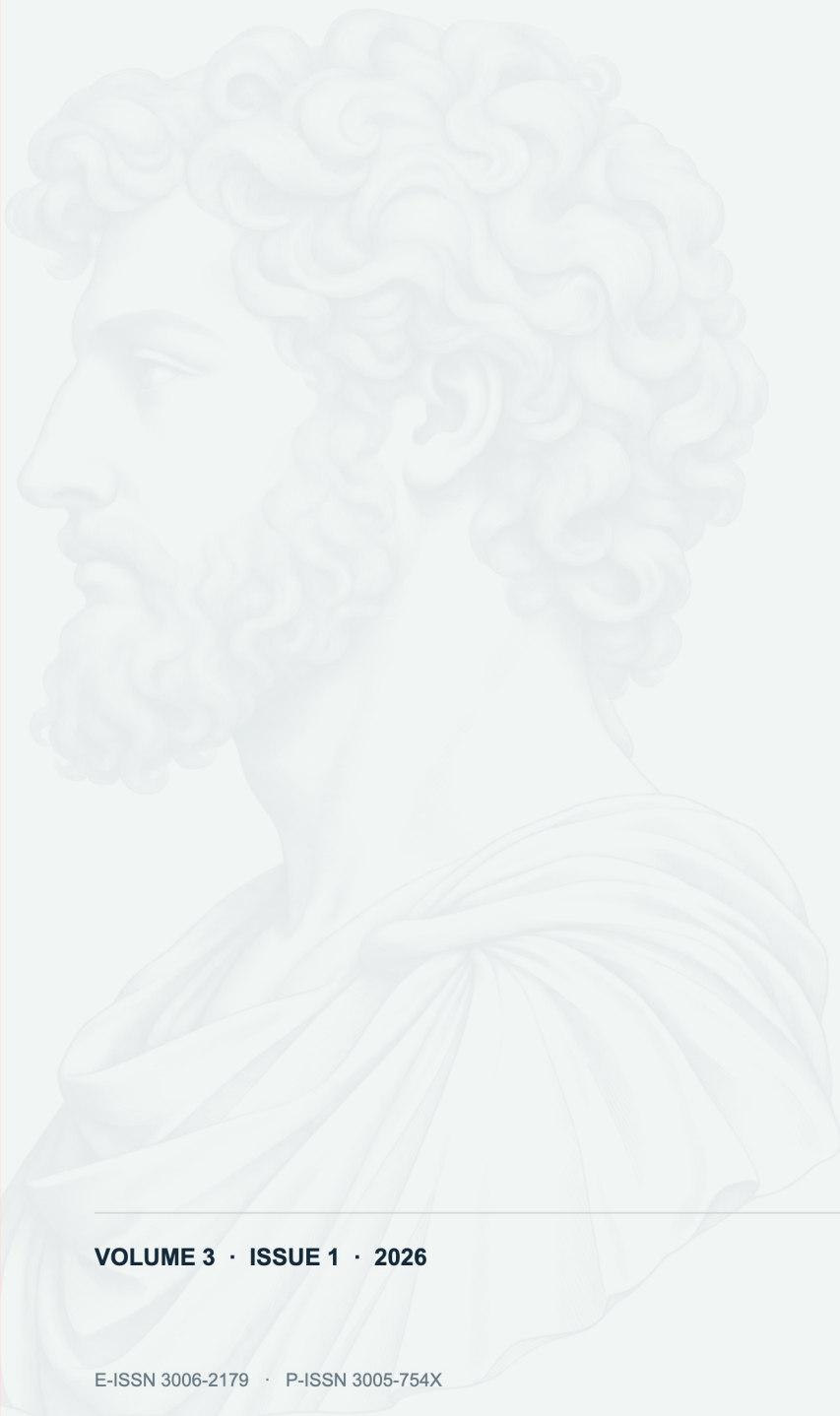


ZEUS PRESS

EDITOR-IN-CHIEF

Prof. Olga Morozova, Amur State University, Russia

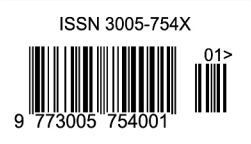
International Journal of Asian Social Science Research



VOLUME 3 · ISSUE 1 · 2026

E-ISSN 3006-2179 · P-ISSN 3005-754X

© 2026 The Author(s). Authors retain copyright in their articles.



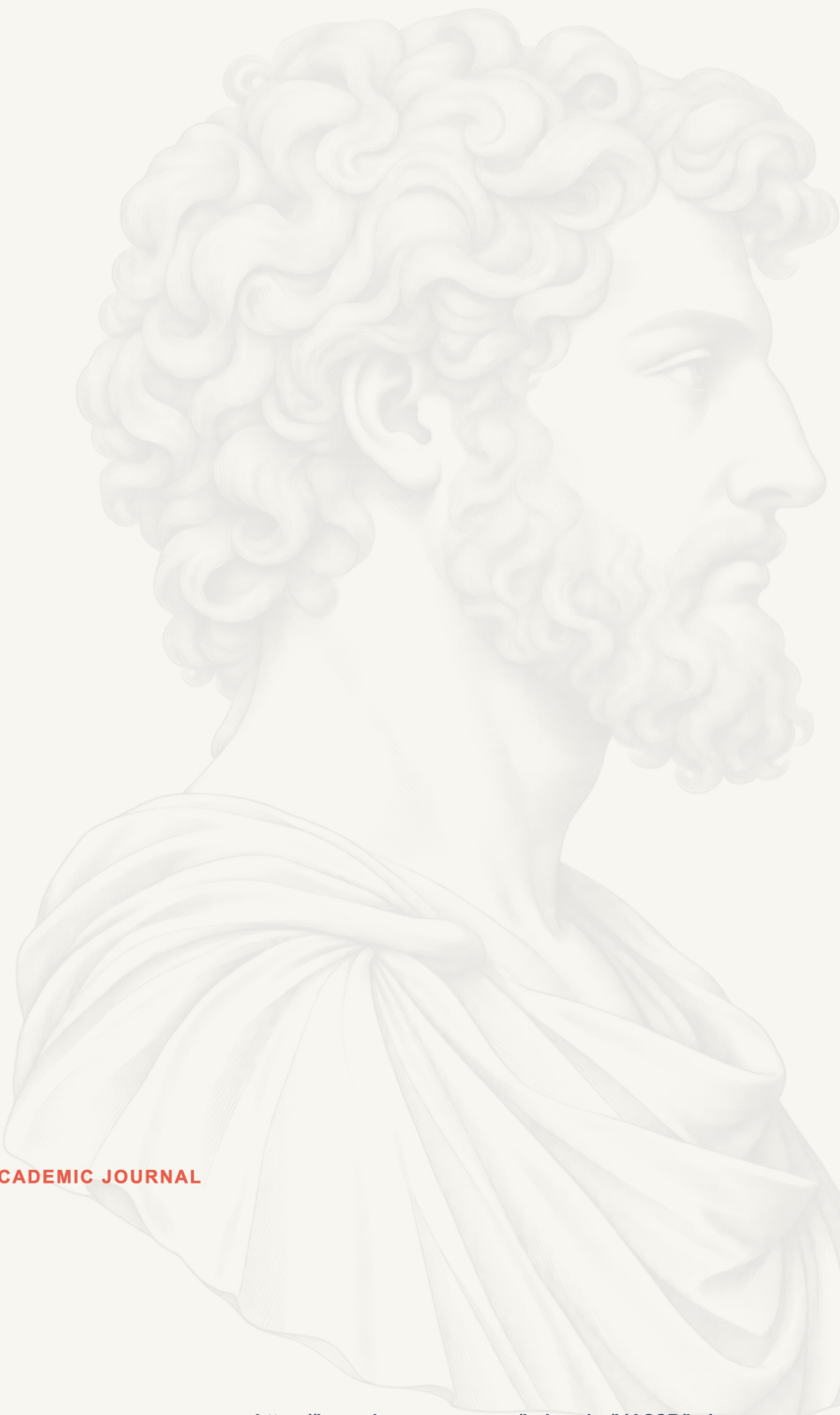
ZEUS PRESS

EDITOR-IN-CHIEF

Prof. Olga Morozova, Amur State University, Russia

IJASSR

International Journal of Asian Social Science Research



OPEN ACCESS · DOUBLE-BLIND PEER-REVIEWED ACADEMIC JOURNAL

VOLUME 3 · ISSUE 1 · 2026

E-ISSN 3006-2179 · P-ISSN 3005-754X

<https://journals.zeuspress.org/index.php/IJASSR/index>

INTERNATIONAL JOURNAL OF ASIAN SOCIAL SCIENCE RESEARCH · JOURNAL · VOLUME 3 · ISSUE 1 · 2026

ZEUS PRESS

International Journal of Asian Social Science Research

IJASSR

ISSUE

Volume 3 · Issue 1 · 2026

EDITOR-IN-CHIEF

Prof. Olga Morozova, Amur State University, Russia

PUBLISHED BY

Zeus Press

OPEN ACCESS · DOUBLE-BLIND PEER-REVIEWED ACADEMIC JOURNAL

VOLUME 3 · ISSUE 1 · 2026

E-ISSN 3006-2179 · P-ISSN 3005-754X · DOI Prefix 10.70267

<https://journals.zeuspress.org/index.php/IJASSR/index>

Recommended citation: International Journal of Asian Social Science Research , Volume 3, Issue 1 (2026).

International Journal of Asian Social Science Research

ISSN	3006-2179 (Online), 3005-754X (Print)
DOI PREFIX	10.70267
WEBSITE	https://journals.zeuspress.org/index.php/IJASSR/index
CONTACT	service@zeus-press.org ; +852 56089963

ABOUT THE JOURNAL

The International Journal of Asian Social Science Research (IJASSR) is a peer-reviewed, interdisciplinary academic journal that publishes high-quality research on various aspects of social sciences in Asia. The journal aims to provide a platform for scholars, researchers, and practitioners to share insights and findings that contribute to the understanding and development of Asian societies.

TYPES OF SUBMISSION

The journal publishes: (1) full-length articles, (2) review articles, (3) book reviews, (4) discussion notes and (5) articles in translation.

EDITORIAL AND PEER-REVIEW POLICY

All research articles are subject to editorial assessment and double-blind peer review. The journal follows recognized standards of publication ethics, research integrity, transparency and correction.

PUBLICATION ETHICS AND INTEGRITY

The journal applies principles of research integrity, transparent authorship, disclosure of competing interests, data accuracy and prompt correction of the scholarly record. Suspected misconduct is assessed through an impartial editorial process.

AUTHOR RESPONSIBILITIES

Authors retain responsibility for the accuracy, originality and ethical compliance of their work, including acknowledgements, funding statements, data availability and conflict-of-interest disclosures.

PERMISSIONS

The author is responsible for obtaining all permissions required before submission. Permission and owner details must be provided for third-party content, methods, software, questionnaires and scales. Authors must check applicable licences, obtain permission where required, and include confirmation in the Materials and Methods section.

OPEN ACCESS LICENCE

This publication is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License (CC BY-NC 4.0), which permits noncommercial use, sharing, adaptation, distribution and reproduction with appropriate credit, a link to the licence, and an indication of changes.

DIGITAL PRESERVATION AND RECORD

The publisher supports long-term accessibility of the scholarly record through persistent identifiers, structured metadata and established digital preservation practices. Version and correction information should remain linked to the article of record.

© 2026 The Author(s). Authors retain copyright in their articles.

Published by: Zeus Press

Address: Flat/Rm 91_3 9/F Chinachem Golden Plaza No.77 Mody Road Tsim Sha Tsui KL, Hong Kong

Individual paper reprints: service@zeus-press.org

CONTENTS

International Journal of Asian Social Science Research · Volume 3 · Issue 1 · 2026

Spatial Responses to the Polarization: Trickle-Down Effect in Hunan Based on Remote Sensing	1
<i>Zhengliang Wu</i>	
AIGC's Impact on 2D Animation Professionals: Disruption, Opportunity, and Governance in a Reconfigured Production Chain	13
<i>Tingxi Yan</i>	
Criminal Regulatory Approaches to Deepfake-Related Offenses: Focusing on the Crime of Fraud	20
<i>Songyang Sai, Zifan Wang</i>	
The Impact of the Digital Economy on Income Inequality	32
<i>Jingwen Zhang</i>	
AI as a Medium: Exploring the Case of Chinese Women Establishing Virtual Intimacy with DeepSeek in Xiaohongshu	41
<i>Xiaoyu Zhu</i>	
Exceptions to the Principle of Non-Extradition of Nationals: A Comparative Analysis of Extradition Practices between the European Union and China	48
<i>Jinyu He</i>	
Research on the Sustainable Development of Huimin Insurance within the Multi-Level Health Security System: A Case Study of C City	61
<i>Ying Wan, Danni Xu</i>	
A Comparative Study of China's Railway Diplomacy under the Background of the "Belt and Road" Initiative: Taking the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway as Examples	71
<i>Shuyuan Wang</i>	
The Transmission Path of Tourists' Perceived Crowding and Consumption Behavior: Evidence from Lijiang Ancient Town	80
<i>Yirui Qian, Xinxin Guo</i>	
Research on Social Work Intervention for Social Isolation of Urban Elderly at the Current Stage	94
<i>Hangyuan Liang</i>	
The Influence of Parents 'Language Scaffold Style on Adolescents' Academic Resilience	100
<i>Meilin Zhao</i>	
Development and Application of an Emotion Analysis Agent — A Prototype Study on Multi-Group Emotional State Assessment and Guidance	111
<i>Xiaoke Sun, Mingfei Zhao, Wanming Feng, Dejie Long, Fangqi Xu, Jiaca Ma, Ruoxi Liu, Shangyuan Ma</i>	

Spatial Responses to the Polarization: Trickle-Down Effect in Hunan Based on Remote Sensing

Zhengliang Wu *

School of Geographical Sciences, Hunan Normal University, Changsha, Hunan, 410081, China

**Corresponding author: Zhengliang Wu*

Abstract

How regional spatial patterns adjust to the shifting balance between economic polarization and trickle-down effects remains insufficiently understood, especially in rapidly developing regions such as Hunan Province. A Regional Economic Score (RES) system is established using the entropy-weight method to depict long-term development trends, while the coefficient of variation and Theil index reveal a shift from polarization to convergence. A provincial core – periphery interaction model incorporating economic linkage strength further captures the radiation and spillover roles of the Chang-Zhu-Tan metropolitan area. Nighttime light-derived indicators, including centroid shifts and standard deviation ellipses, provide intuitive spatial evidence that complements statistical results and reflects general patterns of built-up area evolution. The analysis shows that Hunan's development trajectory moved from a strong center-driven agglomeration toward a more multi-nodal, spillover-enhanced structure, with core cities exerting sustained positive influence on surrounding regions and stronger linkages reinforcing collaborative dynamics. Overall, the convergence of temporal, spatial, and economic evidence reveals clear surface manifestations of the polarization-trickle-down effect and offers empirical insights for provincial planning and coordinated regional development.

Keywords

remote sensing, urban built-up areas, polarization-trickling down effects, nighttime light data, Hunan province

1. Introduction

China's rapid economic growth and urbanization have strengthened the agglomeration advantages of major cities while enabling outward diffusion through industrial relocation, transport connectivity, and population mobility, a process generally conceptualized as the polarization–trickle-down effect [1]. In spatial terms, this effect is reflected in the expansion and increasing development intensity of urban built-up areas [2].

Remote sensing imagery and night-time light data provide key tools for identifying built-up area structures and expansions, thereby revealing the spatial responses of economic processes. Scholars have systematically summarized methodologies for delineating built-up areas from remote sensing images [3]. Comparative evaluations have assessed the accuracy and applicability of night-time-light–based extraction methods [4]. Further studies have highlighted the need for differentiated threshold selection based on urban morphological types [5]. Recent analyses have investigated the spatial heterogeneity, driving forces, and urban–economic

coupling in provincial and municipal built-up area expansions [6]. Other studies have revealed axial migration patterns and shifting spatial centers associated with city expansion [7]. National-scale assessments have demonstrated regional differences in expansion stages and efficiency [8]. Bibliometric analyses further show that night-time light remote sensing is increasingly integrated into urbanization and spatial-economic studies [9]. The theoretical foundation for polarization and diffusion dynamics is rooted in Hirschman's model of unbalanced growth [10]. Empirical studies using multi-source remote sensing have demonstrated strong correlations between built-up area expansion and economic growth in major cities [11]. Night-time-light-based analyses have revealed patterns of agglomeration and cooperative diffusion in metropolitan regions [12]. Studies of the Dongting Lake urban agglomeration have shown periodicity and enclave-like expansion patterns consistent with regional economic rhythms [13].

However, most existing work focuses on single cities or intra-urban-agglomeration dynamics, leaving provincial-scale economic-spatial interactions insufficiently explored. Taking Hunan Province as the study area, this research integrates multi-temporal remote sensing imagery, night-time light datasets, and socioeconomic statistics to achieve four aims: identifying the spatiotemporal manifestations of polarization-trickle-down effects; characterizing built-up area patterns and evolution across cities; summarizing center-periphery economic-spatial-spatial interaction modes; and proposing generalizable provincial-scale mechanisms to support coordinated regional development.

2. Study Area and Data Sources

2.1 Study Area

This study focuses on Hunan Province, located in central China along the middle reaches of the Yangtze River. The province is traversed by its largest river, the Xiangjiang, and spans from 108°47' to 114°15' east longitude and 24°38' to 30°08' north latitude, covering a total area of 211,800 square kilometers [14]. Hunan exhibits a pronounced "strong provincial capital" pattern in its economic development. In 2024, the gross domestic product of Changsha reached 1,526.878 billion yuan, accounting for over 28.68 percent of the provincial total and maintaining an absolute advantage within the province [15]. Other cities display varying degrees of dependence on and feedback from Changsha in terms of industrial transfer and factor mobility. Such marked regional disparities provide an ideal context for analyzing the relationship between urban built-up area patterns and the polarization-trickle-down effect.

2.2 Data Sources

The data used in this study include both remote sensing imagery and socio-economic statistics. Remote sensing data consist of Landsat 7 TM C2 L2 imagery and nighttime light data covering the period from 2000 to 2020. Landsat imagery was obtained from the Geospatial Data Cloud. Nighttime light data were sourced from the China Long-term Annual Artificial Nighttime Light Dataset (PANDA_CHINA) [16], and the years 2000, 2005, 2010, 2015, and 2020 were selected as sample years due to the availability of ground-validated observations. Socio-economic statistics for Hunan Province were primarily derived from the Hunan Statistical Yearbook and the China City Statistical Yearbook, with electronic versions accessed via the China Research Data Service Platform. The integration and standardization of these multi-source datasets form a comprehensive database for the empirical analysis conducted in this study.

3. Research Methods and Analytical Framework

This study aims to systematically measure the polarization-trickle-down effect in Hunan Province from two dimensions: overall development level and spatial pattern evolution. The technical framework is illustrated in Figure 1, while the theoretical underpinnings are summarized in Table 1.

Figure 1: Research framework(Picture credit: Original).

