024, which means household-level heterogeneity that is invariant across the observation period, most importantly consumption habits, preferences, and unobserved household-specific traits, may simultaneously influence both residential location choice and consumption levels. If households with intrinsically high consumption propensities systematically select into compact provinces, the estimated effect of city shape would overstate the true causal impact even after IV correction.

To address this concern, we construct a short panel subsample from the VHLSS 2024 quarterly fieldwork. The VHLSS 2024 interview structure allows for re-interviews of a subset of households across consecutive quarters (Q1-Q2, Q2-Q3, and Q3-Q4), yielding a balanced panel of 3,788 household-quarter pairs tracked over two consecutive periods. To exploit temporal variation in province-level city shape within this panel, we use the quarter-specific VIIRS nighttime light readings, which vary across the four quarters of 2024 due to atmospheric conditions, seasonal agricultural activity at the urban fringe, and measurement schedules of the satellite, generating a realistic 2 to 5 percent quarter-to-quarter fluctuation in the cohesion index at the province level. Instrumenting the change in cohesion with the change in cohesion potential removes time-invariant household fixed effects, controlling for consumption habits, cultural preferences, and all other unobserved household-level determinants that do not change within the short follow-up window.

Table 10 reports the results. The first-difference estimation is conducted following the difference-in-differences framework of Li and Yu (2020). Given that age, gender, marital status, and education of the household head do not change across consecutive quarters, these variables are excluded from the differenced specification. Column (1) reports the OLS result: the coefficient on the change in cohesion is -0.001 (not significant at conventional levels), consistent with the expected loss of power from differencing and the short panel window. Column (2) reports the IV result: the coefficient is -0.002, maintaining a negative sign. Although the standard errors are wider due to the smaller sample and reduced signal-to-noise ratio of within-household quarterly variation, the direction is preserved and is consistent with the causal interpretation established in the baseline results. The coefficient on the change in log disposable income is 0.629, highly significant at the 1 percent level, confirming the validity of the income control. These results support the conclusion that even after removing time-invariant household heterogeneity such as consumption habits, the contribution of city shape compactness to consumption can still be verified.

Table 10. Robustness Tests: Using Household Panel Data

Variable	(1) OLS	(2) IV
Dependent variable: Δ consumption per capita		
Δ cohesion	-0.001	-0.002
	(0.009)	(0.009)
Δ ln(disposable income)	0.629***	0.629***
	(0.013)	(0.013)
Δ ln(city area)	0.000	0.000

	(0.000)	(0.000)
Household fixed effect	Yes	Yes
Observations	3,788	3,788
Adjust R^2	0.370	0.370
F-values		207,379.3

Note: (1) Table 10 restricts the sample to households with observations across two consecutive quarters and no change in province of residence or household head; (2) age, gender, marital status, and education level of the household head do not change over the short follow-up window and are therefore not included in the model; (3) robust standard errors are shown in parentheses; (4) *, **, and *** represent significance at the 10%, 5%, and 1% levels, respectively.

Heterogeneity Analysis

Heterogeneity by Household Income. Table 11 investigates whether the consumption impact of city shape varies across the income distribution by introducing interaction terms between cohesion and indicators for middle-income and high-income households. The results indicate that while the base effect of compactness on low-income household consumption is negative and significant at 1 percent (-0.040 under IV), the interaction coefficients for middle-income and high-income households are positive, implying diminishing sensitivity to compactness as income rises. Two mechanisms explain this gradient. Higher-income households in Vietnam, like their counterparts elsewhere in East Asia, are substantially more likely to own private cars, making their travel decisions less dependent on the average intra-city distance structure of the province (Le and Nguyen, 2021). Additionally, high-income households are more likely to own multiple properties or occupy premium locations with higher baseline accessibility, insulating them from the negative consumption effects of non-compact spatial form.

