Research Article

Xin Zhao, Xue Lei*, Hetong Yuan, and Caihua Zhang

Can Urban "Gold Signboards" Yield Carbon Reduction Dividends? A Quasi-Natural Experiment Based on the "National Civilized City" Selection

https://doi.org/10.1515/econ-2025-0150
received December 16, 2024; accepted April 07, 2025

Abstract: As a crucial lever for urban governance transformation, city branding not only strengthens urban identity and attracts external capital but may also drive green and low-carbon transformation through reputational effects. However, existing research has paid limited attention to the impact mechanisms of city brand value on carbon reduction. Based on this, using a sample of 262 prefecture-level and above cities in China from 2002 to 2022, this article analyzes the impact of city branding on carbon productivity (CPR) through a multi-period difference-in-differences model based on the quasi-natural experiment of "National Civilized City" selection. Results show that the city branding initiative of National Civilized City can enhance CPR. The findings remain robust after parallel trend tests, placebo tests, and controlling for other policy interventions. Heterogeneity analysis indicates that the impact of National Civilized City branding on CPR is more pronounced in cities with superior geographical locations, higher brand dependence, and relative brand scarcity. Mechanism analysis reveals that National Civilized City branding can improve urban CPR by optimizing energy consumption structure, promoting technological progress, and increasing labor productivity. The research conclusions provide policy insights for deepening understanding of the emission reduction effects of city branding and expanding urban low-carbon development pathways.

*** Corresponding author: Xue Lei,** School of Management, Shanghai University, Shanghai, 200444, China, e-mail: leixue_work@shu.edu.cn
Xin Zhao: Department of Modern Services, Baotou Light Industry Vocational Technical College, Baotou, 014030, China
Hetong Yuan: School of Management, Shanghai University, Shanghai, 200444, China
Caihua Zhang: School of Economics and Trade, Guangzhou Xinhua University, Guangzhou, 510520, China

Keywords: city branding, carbon productivity, energy consumption structure, technological progress, labor productivity

1 Introduction

As global climate change intensifies and urbanization continues to advance, coordinating urban economic development with carbon reduction has become a critical issue requiring urgent resolution in urban development (Lei & Xu, 2025). Research indicates that urban areas contribute 80% of global carbon emissions, making them the key battleground for achieving the "dual carbon" goals (Fang et al., 2022; Liu et al., 2014). Against this background, city branding, as an important lever for urban governance transformation, can not only enhance urban identity and competitiveness but may also drive low-carbon transformation through reputational effects. Existing research shows that high-quality city brands help concentrate innovation resources, promote industrial structure optimization, and improve energy utilization efficiency, thereby driving carbon emission reduction (de Jong et al., 2016; de Jong, 2019).

From existing research, studies on the relationship between city branding and carbon reduction mainly focus on the following aspects: first, from the perspective of city branding, examining its impact on urban competitiveness, resident perception, and local identity (Gao et al., 2023; Swain et al., 2024); second, from the carbon reduction perspective, exploring urban low-carbon transformation pathways and emission reduction effects (Jia et al., 2024; Li et al., 2024); third, from the urban governance dimension, investigating the interaction mechanisms between brand building and urban development (Zhu et al., 2019). These studies provide important insights for understanding the relationship between city branding and carbon reduction.

However, existing research still has the following limitations: first, insufficient attention has been paid to the impact mechanisms of city branding on carbon productivity (CPR), particularly lacking systematic examination of how brand reputation influences urban CPR; second, there is a lack of reliable identification strategies and quantitative assessment of the carbon reduction effects of city branding; third, the action mechanisms and heterogeneous characteristics of how city branding influences CPR have not been deeply explored. These issues raise the following important research questions: first, does and how does city branding affect urban CPR? Second, through what mechanisms are the carbon reduction effects of city branding achieved? Third, are there differences in the carbon reduction effects of different types of city branding? Answering these questions helps not only deepen theoretical understanding of the relationship between city branding and carbon reduction but also provides important insights for urban low-carbon transformation practices.

From a theoretical significance perspective, this research enriches the academic content of city brand theory and low-carbon development research by constructing an analytical framework of city branding and CPR, revealing the mechanisms through which brand reputation affects urban low-carbon transformation. From a practical significance perspective, the research conclusions can provide policy reference for urban managers in formulating brand-building strategies and advancing low-carbon transformation, helping achieve coordinated unity of urban economic development and environmental protection.

Based on this, using a sample of 262 prefecture-level and above cities in China from 2002 to 2022, this article analyzes the impact of city branding on CPR and its internal mechanisms through a multi-period difference-in-differences model based on the quasi-natural experiment of "National Civilized City" selection. Compared to existing research, the marginal contributions of this article are mainly reflected in: first, it pioneers the incorporation of city branding into the CPR research framework, systematically evaluating the impact of city branding on CPR, addressing the question of "whether and how it affects." While previous studies have extensively examined either city branding effects on economic outcomes or isolated environmental policy impacts, our work creates a novel integration of these previously separate research streams, advancing a more holistic understanding of how symbolic urban governance tools affect substantive environmental outcomes. Second, it constructs theoretical mechanisms of how city branding influences CPR, verifying the question of "through what mechanisms" via multiple channels including energy structure optimization, technological progress (TP), and labor productivity (LP) improvement. Unlike prior research that often treats urban environmental performance as a black box, our multi-pathway analysis unpacks specific causal channels, contributing to a more nuanced understanding of urban carbon governance processes that operates through both direct policy pathways and indirect reputational effects. Third, it examines heterogeneous effects across different types of cities from dimensions such as geographical location, urban function, and brand scarcity, answering the question of "whether differences exist," enriching the theoretical connotations of city brand and low-carbon development research. This heterogeneity analysis moves beyond the average treatment effects typically reported in urban policy studies to provide context-specific insights, acknowledging that city branding effects are moderated by structural and institutional factors rather than operating uniformly across diverse urban environments.

The remainder of this article is organized as follows: Section 2 presents the literature review and research hypotheses; Section 3 introduces the research design, including data sources, variable definitions, and model specification; Section 4 presents the empirical analysis, including baseline regression, robustness tests, heterogeneity analysis, and mechanism tests; Section 5 presents research conclusions and policy recommendations.