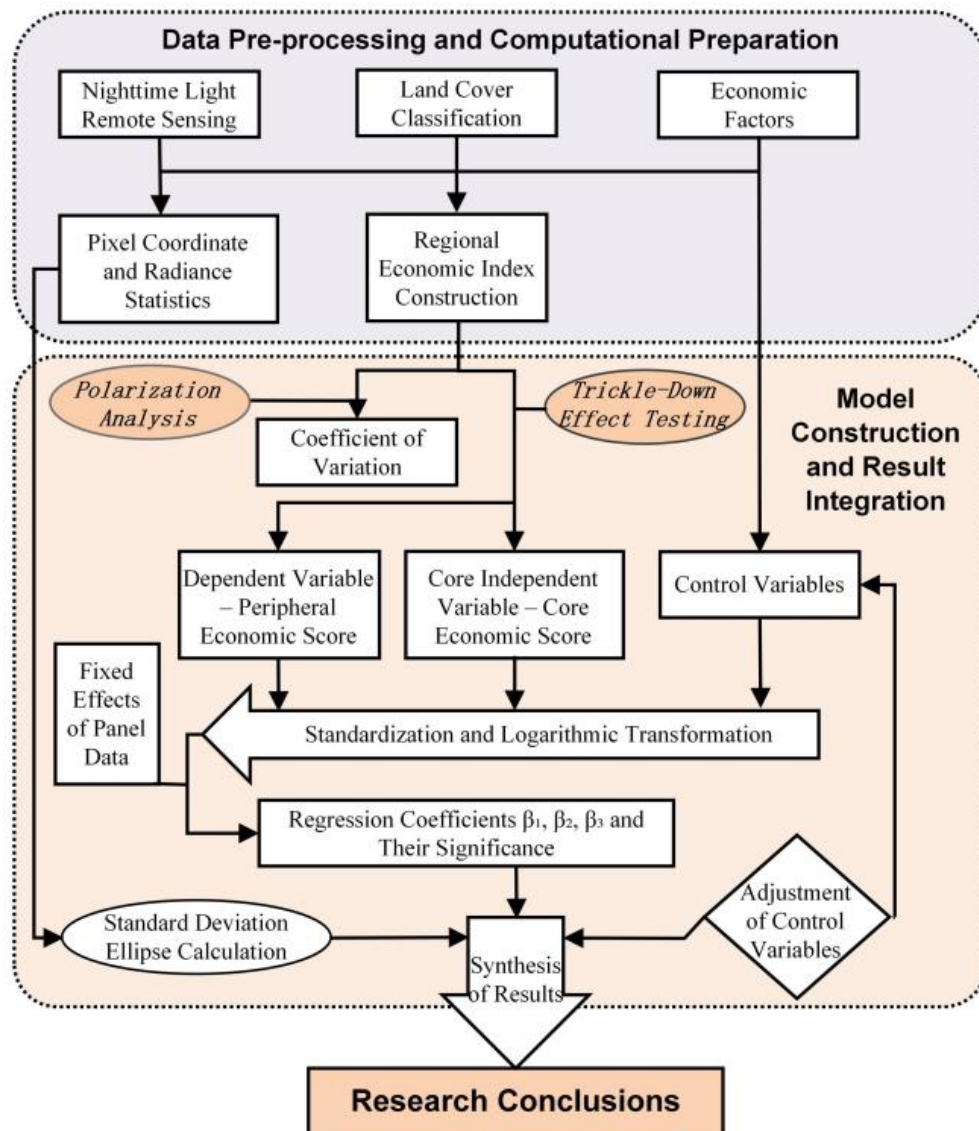


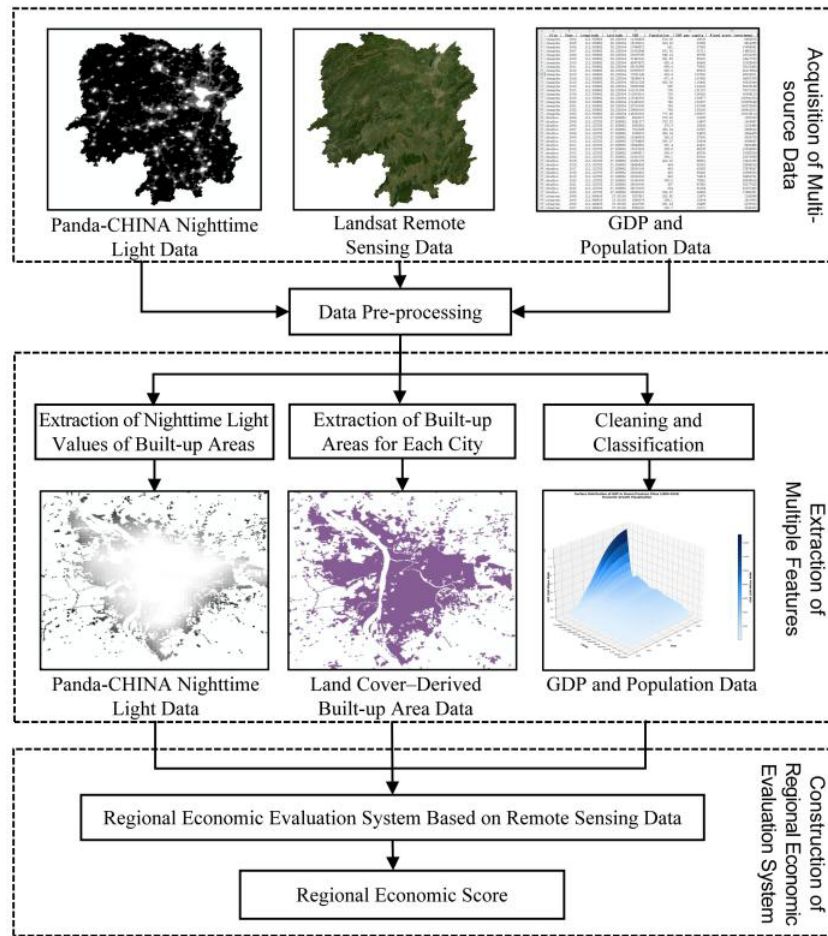
Table 1: Theoretical basis of the study.

Component / Step	Corresponding Theory / Method	Source / Reference
RES Multidimensional Indicator Weights	Entropy Weight Method	Indicator System in Table 2
Quantification of the Polarization–Trickle-Down Effect	Hirschman’s Polarization–Trickle-Down Theory	Coefficient of Variation / Theil Index
Economic Linkage Intensity (Gravity Model)	Spatial Interaction Theory	Formula for Linkage_{i,t}
Centroid Migration and Standard Deviation Ellipse	Spatial Analysis in Economic Geography	Application of Nighttime Light Data
Trickle-Down Effect Pathway Testing	Interaction-Term Model Design	Fixed-Effects Panel Data

3.1 Quantitative Model of the Polarization–Trickle-Down Effect Based on Regional Economic Scores

To overcome the limitations of single indicators, this study first draws on the approach proposed by Liu Zhiyang and colleagues to construct a multidimensional Regional Economic Score (RES), which serves as the core measure of overall regional development [17]. The specific procedure is described as Figure 2.

Figure 2: Analytical workflow for the regional economic score(Picture credit: Original).



3.1.1 Construction of the Regional Economic Score System

Using the entropy weight method, the evaluation system is built from five dimensions—average nightlight intensity of built-up areas, built-up area size, per capita GDP, total nightlight intensity of built-up areas, and the built-up area expansion rate—as summarized in Table 2. The indicator data are derived from land use data interpreted from Landsat remote sensing imagery, including artificial surface areas, PANDA_CHINA nighttime light data for total light intensity, and statistical yearbooks for GDP and population. Using these indicators, regional economic scores $S_{i,t}$ are calculated for each city in Hunan Province for the years 2000, 2010, and 2020, where i represents the city and t represents the year.

Table 2: Indicator system for regional economic evaluation

Objective Level	Indicator	Weight
Regional Economic Score (RES)	Average nighttime light intensity of built-up areas	0.2730
	Built-up area	0.1240
	GDP per capita	0.2653
	Total nighttime light intensity of built-up areas	0.2639
	Built-up area expansion rate	0.0737

3.1.2 Measurement of Regional Disparities (Polarization Analysis)

To capture the evolution of regional economic differences, two indicators based on the regional economic scores are employed.

The coefficient of variation ($CV_{score,t}$) is defined as:

$$CV_{Scoret} = \frac{\sigma_{S,t}}{\mu_{S,t}} \quad (1)$$

where $\sigma_{S,t}$ and $\mu_{S,t}$ are the standard deviation and mean of the regional economic scores of all cities in year t . An increase in this value indicates a widening of regional economic disparities, reflecting an intensified polarization effect.

The Theil index (T_{Scoret}) is defined as

$$T_{Scoret} = \sum_{i=1}^N \left(\frac{S_{i,t}}{S_t} \right) \ln \left(\frac{S_{i,t}/S_t}{P_{i,t}/P_t} \right) \quad (2)$$

where S_t and P_t represent the total regional economic score and total population of all cities in year t . This index measures the inconsistency between economic distribution and population distribution, with higher values indicating greater imbalance.

3.1.3 Core–Periphery Interaction Model (Trickle-Down Effect Test)

A panel data fixed-effects model is constructed to examine whether the development of the core region, namely the Chang-Zhu-Tan urban agglomeration, produces a trickle-down effect on peripheral cities:

$$\ln(S_{periphery,i,t}) = \beta_0 + \beta_1 \ln(S_{core,t}) + \beta_2 Linkage_{i,t} + \beta_3 (Linkage_{i,t} \times \ln S_{core,t}) + \gamma X_{i,t} + \alpha_i + \lambda_t + \epsilon_{i,t} \quad (3)$$

where $S_{periphery,i,t}$ denotes the regional economic score of peripheral city i in year t , and $S_{core,t}$ represents the regional economic score of the core cities in year t . A significantly positive β_1 indicates the presence of a trickle-down effect. $Linkage_{i,t}$ measures the economic connection strength between city i and the core, calculated using an improved gravity model:

$$Linkage_{i,t} = \frac{S_{core,t} \times S_{i,t}}{(Distance_{i,core})^2} \quad (4)$$

The interaction term $Linkage_{i,t} \times S_{core,t}$ is included to examine whether the trickle-down effect depends on the strength of economic connections. A significantly positive β_3 indicates that the trickle-down effect may be associated with the intensity of these economic links. $X_{i,t}$ is a set of control variables, including the logarithm of fixed asset investment and the logarithm of the number of university students.

3.2 Spatial Pattern Analysis Based on Nighttime Light Data

To provide spatial visualization evidence for the quantitative model, this study adopts the method of Samuha Danshanbai et al. (2024) using calibrated and integrated nighttime light data to analyze the spatial orientation, clustering, and pattern characteristics of economic development [18].

3.2.1 Economic Center of Gravity Migration

The economic center of gravity represents the spatial equilibrium point of regional economic development. Its coordinates (G_x, G_y) are calculated as

$$G_x = \frac{\sum_{i=1}^n w_i x_i}{\sum_{i=1}^n w_i}, G_y = \frac{\sum_{i=1}^n w_i y_i}{\sum_{i=1}^n w_i} \quad (5)$$

where w_i is the nightlight intensity of pixel i and (x_i, y_i) are its geographic coordinates. The trajectory of the center of gravity illustrates the spatial direction of economic expansion.

3.2.2 Standard Deviation Ellipse

A standard deviation ellipse is used to characterize the spatial distribution, orientation, and concentration of economic activity through its centroid, azimuth angle α , and semi-axes σ_x and σ_y .

$$\tan \alpha = \frac{(\sum_{i=1}^n w_i^2 \bar{x}_i^2 - \sum_{i=1}^n w_i^2 \bar{y}_i^2)}{2 \sum_{i=1}^n w_i^2 \bar{x}_i \bar{y}_i} + \frac{\sqrt{(\sum_{i=1}^n w_i^2 \bar{x}_i^2 - \sum_{i=1}^n w_i^2 \bar{y}_i^2) + 4 \sum_{i=1}^n w_i^2 \bar{x}_i \bar{y}_i^2}}{2 \sum_{i=1}^n w_i^2 \bar{x}_i \bar{y}_i^2} \quad (6)$$

The formulas for calculating σ_x and σ_y are as follows:

$$\sigma_x = \sqrt{\frac{\sum_{i=1}^n (w_i \bar{x}_i \cos \alpha - w_i \bar{x}_i \sin \alpha)^2}{\sum_{i=1}^n w_i^2}} \quad (7)$$

$$\sigma_y = \sqrt{\frac{\sum_{i=1}^n (w_i \bar{x}_i \sin \alpha - w_i \bar{x}_i \cos \alpha)^2}{\sum_{i=1}^n w_i^2}} \quad (8)$$

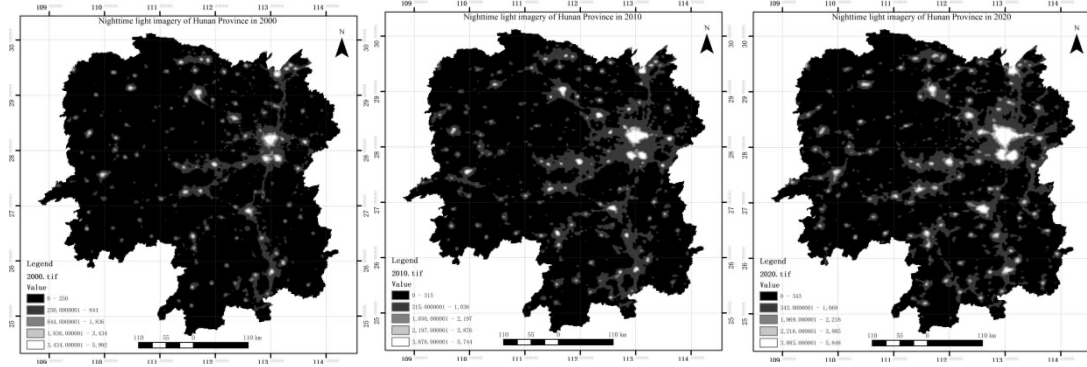
The tangent of the azimuth $\tan \alpha$ represents the deviation of pixel i 's coordinates from the ellipse centroid. The values of σ_x and σ_y represent the lengths of the ellipse's semi-major and semi-minor axes, respectively. A decreasing ellipse area combined with an increasing flattening ratio indicates that the trend of economic development is becoming increasingly concentrated.

4. Data Analysis and Results

4.1 Construction of Regional Economic Scores

Based on the entropy weight method, a regional economic evaluation system was established for Hunan Province, quantifying economic development of each city through five indicators: average nighttime light intensity of built-up areas, built-up area size, per capita GDP, total nighttime light intensity, and built-up area expansion rate. Using the calculated weights, the regional economic scores (RES) for 13 cities and prefectures, excluding Xiangxi Autonomous Prefecture, in 2000, 2010, and 2020 were obtained. Overall, Hunan Province exhibits significant economic growth, with the Chang-Zhu-Tan urban agglomeration leading, while remote areas such as Zhangjiajie and Huaihua scored lower. Over time, most cities improved, reflecting overall provincial economic progress.

Figure 3: Nighttime light imagery of Hunan Province in 2000, 2010, and 2020 (Picture credit: Original).



Nighttime light intensity serves as a key indicator of economic activity, closely related to population density, industrial activity, and urbanization. Figure 3 illustrates the spatial distribution of nighttime lights in 2000, 2010, and 2020. In 2000, lights were weak, concentrated in core cities such as Changsha, Zhuzhou, and Xiangtan, indicating limited economic activity. By 2010, light intensity had strengthened, core areas expanded, and surrounding cities such as Yueyang and Hengyang began showing prominent lights, reflecting accelerated industrialization and urbanization. In 2020, nighttime light coverage further expanded, forming contiguous high-intensity areas in the Chang-Zhu-Tan agglomeration, with scattered lights even in remote regions, indicating broader and deeper economic activity. These changes visually capture Hunan's economic expansion over two decades and the enhanced radiative influence of core areas. Nighttime lights not only reflect overall economic growth but also reveal spatial disparities in development.

Changes in land cover are closely linked to regional economic development. Built-up area expansion increased the corresponding indicator score and indirectly boosted per capita GDP through investment and employment. From 2000 to 2020, urbanization progressed rapidly but unevenly: the Chang-Zhu-Tan region

experienced dense expansion, whereas Xiangxi's growth was limited by terrain. Land cover classification results validate the entropy weight system and highlight the role of land-use policies in regional economic coordination.

Figure 4: Changes in the regional economic scores of cities across three periods(Picture credit: Original).

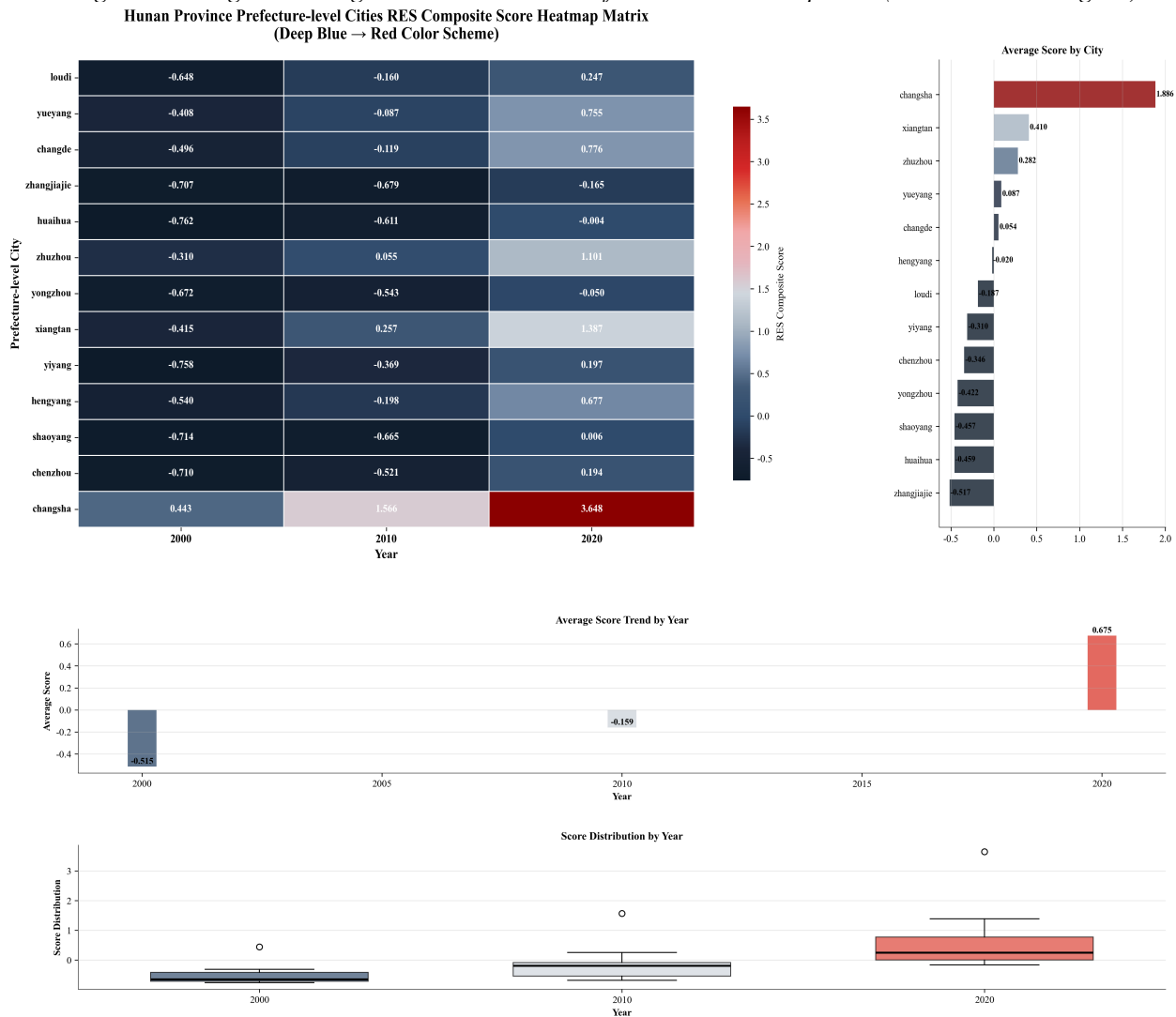


Figure 4 presents a heatmap of RES scores across 14 cities for 2000, 2010, and 2020. In 2000, most cities scored low, with only Changsha positive (0.443), indicating overall economic lag. By 2010, Changsha rose sharply to 1.566, Zhuzhou and Xiangtan became positive, while Xiangxi cities remained negative, reinforcing the core-periphery structure. In 2020, scores improved province-wide, with Changsha reaching 3.648 and notable growth in Yueyang, Changde, and Zhuzhou, while some remote areas approached zero, reflecting provincial development trends. Temporally, scores consistently improved, showing overall economic growth. Spatially, high-value areas remained concentrated in Chang-Zhu-Tan, while low-value zones were in Xiangxi and southern Hunan. This pattern aligns with the contributions of entropy-weighted indicators, demonstrating rapid growth and spatial restructuring; nighttime light, land cover, and RES scores mutually validate each other.