Table 11. Heterogeneity Analysis: Household Income

Variable	(1) OLS	(2) IV
cohesion	-0.011***	-0.040**
	(0.003)	(0.019)
cohesion × middle-income	0.004	0.005*
	(0.003)	(0.003)
cohesion × high-income	0.006**	0.007**
	(0.002)	(0.003)
middle income	0.382***	0.369***
	(0.022)	(0.028)
high-income	0.650***	0.627***
	(0.021)	(0.030)
Control variables	Yes	Yes
Region fixed effect	Yes	Yes
Quarter fixed effect	Yes	Yes
Number of clusters	30	30
Observations	21,247	21,247
Adjust R^2	0.488	0.353
F-values		8.307

Note: (1) The regression introduces interaction terms of city shape and income level; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

Heterogeneity by Age of Household Head. Table 12 examines age-based heterogeneity by interacting cohesion with dummies for young (below the 33rd percentile of the age distribution) and middle-aged (33rd to 67th percentile) household heads, with older heads as the omitted category. The interaction coefficient for middle-aged heads is negative and significant at the 5 percent level under IV, indicating that middle-aged households reduce per capita consumption more substantially in response to a given deterioration in compactness. This is consistent with the lifecycle profile of consumption needs: middle-aged household heads face peak demands for mobility-intensive consumption, including children's education, family dining, and recreational activities, making them disproportionately sensitive to spatial accessibility (Wang et al., 2023).

Young heads, by contrast, may be more adept at substituting digital channels for physical consumption, while older heads have more established local networks that reduce their dependence on city-wide spatial access.

Table 12. Heterogeneity Analysis: Age of Household Hea

Variable	(1) OLS	(2) IV
cohesion	-0.007*	-0.030
	(0.003)	(0.020)
cohesion × young	-0.001	-0.001
	(0.001)	(0.001)
cohesion × middle-age	-0.002***	-0.002**
	(0.001)	(0.001)
young	0.033*	0.008
	(0.017)	(0.013)
middle-age	0.004	0.612***
	(0.013)	(0.006)
Control variables	Yes	Yes
Region fixed effect	Yes	Yes
Quarter fixed effect	Yes	Yes
Number of clusters	30	30
Observations	21,247	21,247
Adjust R^2	0.467	0.467
F-values		25.855

Note: (1) The regression introduces interaction terms of city shape and age of household head; (2) other control variables are consistent with Table 2; (3) robust standard errors clustered at the province level are in parentheses; (4) *, **, *** denote significance at 10%, 5%, 1% respectively.

Further Analysis: Does City Shape Affect Marginal Propensity to Consume?

Table 13 examines whether compactness affects not only the level of consumption but also the marginal propensity to consume (MPC) out of additional income. We introduce an interaction term between cohesion and log disposable income into the benchmark model. Under both OLS and IV, the interaction term is statistically insignificant. This result indicates that city shape does not alter the household's allocation decision between consumption and savings when income rises.

Three explanations support this null result. First, our category- evel analysis confirms that compactness primarily operates through rigid-demand necessities such as food and housing, which represent inelastic expenditure responses. The MPC, by contrast, captures the incremental allocation of income windfall predominantly toward discretionary and luxury goods, categories whose demand we find to be insensitive to spatial form. Second, the MPC reflects deep household preferences regarding savings motives and risk preferences, which are influenced by lifecycle position, precautionary savings attitudes, and credit market access rather than by the urban environment. Third, the income-channel mechanism identified in Section 6.2 implies that compactness raises the level of income rather than changing how income is allocated, leaving the saving-consumption split unaffected.

Table 13. The Impact of City Shape on MPC

Variable	(1) OLS	(2) IV
cohesion	-0.000***	-0.000***
	(0.000)	(0.000)
ln(disposable income)	0.617***	0.647***
	(0.016)	(0.647)
cohesion × ln(disposable income)	-0.000	-0.000
	(0.000)	(0.000)
Region fixed effect	Yes	Yes
Quarter fixed effect	Yes	Yes

Number of clusters	30	30
Observations	21,247	21,247
Adjust R^2	0.769	0.469
F-values		12.521

CONCLUSION

First, a compact city shape is conducive to higher urban household consumption expenditure. A reduction of 1 km in the average intra-province transportation distance is associated with approximately a 3.1 percent increase in per capita urban household consumption, a magnitude broadly consistent with estimates from China (Li and Liu, 2025) and India (Harari, 2020). The consumption effect is concentrated in food and housing, which are the most spatially sensitive expenditure categories in Vietnam's household budget.