2 Literature Review and Hypothesis Development

2.1 Literature Review

In the context of globalization, cities serve as crucial carriers of regional economic development and environmental governance, with their brand-building and CPR improvement becoming focal points of academic attention. Dinnie's (2010) seminal work on city branding defines it as "the practice of applying brand strategy and other marketing techniques and disciplines to the economic, social, political and cultural development of cities, regions and countries." This definition underscores the multidimensional nature of city branding beyond mere marketing (Dinnie, 2010). Lucarelli and Berg (2011) further categorized city branding research into general, branding process, and evaluation studies, demonstrating the field's evolution from tactical promotion to strategic governance (Lucarelli & Berg, 2011). As Lucarelli (2018) argues, city branding has increasingly become a form of urban policy with significant implications for sustainable development (Lucarelli, 2018).

Research on city branding has evolved from city marketing to city brand development. Early studies primarily focused on urban image promotion and marketing strategies, but as theory deepened, scholars began emphasizing city branding as a systematic project requiring the integration of various urban resources and stakeholders. Research indicates that successful city branding requires joint participation from government, enterprises, and residents to achieve sustainable urban development through enhanced urban competitiveness and resident identification (Ma et al., 2020; Zhao, 2024). Furthermore, city branding encompasses multiple dimensions including urban culture and ecological environment, which collectively constitute the core value of urban brands (Zhang et al., 2024).

The relationship between city branding and sustainable development has received significant attention as well. Dinnie (2010) has conceptualized city branding as a strategic approach that involves the creation and management of emotional and psychological associations with a city (Dinnie, 2010). His work highlights how city branding goes beyond mere promotion to become an integral part of urban governance systems across the globe. Lucarelli and Berg (2011) conducted a comprehensive review of city branding literature, identifying how city branding practices affect various dimensions of urban development including environmental sustainability (Lucarelli & Berg, 2011). Warren and Dinnie (2018) further examined how place branding professionals influence policy decisions, suggesting that brand-building activities often drive governance transformations through both formal and informal mechanisms (Warren & Dinnie, 2018). Zenker et al. (2017) emphasized that successful city branding requires integrating multiple stakeholder perspectives (Zenker et al., 2017), including environmental considerations, to achieve truly sustainable urban development.

In the context of environmental governance specifically, studies from diverse geographic contexts have demonstrated how city branding initiatives impact sustainability outcomes. Pasquinelli (2014) documented how European cities have leveraged green city branding to attract sustainable investments and promote ecological innovation (Pasquinelli, 2014). Andehn et al. (2020) explored how city brand identity construction affects policy prioritization, including environmental policies (Andehn et al., 2020).

Regarding urban CPR research, scholars have primarily explored it from perspectives of TP, industrial structure optimization, and environmental regulation. Studies reveal that urban CPR improvement is influenced by multiple factors, with innovation drive and industrial upgrading serving as key drivers (Lei & Xu, 2024; Lu & Ma, 2023). Additionally, new driving forces such as digital economy development and green technology innovation have significantly promoted urban CPR improvement (Liu et al., 2024b). Particularly at the urban agglomeration scale, CPR exhibits notable spatial heterogeneity, with such differences closely related to urban development stages and industrial structure (Chen et al., 2024).

In recent years, the implementation of low-carbon city pilot policies has provided new perspectives for studying urban CPR. Empirical research shows that low-carbon city construction has significantly enhanced urban CPR, with this effect more pronounced in eastern regions and central cities (Song et al., 2023). Meanwhile, the coordinated advancement of urban green innovation and environmental governance has also provided new approaches for improving CPR (Liu et al., 2024a).

However, existing research has paid limited attention to the interactive relationship between city branding and CPR. In fact, as an important means of enhancing urban competitiveness, the synergistic improvement of city branding and CPR holds significant theoretical and practical implications. On one hand, strong city brands help attract green innovation resources and environmental protection industry clusters, thereby promoting CPR improvement; on the other hand, higher CPR can enhance a city's green development image, strengthening city brand value. Research on this bidirectional interactive relationship not only enriches urban development theory but also provides new ideas and directions for urban transformation development.

In the context of environmental governance specifically, studies from diverse contexts have demonstrated how various governance structures and institutional factors impact sustainability outcomes. Research by Mao et al. (2024) found that Party organization embedding significantly enhances the green governance effects of firms (Mao et al., 2024), particularly in environments with high-quality internal control. This organizational embedding facilitates green governance by reducing agency costs and optimizing management decisions. Similarly, Lv et al. (2024) demonstrated how digital finance significantly lowers household carbon emissions through mechanisms of digital transformation (Lv et al., 2024), consumption structure upgrades, and improved financial literacy. Fu et al. (2024) comprehensively reviewed interconnections between climate change, decarbonization, and green finance, highlighting green finance as a vital tool in addressing environmental challenges (Fu et al., 2024). Lu et al. (2024) examined the impact of China's green credit policy on enterprise digital innovation, finding that implementation pathways and boundary conditions significantly affect outcomes (Lu et al., 2024). These studies collectively emphasize the importance of institutional arrangements, financial mechanisms, and policy design in driving environmental performance improvement. While these studies provide valuable insights into specific governance mechanisms, they have not explicitly examined how city branding, as a reputation-based governance tool, affects CPR – a gap our study addresses.

2.2 Research Hypotheses

As urbanization accelerates, city branding has become an essential component of urban development strategy. City branding drives urban innovation transformation and sustainable development through shaping urban image and enhancing urban competitiveness. Dinnie (2010) conceptualizes successful city brands as those that achieve distinctiveness, authenticity, memorability, and co-creation with diverse stakeholders (Dinnie, 2010). This theoretical framework, combined with institutional theory and reputational economics, provides a robust foundation for understanding the CPR impacts of city branding. From an institutional perspective, city branding creates both formal constraints through explicit requirements for maintaining designation status and informal constraints via public expectations and reputational pressure that collectively shape organizational behavior within cities (Croad & Lincoln, 2023). These institutional forces can trigger normative isomorphism, whereby cities adopt environmentally responsible practices to maintain legitimacy within their institutional field (Joseph et al., 2019). Simultaneously, reputational economics suggests that city brands function as credible signals that reduce information asymmetries between cities and potential investors, residents, or businesses (Li & Jiang, 2024; Su et al., 2018). Once established, these reputational assets require ongoing maintenance through consistent performance, creating strong incentives for sustained environmental governance improvements rather than one-time adjustments (Graham & Cascio, 2018; Thomas et al., 2022). Together, these theoretical perspectives help explain why city branding can attract high-quality talent, advanced technology, and premium capital resources, promoting industrial structure optimization and upgrading, which lays the foundation for improving urban CPR.