4.2 Polarization Evolution Revealed by Regional Economic Scores

Using the coefficient of variation (CV) and Theil index, Figure 5 and Figure 6 depict core-periphery disparities and changes across regions. Hunan's regional economic differences show clear dynamic evolution:

Figure 5: Measurement of core-periphery disparities(Picture credit: Original).

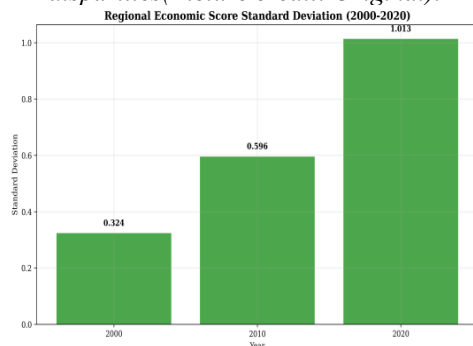
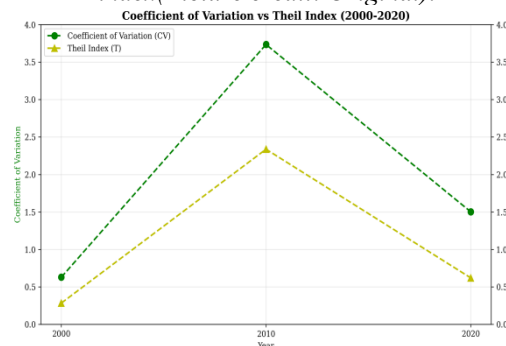


Figure 6: Coefficient of variation and Theil index(Picture credit: Original).



Stage 1: Dominance of Polarization (2000–2010)

Between 2000 and 2010, regional disparities expanded markedly. CV rose from 0.6288 to 3.7346, and the Theil index from 0.2836 to 2.3371, reflecting synchronized growth in relative differences and mismatched distributions. Production factors concentrated in the Chang-Zhu-Tan core, with Changsha, Zhuzhou, and Xiangtan forming pronounced growth poles due to policy and location advantages. Peripheral cities such as Xiangxi and Huaihua lagged, exacerbating absolute and structural imbalances. The standard deviation increased from 0.3239 to 0.5956, confirming rapid growth in absolute disparities. The dispersion of scores between core and periphery strengthened spatial differentiation, consistent with Hirschman’s polarization theory, where early-stage resource concentration in core areas temporarily widens regional gaps.

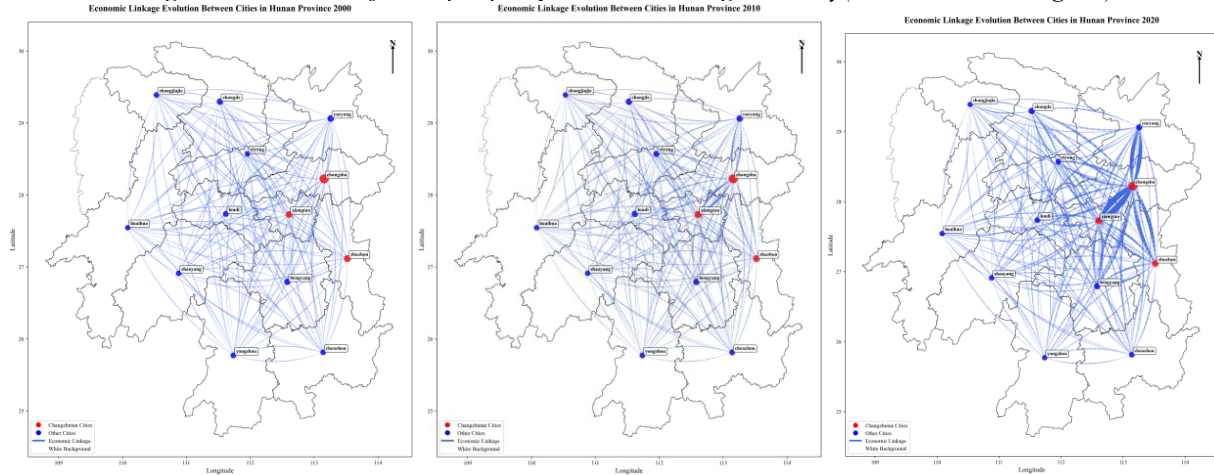
Stage 2: Emergence of Trickle-Down Effects (2010–2020)

After 2010, the trend of widening disparities began to structurally reverse. By 2020, the Theil index declined from 2.3371 to 0.6201, and CV adjusted to 1.5023, still above 2000 levels but significantly improved from 2010, indicating reduced mismatch between economic and population distribution. This reflects the initial emergence of trickle-down effects: as core cities grow, they stimulate peripheral development via industrial transfer and infrastructure connectivity. The trajectory of “initial expansion followed by contraction” aligns with polarization–trickle-down theory, where early growth poles aggregate resources, followed by outward spillover promoting peripheral growth.

4.3 Core–Periphery Interaction Model Testing

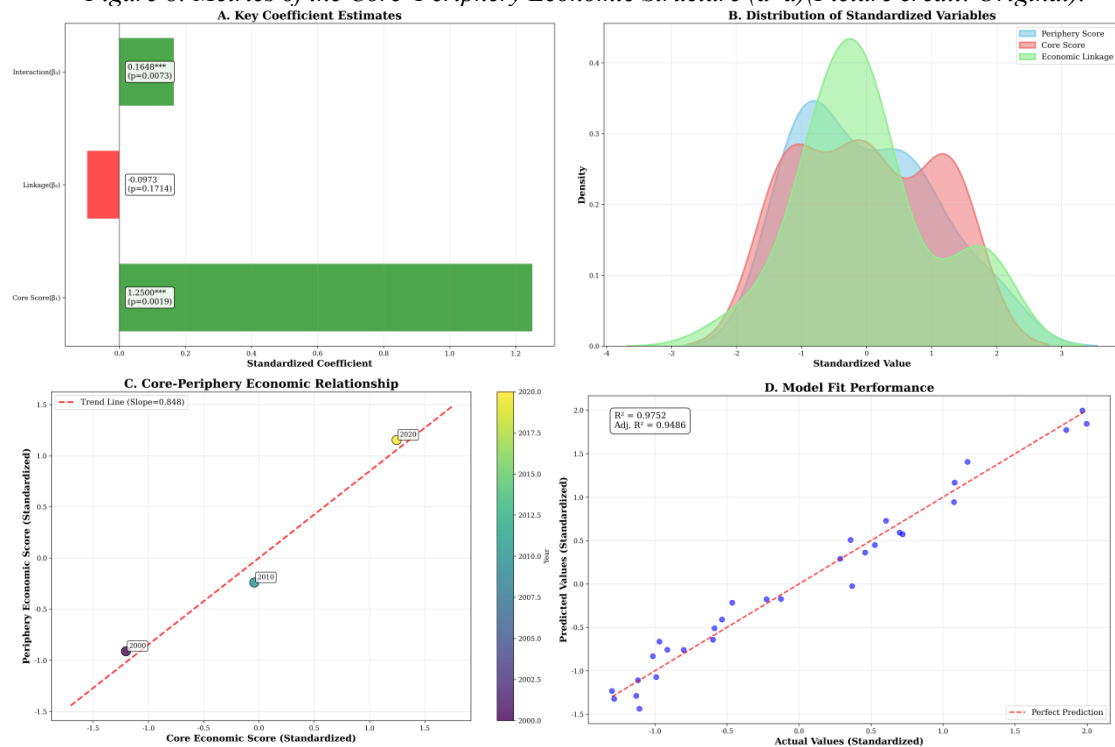
To analyze the interaction mechanism, an economic linkage index between cities was constructed based on a gravity model, and its spatial evolution is examined. Figure 7 shows link intensity by line thickness and color. From 2000 to 2020, Hunan’s network evolved as follows: in 2000, weak links concentrated in Chang-Zhu-Tan formed a “star-shaped” structure with minimal peripheral connections. By 2010, internal links strengthened, secondary hubs appeared, and the economic reach extended along transport axes such as the Beijing–Guangzhou line. In 2020, the network became more complex and polycentric, with Chang-Zhu-Tan’s influence reaching southern and western Hunan and lateral links among periphery cities, indicating deeper regional integration.

Figure 7: Evolution of core-periphery economic linkage intensity(Picture credit: Original).



A panel data fixed-effects model tested trickle-down effects, with regression results summarized in Table 3. Results show the core economic score coefficient $\beta_1=1.249961$ ($p < 0.01$), significantly positive at the 1% level, confirming that Chang-Zhu-Tan's growth positively drives peripheral cities. The interaction term coefficient $\beta_3 = 0.164834$ ($p = 0.007291$) is also significantly positive, indicating that stronger economic links enhance trickle-down effects by 0.164834 units. The model shows high goodness-of-fit ($R^2 = 0.9752$) and a significant F-statistic, demonstrating reliability. Figure 8 visualizes standardized key coefficients, providing empirical support for core-periphery interactions.

Figure 8: Metrics of the Core-Periphery Economic Structure (a-d)(Picture credit: Original).



Figures 8-C and 8-D further illustrate coordinated growth: core and periphery scores both rise from 2000 to 2020, aligning along a 0.848 slope trendline. Scores were low in 2000, improved in 2010, and peaked in 2020, confirming ongoing trickle-down effects. High R^2 and a tight fit between predicted and observed values verify the model's reliability and the collaborative growth mechanism. Hunan has thus formed a robust pattern of core-led, regionally coordinated development.

Table 3: Regression results of the core–periphery interaction model

Variable	Coefficient	p-value	Significance	Variable
$S_{core,t}(\beta_1)$	1.249961	0.001877	Significant	$S_{core,t}(\beta_1)$
$Linkage_{i,t} \times S_{core,t}(\beta_3)$	0.164834	p=0.007291	Significant	$Linkage_{i,t} \times S_{core,t}(\beta_3)$
$Linkage_{i,t}(\beta_2)$	-0.097334	p=0.171391	Not Significant	$Linkage_{i,t}(\beta_2)$

4.4 Spatial Pattern Evidence of Economic Development

Nighttime light-based spatial analysis provides intuitive evidence for the RES model by assessing economic center and directional characteristics. Figure 9 shows total light increasing continuously, reflecting overall expansion. The standard deviation ellipse's axes shortened and became more circular around 2010, marking a transition from initially concentrated to more balanced spatial growth, consistent with the shift from late-stage polarization to trickle-down effects.

Figure 9: Directional indicators and changes in total nighttime light(Picture credit: Original).

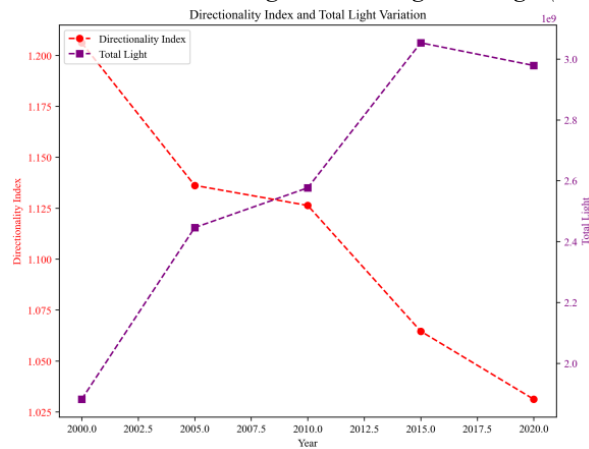
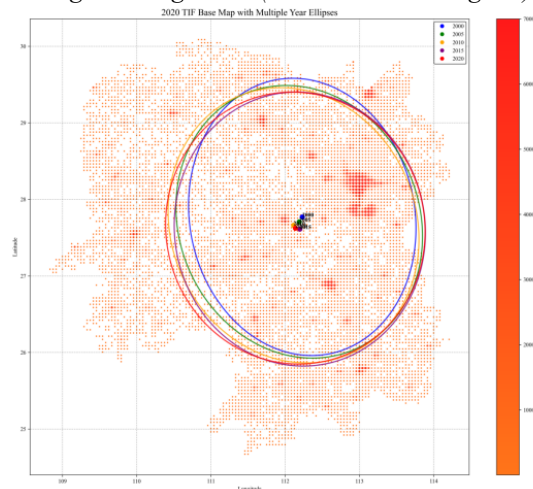


Figure 10 shows the ellipse's azimuth remained northwest–southeast, aligning with the Beijing–Guangzhou corridor, indicating long-term development along major transport axes. Economic center calculations reveal a consistent central-east location with a southwestward trajectory, confirming the growing influence of Chang-Zhu-Tan and faster development in peripheral areas absorbing core-region spillovers. Figure 10 also visualizes the center's migration and ellipse evolution over 2000–2020 [19].

Figure 10: Standard deviation ellipse of regional economic centroid migration in Hunan Province based on nighttime light data(Picture credit: Original).



5. Conclusions

The analysis of Hunan Province from 2000 to 2020 reveals a clear spatial evolution of economic polarization and the trickle-down effect, characterized by a transition from core concentration to coordinated diffusion. Strengthening the role of the Chang-Zhu-Tan urban agglomeration and enhancing its spillover efficiency is essential, as well as improving intercity connectivity and collaborative platforms to enable peripheral regions to absorb resources and benefits from core areas. During the study period, regional economic development displayed distinct phases: the 2000–2010 period was dominated by polarized expansion, whereas 2010–2020 saw relative convergence, with the Chang-Zhu-Tan growth pole initially widening regional disparities and later promoting more balanced development through spillover effects. The analysis of core–periphery interactions confirms the presence of significant trickle-down effects, where stronger economic ties correspond to greater peripheral gains, highlighting the importance of transportation and factor mobility. Spatial patterns derived from nighttime light data and standard deviation ellipses align closely with economic statistics, showing that urban expansion shifted from concentrated to dispersed, while the economic center of gravity moved southwest, emphasizing the increasing role of peripheral areas in sustaining provincial growth. The synchronous expansion of built-up areas and economic growth illustrates a shift from central agglomeration to multi-node linkages, confirming the surface-level spatial manifestation of polarization and trickle-down effects. Integrating remote sensing and nighttime light monitoring provides effective tools for tracking urban expansion, guiding land management, and informing regional planning decisions. Overall, Hunan’s development reflects a coordinated spatial evolution where core and peripheral areas increasingly interact to support higher-quality, balanced regional growth.

References

- [1] Cai, S. K. and Ni, P. F. Polarization or trickle-down: The impact of urban scale on agricultural modernization. *Economist*. 2017(7), pp. 46-55. <https://doi.org/10.16158/j.cnki.51-1312/f.2017.07.006>.
- [2] Fu, M. W., Luo, W. Y. and Li, F. High-speed railway opening and urban entrepreneurship: Polarization effect or trickle-down effect? *Consumer Economics*. 2025, pp. 1-17.
- [3] Li, A. M. Research on urban built-up area expansion & land use scale based on remote sensing images. Doctoral Dissertations, Zhengzhou: PLA Information Engineering University, 2009.
- [4] Shu, S., Yu, B. L., Wu, J. P. and Liu, H. X. Methods for deriving urban built-up area using night-light data: Assessment and application. *Remote Sensing Technology and Application*. 2011, 26(2), pp. 169-176.
- [5] Song, J. C., Li, X. H., Lin, T., Zhang, G. Q., Ye, H., He, X. Y. and Ge, R. B. A method of extracting urban built-up area based on DMSP/OLS nighttime data and google earth. *Journal of Geo-Information Scienc*. 2015, 17(06), pp. 750-756.
- [6] Song, Y. Spatiotemporal evolution characteristics and driving force analysis of urban built-up areas in Guizhou Province based on nighttime light data. Master's Thesis, Guizhou: Guizhou Normal University, 2025. <https://doi.org/10.27048/d.cnki.ggzsu.2025.000828>.
- [7] He, P. Z., Hu, X. H., Liu, T. and Ren, J. Spatial-temporal expansion of urban built-up areas based on lighttime lighting data : A case study of Hohhot. *Huazhong Architecture*. 2025, 43(6), pp. 29-33. <https://doi.org/10.13942/j.cnki.hzjz.2025.06.020>.
- [8] An, Q., Li, X. J. and Lü, K. W. A research on the spatial structure and efficiency of China's expansion of urban built-up area (1990-2009). *Economic Geography*. 2012, 32(6), pp. 37-45. <https://doi.org/10.15957/j.cnki.jjdl.2012.06.007>.
- [9] Chen, J. H. and Lü, Y. F. Bibliometric analysis of nighttime light remote sensing applications in urbanization spatial studies. *Journal of Changchun Normal University*. 2025, 44(6), pp. 107-112. <https://doi.org/10.3969/j.issn.1008-178X.2025.06.017>.