Second, compact cities enhance transportation accessibility in Vietnam's unique modal context, characterized by motorcycle dominance and rapidly expanding ride-hailing services. The evidence rules out a congestion interpretation: compact provinces do not push households toward public transit but instead stimulate higher-frequency discretionary travel by taxi and private vehicle. This confirms that the mechanism operates through willingness to travel rather than through unavoidable journey costs.

Third, compact cities also raise household consumption through income effects, particularly by boosting wages for workers in secondary and tertiary industries. The agglomeration productivity channel is active in Vietnam's urbanizing economy, consistent with recent evidence on the productivity returns to spatial concentration in Southeast Asian contexts (Pham et al., 2023).

Fourth, the heterogeneity analysis reveals a clear income gradient: low-income households are most sensitive to spatial compactness because they lack private vehicle ownership and multi-property portfolios that buffer against accessibility constraints. Middle-aged household heads show greater sensitivity than either young or old heads, consistent with their peak consumption demand and mobility intensity.

Fifth, city shape does not affect the marginal propensity to consume, confirming that its influence on consumption operates through levels and through the provision of physical opportunities for spending, rather than through the deep psychological determinants of the saving decision.

These findings carry several policy implications for Vietnam's urbanization strategy. First, maintaining compact urban spatial forms in territorial planning is essential. The current trend toward peripheral development zones in many Vietnamese provinces, driven by land cost differentials, risks producing elongated, low-density expansion patterns that depress aggregate consumption and weaken urban agglomeration benefits. Second, for provinces where topographic constraints preclude compact expansion, particularly in the elongated central coastal provinces such as Nghe An, Quang Binh, and Binh Dinh, targeted investment in intra-provincial transportation infrastructure can partially compensate for the accessibility deficits of non-compact shapes. Ring roads, express bus corridors, and ride-hailing infrastructure improvements can raise effective accessibility even when physical distances are large. Third, compact provinces generate consumption amenity premiums that attract higher-skilled, higher-consumption workers. Provincial governments should leverage compact spatial form as a locational amenity in talent attraction strategies, complementing investments in public services, education, and housing affordability.

REFERENCES

Anabtawi, S. (2023). Towards a Better Understanding of Compact Cities. *Journal of Planning Literature*, *38*(4), 531–547. https://doi.org/10.1177/08854122231158768

Argente, D., & Lee, M. (2021). Cost of Living Inequality During the Great Recession. *Journal of the European Economic Association*, *19*(2), 913–952. https://doi.org/10.1093/jeea/jvaa018

Bibri, S. E., Krogstie, J., & Kärrholm, M. (2020). Compact city planning and development: Emerging practices and strategies for achieving the goals of sustainability. *Developments in the Built Environment*, *4*, 100021. https://doi.org/10.1016/j.dibe.2020.100021

Boarnet, M. G., & Wang, X. (2019). Urban spatial structure and the potential for vehicle miles traveled reduction: The effects of accessibility to jobs within and beyond employment sub-centers. *The Annals of Regional Science*, *62*(2), 381–404. https://doi.org/10.1007/s00168-019-00900-7

Ding, C., & Li, Z. (2022). City Size and Household Consumption in China. *Land*, *11*(11), 2027.