From a pathway mechanism perspective, city branding influences urban CPR through multiple channels including technological innovation effects, industrial structure effects, and resource allocation effects. High-quality city brands help concentrate innovation resources, stimulate enterprise R&D investment, and promote low-carbon technology innovation and application, thereby enhancing economic output per unit of carbon emissions. Meanwhile, city branding guides industrial structure transformation toward low-carbon and high-end directions, promoting traditional energy-intensive industries' transformation and upgrading, developing strategic emerging industries and modern service sectors, and optimizing urban industrial structure (Hou et al., 2024; Song et al., 2023).

From practical experience, many cities have incorporated concepts such as low-carbon, green, and innovation into their urban development planning during brand building, attracting quality enterprises, and promoting industrial clustering through improving infrastructure, business environment, and public services. This high-quality development model is conducive to improving resource allocation efficiency and energy utilization efficiency, achieving decoupling of economic growth from carbon emissions, and thereby enhancing urban CPR (Chen et al., 2024; Ma & Wu, 2022).

Based on the above analysis, this article proposes the following research hypothesis:

H1: City branding is conducive to improving urban CPR.

3 Research Design

3.1 Data Sources

The research data for this study primarily come from multiple authoritative statistical databases and yearbooks. Energy consumption data required for carbon emissions calculation is sourced from the China Energy Statistical Yearbook (2002–2022), including consumption data for major energy types such as coal, oil, and natural gas. Urban economic and social development data is mainly derived from the China City Statistical Yearbook, China Statistical Yearbook, and provincial statistical yearbooks from 2002 to 2022. To ensure data continuity and reliability, we supplemented missing values for certain years using the latest revised data published on the National Bureau of Statistics official website and addressed sparse missing data through linear interpolation, ultimately constructing a balanced panel dataset covering 262 prefecture-level and above cities. Additionally, we consulted annual National Economic and Social Development Statistical Bulletins from each city to obtain more detailed urban development data, providing robust data support for the research.

It is important to note that China's administrative divisions categorize cities into several levels. Prefecture-level cities represent the second level in this administrative hierarchy, below provincial-level divisions and above county-level divisions. These cities typically govern surrounding counties and have significant administrative autonomy. "Above prefecture-level" also includes municipalities directly under central government control (Beijing, Shanghai, Tianjin, and Chongqing), which have provincial-level status. This study focuses on these urban centers as they represent China's major economic and population hubs with substantial influence on national carbon emissions.

3.2 Variable Definitions

The dependent variable in this study is urban CPR, defined as the ratio of regional GDP to carbon emissions. Considering the disparities in regional development levels, using total carbon emissions alone cannot accurately reflect cities' emission reduction effectiveness; therefore, adopting the relative indicator of CPR is more reasonable. Carbon emissions calculation follows the IPCC (2006) recommended methodology, comprehensively considering the actual consumption of nine major energy sources: coal, coke, gasoline, kerosene, fuel oil, diesel, natural gas, heat, and electricity. To eliminate price fluctuation effects, we deflated regional GDP using 2002 as the base year, ensuring data comparability.

The core explanatory variable is a dummy variable (NCC) for the "National Civilized City" selection, taking a value of 1 when a city receives or maintains the National Civilized City designation in a given year, and 0 when not designated or loses the title due to failed review. During sample screening, to ensure comparability of research subjects and data availability, we excluded district and county samples from municipalities directly under the central government, prefecture-level cities in the Tibet Autonomous Region, and city samples that underwent major administrative division adjustments, ultimately identifying 129 cities as the treatment group. The "National Civilized City" designation represents China's highest recognition for urban comprehensive development. Initiated by the Central Commission for Guiding Cultural and Ethical Progress in 2003 and first implemented in 2005, this program evaluates cities based on four key dimensions: cultural and ethical development, urban infrastructure, social undertakings, and improvements in people's livelihood. The selection follows a rigorous process including city application, provincial recommendation, central review, media publicity, and comprehensive evaluation, with reassessments conducted every three years. This prestigious designation functions as a valuable "gold signboard" in inter-city competition, with only a small percentage of Chinese cities achieving this status despite growing participation rates.

Our treatment variable employs a binary indicator for National Civilized City designation, reflecting the inherently discrete nature of this recognition. This methodological choice aligns with the quasi-experimental difference-in-differences framework, which identifies causal effects through clear demarcation between treatment and control states. The designation itself represents a threshold achievement that triggers substantial public recognition, media coverage, and policy attention, making a binary indicator conceptually appropriate. Moreover, the detailed scoring data from the evaluation process remains confidential, precluding the construction of continuous measures of "branding intensity."

To control for other factors affecting CPR, we selected a series of control variables based on established theoretical frameworks in urban carbon emission studies and prior empirical evidence. Financial development level (FIN), measured by the ratio of financial institution loan balance to GDP, is included because financial markets influence resource allocation efficiency and technology adoption patterns critical for carbon reduction. Economic development scale (SCALE), represented by the natural logarithm of population size, controls for city size effects, as larger cities typically benefit from economies of scale in infrastructure but may face greater coordination challenges in emission reduction. Degree of openness (OPEN), measured by the ratio of total imports and exports to GDP, accounts for how international trade exposure affects production technology transfer and environmental standards adoption. Human capital level (HC), indicated by the logarithm of higher education students per 10,000 population, captures a city's knowledge base and innovation capacity, crucial factors in developing and implementing low-carbon technologies. Government intervention degree (GOV), measured by the ratio of fiscal expenditure to GDP, controls the public sector's role in environmental governance and infrastructure investment. Industrial structure advancement (STR), represented by the tertiary industry's value-added proportion in GDP, accounts for the well-established relationship between services-oriented economies and lower carbon intensities.

While we considered additional controls such as specific environmental policies and more detailed industrial composition variables, their inclusion presented challenges including data availability limitations across our expansive sample period and high collinearity with our existing control set. However, our city-fixed effects capture time-invariant city characteristics, while city-specific time trends and year-fixed effects account for much of the time-varying policy environment, mitigating concerns about omitted variable bias from these factors.

3.3 Model Specification

Our empirical strategy employs a multi-period difference-in-differences approach to evaluate how National Civilized City designation affects urban CPR. This methodology offers distinct advantages for our research context. First, it accounts for the staggered implementation of the National Civilized City program, where cities received the designation at different times throughout our study period. Second, it effectively controls for both time-invariant city characteristics through city-fixed effects and temporal shocks affecting all cities through year-fixed effects. The econometric model is specified as follows:

$$\mathrm{CPR}_{it} = \beta_0 + \beta_1\mathrm{NCC}_{it} + \sum \rho X_{it} + \delta_t + \mu_i + \epsilon_{it}. \quad (1)$$

In this specification, CPR_{it} represents CPR for city i in year t, measured as GDP output per unit of carbon emissions. Our primary explanatory variable, NCC_{it}, takes a value of 1 when a city holds the National Civilized City designation and 0 otherwise. The model includes a comprehensive set of time-varying control variables (X_{it}) that might influence CPR: financial development level, economic scale, international openness, human capital, government intervention, and industrial structure advancement. The coefficient of interest, β_1, captures the average treatment effect of receiving the National Civilized City designation on CPR. City fixed effects (μ_i) control for time-invariant characteristics such as geographic location and resource endowments, while time fixed effects (δ_t) account for macroeconomic conditions and national policy changes affecting all cities simultaneously. The error term (ϵ_{it}) represents unobserved random factors influencing CPR.