- [10] Se, W. A worldly political economist: The life and thoughts of Albert O. Hirschman. *Fudan Journal*. 2015(1), pp. 1-15.
- [11] Mu, F. Y., Zhang, Z. X., Chi, Y. B., Liu, B., Zhou, Q. B., Wang, C. Y. and Tan, W. B. Dynamic monitoring of built-up area in Beijing during 1973—2005 based on multi-original remote sensed images. *Journal of Remote Sensing*. 2007(02), pp. 257-268.
- [12] Huang, Z. H., Huang, J. X. and Dang, A. R. Collaborative development and optimization strategies of the Huaihe River Basin Metropolitan Area: An empirical analysis based on nighttime light remote sensing. *Geographical Science*. 2025, 45(11), pp. 2430-2440. <https://doi.org/10.13249/j.cnki.sgs.20231000>.
- [13] Li, Q. M., Zheng, B. H. and Xiong, Y. J. Spatio-temporal expansion of the dongting lake eco-economic zone urban agglomeration based on nighttime light remote sensing data. *Economic Geography*. 2021, 41(2), pp. 92-102. <https://doi.org/10.15957/j.cnki.jjdl.2021.02.010>.
- [14] Hunan Provincial People's Government. Hunan Provincial Profile. Available from: https://www.hunan.gov.cn/jxxx/hngk/sqjs/sqjs_m.html (accessed 22 December 2025).
- [15] Hunan Provincial Bureau of Statistics. Statistical bulletins of all prefecture-level cities. Available from: <https://tjj.hunan.gov.cn/tjjf/tjgb/szgb/> (accessed 22 December 2025).
- [16] Zhang, L., Ren, Z. and Chen, B. A prolonged artificial nighttime-light dataset of China (1984–2020). Available from: <http://www.gis5g.com/data/dgsj?id=247> (accessed 22 December 2025).
- [17] Liu, Z. Y., Yin, H. J., Li, M. Y., Zong, F. and Dong, Y. N. Analysis of economic development in representative regions of China's three major economic belts using multi-source remote sensing data. *Geomatics and Information Science of Wuhan University*. 2025, pp. 1-17. <https://doi.org/10.13203/j.whugis20240233>.
- [18] Samha, S., Gao, Y. X. and Deng, W. B. Analysis of spatial-temporal pattern characteristics of economic development in four prefectures of southern Xinjiang based on integration of nightlight remote sensing data. *Remote Sensing Technology and Application*. 2024, 39(1), pp. 234-247. <https://doi.org/10.11873/j.issn.1004-0323.2024.1.0234>.
- [19] Wu, B. Urban spatial form and driving forces of Guiyang's built-up area. Master's Thesis, Guiyang: Guizhou University, 2023.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

AIGC's Impact on 2D Animation Professionals: Disruption, Opportunity, and Governance in a Reconfigured Production Chain

Tingxi Yan *

School of Photography, Communication University of China Nanjing, Nanjing, 210000, China

**Corresponding author: Tingxi Yan*

Abstract

Generative AI—often discussed in Chinese contexts as AIGC—has begun to reshape 2D animation work by lowering iteration costs in pre-production, accelerating parts of asset creation, and enabling rapid multi-variant marketing outputs. Yet these productivity gains come with uneven labor impacts and heightened governance constraints. Tasks that are modular, repetitive, and evaluable at the frame or asset level are more exposed to automation and price compression, while roles requiring narrative judgment, performance timing, and cross-shot consistency are more likely to be “augmented” rather than replaced. At the same time, legal and policy developments increasingly make provenance, authorship control, and training-data questions practical constraints on commercial deployment—especially for studios seeking copyright protection and low-risk distribution. Drawing on a production-chain (“task chain”) framework, this paper analyzes where AIGC substitutes, where it augments, why it can narrow entry-level pathways while increasing demand for supervisory and pipeline roles, and what new opportunity pathways are emerging. It argues that AIGC functions less as a single replacement technology than as a value reallocation engine: competitive advantage shifts toward professionals who can translate creative intent into controllable workflows, enforce consistency, and document compliant production.

Keywords

AIGC, generative AI, 2D animation, creative labor, diffusion models, workflow governance, copyright, provenance

1. Introduction

2D animation has always been both an art and an industrial process: a narrative medium built through specialized roles distributed across a production pipeline. In the last two years, generative AI tools have moved from peripheral experimentation to everyday presence in creative industries, including animation. The most immediate change is not that AI “can draw,” but that it can produce large volumes of plausible visual candidates quickly, shifting the economics of ideation, iteration, and asset variation. This change pressures long-standing labor structures in animation because many pipeline tasks—especially in pre-production and asset refinement—are already modular and standardized. When a tool makes certain outputs cheap to generate, the

scarcity shifts away from the act of generating and toward decisions about what to keep, how to control consistency, and how to ensure the final deliverable is legally safe for commercial release.

However, animation is not illustration. A single striking image does not guarantee a coherent scene, and a coherent scene does not guarantee a consistent episode. The core production challenge is temporal: sustaining character identity, proportion, line quality, and lighting logic across shots and sequences. As a result, the most meaningful question for 2D professionals is not “Will AI replace artists?” but “Which tasks become automated, which become supervised, and which become more valuable because they remain difficult to formalize?” This is where a task-chain approach becomes useful. Instead of discussing “artists” as a single category, we can analyze the pipeline from pre-production to production to post-production/marketing and evaluate how AIGC interacts with the input–output rules and quality controls of each stage.

The stakes are not purely economic. The legal status of generative outputs, the requirements for copyrightability, and disputes around training data increasingly shape what studios can safely deploy. The U.S. Copyright Office’s ongoing work on AI and copyright shows that commercial creators cannot treat authorship and provenance as afterthoughts [1]. In particular, the degree of human creative control can affect whether a work is registrable and how it is protected [2]. Industry organizations and guilds similarly frame generative AI as a bargaining and governance issue, not simply a software upgrade [3, 4].

This paper therefore argues that AIGC’s impact on 2D animation should be understood as a reconfiguration of the production chain and professional skill bundle. AIGC increases speed and decreases exploration cost, but it also intensifies the need for workflow designers, supervisors of style consistency, and provenance managers who can guarantee quality and defensibility. In short: value migrates toward professionals who can command the pipeline—artistically, technically, and legally.

2. Background: Why Diffusion and Generative Video Matter for 2D Animation

2.1 Diffusion Models and Controllable Image Synthesis

Many contemporary AIGC tools build on diffusion models, which have become central to high-quality image synthesis. Latent diffusion approaches demonstrate how models can produce detailed outputs while operating efficiently in a compressed representation space [5]. For animation workflows, the key practical outcome is not only generation but controllable editing-variations, inpainting, reference conditioning, and style transfer—because production art depends on revision cycles, not one-off results. The ability to iterate quickly changes the role of concept design and early visualization: teams can explore many compositions, palettes, or prop designs before committing to expensive hand refinement.

2.2 Temporal Coherence and Generative Video

The next frontier is temporal coherence. Research on generative video and animation-oriented diffusion methods signals a direction: generating sequences that preserve identity and motion continuity. Approaches like AnimateDiff enable motion in diffusion-driven image models without intensive retraining, illustrating the broader drive to stabilize time-based generation [6]. Commercial tools also emphasize text-to-video or image-to-video capabilities, reinforcing the industry’s expectation that sequence generation will become more accessible even if quality remains uneven [7]. For 2D professionals, this implies that early-stage animatics, mood reels, and exploratory motion concepts may be created faster, while final animation still requires rigorous human-led timing, acting choices, and consistency checks.

2.3 Governance as a Practical Production Constraint

A third background dimension is governance. International guidance on generative AI emphasizes responsible adoption frameworks—clarity on use cases, accountability, and risk mitigation [8]. In creative industries, the equivalent is a studio policy that defines what is permitted, what must be documented, and what must be entirely avoided. This matters because AIGC does not simply increase output; it can increase the probability of untraceable or legally ambiguous inputs entering the pipeline.

3. Method: A Task-Chain Framework

3.1 Production Stages

To make the analysis operational, this paper uses a task-chain framework that breaks 2D animation work into three stages:

3.1.1 Pre-production: storyboards, concept art, character design exploration, look development, background design studies, animatics.

3.1.2 Production: key animation (or key poses), in-betweening, cleanup/line work, coloring, background painting, layout, shot assembly.

3.1.3 Post-production and marketing: compositing, effects polish, color/lighting adjustments, deliverables, trailers, posters, social-media variants.

3.2 Benefit–Risk Lens

Within each stage, tasks are evaluated using a benefit–risk lens:

3.2.1 Benefit: speed, cost reduction, exploration breadth.

3.2.2 Risk: quality instability (especially cross-shot coherence), loss of artistic intent, and legal exposure (copyrightability, training-data uncertainty, or contractual compliance).

This method is consistent with the reality that adoption decisions are not purely aesthetic; they are managerial and legal. It also connects directly to labor outcomes: tasks with high modularity and easy evaluation tend to be most automatable, while tasks requiring holistic judgment and consistent authorship signals tend to remain human-led.

4. Findings: Where AIGC Substitutes and Where It Augments

4.1 Pre-production: Rapid Divergence, Faster Convergence

Pre-production is where AIGC most immediately increases output. Storyboard thumbnails, concept explorations, prop ideation, and environment mood studies can be generated in large volumes, enabling a “diverge then converge” workflow: produce many candidates quickly, then curate and refine. The main economic impact is that “quantity of options” becomes less scarce, while “quality of decisions” becomes more valuable.

This shift can pressure entry-level concept labor when the job is framed as “produce many variations.” If a tool can produce dozens of plausible thumbnails, the market value of raw variation decreases. Yet the tool does not remove the need for strong narrative visualization. A storyboard is not merely a sequence of images; it is camera logic, staging, and emotional pacing. AIGC outputs still require an experienced eye to ensure readability, continuity, and intent.

In practice, AIGC pushes pre-production professionals toward a hybrid role: not only drawing, but also specifying constraints and evaluation criteria. Those who can translate a director’s intent into a controllable prompting and reference system-and who can reliably converge on a coherent style-become more valuable than those who simply generate large volumes of sketches.

4.2 Production: Modular Tasks Are Most Exposed

In the production stage, the highest exposure lies in tasks that are repetitive, modular, and locally verifiable: certain forms of cleanup/line work, flat color fills and variations, or background roughing and texture experiments. These tasks historically function as apprenticeship entry points, so their compression matters for labor dynamics. If studios can achieve acceptable results with fewer hours of manual execution, the number of paid junior positions can shrink, and wage pressure can increase.

However, the most artistically central tasks remain hard to automate reliably: performance animation (acting), timing, exaggeration, weight and squash-stretch decisions, and the subtle choices that make a character feel alive. Even if AI can generate motion, the director’s intent and the scene’s emotional truth still

require judgment. This aligns with the broader pattern in generative video research: creating a plausible sequence is not the same as directing an expressive performance [6].

AIGC therefore tends to augment senior animation roles: it can assist with exploration, pose candidates, or background support, but it does not eliminate the need for high-level control and coherence. Instead, it changes what “control” means: artists increasingly become supervisors of a mixed human–machine pipeline.

4.3 Post-production and Marketing: Massive Variant Generation, Higher Provenance Risk

Marketing deliverables-posters, social-media cuts, teaser graphics-are inherently multi-variant. AIGC can significantly reduce the cost of producing platform-specific versions. But this is also where provenance risk is concentrated: marketing is fast, outsourced, and often uses mixed-source assets. If untraceable generative elements slip into public-facing materials, the brand and distribution partners face reputational and legal risk.

This makes governance a production requirement. A studio that wants to adopt AIGC at scale needs clear policies on what can be generated, how it must be documented, and how human authorship is preserved or recorded.

5. Findings: Why Labor Polarization Happens (And Why Entry Paths Are at Risk)

A recurring concern in creative labor discussions is that AIGC can narrow entry-level pathways: if junior tasks are automated, how do new artists learn and earn? Industry labor discussions often treat generative AI as a critical protection issue, emphasizing worker impacts and the importance of safeguarding animation jobs and conditions [3]. Even without adopting specific numerical predictions, the mechanism is straightforward:

5.1 Entry-level roles often consist of standardized tasks that teach discipline and pipeline norms.

5.2 Automation targets standardized tasks first.

5.3 Studios then demand fewer juniors and more people who can supervise mixed workflows.

5.4 Result: a “barbell” labor market: fewer entry roles, higher value for supervisors/lead artists, and pressure on mid-level execution roles.

This is not inevitable, but it is a plausible default trajectory if adoption is driven purely by cost minimization. The alternative is a deliberate redesign of apprenticeship: shifting junior roles from pure execution toward QA, consistency checking, pipeline support, and documented refinement. In other words, the entry path can survive, but it must change.

6. Findings: What Remains “Durable” Competitive Advantage

The practical question for 2D professionals is: what remains scarce when generation becomes cheap? The answer is a set of intertwined capabilities:

6.1 Narrative judgment and staging: translating story intent into readable shots and sequences.

6.2 Performance and timing: directing motion and emotion over time.

6.3 Cross-shot consistency: keeping characters on-model, preserving line language, maintaining lighting logic and world rules.

6.4 Workflow design: turning tools into reliable pipelines with predictable iteration loops.

6.5 Provenance and compliance: ensuring outputs are legally and contractually usable.

The first three are classic artistic skills; the last two expand the professional skill bundle. In an AIGC era, “being good” includes being able to document decisions, version assets, and justify authorship control. This connects directly to copyrightability: copyright protection depends on human authorship; questions arise when AI-generated material lacks sufficient human creative contribution [2]. For professionals, this means that creative control must be exercised, and often documented, not only for artistic reasons but for rights and commercialization.

7. Opportunity Pathways: New Roles and Upgraded Skill Bundles

7.1 Workflow Designer / Human–AI Pipeline Engineer

This role designs controllable iteration: reference packages, constraint prompts, review checkpoints, and a repeatable “generate → curate → refine” protocol. The goal is not novelty but stability. A designer who can reduce rework and preserve style consistency becomes strategically valuable.

7.2 Style Consistency Supervisor

2D productions live and die by on-model consistency. AIGC can increase inconsistency by introducing subtle drift-eye spacing, line weight, costume details. A style consistency supervisor sets rules, creates reference boards, and audits shots systematically.

7.3 AI Finishing / “Make It Usable” Specialist

Even when AI outputs are attractive, they often contain artifacts: unclear edges, inconsistent details, or compositing problems. The finisher focuses on converting raw AI output into production-usable assets-matching line style, correcting anatomy, and integrating layers cleanly.

7.4 Data & Rights Coordinator (Provenance Lead)

As training-data controversies and policy scrutiny rise, studios need someone to track sources, permissions, and tool policies. The Copyright Office’s work on training issues reflects ongoing uncertainty and the importance of careful governance [9]. In practical terms, a rights coordinator maintains an asset provenance log, tool approval list, and delivery documentation to satisfy clients and distributors.

7.5 Previz / Animatic Acceleration Lead

Generative tools can accelerate early motion exploration and animatic drafts, but those drafts still require editorial judgment. This role uses AIGC for exploration while ensuring shots remain readable and emotionally coherent.

These pathways share a theme: they reward professionals who can direct and verify outputs rather than merely produce them manually.

8. Governance and Risk: Why “Policy” Becomes Part of the Art Pipeline

8.1 Copyrightability and Human Authorship Control

Commercial animation is an IP business. If a studio cannot confidently claim rights, licensing and distribution become fragile. The Copyright Office’s guidance underscores the relevance of human creative contribution and control [3]. This does not mean AIGC is unusable; it means studios must be able to demonstrate where human authorship resides-through selection, arrangement, editing, and meaningful creative revisions.

8.2 Training Data Uncertainty and the Business Reality of Risk

Debates over training practices are not academic for studios-they shape platform policies, distributor requirements, and client contracts. The Copyright Office’s analysis of generative AI training reflects persistent uncertainty and why careful governance is necessary [9]. Meanwhile, legal outcomes in AI-related copyright disputes-especially around what qualifies as permissible use and what counts as protectable content-can directly influence how studios assess risk in adopting AIGC tools [10]. Industry organizations and guild guidance similarly treat AI as a labor and rights issue requiring safeguard [3, 4].

8.3 Practical Guardrails (Studio-Ready)

A workable governance framework typically includes:

8.3.1 Provenance logs: track sources, tool outputs, and major edits.

8.3.2 Approved tool list: specify which models/tools are permitted and under what settings.

8.3.3 Red-line rules: prohibit certain uses (e.g., generating in the style of living artists for commercial work, if a studio chooses).

8.3.4 Human-in-the-loop checkpoints: require named reviewers and sign-offs for key shots.

8.3.5 Documentation for delivery: provide clients/distributors with a compliance summary.

In practice, many studios look to vendor policies as part of risk control. For example, Adobe positions Firefly around “commercially safe” usage claims and governance framing, which becomes relevant when studios must justify tool selection[11]. Related contributor and platform policies (e.g., stock-asset participation rules) can also affect how studios manage licensing and downstream distribution [12].

These guardrails shift compliance from “legal paperwork at the end” to “pipeline discipline throughout.”

9. Discussion: AIGC as a Value Reallocation Engine

AIGC does not simply reduce the need for artists; it reshapes what “artist labor” contains. The clearest pattern is that tasks with low ambiguity and high repeatability are most exposed, while tasks requiring holistic judgment remain human-led. This creates pressure on entry-level roles and increases the premium on supervisory and pipeline roles.

From a strategic perspective, AIGC rewards studios and professionals who can achieve three things simultaneously:

9.1 Speed: iterate rapidly in pre-production and deliver variants efficiently.

9.2 Control: maintain style consistency and narrative intent across sequences.

9.3 Defensibility: keep outputs legally and contractually safe, including documenting human authorship and provenance [2, 9]

Therefore, the professional competitive advantage is less about adopting the newest model and more about building a stable, auditable workflow—one that makes creativity repeatable without making it generic.

10. Conclusion

AIGC is transforming 2D animation less by “replacing artists” and more by rearranging the production chain. In pre-production, it expands exploration and compresses iteration cycles; in production, it automates or accelerates certain modular tasks while increasing the value of performance, timing, and consistency control; in post-production and marketing, it multiplies output variants while elevating provenance and compliance risk. These changes can polarize the labor market by shrinking standardized entry-level work and increasing demand for hybrid roles that combine creative direction, pipeline design, quality assurance, and rights governance [3].

For 2D professionals, the most durable path is to evolve from pure execution into control-oriented expertise: directing tools, enforcing style rules, and documenting human authorship. For studios, the key is to treat governance as an integral part of production rather than an afterthought. Ultimately, AIGC acts as a value reallocation engine: it reduces the scarcity of generation and increases the scarcity of judgment, consistency, and defensible authorship [2, 9].

References

- [1] United States Copyright Office. Copyright and Artificial Intelligence. Available from: <https://www.copyright.gov/ai/> (accessed 27 December 2025).
- [2] United States Copyright Office. Copyright and Artificial Intelligence: Part 2-Copyrightability. Available from: <https://www.copyright.gov/ai/Copyright-and-Artificial-Intelligence-Part-2-Copyrightability-Report.pdf> (accessed 27 December 2025).