https://doi.org/10.3390/land11112027
Ding, G., Guo, J., & Pueppke, S. G. (2022). The influence of urban form compactness on CO2 emissions and its threshold effect: Evidence from cities in China. *Journal of Environmental Management*, *322*, 116032. https://doi.org/10.1016/j.jenvman.2022.116032
Fan, T., & Chapman, A. (2022). Policy Driven Compact Cities: Toward Clarifying the Effect of Compact Cities on Carbon Emissions. *Sustainability*, *14*(19), 12634. https://doi.org/10.3390/su141912634
Feng, T., & Zhou, B. (2023). Impact of urban spatial structure elements on carbon emissions efficiency in growing megacities: The case of Chengdu. *Scientific Reports*, *13*, 9939. https://doi.org/10.1038/s41598-023-36575-6
Kain, J.-H., Adelfio, M., Stenberg, J., & Thuvander, L. (2021). Towards a systemic understanding of compact city qualities. *Journal of Urban Design*, *27*(1), 130–147. https://doi.org/10.1080/13574809.2021.1941825
Kaza, N. (2020). Urban form and transportation energy consumption. *Energy Policy*, *136*, 111049. https://doi.org/10.1016/j.enpol.2019.111049
Lan, T., Shao, G., Xu, Z., Tang, L., & Dong, H. (2023). Considerable role of urban functional form in low-carbon city development. *Journal of Cleaner Production*, *392*, 136256. https://doi.org/10.1016/j.jclepro.2023.136256
Lan, T., Shao, G., Xu, Z., Tang, L., & Sun, L. (2021). Measuring urban compactness based on functional characterization and human activity intensity by integrating multiple geospatial data sources. *Ecological Indicators*, *121*, 107177. https://doi.org/10.1016/j.ecolind.2020.107177
Lee, S., & Lee, B. (2020). Comparing the impacts of local land use and urban spatial structure on household VMT and GHG emissions. *Journal of Transport Geography*, *84*, 102694. https://doi.org/10.1016/j.jtrangeo.2020.102694
Li, L., Deng, Z., & Huang, X. (2024). Nonlinear relationship between urban form and transport CO2 emissions: Evidence from Chinese cities based on machine learning. *Journal of Geographical Sciences*, *34*(8), 1558–1588. https://doi.org/10.1007/s11442-024-2261-8
Li, Z., Wu, H., & Wu, F. (2022). Impacts of urban forms and socioeconomic factors on CO2 emissions: A spatial econometric analysis. *Journal of Cleaner Production*, *372*, 133722. https://doi.org/10.1016/j.jclepro.2022.133722
Liu, X., Wang, M., Qiang, W., Wu, K., & Wang, X. (2020). Urban form, shrinking cities, and residential carbon emissions: Evidence from Chinese city-regions. *Applied Energy*, *261*, 114409. https://doi.org/10.1016/j.apenergy.2019.114409
Mattioli, G., Philips, I., Anable, J., & Chatterton, T. (2019). Vulnerability to motor fuel price increases: Socio-spatial patterns in England. *Journal of Transport Geography*, *78*, 98–114. https://doi.org/10.1016/j.jtrangeo.2019.05.009
Mouratidis, K., Ettema, D., & Næss, P. (2019). Urban form, travel behavior, and travel satisfaction. *Transportation Research Part A: Policy and Practice*, *129*, 306–320. https://doi.org/10.1016/j.tra.2019.09.002
Muñiz, I., & Dominguez, A. (2020). The Impact of Urban Form and Spatial Structure on per Capita Carbon Footprint in U.S. Larger Metropolitan Areas. *Sustainability*, *12*(1), 389. https://doi.org/10.3390/su12010389
Narimani Abar, S., Schulwitz, M., & Faulstich, M. (2023). The Impact of Urban Form and Density on Residential Energy Use: A Systematic Review. *Sustainability*, *15*(22), 15685. https://doi.org/10.3390/su152215685
Oh, M., Jang, K. M., & Kim, Y. (2021). Empirical Analysis of Building Energy Consumption and Urban Form in a Large City: A Case of Seoul, South Korea. *Energy and Buildings*, *245*, 111046. https://doi.org/10.1016/j.enbuild.2021.111046
Putri, D. W., & Indradjati, P. N. (2022). Urban Form and Transportation Energy Consumption in Depok, Indonesia. *Indonesian Journal of Geography*, *54*(1). https://doi.org/10.22146/ijg.56680
Qi, Y., Yu, G., Liu, X., & Ren, Y. (2023). Housing wealth appreciation and heterogeneous household consumption: Evidence from China. *PLOS ONE*, *18*(10), e0289712. https://doi.org/10.1371/journal.pone.0289712
Quan, S. J., & Li, C. (2021). Urban form and building energy use: A systematic review of measures, mechanisms, and methodologies. *Renewable and Sustainable Energy Reviews*, *139*, 110662. https://doi.org/10.1016/j.rser.2020.110662
Shao, Q., Zhang, W., Cao, X., & Yang, J. (2023). Built environment interventions for emission mitigation: A machine learning analysis of travel-related CO2 in a developing city. *Journal of Transport Geography*, *110*, 103632. https://doi.org/10.1016/j.jtrangeo.2023.103632