4 Results Analysis

4.1 Data Overview

Before conducting the empirical analysis, this study first examines the descriptive statistical characteristics of the key variables to comprehensively understand the basic features of the sample data. As shown in Table 1, the balanced panel data constructed in this study contains 5,502 observations. Regarding the core explanatory variable, the mean value of "National Civilized City" (NCC) is 0.156, with a standard deviation of 0.363, indicating that approximately 15.6% of cities in the sample period obtained or maintained the National Civilized City designation. This moderate proportion ensures both sufficient treatment group samples and maintains the scarcity and representativeness of this honorary title.

Table 1: Descriptive statistical analysis

Variable	Size	Mean	S.D.	Minimum	Maximum
CPR	5,502	0.4400	0.1670	0.0600	1.3360
NCC	5,502	0.1564	0.3634	0.0000	1.0000
FIN	5,502	0.8859	0.5404	0.1122	7.4502
SCALE	5,502	5.9107	0.6065	3.9198	7.6473
OPEN	5,502	0.2006	0.4184	0.0004	12.2101
HC	5,502	4.4446	1.2163	2.7536	7.1787
GOV	5,502	0.1649	0.0858	0.0312	1.4763
STR	5,502	0.9412	0.4872	0.1286	5.4483

Examining the distribution characteristics of the dependent variable, CPR, there are notable differences in CPR levels across cities, reflecting regional heterogeneity in economic development quality and carbon emission efficiency among Chinese cities. Regarding control variables, the mean value of financial development level (FIN) is 0.886, with a maximum value reaching 7.450, demonstrating the imbalance in urban financial development. The standard deviation of city size (SCALE) is relatively small at 0.607, indicating relatively stable population size differences among sample cities. The standard deviation of the degree of openness (OPEN) reaches 0.418, with significant differences between maximum and minimum values, reflecting vast disparities in city openness levels. The mean value of human capital level (HC) is 4.445, with a standard deviation of 1.216, suggesting that there are still certain gaps in the distribution of educational resources between cities. The mean value of government intervention degree (GOV) is 0.165, with a relatively small standard deviation, indicating relatively balanced government fiscal expenditure intensity. The mean value of industrial structure advancement level (STR) is 0.941, with a maximum value reaching 5.448, reflecting differences in cities' industrial structure adjustment processes.

4.2 Baseline Model

This research first examined the impact of city branding on CPR through a quasi-natural experiment of the "National Civilized City" selection. By constructing a multi-period difference-in-differences model and controlling for year-fixed effects, city-fixed effects, and relevant control

Table 2: City branding and CPR

Variable	(1) CPR	(2) CPR
NCC	0.0381***	0.0116***
	(0.0074)	(0.0064)
N	5,502	5,502
Controls	YES	YES
City	YES	YES
Year	YES	YES
City × Year	No	YES
Adjust R^2	0.798	0.875

Note: Robust standard errors clustered at the city level are reported in parentheses; ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

variables, the study finds that city branding has a significant positive effect on CPR. Specifically, as shown in Table 2, when controlling only for basic fixed effects, obtaining the "National Civilized City" title increases a city's CPR by 3.81 percentage points on average, with statistical significance. Furthermore, when considering city heterogeneity characteristics and including the interaction terms between city dummy variables and time trends, this enhancement effect remains significant at 1.16 percentage points. This finding indicates that city branding can indeed positively impact urban low-carbon transformation through reputation effects. This influence may stem from the following mechanisms: First, obtaining the National Civilized City title increases social attention and public expectations for the city, compelling it to place greater emphasis on environmental protection during development. Second, the creation process of a civilized city itself includes an assessment of urban environmental governance capabilities, and this institutional constraint can urge cities to adopt more proactive emission reduction measures. Finally, the enhancement of city brands often accompanies the optimization of industrial structure and improvement of innovation capabilities, all of which help improve CPR.

4.3 Robustness Tests

4.3.1 Parallel Trend Test

To verify the reliability of the research conclusions, this study first conducts parallel trend tests. In 2005, the nation launched its first "National Civilized City" evaluation and commendation activity. We set 2004 as the base period and uniformly categorize the fourth period after policy implementation and subsequent periods as the fourth period.

The graphical representation in Figure 1 provides visual confirmation of the parallel trends assumption critical to our difference-in-differences approach. Prior to policy implementation, the treatment and control groups exhibit remarkably similar trajectories in CPR, with confidence intervals that clearly overlap. To further substantiate this visual evidence, we conducted formal statistical tests by estimating a dynamic model with leads and lags of the treatment variable.

$$\mathrm{CPR}_{it} = \alpha + \sum_{k=-4}^{4} \beta_k \mathrm{NCC}_{i,t+k} + \gamma X_{it} + \delta_t + \mu_i + \epsilon_{it}, \quad (2)$$

where the coefficients on the lead terms (β_{-4} to β_{-1}) capture potential anticipatory effects or pre-existing differences before treatment. The coefficients on pre-treatment periods show no statistically significant differences between treatment and control groups, confirming the absence of anticipatory effects or

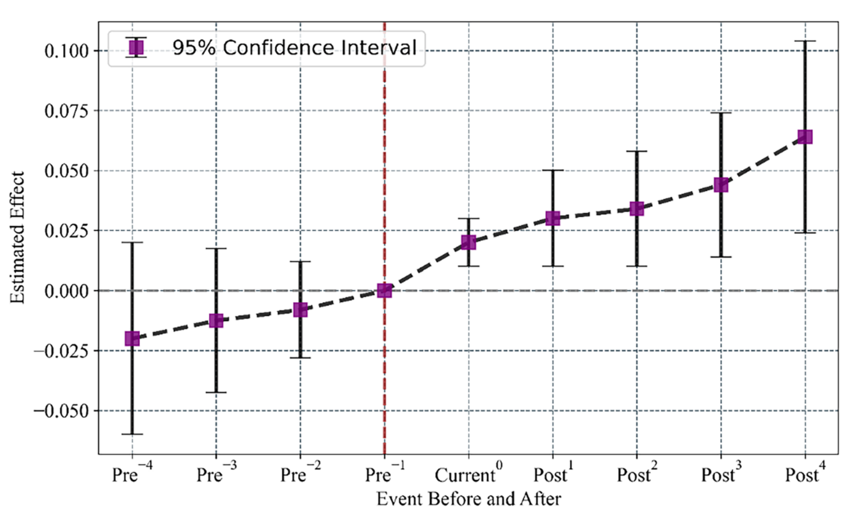

Figure 1: Parallel trends test.