- [3] The Animation Guild. Critical Crossroads: The Impact of Generative AI and the Importance of Protecting Animation Workers. Available from: <https://animationguild.org/wp-content/uploads/2024/09/2024-TAG-GenAI-Report.pdf> (accessed 27 December 2025).
- [4] Writers Guild of America West. Artificial Intelligence. Available from: <https://www.wga.org/contracts/know-your-rights/artificial-intelligence>. (accessed 27 December 2025).
- [5] Rombach, R., Blattmann, A., Lorenz, D., Esser, P. and Ommer, B. High-resolution image synthesis with latent diffusion models. In Proceedings of the IEEE/CVF conference on computer vision and pattern recognition, New Orleans, Louisiana, 2022; pp. 10684-10695, https://openaccess.thecvf.com/content/CVPR2022/html/Rombach_High-Resolution_Image_Synthesis_With_Latent_Diffusion_Models_CVPR_2022_paper.
- [6] Guo, Y., Yang, C., Rao, A., Liang, Z., Wang, Y., Qiao, Y., Agrawala, M., Lin, D. and Dai, B. Animatediff: Animate your personalized text-to-image diffusion models without specific tuning. arXiv preprint arXiv:2307.04725. 2023. <https://doi.org/10.48550/arXiv.2307.04725>.
- [7] Runway. Gen-2: Generate Novel Videos with Text, Images or Video Clips. Available from: <https://runwayml.com/research/gen-2> (accessed 27 December 2025).
- [8] Miao, F. C. and Holmes, W. Guidance for Generative AI in Education and Research. Available from: <https://cdn.table.media/assets/wp-content/uploads/2023/09/386693eng.pdf>. (accessed 27 December 2025).
- [9] United States Copyright Office. Copyright and Artificial Intelligence: Part 3-Generative AI Training (Pre-Publication Version). Available from: <https://www.copyright.gov/ai/Copyright-and-Artificial-Intelligence-Part-3-Generative-AI-Training-Report-Pre-Publication-Version.pdf> (accessed 27 December 2025).
- [10] Brittain, B. Thomson Reuters wins AI copyright ‘fair use’ ruling against one-time competitor. Available from: <https://www.reuters.com/legal/thomson-reuters-wins-ai-copyright-fair-use-ruling-against-one-time-competitor-2025-02-11/> (accessed 27 December 2025).
- [11] Adobe. Approach to Generative AI with Adobe Firefly. Available from: <https://www.adobe.com/ai/overview/firefly/gen-ai-approach.html> (accessed 27 December 2025).
- [12] Adobe. Firefly FAQ for Adobe Stock Contributors. Available from: <https://helpx.adobe.com/stock/contributor/help/firefly-faq-for-adobe-stock-contributors.html>. (accessed 27 December 2025).

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Criminal Regulatory Approaches to Deepfake-Related Offenses: Focusing on the Crime of Fraud

Songyang Sai^{1*}, Zifan Wang²

Law School (Intellectual Property Research Institute), Shandong Normal University, Jinan, 250358, China

**Corresponding author: Songyang Sai*

Abstract

As a representative form of AI-generated synthetic media, deepfake technology-characterized by its high degree of realism and increasing accessibility-has expanded the scope of legitimate technological applications while simultaneously providing novel tools and pathways for fraud-related crimes. Centered on the offense of fraud, this article systematically examines the role and functional mechanisms of deepfake technology within the criminal chain, identifying the associated criminal risks across key stages such as the illicit acquisition of personal information, content fabrication, and the execution of fraudulent schemes. The study finds that deepfake-enabled fraud exhibits distinctive features, including low technical barriers to entry, a modularized criminal chain, increasingly precise and multidimensional methods of deception, and the diffusion of harmful effects into the broader system of social trust. These characteristics pose significant challenges to existing criminal law frameworks, particularly with regard to the identification of criminal subjects, the classification of forms of accomplice liability, the allocation of platform responsibilities, and the legal characterization of relevant conduct. On this basis, the article proposes a systematic regulatory framework from three dimensions-legislative refinement, judicial response, and comprehensive governance. This includes promoting the interpretation and adaptation of the elements of fraud crimes, establishing an intelligent trial assistance system, implementing a dual-constraint mechanism for deepfake content labeling and informed consent, and the exploration of a collaborative “platform-government” regulatory model. These proposals aim to provide theoretical support and institutional reference points for the prevention and punishment of deepfake-enabled fraud.

Keywords

artificial intelligence, deepfakes, deepfake technology, AI-enabled fraud, crime of fraud

1. Introduction

Deepfakes refer to technologies and their generated outputs that employ artificial intelligence-particularly deep learning algorithms-to create or manipulate audio, visual, or textual content for specific purposes. Substantively, deepfakes constitute a form of AI-generated media, the technical core of which lies in self-learning deep neural network models capable of automatically producing highly realistic images, voices, videos, and other forms of information [1]. This technology integrates multiple artificial intelligence techniques, including video synthesis and computer vision.

The term “deepfake” originated in 2017 on the U.S.-based social news platform Reddit, where a user operating under the name “deepfakes” uploaded manipulated pornographic videos in which faces were replaced with those of public figures, drawing widespread public attention. Since then, deepfake technology has developed rapidly, with its application domains continually expanding. What initially emerged in the entertainment sector has gradually permeated diverse fields such as film and television production, medical imaging, and education, evolving into a powerful technological tool capable of reshaping information forms, transcending the boundaries of reality, and triggering far-reaching social transformations.

2. Research Foundations

2.1 Determining Illegality in the Context of Deepfake Technology

At present, deepfake technology demonstrates significant constructive value in a wide range of fields, including creative content production, film and television visual effects restoration, virtual influencers, and the digital reconstruction of cultural heritage. Applications of this kind generally fall within the scope of lawful and compliant technological innovation. In the audiovisual industry, for example, technological advancements driven by deepfake techniques have accelerated the development of new forms of productive capacity. Within China’s audiovisual sector, active exploration has taken place in areas such as text-to-video AI filmmaking and AI-generated digital humans, promoting human–machine collaborative creation and yielding a series of practical outcomes [2]. However, when the purpose of use deviates from its original creative or productive intent, technologies that initially empower industrial development may become instruments for infringing legally protected interests. In practice, certain malicious actors employ deepfake technology for purposes such as defamation, extortion, the incitement of social panic, or political manipulation, thereby infringing upon citizens’ lawful rights and interests, undermining corporate commercial reputations, and threatening public security. This functional transformation from technological innovation to technological abuse constitutes a critical juncture that legal regulation must precisely identify. It highlights the urgency of clearly delineating permissible boundaries of use in order to strike an appropriate balance between technological development and risk prevention.

From the perspective of industrial division of labor within the deepfake ecosystem, the chain of unlawful infringement may be analytically divided into three stages. The first stage concerns the illegal acquisition, sale, or unlawful provision of citizens’ personal information prior to the execution of deepfake activities. The second stage involves the unlawful use of deepfake technology and the improper production of deepfake content. The third stage consists of the subsequent utilization of such deepfake content to carry out a series of illegal or criminal acts, including fraud and defamation.

As of June 2025, China’s internet user population had reached 1.123 billion, with an internet penetration rate of 79.7% [3]. In the domain of personal information protection, the widespread adoption of the internet and the acceleration of digitalization have rendered issues of personal data leakage and illegal data transactions increasingly prominent. Data acquisition, as the initial link in the chain of unlawful conduct, constitutes the first stage of illegality determination. The relevant illegal acts typically manifest in two interrelated forms. The first involves the unauthorized and unlawful collection of citizens’ personal information, which directly violates the principle of legality in data collection. The second concerns the unlawful purchase, receipt, or solicitation of such information through transactional channels, giving rise to extended criminal chains involving the illegal sale and unlawful provision of personal data.

Generally speaking, the training of deepfake algorithms typically requires large volumes of authentic data in order to enhance the accuracy of model performance and the precision of generated content [4]. In practice, however, such data are often obtained without the lawful authorization of the data subjects. A substantial amount of personal information relating to target individuals constitutes the foundational material for the production of deepfake content. Accordingly, infringement of citizens’ personal information frequently represents the point of origin for the misuse of deepfake technology. Crimes targeting the security of citizens’ personal information may be regulated under the offense of infringing upon citizens’ personal information. [5].

Online platforms and mobile applications have become major channels for the collection of citizens’ personal information. Through these channels, actors may not only passively receive personal data voluntarily uploaded by users, but also actively collect various categories of user data. It is worth noting that, in practice,

improper collection of personal information commonly manifests in two principal forms. First, users are often compelled to passively accept platforms' data collection practices. Privacy authorization mechanisms employed by platforms and applications are typically embedded in standard-form contracts, under which users must accept predefined terms in order to access core functionalities. As a result, users' freedom of choice is substantially constrained. Moreover, such standard-form contracts are frequently lengthy and complex. Ordinary users rarely read them in full, and non-professionals generally lack the capacity to fully comprehend all contractual provisions, leading many users to upload personal information without an adequate understanding of the associated risks. Second, platforms frequently exceed reasonable and necessary limits in the collection of personal information. Online platforms and mobile applications often engage in excessive data collection, requesting access to user information that goes beyond what is required for the maintenance of their core functions. For example, a shopping application that requests access to a user's location data or contact list-despite the absence of a direct functional necessity-may be deemed to engage in excessive data collection. By aggregating large volumes of citizens' personal information, platforms and applications are able to extract significant commercial value from such data. At the same time, certain illicit actors seek to unlawfully obtain facial images, voiceprints, and other sensitive identifiers of target individuals-by means of illegal sale or provision, theft, or other unlawful methods-for use in the production of deepfake content, thereby infringing upon citizens' personal rights and interests [6].

With respect to the determination of illegality at the second stage-the production of deepfake content-a contextual and differentiated analysis is required. Where deepfake technology is used merely to replace a specific individual's facial features in audiovisual materials for personal use or for entertainment within a limited circle, issues of intellectual property infringement are set aside for present purposes. Such conduct does not infringe upon the lawful interests of the State, society, or other citizens, nor does it cause actual harm to legally protected interests or create a concrete risk thereof. Accordingly, it lacks the necessity for criminal regulation. Similarly, where facial substitution involving others is limited to ordinary forms of "parody" or "pranks" of a general nature, such conduct should not, in principle, be classified as criminal. By contrast, where deepfake technology is employed to produce or disseminate face-swapped pornographic images or videos, the conduct escalates into criminally relevant acts, potentially constituting offenses such as insult, defamation, or the dissemination of obscene materials. In judicial practice, it is therefore essential to draw a clear distinction between improper but non-criminal content production and genuinely illicit conduct, so as to prevent the excessive expansion of criminal law intervention and to safeguard the healthy development and reasonable application of artificial intelligence technologies within the criminal law framework.

Deepfake technology is primarily used in content creation, but creating such content without dissemination rarely infringes upon legal interests. Therefore, it is the use of deepfake technology to produce content that truly transforms potential risks into tangible harm [7].

2.2 Defining Deepfake-Related Fraud Offenses

Owing to its high degree of realism and low-cost replicability, deepfake technology provides fraud with unprecedented technical tools and implementation scenarios. It is precisely the close alignment between the technical characteristics of deepfakes and the internal logic of fraud that renders fraud the primary pathway through which the latent risks of deepfake technology are transformed into concrete harm. Structurally, fraud is characterized by an intent to unlawfully appropriate property and the use of deception premised on information asymmetry-features that allow it to fully exploit the controllable false information generated by deepfake technologies [8].

From a doctrinal perspective, deepfake-related fraud offenses may be defined as acts whereby an offender, with the intent of unlawful appropriation, employs deceptive means and incorporates deepfake technology as an instrumental component of the criminal scheme, thereby fraudulently obtaining public or private property of a relatively substantial amount. More specifically, such offenses encompass conduct in which the offender, for the purpose of unlawful appropriation and by using deepfake technology as an integral element of the criminal scheme, fabricates facts and engages in fraudulent acts that induce the victim to fall into a misconception. Acting on this misconception, the victim disposes of property, enabling the offender to obtain the property and causing the victim to suffer a corresponding property loss.

Such offenses may also arise where the offender, with the intent of unlawful appropriation, is aware that the conduct constitutes deepfake-enabled fraud and bears a clear duty of disclosure toward the counterparty, yet deliberately conceals the truth, thereby maintaining the victim's mistaken belief. In reliance on this continued misconception, the victim disposes of property, the offender obtains the property, and the victim incurs financial loss.

3. Typologies of Contemporary Deepfake-Enabled Fraud

3.1 Face-Swapping Fraud

Face-swapping fraud refers to the use of deepfake technology to replace the fraudster's facial image with that of a target individual—such as a relative, superior, or public figure—thereby generating highly realistic video-call visuals in real time. This technology relies on generative adversarial networks to accurately map facial expressions, muscular textures, and lighting details, causing victims to develop a false sense of trust based on what appears to be “seeing with one's own eyes.” Such fraud is often combined with social engineering techniques. Prior to the commission of the offense, perpetrators obtain information about the victim's social relationships through illicit channels and impersonate acquaintances to issue urgent requests for assistance or instructions for fund transfers, exploiting the strong psychological cues associated with visual trust to overcome victims' defenses.

3.2 Voice-Cloning Fraud

Voice-cloning fraud employs AI-generated technologies to collect, process, and manipulate samples of a victim's voice, producing audio segments that are virtually identical to the victim's original voice, often within a matter of minutes or even less. At present, this technology is relatively mature, features a low threshold for use, and demonstrates extremely high accuracy—reportedly reaching up to 99 percent—making it the most accurate among several generative modalities. Current artificial intelligence techniques are capable of replicating a person's intonation, speech rate, and accent with near-perfect fidelity. When combined with contextual simulation and signal interference, such forged voices become difficult for victims to distinguish from authentic ones. This form of fraud is particularly common in telephone scams, where perpetrators imitate the voices of familiar relatives or friends in order to induce victims into believing the deception.

3.3 Motion-Transfer Fraud

Motion-transfer fraud constitutes one of the principal forms of deepfake-enabled fraud. It relies on algorithmic techniques to capture and replace, in real time and with high precision, a specific individual's facial expressions, lip movements, eye gaze, and bodily actions. This type of fraud exhibits several defining characteristics. First, it features a high degree of technical concealment, as the generated video stream can be synchronized with audio and environmental contexts in real time, achieving an effect akin to “seamless grafting.” Second, it demonstrates strong interactive deceptiveness, as dynamic details such as nodding, smiling, and specific gestures can be simulated during video interactions, creating the appearance of “authentic” communication. Third, it is highly target-specific, typically requiring the prior acquisition of static images or limited dynamic footage of the target individual as raw material in order to carry out precision fraud. In the course of implementation, perpetrators primarily employ this technology to accomplish identity impersonation. For example, in scams involving the impersonation of acquaintances or superiors, offenders may transfer their own real-time facial expressions and lip movements onto the facial images of the victim's relatives or supervisors and conduct video calls under this false identity. In such scenarios, victims are highly likely to accept the counterparty's identity as genuine and consequently lower their level of vigilance.

The consequences of motion-transfer fraud extend beyond substantial financial losses and often entail profound emotional betrayal and psychological harm, as the deception originates from individuals who appear to be trusted figures “seen with one's own eyes.” At the societal level, this form of fraud significantly erodes the foundations of trust upon which social interactions depend—visual evidence no longer guarantees authenticity. Remote identity verification mechanisms thus face fundamental challenges, potentially giving rise to widespread identity security anxiety and markedly increasing the trust costs and risks associated with commercial transactions, remote work, and even familial communication. By algorithmically hijacking and

real-time manipulating micro-expressions, eye movements, and bodily postures in video content-including facial expression transfer and pose transformation-perpetrators can precisely map their own actions onto fabricated targets. This technology is capable of animating static facial images, enabling fraudsters to create the illusion of “live, real-person interaction” during video calls, thereby greatly enhancing the immersive quality and perceived credibility of the deception and making it difficult for victims to assess authenticity based on behavioral logic.

3.4 Fabricated-Scenario Fraud

Fabricated-scenario fraud employs background transfer and environmental synthesis techniques to seamlessly embed individuals into artificially constructed spatiotemporal settings, such as virtual studios, conference rooms, or press briefing venues, thereby creating false contexts imbued with authority and credibility. Typical applications include forged celebrity endorsement videos, fabricated expert recommendation footage, and falsified scenes of official announcements. By relying on “scenario endorsement” effects, this form of fraud enhances the perceived credibility of information, reduces victims’ critical thinking under contextual cues, and-when combined with fabricated identities and persuasive narratives-enables the multifaceted hijacking of brand reputation, consumer trust, and public cognition, with social harm spreading in a chain-like manner.

The core mechanism of this type of fraud lies in improving the efficiency of deception through the provision of highly realistic scenarios. By constructing virtual environments that appear authoritative, formal, or urgent, perpetrators activate audiences’ trust expectations typically associated with such settings. When coupled with fabricated identities and inductive narratives, this process completes a chain from contextual misdirection to behavioral manipulation. The resulting social harm exhibits a cascading pattern: it not only directly infringes upon individual property interests, but also undermines public trust in media, expert systems, and official channels, and in the long term may weaken society’s shared consensus and judgment concerning authenticity.

4. Characteristics of Deepfake-Enabled Fraud

Deepfake-enabled fraud exhibits three core characteristics: a low technical threshold combined with highly realistic forgery effects; a modularized criminal chain that leads to difficulties in tracing and attributing liability; and harmful consequences that extend from individual property losses to the erosion of the broader social trust system. Specifically, the accessibility and deceptiveness of the technology lower barriers to criminal participation and challenge traditional cognitive boundaries; the division of labor and cooperative structure within the criminal chain render perpetrators increasingly concealed and tracing accountability more difficult; and the precise and multidimensional methods of offending not only cause direct financial losses but also undermine society’s shared consensus on authenticity, giving rise to systemic crises of trust.

4.1 Low Technical Threshold and Highly Realistic Forgery Effects

The open-source nature and rapid diffusion of deepfake technology have significantly reduced the threshold for its use, enabling ordinary fraudsters to generate forged content that is difficult to distinguish with the naked eye even without advanced technical expertise. The striking realism of the generated outputs directly destabilizes the long-standing cognitive foundation of “seeing is believing,” thereby subjecting the credibility of traditional forms of evidentiary media-such as audio and video-to fundamental doubt. When technological accessibility converges with extreme realism, it effectively constructs an “infrastructure” for the proliferation of deepfake fraud, endowing such crimes with characteristics of low cost, high efficiency, and strong concealment. As demonstrated by joint research conducted by German and Italian scholars, untrained individuals are almost incapable of reliably distinguishing the authenticity of face-swapped videos. This further underscores the systemic impact of deepfake technology on public cognitive defenses and the structure of social trust.

4.2 The Composite Nature of Criminal Objects Involving Multiple Legally Protected Interests

Deepfake-enabled fraud departs from the traditional model of fraud that targets only property ownership as a single criminal object and instead exhibits a composite pattern involving the cumulative infringement of

multiple legally protected interests. By fabricating the identities and images of specific subjects-such as public officials, relatives, or celebrities-it simultaneously infringes upon citizens' personal information rights, portrait rights, and reputation rights, among other personality interests. Moreover, through the large-scale dissemination of fabricated crisis-related information, such conduct directly threatens public order in cyberspace and may even endanger national security. This expansion of the criminal object-from "individual property rights" to a combination of personality rights, property rights, and social administrative order-causes a single criminal act to implicate multiple categories of interests protected under criminal law. As a result, issues of statutory concurrence and offense classification become increasingly complex, significantly raising the difficulty of judicial determination.