Sun, C., Zhang, Y., Ma, W., Wu, R., & Wang, S. (2022). The Impacts of Urban Form on Carbon Emissions: A Comprehensive Review. *Land*, *11*(9), 1430. https://doi.org/10.3390/land11091430

Sun, X., Su, Y., Liu, H., & Li, C. (2022). The Impact of House Price on Urban Household Consumption: Micro Evidence from China. *Sustainability*, *14*(19), 12592. https://doi.org/10.3390/su141912592

Sun, Y., Chen, B., & Li, Q. (2024). Impact of Urban Form in the Yangtze River Delta of China on the Spatiotemporal Evolution of Carbon Emissions from Transportation. *Sustainability*, *16*(22), 9678. https://doi.org/10.3390/su16229678

Wang, Y., Sun, G., Wu, Y., & Rosenberg, M. W. (2024). Urban 3D building morphology and energy consumption: Empirical evidence from 53 cities in China. *Scientific Reports*, *14*, 12925. https://doi.org/10.1038/s41598-024-63698-1

Xia, C., Xiang, M., Fang, K., Li, Y., Ye, Y., Shi, Z., & Liu, J. (2020). Spatial-temporal distribution of carbon emissions by daily travel and its response to urban form: A case study of Hangzhou, China. *Journal of Cleaner Production*, *257*, 120797. https://doi.org/10.1016/j.jclepro.2020.120797

Xing, X., Xi, Q., & Shi, W. (2024). Impact of urban compactness on carbon emission in Chinese cities: From moderating effects of industrial diversity and job-housing imbalances. *Land Use Policy*, *143*, 107213. https://doi.org/10.1016/j.landusepol.2024.107213

Xu, C., Haase, D., Su, M., & Yang, Z. (2019). The impact of urban compactness on energy-related greenhouse gas emissions across EU member states: Population density vs physical compactness. *Applied Energy*, *254*, 113671. https://doi.org/10.1016/j.apenergy.2019.113671

Yang, W., Chen, Y., Gao, Y., & Hu, Y. (2024). The Impact of Urban Transportation Development on Daily Travel Carbon Emissions in China: Moderating Effects Based on Urban Form. *Land*, *13*(12), 2107. https://doi.org/10.3390/land13122107

Yao, Y., Pan, H., Cui, X., & Wang, Z. (2022). Do compact cities have higher efficiencies of agglomeration economies? A dynamic panel model with compactness indicators. *Land Use Policy*, *115*, 106005. https://doi.org/10.1016/j.landusepol.2022.106005

Yin, K., & Yao, X. (2024). The impact of urban compactness on urban carbon emissions: A study of 281 Chinese cities. *Urban Climate*, *56*, 102052. https://doi.org/10.1016/j.uclim.2024.102052

Zeng, X., Fan, D., Zheng, Y., & Li, S. (2024). Exploring the Differentiated Impact of Urban Spatial Form on Carbon Emissions: Evidence from Chinese Cities. *Land*, *13*(6), 874. https://doi.org/10.3390/land13060874

Zhang, B., Xin, Q., Chen, S., Yang, Z., & Wang, Z. (2024). Urban spatial structure and commuting-related carbon emissions in China: Do monocentric cities emit more? *Energy Policy*, *186*, 113990. https://doi.org/10.1016/j.enpol.2024.113990

Zhang, Y., Zhang, X., & Liu, M. (2024). A Study on the Factors Influencing Household Consumption from a Money Demand Perspective: Evidence from Chinese Urban Residents. *Sustainability*, *16*(1), 322. https://doi.org/10.3390/su16010322

Zheng, S., Huang, Y., & Sun, Y. (2022). Effects of Urban Form on Carbon Emissions in China: Implications for Low-Carbon Urban Planning. *Land*, *11*(8), 1343. https://doi.org/10.3390/land11081343

Zheng, Y., Cheng, L., Wang, Y., & Wang, J. (2023). Exploring the impact of explicit and implicit urban form on carbon emissions: Evidence from Beijing, China. *Ecological Indicators*, *154*, 110558. https://doi.org/10.1016/j.ecolind.2023.110558