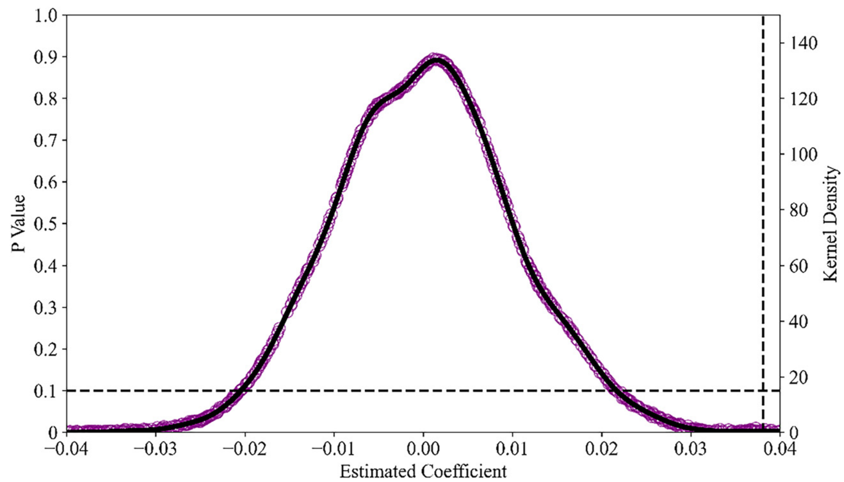

Figure 2: Placebo test.

pre-existing divergent trends. Conversely, the post-treatment coefficients reveal a progressive strengthening of the effect over time, with increasingly positive and significant values. This gradual intensification aligns with our theoretical understanding that city branding influences operate through cumulative mechanisms rather than instantaneous adjustments, as both reputational effects and structural changes require time to fully materialize within urban governance systems.

4.3.2 Placebo Test

Regarding the placebo test, as shown in Figure 2, this study randomly selected 129 cities from the 262 city samples as the treatment group and randomly generated policy implementation years to construct virtual policy variables. Repeating this process 500 times yielded kernel density distributions and *P*-value distributions of 500 coefficient estimates. The kernel density plot of coefficient estimates from 500 iterations with randomly assigned treatment status demonstrates that our actual treatment effect (indicated by the black dashed line at 0.0381) lies well outside the distribution of random effects. Quantitatively, less than 2.5% of random assignments produced effects of similar magnitude, effectively establishing a non-parametric *p*-value below conventional significance thresholds. This confirms that our findings represent genuine policy impacts rather than statistical artifacts.

Table 3: Multi-dimensional robustness tests

Variable	(1) PSM-DID CPR	(2) Innovation City Pilot CPR	(3) Low-carbon City Pilot CPR
NCC	0.0351***	0.0319***	0.0354***
	(0.0074)	(0.0074)	(0.0073)
INNO		0.0397***	
		(0.0104)	
CARB			0.0426***
			(0.0110)
N	5,285	5,502	5,502
Controls	YES	YES	YES
City	YES	YES	YES
Year	YES	YES	YES
Adjust R^2	0.806	0.801	0.801

Note: Robust standard errors clustered at the city level are reported in parentheses; ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

4.3.3 PSM-DID Method and Excluding Other Policy Interferences

Second, considering the potential impact of self-selection bias, this study employs the propensity score matching (PSM) method, using 0.05 as the caliper value for sample matching. As shown in Table 3, the regression results based on the matched samples remain significantly positive at the 1% level, with the estimated coefficient maintaining at 3.51 percentage points, further supporting our core findings. Additionally, to exclude interference effects from other city honorary titles, this study also controls for the impacts of two important policies: innovative city pilot programs and low-carbon city pilot programs. The results show that even when simultaneously considering these policy effects, the positive impact of the National Civilized City title on CPR remains robust. Particularly noteworthy is that through placebo tests involving random selection of

Table 4: Additional robustness tests

Variable	(1) PCE	(2) CPR	(3) CPR
NCC	−0.0298***	0.0377***	0.0364***
	(0.0070)	(0.0072)	(0.0075)
N	5,502	3,937	5,502
Controls	YES	YES	YES
City	YES	YES	YES
Year	YES	YES	YES
Adjust R^2	0.766	0.795	0.789

Note: Robust standard errors clustered at the city level are reported in parentheses; ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

treatment groups and generation of virtual policy timing, this study again verified the reliability of the research conclusions. This series of rigorous robustness tests not only enhances the persuasiveness of the research conclusions but also provides a solid empirical foundation for understanding the relationship between city branding and low-carbon development.

4.3.4 Other Robustness Tests

Table 4 presents additional robustness checks that further validate our main findings. In columns 1, we employ alternative outcome measures to verify that our results are not sensitive to the specific measurement of environmental performance. Per capita emissions (PCE) decreased by 2.98 percentage points ($p < 0.01$) in designated cities. In column 2, we test the temporal stability of our findings by restricting the analysis to different time windows. Column 2 excludes the earliest and latest years (2005–2019). The NCC coefficient remains remarkably stable at 0.0377. We also address concerns about spatial correlation in the error terms by employing different approaches to standard error clustering. While our main analysis uses city-level clustering, column 3 clusters at the province level to account for potential within-province correlation. The statistical significance of the NCC coefficient persists across all these specifications, alleviating concerns about inflated significance due to error correlation.