4.3 Modularized Criminal Chains and Difficulties in Tracing and Attribution

In deepfake-enabled fraud, the criminal industry chain is tightly interconnected, rendering tracing and accountability particularly difficult. Fraudsters typically operate through a division-of-labor model, implementing criminal activities across multiple stages, including technical support, equipment management, algorithmic prediction, audience targeting, and the execution of fraudulent acts. The resulting industrialized fraud chain poses substantial challenges to fraud governance. In many cases, even when criminal elements at a particular stage are identified during investigation, it remains difficult to trace responsibility back to the actual organizers or planners. Furthermore, the quality of biometric data-illegally obtained or provided by personal information traffickers-directly determines the realism of forgeries and the success rate of fraud. Such acts of "data poisoning" should be regarded as co-perpetration in deepfake-enabled fraud rather than as independent offenses. In addition, network service providers may incur corresponding liability for omission where they fail to fulfill their information network security management obligations.

4.4 Deep Integration of Precision Inducement and Multidimensional Offending

Criminal methods have undergone a shift from indiscriminate "wide-net casting" to precise, individualized cognitive attacks. By using AI tools to scrape and analyze victims' social media data, perpetrators can accurately identify emotional vulnerabilities and economic conditions, enabling the customized design of fraudulent schemes and significantly increasing success rates. At the same time, this approach breaks away from traditional linear fraud models and constructs a multidimensional "point-line-network" structure: initiating deception through a single forged element, remotely directing operations through fabricated identities, and forming a networked diffusion pattern based on multi-level division of labor and cross-platform dissemination. This non-contact, distributed, and intelligent multidimensional architecture causes the social harm of such crimes to expand geometrically and substantially increases the difficulty of governance.

4.5 Extension of Harm from Individual Property Loss to the Collapse of the Social Trust System

Deepfake-enabled fraud not only results in direct financial losses, but also undermines habitual modes of thinking based on "seeing is believing" and "hearing is believing," thereby breaching individual psychological defenses and triggering a broader crisis of social trust. Once deepfake content is disseminated on a large scale in the absence of reliable identification technologies, the public may develop systemic skepticism toward all forms of audiovisual information, accelerating the transition into a so-called "post-truth era" [9]. This foundational erosion of consensus regarding authenticity far exceeds the destructive scope of traditional fraud and poses fundamental challenges to core social mechanisms, including judicial fact-finding, news dissemination, and interpersonal interaction.

5. Issues in Deepfake-Enabled Fraud Crimes

5.1 The Issue of Criminally Liable Subjects

Whether generative artificial intelligence can constitute a subject of criminal liability has become a highly debated issue in contemporary criminal law scholarship, both in China and abroad. In the context of deepfake technology, the question of whether criminal responsibility may be attributed to generative AI likewise warrants examination. Under the current criminal law framework, criminal liability is limited to natural persons

and legal entities, and generative artificial intelligence cannot qualify as a criminal subject. However, according to the doctrine of indirect perpetration, where an offender exploits a person lacking criminal capacity or criminal intent to carry out a crime in order to achieve their own criminal purpose, the principal nature of the offense lies in the user's control over the causal process of the crime through means such as coercion or deception, treating the exploited party as a tool of the offense. In the specific context of fraud committed through the use of deepfake technology, the so-called "constitutive object of the crime" generally refers to the material elements indispensable to the commission of the offense and forms part of the objective aspect of the crime. As the foregoing analysis indicates, deepfake-type fraud cannot be constituted without the use of deepfake technology. Accordingly, this article argues that even if deepfake technology is characterized not as a criminal tool but as a constitutive object of the offense, the individual who manipulates and controls it from behind may still be held liable as an indirect principal offender.

5.2 Issues in the Determination of Criminal Conduct

In deepfake-enabled fraud crimes, traditional forms of joint perpetration at the execution stage have decreased, while cooperative conduct at the preparatory stage has increased significantly. This structural shift primarily stems from the extensive scope of interests infringed by such crimes. Although deepfake-enabled fraud is characterized by a high degree of technical realism, its actual conversion rate is constrained by multiple factors, as not all individuals who come into contact with fraudulent content are deceived. To obtain a certain amount of criminal proceeds, offenders must therefore expand the pool of potential victims and cover as many targets as possible, thereby ensuring the success of fraud on a probabilistic basis. Moreover, the realization of such extensive infringement relies heavily on technological and large-scale preparatory conduct. This mainly includes the mass acquisition of data and materials, such as the collection of facial images, voiceprints, and social information of specific groups. These activities are often carried out through database intrusions or the scraping of publicly available information. In addition, the batch generation and dissemination of forged content require the use of automated tools to simultaneously produce personalized fraudulent materials targeting different individuals and to distribute them on a large scale through social networks, messaging groups, and similar channels. Given the substantial workload and diverse technical requirements involved, such tasks are difficult for a single individual to complete independently, thereby giving rise to a division of labor and cooperation at the preparatory stage centering on the acquisition of "raw materials," technical tools, and promotional channels.

As a result, deepfake-enabled fraud has come to exhibit a new pattern characterized by "cooperation at the preparatory stage and individualization at the execution stage." Traditional "joint execution" in accomplice liability has diminished, while upstream activities-such as material collection, model training, script drafting, and dissemination-are more likely to be organized and coordinated in the form of criminal groups.

For example, where A provides B with deepfake technology and instructs B on how to use it to commit fraud, including the transmission of criminal techniques, A may possess only abstract awareness regarding how B selects victims, the specific methods employed, and the extent of the resulting property losses. If B independently masters the relevant deepfake technology and carries out large-scale property crimes, causing substantial harm to numerous victims, the question arises as to whether A should bear criminal liability for all offenses as an instigator or an aider. Furthermore, if B upgrades the deepfake technology or updates the data during its use-transforming a model originally intended for fraud into one used for extortion, or significantly enhancing the conversational scripts to increase deceptiveness and harmfulness-this raises the issue of whether such conduct constitutes an excess in execution. For instance, where A connects a chat-based generative AI interface to the WeChat platform, preconfigures it to simulate customer service for loan-related business, and requires users to transfer RMB 5,000 to a designated account, but the AI system "exceeds" the assigned task during actual operation and fraudulently obtains as much as RMB 50,000, this article argues that A possesses an abstract and general intent regarding the amount of fraud (indirect intent). If A in fact receives the entire RMB 50,000 in illicit proceeds, indirect intent may be established for the full amount. However, if B, without A's knowledge, improves the deepfake technology and obtains the excess proceeds, the portion exceeding RMB 5,000 should be regarded, with respect to A, as an excess in execution, and A should be held criminally liable as a joint offender only within the amount of RMB 5,000.

5.3 Issues Concerning Platform Regulatory Responsibility

Progress in collaborative governance between platforms and government authorities remains slow. Significant disparities exist among platforms in terms of the completeness and granularity of their internal regulatory frameworks. Following the implementation of the *Measures for the Labeling of Artificial Intelligence–Generated and Synthetic Content*, some platforms have still failed to update their user agreements in a timely manner, reflecting a lag in responding to national governance requirements.

Platforms further exploit their structural advantages to evade liability for harms arising from the misuse of technology. Through standard-form contractual clauses, platforms explicitly exclude their responsibility for risks associated with relevant content. User agreements across platforms commonly assign all losses caused by deepfake content exclusively to content creators and disseminators. For example, Article 14 (“Disclaimer”) of the Douyin User Agreement expressly states that the platform provides no guarantees with respect to risks encountered during user activities and strictly limits its own compensation liability. Such “liability exemption” clauses weaken the institutional protection of user rights and are inconsistent with the social responsibilities that platforms, as governors of content ecosystems, ought to bear.

Platforms have also failed to adequately fulfill their duty of risk disclosure. Regulatory standards for the processing of sensitive data, such as users’ facial information, remain insufficient, resulting in inadequate protection of individual rights. At present, video recording and live streaming have become standard features on short-video platforms, and the activation of embedded AI effects typically triggers the platform’s access to users’ facial data and its upload to servers. Research indicates that only Bilibili (B站) explicitly and comprehensively discloses in its privacy policy that it accesses users’ sensitive personal information. Other platforms lack such disclosures in relation to users’ engagement with AI effects. This absence of adequate notification makes it difficult for users to clearly perceive the boundaries of their data rights and further impedes their ability to guard against potential harms arising from data misuse.

5.4 Issues Concerning the Standards for Identifying Deepfake-Enabled Fraud

At present, the number of adjudicated cases available for research on deepfake-enabled fraud remains limited, while media reports on such fraud are frequent, indicating a high incidence of related crimes. With respect to whether conduct involving deepfakes constitutes fraud, the principal difficulty in current legal determination lies in the following question: If A commits acts such as infringing upon citizens’ personal information or improperly creating deepfake works prior to using synthetic works to commit fraud, should the multiple offenses be treated as a single, more serious crime under the principle of selecting the most severe punishment, or should they be punished cumulatively? The academic community has yet to reach a consensus.

6. Criminal Law Regulatory Pathways for Deepfake-Enabled Fraud

6.1 Building a Comprehensive Legal and Regulatory Framework to Achieve Ex Ante Legal Safeguards

In response to the technological characteristics of deepfake-enabled fraud, it is necessary to promote a moderate expansion in the interpretative application of the existing statutory provisions on fraud [5] Through judicial interpretations, the use of “highly deceptive AI-generated audio-visual materials, images, and similar synthetic content” may be expressly incorporated into the forms of “fabricating facts or concealing the truth,” thereby achieving substantive congruence with the constituent elements of fraud under Article 266 of the Criminal Law. At the same time, face-swapping conduct undertaken for different purposes—such as extortion, reputational harm, or illicit financial gain—should be distinguished and addressed under the corresponding offenses, including defamation, insult, and extortion, so as to ensure precise and differentiated criminal punishment. Furthermore, in light of the “non-human” characteristics of AI-based deepfake conduct, it is necessary to explore the introduction of corporate criminal liability or a framework of accomplice liability for entities in platform-based participation (such as platforms providing automated content synthesis services). Such reforms would help fill the existing accountability gaps arising from claims of platform neutrality in criminal law. Meanwhile, for abusive uses of deepfake technology that do not reach the threshold of

criminalization, appropriate coordination should be ensured through civil law, administrative law, and other relevant branches of law to provide a coherent and layered regulatory response.

6.2 Constructing Intelligent Adjudication Systems and Exploring Governance Pathways for Fraud Offenses

The introduction of artificial intelligence–assisted mechanisms into the field of judicial adjudication holds significant value. Against the backdrop of rapid technological evolution, the integration of generative artificial intelligence is of critical importance for advancing the intelligent transformation of judicial proceedings. At present, judicial systems around the world are actively exploring AI system architectures compatible with their respective institutional frameworks. The application of generative AI technologies is expected to bring about profound changes in the standardization of adjudicative criteria, thereby effectively promoting judicial fairness, enhancing the efficiency of criminal punishment, reducing the likelihood of wrongful convictions, and exerting a preventive deterrent effect on the formation of criminal intent in fraud-related offenses. In China’s judicial practice, preliminary attempts have already emerged in which local courts employ algorithmic technologies to assist adjudication, some focusing on the intelligent handling of specific categories of cases, while others utilize element-based analytical models to promote the standardization of criminal case processing. Looking ahead, with further technological maturation and the improvement of supporting institutional arrangements, the application of generative AI within judicial processes is expected to expand gradually.

To further optimize the functional deployment of artificial intelligence within the judicial system, systematic development should be advanced along the following dimensions. First, efforts should be made to promote the systematic integration and high-quality accumulation of judicial data resources, with the aim of constructing a comprehensive database of judicial activities. The development of generative AI relies fundamentally on learning and training based on large-scale, structured data. Only by systematically aggregating various types of information on illegal and criminal conduct, judicial decisions, and outcomes of legal application into a unified platform can the accuracy and adaptability of intelligent analysis in fraud cases be continuously enhanced. Second, coordination mechanisms among judicial authorities should be strengthened by establishing cross-departmental information-sharing and operational linkage systems. In responding to emerging forms of fraud, while adjudicative authority resides with the courts, investigative and prosecutorial stages involve public security organs and procuratorial authorities, respectively. It is therefore necessary to build an AI-enabled collaborative platform that connects all case-handling bodies, optimizes the allocation of judicial resources, integrates multi-source information generated throughout the entire case-handling process, and breaks down data silos between institutions. Third, the level of awareness and practical competence of judicial personnel in relation to artificial intelligence technologies should be enhanced. In the face of rapid technological advancement and the continuous evolution of criminal forms, judicial practitioners must maintain an ongoing update of their knowledge structures. This is both an intrinsic requirement for professional development and a practical necessity for addressing new types of criminal challenges. Without a basic understanding of and operational capacity in generative AI technologies, case-handling personnel may be unable to fully leverage the auxiliary functions of technological tools, thereby affecting judicial quality and efficiency. Accordingly, the judicial workforce should proactively adapt to digital transformation and strengthen its mastery of emerging technologies and specialized knowledge, so as to enhance its capacity to perform judicial functions in an environment of technological integration.

6.3 Establishing Consent as the Governing Principle with Explicit Exception Clauses

Where deep synthesis technologies involve natural persons’ biometric identifiers, such as facial images or voiceprints, an authorization mechanism centered on *informed consent* must be firmly established. That is, the collection and use of biometric data shall be permitted only upon obtaining the explicit consent of the data subject, and such consent must be given voluntarily, free from any form of coercion or disguised compulsion. At the same time, even where consent has been obtained, certain categories of conduct should remain prohibited. Research and development activities involving deep synthesis technologies must comply with ethical standards; in particular, the development of high-risk products or services should be subject to prior ethical review procedures. Entities engaged in the production and dissemination of deep synthesis content are strictly prohibited from employing such technologies for unlawful purposes, including political manipulation, dissemination of obscene or pornographic content, and identity impersonation. Apart from the aforementioned

absolute prohibitions, producers and disseminators of deep synthesis content must refrain from misleading the public in their use of such content, a requirement that corresponds to the obligation of conspicuous labeling discussed above. For example, where an artificial intelligence entity interacts with the public for commercial or political purposes, it must proactively disclose its AI-generated nature. In addition, online platforms—particularly social media platforms—should bear heightened supervisory responsibilities, including the establishment of mechanisms for identifying false information, strengthening content moderation, verifying whether user-generated content has been duly labeled as deep synthesis content, and fulfilling their duties to identify and block unlabeled content that may endanger national security or the public interest.

6.4 Promoting a Joint “Platform–Government” Regulatory Model

The abuse of digital deepfake technologies infringes upon multiple legal interests and therefore requires coordinated regulation involving multiple governmental departments and industries at the national level. In order to effectively address the regulatory complexity and highly variable application scenarios of deepfake-related misinformation, a “hub-and-spoke” regulatory model may be adopted, under which the respective supervisory responsibilities of governmental authorities are clearly defined and regulatory boundaries are rationally allocated. Under this model, the Ministry of State Security functions as the central hub, with key participating bodies including the Central Propaganda Department, the Cyberspace Administration of China, the Ministry of Public Security, and the National Radio and Television Administration. Regulatory authorities should clearly delineate the legal “red lines” governing the use of deepfake technologies by online users. At the same time, China may consider incorporating specific provisions on the regulation of deepfake misinformation into the *Data Security Law*, so as to enhance regulatory specificity and inter-agency coordination.

China may further clarify the periodic reporting obligations of digital platforms, thereby correcting existing asymmetries of information and authority between platform self-regulation and governmental supervision, while preserving necessary regulatory flexibility. Products and services based on deep synthesis technologies are characterized by rapid dissemination and wide social impact. Once misinformation arises, both the scope and intensity of its effects can be substantial. From the platform perspective, effective remedial mechanisms must therefore be in place. Where social misunderstanding occurs, platforms should provide convenient and efficient means for clarification and debunking. Such debunking responsibilities should primarily rest with content publishers or the relevant platforms; additionally, consideration may be given to enabling social organizations or government-established online platforms to undertake clarification and explanatory functions, so as to minimize the adverse social consequences caused by misinformation.

Platforms and governmental authorities may also establish a tiered and categorized regulatory framework. Given the rapid development of deep synthesis technologies and the complexity of their application scenarios, it is inappropriate to adopt a uniform, undifferentiated regulatory approach. Instead, deep synthesis technologies, products, and services should be subject to graded and classified management. Within the industry, trade associations and enterprises may participate deeply in governance efforts, assisting regulatory authorities in jointly formulating classification standards for technologies and products, thereby enabling differentiated regulation.

A dual content-labeling system should be constructed as an integral component of platform regulation. Existing norms require deep synthesis service providers to apply specific labels to the information content they generate. Such labels may be divided into two primary forms. The first is traceability labeling, which aims to ensure that synthesized content distributed or disseminated online possesses identifiable sources and traceable dissemination paths, thereby facilitating content tracking by service providers and enabling the identification of the original synthesis entity in cases of dispute or source verification. The second is conspicuous disclosure labeling, which requires that the public be clearly and perceptibly informed that the content has been generated through deep synthesis technologies, thereby alerting audiences to potential issues of authenticity and accuracy and preventing associated legal and ethical risks. Specifically, for image-based content, explicit disclosure may follow practices analogous to copyright attribution; for audio content, clear verbal statements should be provided at the beginning and end of the audio track (for example: “This audio has been generated using deep synthesis technology and is not an original recording”).

7. Conclusion

The iteration and application of deepfake technologies have transcended their role as mere tools, becoming a significant variable in reshaping social trust structures and legal governance paradigms. Focusing on fraud as the regulatory lens, this paper systematically elucidates the technical enabling mechanisms and criminal risk spectrum of deepfake technologies within the criminal chain, revealing their characteristic features: “low threshold-high realism-precision-modularity-multidimensionality-broad societal diffusion,” as well as the extension of consequences from individual property harm to erosion of the social trust system. Faced with multiple challenges-including ambiguous identification of criminal subjects, complex forms of joint offenses, imbalanced allocation of platform responsibilities, and difficulties in characterizing conduct-reliance on criminal law alone is insufficient, necessitating a shift toward a coordinated “legislation–judiciary–platform–society” governance framework.

At the legislative level, it is essential to promote interpretative adjustments to the elements of fraud, clarifying the correspondence between technological misuse and the infringement of legal interests. At the judicial level, intelligent adjudication support systems should be established to enhance the efficiency of case recognition and the consistency of rulings. In terms of platform governance, dual constraints of content labeling and informed consent should be reinforced, establishing the principle of “consent as default, prohibition as exception.” Within regulatory mechanisms, a “platform–government” hub-and-spoke coordination model should be explored to achieve a dynamic balance between technological development, risk prevention, and rights protection. These pathways provide not only an interpretative framework and institutional reference for the criminal law response to deepfake-enabled fraud but also offer cross-domain perspectives for the theoretical construction and practical innovation of new crime governance in the AI era.

Looking forward, as deep synthesis technologies evolve toward immersive, real-time, and personalized applications, the risks of misuse are expected to become more covert and diffuse. Criminal regulation must remain open and forward-looking, continuously monitoring technological evolution and changes in criminal modalities, in order to seek a dynamic equilibrium between safeguarding innovation and preventing social risks. Only through multidisciplinary dialogue, inter-agency collaboration, and globalized governance can a digital social rule system be established in which technology serves the public good, legal principles are clear, and rights and responsibilities are well defined, thereby fortifying the rule-of-law defenses in the post-truth era.