4.4 Heterogeneity Analysis

In-depth research reveals significant heterogeneous characteristics in the impact of city branding on CPR. As shown in Table 5, from a geographical location perspective, the enhancement effect of the National Civilized City title on CPR in eastern cities (4.24 percentage points) is significantly higher than in central and western cities (3.75 percentage points). This difference reflects the importance of regional development environments: eastern cities generally possess more open institutional environments, more abundant talent accumulation, and higher levels of marketization, these advantageous conditions enable them to better transform brand reputation into actual emission reduction momentum. From the perspective of city functional positioning, the brand effect in excellent tourism cities (3.47 percentage points) is notably stronger than in non-tourism cities (2.63 percentage points), indicating that cities dependent on tourism development often pay more attention to environmental quality and are more willing to maintain their city image through environmental

Table 5: Heterogeneity analysis

Variable	(1) Eastern cities CPR	(2) Central and Western cities CPR	(3) Excellent tourism cities CPR	(4) Non-excellent tourism cities CPR	(5) Brand-rich cities CPR	(6) Brand-scarce cities CPR
NCC	0.0424***	0.0375***	0.0347***	0.0263	0.0230***	0.0428***
	(0.0119)	(0.0078)	(0.0074)	(0.0231)	(0.0088)	(0.0108)
N	2,035	3,467	4,181	1,321	2,090	3,412
Controls	YES	YES	YES	YES	YES	YES
City	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
Adjust R^2	0.821	0.784	0.802	0.793	0.816	0.792
Test *P*-value	0.045				0.009	

Note: Robust standard errors clustered at the city level are reported in parentheses; ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

protection investments and industrial structure optimization. Analyzing from the perspective of brand scarcity, cities in a state of brand scarcity demonstrate stronger effects (4.28 percentage points), significantly higher than brand-rich cities (2.30 percentage points). This phenomenon reveals the marginal effect law of brand resources: for regions that have not yet accumulated sufficient city honors, the reputation enhancement brought by the National Civilized City brand is more significant, thus stimulating stronger construction momentum and greater investment intensity.

4.5 Further Extensions

Understanding how city branding influences CPR requires exploring the underlying mechanisms that connect symbolic urban governance to substantive environmental outcomes. We developed a comprehensive analytical framework to examine three potential pathways: energy structure optimization, technological innovation, and efficiency improvement. Each pathway represents a distinct but complementary process through which city branding might transform urban carbon governance. First, for energy consumption structure (ECS), we quantified the proportion of coal consumption within a city's total energy consumption mix. This measure directly captures the carbon intensity of the energy portfolio, as coal has substantially higher emission factors compared to cleaner alternatives like natural gas or renewable sources. Second, for TP, we utilized the natural logarithm of granted invention patents, which represents the actual innovation output of a city rather than merely innovation inputs (like R&D expenditure). Invention patents, compared to other patent types, require higher levels of novelty and technological advancement, making them particularly suitable for capturing meaningful TP relevant to CPR. Third, for LP, we measured the ratio of industrial added value to year-end labor employment, focusing specifically on the industrial sector given its outsized contribution to urban carbon emissions in China. This indicator reflects how efficiently human resources are utilized in value creation relative to resource consumption and emissions. For each mechanism, we employed a two-step approach: first testing whether NCC designation significantly impacts the mechanism variable, then examining whether the mechanism variable significantly affects CPR, while controlling for other factors.

As shown in Table 6, first, the ECS pathway demonstrates how National Civilized City designation transforms urban energy portfolios. Cities obtaining this prestigious designation exhibit a significant reduction in coal consumption relative to other energy sources (coefficient of −0.0210, significant at the 5% level). This shift toward cleaner energy alternatives directly contributes to CPR improvement (coefficient of −0.1426, significant at the 1% level). The relationship suggests that city branding creates both policy imperatives and public expectations for environmental responsibility, compelling local governments to prioritize lower-carbon energy sources in urban development planning.

The technological innovation pathway reveals another important mechanism. National Civilized City designation

Table 6: Mechanism test

Variable	(1) ECS	(2) CPR	(3) TP	(4) CPR	(5) LP	(6) CPR
NCC		−0.0210**	0.0351***	0.3370***	0.0319***	0.1406***
0.0354***						
	(0.0082)	(0.0074)	(0.0451)	(0.0074)	(0.0392)	(0.0073)
ECS		−0.1426***				
		(0.0285)				
TP				0.0184***		
				(0.0052)		
LP						0.0192***
						(0.0058)
N	5,502	5,502	5,502	5,502	5,502	5,502
Controls	YES	YES	YES	YES	YES	YES
City	YES	YES	YES	YES	YES	YES
Year	YES	YES	YES	YES	YES	YES
Adjust R^2	0.786	0.802	0.815	0.801	0.798	0.801

Note: Robust standard errors clustered at the city level are reported in parentheses; ***, **, and * indicate statistical significance at the 1, 5, and 10% levels, respectively.

significantly boosts innovation output as measured by invention patents (coefficient of 0.3370, significant at the 1% level). This enhanced innovative capacity subsequently drives improvements in CPR (coefficient of 0.0184, significant at the 1% level). This mechanism operates through multiple channels: city branding attracts innovative enterprises and talent, enhances local innovation ecosystems, and creates supportive environments for developing and deploying low-carbon technologies across economic sectors.

The third pathway operates through industrial efficiency improvements. Given that China's carbon emissions predominantly originate from industrial activities, efficiency gains in this sector are particularly important for CPR. Our analysis confirms that civilized cities achieve substantially higher LP in industrial sectors (coefficient of 0.1406, significant at the 1% level), which translates directly into CPR improvements (coefficient of 0.0192, significant at the 1% level). This suggests that cities pursuing prestigious branding designations implement more effective industrial policies that simultaneously enhance economic value creation and reduce environmental impacts.

The quantitative test results of these three mechanisms reveal the complex pathways through which city branding promotes low-carbon development: on one hand, it compels energy structure optimization through enhanced environmental governance requirements; on the other hand, it attracts innovative element clustering through brand effects, driving TP; meanwhile, it promotes industrial upgrading and efficiency improvement during the creation process. These mechanisms interact and work synergistically, ultimately achieving overall improvement in CPR. The empirical results not only confirm theoretical expectations but also provide important implications for urban low-carbon transformation policy formulation: city branding is not merely an honorary symbol but an important tool for promoting green development, and policy-makers should fully recognize and utilize this tool's multi-dimensional value.

5 Conclusions and Policy Recommendations

5.1 Research Conclusions

Based on panel data from 262 prefecture-level and above cities in China from 2002 to 2020, this study systematically examines the impact of city branding on CPR using a multi-period difference-in-differences approach. The research finds that obtaining the "National Civilized City" designation significantly enhances urban CPR, a conclusion that remains robust after a series of rigorous tests including parallel trend tests, placebo tests, and PSM. Specifically, cities receiving the National Civilized City title experience an average increase in CPR of 3.81 percentage points, with this effect maintaining significance at 1.16 percentage points even after controlling for city heterogeneity characteristics. In-depth heterogeneity analysis reveals that this promotional effect is more pronounced in eastern cities, excellent tourism cities, and cities with brand scarcity, reflecting the crucial moderating roles of regional environment, industrial characteristics, and brand resource endowment in urban low-carbon transformation processes. Mechanism tests further reveal that city branding ultimately achieves CPR improvement through the synergistic effects of three pathways: promoting energy structure optimization, facilitating technological innovation, and enhancing LP. These findings not only enrich the academic understanding of city brand theory and low-carbon development research but also provide new perspectives for formulating urban green transformation policies.

5.2 Policy Recommendations

Based on the above research conclusions, this study proposes the following policy recommendations:

First, policymakers should fully recognize the positive role of city branding in promoting low-carbon transformation, organically combining environmental governance with city brand building, and establishing and improving a city evaluation system centered on environmental performance.

Second, considering the importance of regional development environments, central and western cities should accelerate the improvement of infrastructure construction, optimize business environments, and strengthen talent policies to create favorable conditions for fully leveraging brand effects.

Third, cities should conduct brand building according to their functional positioning and local conditions. Tourism cities may focus on creating ecological livability brands, while industrial cities can emphasize developing green manufacturing brands. Cities with relatively scarce brand resources should seize brand-building opportunities to enhance environmental governance capabilities through the pursuit of civilized city status.

Fourth, attention should be paid to leveraging the comprehensive effects of brand building, coordinating the advancement of energy structure adjustment, technological innovation, and industrial upgrading to form a multi-dimensional collaborative pattern of low-carbon development.

Finally, drawing from both Chinese experiences and international best practices (Dinnie, 2010; Lucarelli & Berg, 2011), we recommend establishing long-term mechanisms for city brand building, incorporating environmental governance into normalized urban development work to ensure the sustained effectiveness of brand effects and promote cities toward high-quality green development paths. This approach aligns with global trends in which cities increasingly integrate brand management with sustainability governance to create distinctive competitive advantages while addressing climate challenges.

5.3 Limitations and Future Outlook

While this study employs a comprehensive research design to examine the impact of city branding on CPR, several limitations should be acknowledged. First, although we control for various urban characteristics and employ a multi-period difference-in-differences design, unobservable time-varying factors may still affect our results. Second, the measurement of carbon emissions relies on energy consumption data, which might not fully capture all emission sources across cities. The carbon emissions calculation methodology, although following IPCC guidelines, may introduce measurement errors due to the use of standardized emission factors that might not perfectly reflect local conditions. Third, while our sample covers 262 prefecture-level and above cities over 21 years, providing substantial spatial and temporal variation, some cities might have experienced unique development paths not fully captured by our control variables. Finally, the "National Civilized City" designation, as our proxy for city branding, represents only one specific type of city branding initiative in China and may not fully capture all dimensions of city brand-building activities. A methodological limitation concerns our primary outcome measure, CPR. As a ratio indicator combining economic output and emissions, CPR can be sensitive to fluctuations in either component, potentially complicating causal inference. For instance, improvements might stem from genuine efficiency gains or merely reflect economic structure changes during business cycles. Additionally, since city-level carbon emissions must be calculated rather than directly observed, measurement error remains a concern despite our consistent application of IPCC methodologies. We addressed these challenges through several approaches: employing year fixed effects and city-specific trends to control for economic cycles, conducting sensitivity analyses with alternative metrics, and examining mechanism variables that help distinguish genuine improvements from statistical artifacts. Nevertheless, future research might benefit from developing more direct measures of urban environmental performance that are less sensitive to economic fluctuations.

Funding information: This research was supported by the Doctoral Research Plan of Guangzhou Xinhua University, the 2016 Guangdong Province Key Discipline Construction Project in Public Administration (2020STSZD01), Guangdong Province Key Discipline Research Capacity Enhancement Project (2021ZDJS141), and Guangzhou Xinhua University Scientific Research Fund Project (2017QN004).

Author contributions: All authors have accepted responsibility for the entire content of this manuscript and consented to its submission to the journal. All authors have read and agreed to the published version of the manuscript. Conceptualization, X.Z. and X.L.; methodology, X.Z. and X.L.; software, H.Y.; validation, X.L. and H.Y.; writing – original draft preparation, X.L.; writing – review and editing, X.Z., X.L., H.Y., and C.Z.; funding acquisition, C.Z.

Conflict of interest: Authors state no conflict of interest.

Data availability statement: The data presented in this study are available on request from the corresponding author.

Article note: As part of the open assessment, reviews and the original submission are available as supplementary files on our website.

References

Andehn, M., Hietanen, J., & Lucarelli, A. (2020). Performing place promotion-On implaced identity in marketized geographies. *Marketing Theory*, *20*(3), 321–342, 1470593119887497. doi: 10.1177/1470593119887497.

Chen, X., Miao, Z., Wu, G., & Zhu, P. (2024). City-level green growth accounting: Evidence from China's thirteen urban agglomerations. *Renewable & Sustainable Energy Reviews*, *203*, 114776. doi: 10.1016/j.rser.2024.114776.

Croad, J., & Lincoln, A. (2023). Sustainable city branding. In *Encyclopedia of sustainable management* (pp. 3415–3420). Springer.

de Jong, M. (2019). From eco-civilization to city branding: A neo-marxist perspective of sustainable urbanization in China. *Sustainability*, *11*(20), 5608. doi: 10.3390/su11205608.

de Jong, M., Yu, C., Joss, S., Wennersten, R., Yu, L., Zhang, X., & Ma, X. (2016). Eco city development in China: Addressing the policy implementation challenge. *Journal of Cleaner Production*, *134*, 31–41. doi: 10.1016/j.jclepro.2016.03.083.

Dinnie, K. (2010). *City branding: Theory and cases*. Springer.

Fang, G., Gao, Z., Tian, L., & Fu, M. (2022). What drives urban carbon emission efficiency? - Spatial analysis based on nighttime light data. *Applied Energy*, *312*, 118772. doi: 10.1016/j.apenergy.2022.118772.

Fu, C., Lu, L., & Pirabi, M. (2024). Advancing green finance: A review of climate change and decarbonization. *Digital Economy and Sustainable Development*, *2*(1), 1. doi: 10.1007/s44265-023-00026-x.

Gao, J., Xu, N., & Zhou, J. (2023). Innovative city construction and urban environmental performance: Empirical evidence from China. *Sustainability*, *15*(12), 9336.

Graham, B. Z., & Cascio, W. F. (2018). The employer-branding journey: Its relationship with cross-cultural branding, brand reputation, and brand repair. *Management Research: Journal of the Iberoamerican Academy of Management*, *16*(4), 363–379.