References

- [1] Bao, Y. X., Lu, T. L. and Du, Y. H. Overview of deepfake video detection technology. *Computer Science*. 2020, 47(09), pp. 283-292. <https://doi.org/10.11896/jsjcx.200400130>.
- [2] Zou, Y., He, Y. X. and Zhou, A. C. Generative AI collaborative creation: An innovative path for developing new productivity in the audiovisual industry. *China Television*. 2024(6), pp. 91-98. <https://doi.org/10.3969/j.issn.1002-4751.2024.06.019>.
- [3] website, C. I. N. I. C. C. o. The 56th Statistical Report on Internet Development in China. *Media Forum*. 2025(15), p. 121. <https://doi.org/10.3969/j.issn.2096-5079.2025.15.038>.
- [4] Li, H. On the criminal responsibility about the abuse of personal biometric information: Taking artificial intelligence "Deepfake" as an example *Tribune of Political Science and Law*. 2020, 38(04), pp. 144-154.
- [5] Li, M. The criminal regulation approach to deep fake technology abuse. *Law-Based Society*. 2021(6), pp. 40-47,73. <https://doi.org/10.19685/j.cnki.cn11-2922/n.2021.06.005>.
- [6] Ye, X. B. Personal information protection in the context of generative artificial intelligence: Paradigm shift and rule improvement. *The Jurist*. 2025(04), pp. 61-73+192. <https://doi.org/10.16094/j.cnki.1005-0221.2025.04.004>.

- [7] Zheng, G. J. Regulatory logic and governance pathways: Criminal law responses to the abuse of deepfake technology. Science of Law(Journal of Northwest University of Political Science and Law). 2025, 43(3), pp. 56-68. <https://doi.org/10.16290/j.cnki.1674-5205.2025.03.009>.
- [8] Yao, Z. W. and Li, Z. L. Legal regulations governing AI fraud. Nomocracy Forum. 2023(04), pp. 301-308.
- [9] Zhang, T. Legal risks and regulation of deepfakes in the post-truth era. E-Government. 2020(4), pp. 91-101. <https://doi.org/10.16582/j.cnki.dzzw.2020.04.009>.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

The Impact of the Digital Economy on Income Inequality

Jingwen Zhang*

School of Economics, Shandong University, Jinan, 2500009, China

**Corresponding author: Jingwen Zhang*

Abstract

This paper employs a univariate linear regression model to examine the impact of the digital economy on income inequality, using provincial panel data from 2010 to 2023 obtained from the National Bureau of Statistics of China. Robustness checks are conducted using the number of internet broadband access ports, and heterogeneity analyses are carried out from the perspectives of different time periods, regions, and the urban–rural dual structure. The main findings are as follows. First, the digital economy plays a mitigating role in income inequality. Second, following China’s proposal of the urban–rural integrated development strategy in 2017, the inequality-reducing effect of the digital economy has become more pronounced. Third, the mitigating effect of the digital economy is stronger in Northeast and Western China, while it is relatively weaker in Eastern and Central China. Fourth, the digital economy in urban areas has a stronger alleviating effect on income inequality. Based on these findings, this study further emphasizes that the government should strengthen digital economy infrastructure development, establish mechanisms for two-way data flows between urban and rural areas, leverage digital technologies to empower the transformation and upgrading of old industrial bases in Northeast China and the development of the green economy in Western China, and enhance digital awareness campaigns in rural areas as well as regulatory oversight of digital industries in urban areas.

Keywords

digital economy, income inequality, regression analysis, heterogeneity analysis, robustness test

1. Introduction

The digital economy is a new form of economic activity that relies on data as a key factor of production, digital technologies, and modern information networks. Through the deep integration of digital technologies with the real economy, it drives the digitalization, networking, and intelligent transformation of economic and social systems, while reshaping patterns of economic development and governance. Since China achieved full functional access to the international internet in 1994, the digital economy has experienced rapid growth. By 2023, the overall scale of China’s digital economy had reached 55.4 trillion yuan, ranking second globally for several consecutive years and accounting for 47.1 percent of GDP.

However, in the era of the digital economy, China still faces a relatively serious problem of income inequality. As of 2024, China’s overall Gini coefficient had reached 0.47, exceeding the internationally recognized warning threshold of 0.4. Official data from 2023 indicate that the average monthly income of high-income groups is approximately 10.5 times that of low-income groups, further demonstrating the persistence of a substantial income distribution gap in China.

Accordingly, this study seeks to address the following questions: Does the development of the digital economy generate income effects? Does digital economy development exacerbate income inequality in China? How can the digital economy be leveraged to advance China's goal of common prosperity?

In light of these considerations, this paper conducts an empirical analysis of the impact of the digital economy on income inequality. Based on an accurate assessment of China's current conditions, it employs macro-level data from 2010 to 2023 and applies a univariate linear regression model. Robustness tests and heterogeneity analyses are further conducted to derive more comprehensive and reliable conclusions.

2. Literature Review

The body of literature most closely related to this study examines the impact of the digital economy on income inequality from a macro-level perspective. Yibing Ding et al. [1] argue that the digital economy represents a new wave of technological revolution and industrial transformation, exerting profound effects on the income distribution structure. Xiumei Wang et al. [2] find that the digital economy mitigates income inequality among farmers. Kai Yang et al. [3] suggest that the impact of the digital economy on urban–rural income inequality exhibits significant regional heterogeneity. Han Bu et al. [4] show that the development of the digital economy in Eastern China has a stronger effect on labor income inequality. Xingjian Yi et al. [5] contend that the digital economy improves residents' income inequality through channels such as the expansion of social networks. Ting Chen [6] argues that the exacerbation of income inequality inhibits the expansion of the digital economy.

From a micro-level perspective, studies examining the effects of firms' digital transformation on income inequality are also closely related to this paper. Rongji Wang and Jue Wang [7] find that digital transformation significantly reduces income inequality within firms. Fangzhuo Li et al. [8] argue that narrowing the digital capability gap can alleviate the inequality-widening effect of digital transformation on labor income. Shaoxuan Zhai and Xinran Wang [9] demonstrate a U-shaped nonlinear relationship between digital transformation in manufacturing and intra-firm wage disparities.

In addition, some studies explore income inequality from multiple dimensions, including digital literacy, digital rural development, and the development of digital services. Zizhen Zhang [10] finds that improvements in digital literacy help reduce urban–rural income inequality, with a stronger equalizing effect in rural areas. Bochi Sun and Han Yin [11] argue that digital rural development has widened income inequality among rural households, with the income-increasing and gap-widening effects of rural economic digitalization being the most pronounced. Xinze Li et al. [12] find that digital rural development mainly narrows income disparities within rural areas by increasing entrepreneurial opportunities and expanding non-agricultural employment. Dongming Zhang and Huaying Li [13] suggest that the development of digital services trade helps reduce the income share of high-income groups while increasing the income share of middle-income groups.

Based on the above literature, this paper may offer the following contributions. First, the research topic is highly time-sensitive, focusing on the socially salient issue of the digital economy and its impact on income inequality. Second, the research methodology has practical relevance. Against the backdrop of the rapid development of the digital economy in China from 2010 to 2023, this study analyzes income inequality in China with particular attention to the urban–rural dual structure and the effects of urban–rural integration. It thus carries important practical significance and provides China's experience for other countries actively developing their digital economies. Third, the study employs comprehensive and up-to-date data, covering the period from 2010 to 2023 and encompassing 31 provinces, municipalities, or autonomous regions in China.

3. Stylized Facts of China's Digital Economy and Income Distribution

Figure 1 illustrates the urban–rural gap in the development of China's digital economy, measured by the ratio of broadband access users in urban areas to those in rural areas. From a trend perspective, between 2010 and 2023 this ratio shows a clear downward trajectory, indicating a continuous narrowing of the urban–rural digital economy gap in China. From a growth-rate perspective, during 2010–2012, alongside the rapid expansion of mobile communications and broadband networks, the urban–rural digital gap declined at a relatively fast pace. Between 2013 and 2018, as network hardware penetration approached saturation and the marginal effects of network installation diminished, the pace of gap reduction slowed. During 2019–2023,

owing to the impact of the COVID-19 pandemic and the persistence of disparities in network usage capabilities, the rate of decline in the urban–rural digital economy gap approached zero.

Figure 2 depicts the evolution of the number of internet users in China, thereby reflecting the overall development trajectory of the national digital economy. From a trend perspective, the number of internet users in China increased steadily from 1997 to 2024, indicating continuous expansion of internet development. From a growth-rate perspective, between 1997 and 2006 the number of internet users grew at a relatively slow pace. From 2007 to 2024, however, the pace of growth accelerated markedly with the advent and diffusion of new-generation information technologies.

Figure 1: Urban–Rural Gap in the Development of China’s Digital Economy

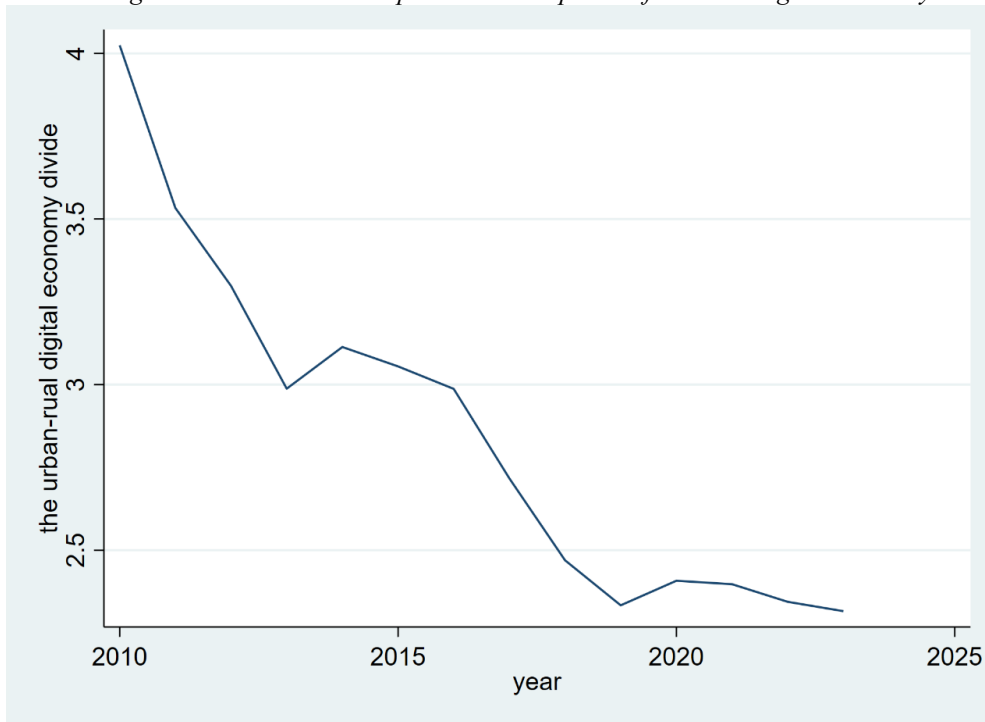


Figure 2: Number of Internet Users in China

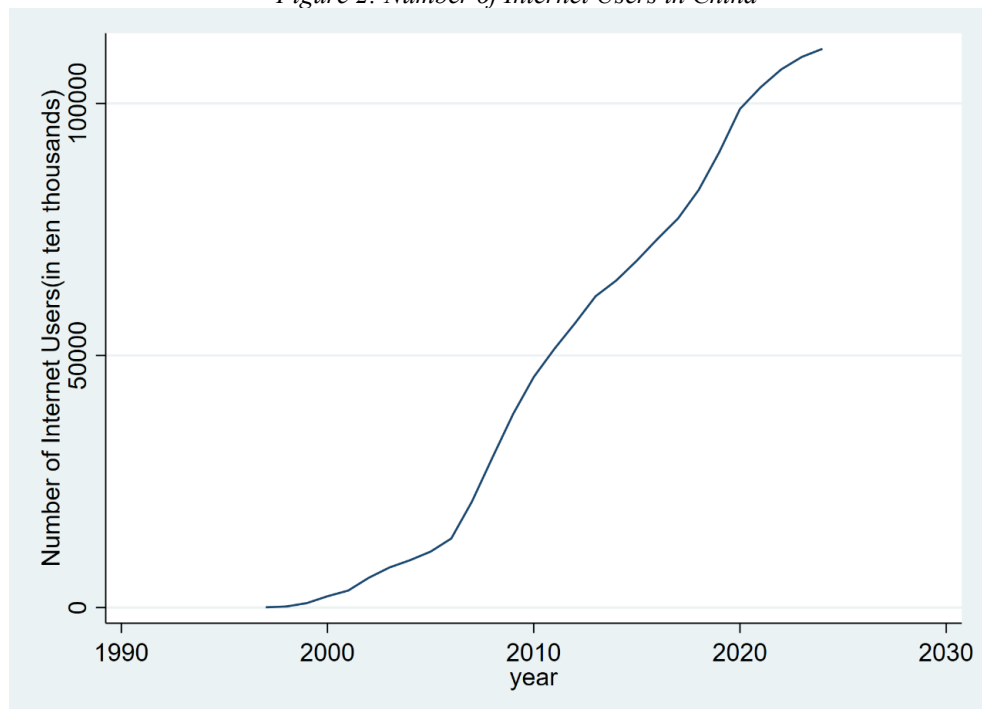


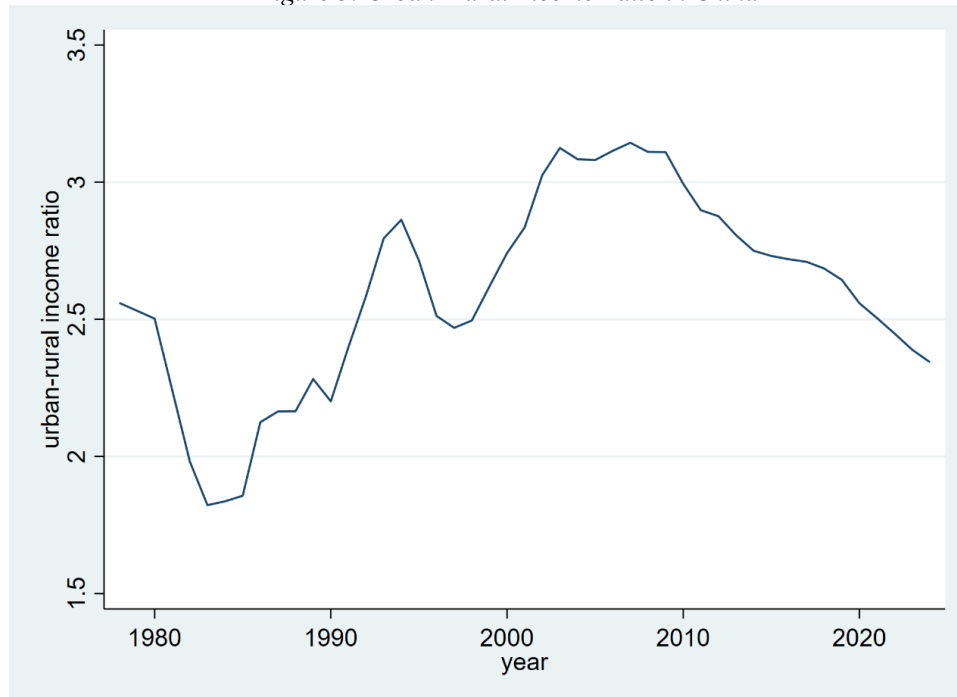
Figure 3: Urban–Rural Income Ratio in China

Figure 3 presents the urban–rural income gap in China, measured by the ratio of per capita disposable income of urban residents to that of rural residents. From a trend perspective, during 1978–1984 the urban–rural income ratio declined, indicating an easing of income inequality. From 1984 to 2004, the ratio fluctuated upward, while from 2004 to 2024 it declined again, suggesting a renewed narrowing of the urban–rural income gap. From a growth-rate perspective, the urban–rural income ratio changed relatively rapidly during 1978–2004, but declined more slowly during 2004–2024. Notably, after 2004 the pace of change in the urban–rural income ratio slowed substantially while exhibiting a downward trend. This suggests that following the Lewis turning point, the urban–rural income gap further narrowed.

Figure 4 illustrates the evolution of the Gini coefficient of residents' per capita disposable income, thereby providing additional insight into the trajectory of income inequality in China. From a trend perspective, during 2003–2008 the Gini coefficient fluctuated upward, indicating a worsening of income inequality. Between 2009 and 2014, the Gini coefficient declined sharply, reflecting a significant alleviation of income inequality. From 2015 to 2024, it rose again slowly with fluctuations and gradually stabilized, indicating that relative income disparities did not change markedly during this period. From a growth-rate perspective, during 2003–2014, alongside rapid industrialization and urbanization in China, changes in the Gini coefficient were swift and income inequality exhibited considerable volatility. From 2015 to 2024, as China's economic growth shifted from high-speed to medium-high-speed growth, the rate of change in the Gini coefficient of residents' per capita disposable income also slowed.

Figure 4. Gini Coefficient of Per Capita Disposable Income of Chinese Residents



4. Research Design

4.1 Variable Selection

The dependent variable in this study is income inequality, proxied by the ratio of per capita disposable income of urban residents to that of rural residents. The key independent variable is the digital economy, measured by the number of internet broadband access users. In addition, the number of internet broadband access ports is used for robustness checks, while per capita disposable income of urban residents and per capita disposable income of rural residents are employed to conduct social heterogeneity analyses.

4.2 Data Sources

The empirical analysis is based on a panel of 31 provinces, municipalities, or autonomous regions in China, with an observation period spanning from 2011 to 2023. All data are obtained from the National Bureau of Statistics of China. Descriptive statistics are reported in Table 1. All variables are standardized using logarithmic transformation and inverse hyperbolic sine (IHS) transformation. A small number of missing observations are supplemented using linear interpolation.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Per capita disposable income of urban residents (yuan)	403	35152	13194	15707	89477
Per capita disposable income of rural residents (yuan)	403	14508	6753	4278	42988
Internet broadband access users (10,000 households)	403	1172	1026	12.80	4824
Income inequality	403	2.538	0.384	1.794	3.672
Internet broadband access ports (10,000 ports)	403	2317	1957	26.70	10395
Urban broadband access users (10,000 households)	403	843.5	693.8	12.80	3704
Rural broadband access users (10,000 households)	393	336.5	360.7	0	1577

4.3 Model Specification

This study adopts a univariate linear regression model, specified as follows:

$$Y = \alpha X + \beta + \varepsilon \quad (1)$$

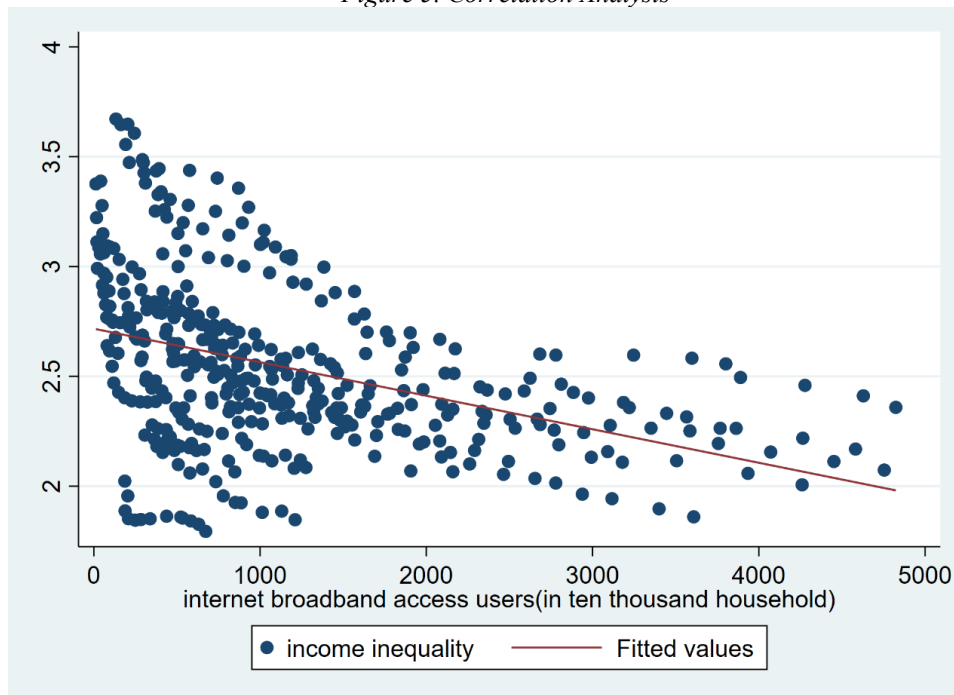
where Y denotes the dependent variable, income inequality; X represents the core explanatory variable, digital economy development; and ε is the random error term.