Hou, C., Chen, H., & Huang, X. (2024). Measurement and distribution characteristics of urban green productivity: Based on fuzzy rough set and spatial autocorrelation analysis. *Environment Development and Sustainability, 1*, 1–29. doi: 10.1007/s10668-024-05440-5.

Jia, Z., Yang, X., Shi, F., & Xing, Y. (2024). Pathways to innovation: How city pilots leverage digital technology to reduce carbon emissions. *Energy Strategy Reviews*, *56*, 101578.

Joseph, C., Nichol, E. O., & Jonathan, L. (2019). Councils' environment management system: An isomorphism inquiry. *Management of Environmental Quality: An International Journal*, *30*(6), 1314–1330.

Lei, X., & Xu, X. (2024). Storm clouds over innovation: Typhoon shocks and corporate R&D activities. *Economics Letters*, *244*, 112014. doi: 10.1016/j.econlet.2024.112014

Lei, X., & Xu, X. (2025). Innovation in the storm: How typhoons are reshaping the corporate R&D landscape. *Technology in Society*, *81*, 102828. doi: 10.1016/j.techsoc.2025.102828.

Li, S., & Jiang, H. (2024). The effect of city reputation on Chinese corporate risk-taking. *Scientific Reports*, *14*(1), 8428.

Li, X., Xu, Y., Tan, H., & Lei, Y. (2024). Low-carbon city pilot policies and urban carbon productivity improvement: An empirical analysis from the perspective of green competitiveness. *Environmental and Sustainability Indicators*, *24*, 100531.

Liu, X., Qin, C., Liu, B., Ahmed, A. D., Ding, C. J., & Huang, Y. (2024a). The economic and environmental dividends of the digital development strategy: Evidence from Chinese cities. *Journal of Cleaner Production*, *440*, 140398. doi: 10.1016/j.jclepro.2023.140398.

Liu, Y., Wang, Y., Yan, B., & Zhang, H. (2024b). The impact of new infrastructure development on urban total factor carbon productivity-empirical evidence based on Chinese cities. *Frontiers in Environmental Science*, *12*, 1432534. doi: 10.3389/fenvs.2024.1432534.

Liu, Y., Xiao, H., Zikhali, P., & Lv, Y. (2014). Carbon emissions in China: A spatial econometric analysis at the regional level. *Sustainability*, *6*(9), 6005–6023. doi: 10.3390/su6096005.

Lu, Q., Deng, Y., Wang, X., & Wang, A. (2024). The impact of China's green credit policy on enterprise digital innovation: Evidence from heavily-polluting Chinese listed companies. *China Finance Review International*, *14*(1), 103–121. doi: 10.1108/CFRI-11-2022-0224.

Lu, H., & Ma, W. (2023). Spatial relationship of city branding strategy adoption in megacity regions: Patterns and influencing factors. *Cities*, *143*, 104567. doi: 10.1016/j.cities.2023.104567.

Lucarelli, A. (2018). Place branding as urban policy: The (im)political place branding. *Cities*, *80*, 12–21. doi: 10.1016/j.cities.2017.08.004.

Lucarelli, A., & Berg, P. O. (2011). City branding: A state-of-the-art review of the research domain. *Journal of Place Management and Development*, *4*(1), 9–27.

Lv, Y., Jia, Y., Sang, C., & Sun, X. (2024). Carbon reduction effect of digital finance in China: Based on household micro data and input-output model. *China Finance Review International*, ahead-of-print. doi: 10.1108/CFRI-03-2024-0083.

Ma, W., de Jong, M., de Bruijne, M., & Schraven, D. (2020). Economic city branding and stakeholder involvement in China: Attempt of a medium-sized city to trigger industrial transformation. *Cities*, *105*, 102754. doi: 10.1016/j.cities.2020.102754.

Ma, A., & Wu, Y. (2022). Total factor productivity of land urbanization under carbon emission constraints: A case study of Chengyu urban agglomeration in China. *Economic Research-Ekonomska Istrazivanja*, *35*(1), 4481–4499. doi: 10.1080/1331677x.2021.2013280.

Mao, J., Yu, B., & Guan, C. (2024). Does Party organization embedding produce green governance effect? *China Finance Review International*, ahead-of-print. doi: 10.1108/CFRI-05-2024-0273.

Pasquinelli, C. (2014). Branding as urban collective strategy-making: The formation of NewcastleGateshead's organisational identity. *Urban Studies*, *51*(4), 727–743. doi: 10.1177/0042098013493025.

Song, T., Dian, J., & Chen, H. (2023). Can smart city construction improve carbon productivity? – A quasi-natural experiment based on China's smart city pilot. *Sustainable Cities and Society*, *92*, 104478. doi: 10.1016/j.scs.2023.104478.

Su, L., Huang, Y., & Hsu, M. (2018). Unraveling the impact of destination reputation on place attachment and behavior outcomes among Chinese urban tourists. *Journal of Hospitality and Tourism Insights*, *1*(4), 290–308.

Swain, S., Jebarajakirthy, C., Sharma, B. K., Maseeh, H. I., Agrawal, A., Shah, J., & Saha, R. (2024). Place branding: A systematic literature review and future research agenda. *Journal of Travel Research*, *63*(3), 535–564.

Thomas, J., Yao, W., Zhang, F., & Zhu, W. (2022). Meet, beat, and pollute. *Review of Accounting Studies*, *27*(3), 1038–1078.

Warren, G., & Dinnie, K. (2018). Cultural intermediaries in place branding: Who are they and how do they construct legitimacy for their work and for themselves?. *Tourism Management*, *66*, 302–314. doi: 10.1016/j.tourman.2017.12.012.

Zenker, S., Braun, E., & Petersen, S. (2017). Branding the destination versus the place: The effects of brand complexity and identification for residents and visitors. *Tourism Management*, *58*, 15–27. doi: 10.1016/j.tourman.2016.10.008.

Zhang, B., Kavaratzis, M., & Papadopoulos, D. (2024). Politicizing, policizing and beyond neoliberalism: Understanding Chinese city branding from the case of Chongqing. *Cities*, *150*, 105085. doi: 10.1016/j.cities.2024.105085.

Zhao, W. (2024). The effect of self-city brand connection on city brand ambassadorial behavior in a cultural city: The mediating role of city attachment. *Place Branding and Public Diplomacy*, *20*(4), 468–481. doi: 10.1057/s41254-024-00346-5.

Zhu, X., Li, Y., Zhang, P., Wei, Y., Zheng, X., & Xie, L. (2019). Temporal–spatial characteristics of urban land use efficiency of China's 35mega cities based on DEA: Decomposing technology and scale efficiency. *Land Use Policy*, *88*, 104083.