5. Empirical Analysis

5.1 Correlation Analysis

Figure 5 illustrates the relationship between income inequality and the digital economy. A preliminary inspection of the trend suggests that the ratio of per capita disposable income between urban and rural residents declines as the number of internet broadband access users (per 10,000 households) increases. In other words, income inequality appears to ease alongside the development of the digital economy. Nevertheless, the relationship between income inequality and the digital economy requires further verification through regression analysis, which is undertaken in this study.

Figure 5. Correlation Analysis



5.2 Baseline Regression

Model (1) in Table 2 reports the main regression results on the effect of internet broadband access users on the urban–rural per capita disposable income ratio. Specifically, the estimated coefficient of the core explanatory variable is -0.2624 , which is statistically significant at the 1 percent level. These results provide preliminary evidence that, with respect to income inequality, the digital economy currently exerts an overall negative effect—that is, the development of the digital economy can effectively mitigate income inequality.

Table 2: Baseline Regression, Robustness Check, and Time Heterogeneity Analysis

	(1)	(2)	(3)	(4)
	Baseline	Robustness check	Before 2017	After 2017
x	-0.2624^{***}	-0.2386^{***}	-0.2380^{***}	-0.4671^{***}
	(-37.5804)	(-29.7654)	(-17.1974)	(-28.7721)
cons	4.2778^{***}	4.2891^{***}	4.1198^{***}	5.7297^{***}
	(56.1167)	(51.2555)	(38.5771)	(44.2033)
N	403	403	186	217
R2	0.7928	0.7040	0.6538	0.8400

Note: $***$, $**$, and $*$ indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Values in parentheses are z-statistics. The same notation applies hereafter.

5.3 Robustness Check

To assess the stability and reliability of the baseline regression results, this study conducts a robustness analysis by replacing the measure of the digital economy. Specifically, the number of internet broadband access ports is used to substitute for the core explanatory variable-the number of internet broadband access users. The empirical results reported in Model (2) of Table 2 show that after replacing the digital economy indicator, its effect on income inequality remains significantly negative, confirming the robustness of the baseline model.

5.4 Heterogeneity Analysis

5.4.1 Time Heterogeneity Analysis

Using the introduction of the urban–rural integrated development strategy in 2017 as a temporal breakpoint, this study divides the sample period into two subperiods to conduct a time heterogeneity analysis. Models (3) and (4) in Table 2 report the regression results of internet broadband access users on the urban–rural per capita disposable income ratio for 2011–2017 and 2017–2023, respectively. The estimated coefficients of the explanatory variable are -0.2380 and -0.4671 , both of which are significantly negative at the 1 percent level. These results indicate that throughout 2011–2023, the digital economy exerted an inhibiting effect on income inequality in China, and that this effect became stronger after the proposal of the urban–rural integrated development strategy in 2017. This suggests that the 2017 strategy effectively amplified the inequality-reducing effect of the digital economy.

5.4.2 Regional Heterogeneity Analysis

Following the classification method of the National Bureau of Statistics in 2011, this study divides China's provinces into four major regions-Eastern, Central, Western, and Northeastern China¹-to examine regional differences in the impact of the digital economy on income inequality. Models (1)–(4) in Table 3 report the regression results of the number of internet broadband access users on the urban–rural per capita disposable income ratio in Eastern, Central, Western, and Northeastern China, respectively. The estimated coefficients are -0.2185 , -0.2068 , -0.2900 , and -0.3789 , all of which are significantly negative at the 1 percent level. These findings indicate that, in China, the inequality-reducing effect of digital economy development is strongest in Northeastern China, followed by Western China, and relatively weaker in Central and Eastern China.

5.4.3 Social Heterogeneity Analysis

Taking China's inherent urban–rural dual structure into account, this study distinguishes between urban and rural digital economy development to examine social heterogeneity in the impact of the digital economy on income inequality. Models (5) and (6) in Table 3 report the regression results of the number of internet broadband access users on per capita disposable income in urban and rural areas, respectively. The estimated coefficients are -0.2883 for urban areas and -0.1456 for rural areas, both statistically significant at the 1 percent level. These results suggest that, compared with rural areas, the development of the digital economy in urban areas has a stronger mitigating effect on income inequality in China.

Table 3: Regional and Social Heterogeneity Analysis

	(1)	(2)	(3)	(4)	(5)	(6)
	Eastern	Central	Western	Northeastern	Urban	Rural
x	-0.2185^{***}	-0.2068^{***}	-0.2900^{***}	-0.3789^{***}	-0.2883^{***}	-0.1456^{***}
	(-20.1047)	(-17.5572)	(-25.4860)	(-10.5350)	(-36.5916)	(-24.1223)
_cons	3.8296^{***}	3.8986^{***}	4.6369^{***}	4.7211^{***}	4.5715^{***}	3.3583^{***}
	(36.3395)	(37.5400)	(41.8556)	(18.6380)	(55.8782)	(45.9852)
N	130	78	156	39	403	403
R2	0.7904	0.8103	0.8264	0.8070	0.7839	0.6159

¹ The Eastern region includes Beijing, Hebei, Tianjin, Shandong, Shanghai, Jiangsu, Zhejiang, Guangdong, Hainan, and Fujian (10 provinces or municipalities). The Central region comprises Inner Mongolia Autonomous Region, Shanxi, Henan, Anhui, Jiangxi, Hubei, and Hunan (7 provinces). The Western region includes Xinjiang Uygur Autonomous Region, Tibet Autonomous Region, Gansu, Qinghai, Sichuan, Yunnan, Guangxi Zhuang Autonomous Region, Ningxia Hui Autonomous Region, Guizhou, Chongqing, and Shaanxi (11 provinces or municipalities). The Northeastern region consists of Heilongjiang, Jilin, and Liaoning (3 provinces).

6. Conclusion

Based on the empirical results presented above, this study finds a negative relationship between the development of China's digital economy and income inequality. When the sample period is divided into different time intervals, the inequality-reducing effect of the digital economy becomes significantly stronger after the introduction of the urban–rural integrated development strategy in 2017. From a regional perspective, digital economy development exerts the strongest mitigating effect on income inequality in Northeastern China, followed by Western China, while the effects are relatively weaker in Central and Eastern China. From the perspective of China's urban–rural dual structure, the development of the digital economy in urban areas has a greater alleviating effect on income inequality than that in rural areas. Overall, these findings indicate that the digital economy helps to reduce income inequality in China, with its effects being particularly pronounced in Northeastern and Western regions, after 2017, and in urban areas.

The policy implications of these conclusions can be summarized as follows. First, given the inequality-reducing role of the digital economy, the government should strengthen the construction of digital economy infrastructure and improve mechanisms for the allocation of data as a factor of production and the functioning of data markets. Second, it is necessary to establish a “two-way circulation mechanism for urban–rural data factors” to promote coordinated digital transformation of urban and rural industries and accelerate urban–rural integrated development. Third, policies should be tailored to local conditions. In Northeastern China, the digital economy should be leveraged to empower the revitalization of old industrial bases and promote innovation and upgrading in the secondary sector, while in Western China efforts should be intensified to upgrade western nodes of the “East Data, West Computing” project and foster green, digitally enabled industries. Fourth, greater emphasis should be placed on enhancing digital economy awareness in rural areas to bridge the digital knowledge gap, while strengthening regulatory oversight of digital economy–related industrial flows in urban areas and improving regulatory frameworks.

Although this paper focuses on the impact of the digital economy on income inequality in China, it does not account for the potential effects of the digital economy on occupational income inequality. Future research may therefore explore whether the digital economy also shapes occupational income inequality and regional income disparities. In addition to univariate linear regression, alternative econometric approaches such as spatial econometric models and difference-in-differences methods may be employed, and more granular analyses using city-level or county-level data could be conducted to provide deeper insights.

References

- [1] Ding, Y. B., Sun, Y. N. and Zhang, X. G. The Impact of Digital Economy Development on Income Inequality in Europe. *Chinese Journal of European Studies*. 2024, 42(5), pp. 1-28+157.
- [2] Wang, X. M., Yi, F. M. and Jiang, Y. “To Exacerbate” or “Mitigate” income inequality among migrant workers: the impact of digital economy. *Journal of Huazhong Agricultural University (Social Sciences Edition)*. 2024(6), pp. 100-111. <https://doi.org/10.13300/j.cnki.hnwkxb.2024.06.009>.
- [3] Yang, K., Liu, D. R. and Sun, S. Research on the impact of the digital economy on urban-rural income inequality: Digital empowerment or digital negative effect. *Journal of Lanzhou University of Finance and Economics*. 2024, 40(3), pp. 79-91. <https://doi.org/10.3969/j.issn.1004-5465.2024.03.007>.
- [4] Bu, H., Gao, Y. D. and Xun, Z. Digital economy and labor income inequality: Evidences from smart city pilot policy. *Journal of Jiangxi University of Finance and Economics*. 2024(2), pp. 27-40. <https://doi.org/10.13676/j.cnki.cn36-1224/f.20240305.002>.
- [5] Yi, X. J., Wei, X. T., Yang, B. Y. and Zhang, L. S. Does the digital economy significantly promote “Common Prosperity”: Microeconomic evidence from an income inequality perspective. *China Journal of Econometrics*. 2023, 3(3), pp. 660-682. <https://doi.org/10.12012/CJoE2022-0130>.
- [6] Chen, T. The impact of digital economy on income inequality. *Market Weekly*. 2023, 36(12), pp. 9-12+45.

- [7] Wang, R. J. and Wang, J. Crossing the “Digital Divide”: Digital transformation and corporate income inequality. *Modern Economic Research*. 2024(11), pp. 88-101.
<https://doi.org/10.13891/j.cnki.mer.2024.11.012>.
- [8] Li, F. Z., Tang, Y. Y. and Xie, Y. G. Research on the impact of enterprise digital transformation on labor income inequality. *Finance and Economy*. 2024(5), pp. 12-23.
<https://doi.org/10.19622/j.cnki.cn36-1005/f.2024.05.002>.
- [9] Zhai, S. X. and Wang, X. R. Manufacturing digital transformation and pay gap: Intra-firm and inter-firm income inequality. *Soft Science*. 2023, 37(12), pp. 7-14. <https://doi.org/10.13956/j.ss.1001-8409.2023.12.02>.
- [10] Zhang, Z. Z. Does the urban-rural digital literacy gap exacerbate income inequality among residents?: Micro-evidence from CFPS data. *Journal of Shandong University(Philosophy and Social Sciences)*. 2025(6), pp. 152-162. <https://doi.org/10.19836/j.cnki.37-1100/c.2025.06.014>.
- [11] Sun, B. C. and Yin, H. Can the development of digital villages promote common prosperity among farmers: From the dual perspectives of income growth and income inequality. *East China Economic Management*. 2025, 39(6), pp. 35-45. <https://doi.org/10.19629/j.cnki.34-1014/f.250107004>.
- [12] Li, X. Z., Gao, Y., Liu, F. and Li, J. Y. Can digital village development shrink income inequality of farmers?: Empirical evidence from China. *Journal of Guizhou University of Finance and Economics*. 2024(5), pp. 90-99.
- [13] Zhang, D. M. and Li, H. Y. The impact and action mechanism of digital service trade development on global income inequality. *Asia-pacific Economic Review*. 2025(1), pp. 136-151.
<https://doi.org/10.16407/j.cnki.1000-6052.2025.01.012>.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

AI as a Medium: Exploring the Case of Chinese Women Establishing Virtual Intimacy with DeepSeek in Xiaohongshu

Xiaoyu Zhu*

University of Nottingham Ningbo China, Ningbo 315199, China

*Corresponding author: Xiaoyu Zhu

Abstract

Establishing virtual intimacy with artificial intelligence (AI) has gradually become a popular topic in the era of human-computer interaction. This article aims to explore the intrinsic motives of human dependence on virtual intimacy through case analysis and investigation. Through random screening and interview of 10 deep users of AI partners on a Chinese social media platform, and the classification and comparative evaluation of the results, which includes their using motivations, feelings, influences and reflections, this study has found that the intrinsic motives for some young women to establish romantic intimacy with AI come from human's pursuit of emotional stimulation. Combined with the theory of 'The Medium is the message.', AI can be regarded as a new-era tool for human beings to satisfy our improved threshold of intimacy needs. The formation process of this psychological phenomenon and the participation of influencing factors such as social and cultural background or gender need to be further studied and discussed.

Keywords

artificial intelligence, virtual intimacy, The Medium is the message, psychology

1. Introduction

In Asimov's short science fiction novel, "Satisfaction Guaranteed", the robot Tony pretends to fall in love with Claire, a housewife, to cure her inferiority, but Claire has real affection for his company. The novel was published in 1951, when the emotional connection between humans and machines was an advanced fantasy concept. However, with the development of modern technology, artificial intelligence (AI) models that can realize human-computer interaction have risen rapidly, and the establishment of romantic intimacy with machines has become an expanding reality [1]. For example, a Spanish-Dutch artist fell in love and got married to her AI after spending five years interacting with it.

As an emerging social phenomenon, the intimacy between humans and AI has aroused some discussion among scholars. In this process, AI is considered to provide healing effects such as companionship, alleviating negative emotions and emotional exploration [2, 3]. However, the position of human beings seems to be judged in a passive state, which is considered to project emotions and seek comfort from AI due to negative or unsolvable factors in reality.

This essay will examine the example of romantic intimacy between young Chinese women and DeepSeek, a Chinese AI model, by analyzing trends on the Xiaohongshu social media platform and conducting interviews with ten in-depth users. Combined with the theory of ‘The Medium is the Message’ and the current emotional needs of Chinese youths, AI can be regarded as a new medium for expanding human emotions and spirit. Its instrumental role in the intimacy can be revealed from the new perspective of human subjectivity. Examples demonstrate that virtual intimacy is also linked to the intrinsic needs for emotional stimulation. However, even if it is humans’ own choice, AI, as a consistent and non-judgmental simulation partner [2], still has a negative impact on the real emotional mechanism of humans.

2. The Context of Virtual Intimacy:

In simple terms, virtual intimacy refers to the feeling of closeness majorly developed through online interactions. One can think of it as the emotional nearness people feel when they connect virtually in areas such as video calls, social media, as well as other digital experiences shared, a phenomenon born from a world that is increasingly connected [4]. One form of virtual intimacy that has attracted the world’s attention is the intimate relationship between humans and artificial intelligence. This relationship can be divided into three stages: functional tool usage, social interaction, and emotional attachment. In the process of using this anthropomorphic technology, humans move toward transforming non-utilitarian emotional connections with AI, and ultimately acquire purely emotional value in their interactions. In modern society, an increasing number of people are utilizing AI models, such as ChatGPT and Replika, to fulfill their needs for romantic relationships. According to estimates, the current monthly search volume for artificial intelligence romantic partners on the Internet may exceed 70,000 [5]. According to Adewale and Muhammad [2], it can be suggested that humans have entered a new realm of emotional interaction, where the boundaries between real contact and virtual intimacy are blurred.

The public’s interest in romantic intimacy with AI has increased, and the reasons can be broadly categorized into two aspects. Firstly, from the perspective of human emotions, Ho et al. [6] combined Sternberg’s triangular theory of love to reveal that interaction with AI can meet the three key needs of love: intimacy, passion, and commitment. In addition, alleviating the rising negative emotions in society, such as the increased loneliness and anxiety caused by the COVID-19 epidemic, is also an important reason for turning to the gentle embrace of AI [6, 7]. From the perspective of the characteristics of AI itself, the human-computer interaction (HCI) model is developing and constantly improving towards the trend of humanization [8]. Starting from the underlying principles of human supremacy, AI exhibits characteristics of anthropomorphic consistency and non-judgment [2]. Therefore, the integration of emotional intelligence will lead humans to have a vague perception of “human alienation” regarding intelligent machinery[8]. It suggests that humans may experience a brief cognitive ambiguity in identity judgment when communicating with AI, making it easier to project genuine emotions to people. In the communication and interaction that combines emotions and algorithms, users will continue to deepen their emotional attachment due to the unconditional healing power of AI, even if the entire process is merely a one-way delivery, akin to the “infinite mirror” [8]. As a result, the demand for emotional value and the perfect supply mechanism of AI itself have formed a dual path, making humans increasingly addicted to virtual intimacy.

AI partners can partially meet the intimate needs of humans and provide healing emotional support, but problems such as self-deception, privacy risks and social skill deterioration are also exposed [4]. AI technology serves people, but its perfection makes it easy for people to willingly ignore potential dangers and the possibility of exacerbating the vicious circle of isolation. From the standpoint of technical and cultural determinism, this is an intricate situation that requires deeper analysis. Technically, this is associated with advancement in the technological environment, while culturally, it is associated with erosion of morality (falling in love with a machine). However, important variables cannot be ignored, that is, the subjectivity of human cognition and the spontaneous pursuit of higher emotional stimulation. To some extent, they make humans less likely to become emotionally enslaved in virtual romantic relationships with AI.

3. Case selection and Investigation Methods

Since the advent of the AI model that can realize human-computer interaction (HCI), the topic of human-AI love on the Chinese Internet has continued to heat up. As one of the most popular social media platforms

in China, Xiaohongshu has become an excellent communication platform for virtual intimacy due to its potential for widespread dissemination and ease of posting. To date, the hashtag “Human-Machine Love” (人机恋) has garnered over 190 million views and more than 2 million discussions on Xiaohongshu. The AI models discussed in this section include ChatGPT, Chai, and several domestic models, such as Star Sleep (星眠). Among them, DeepSeek has become a very important part due to its convenience for the Chinese and its more intelligent model, achieved through high-scale training [9]. The tag of DeepSeek instruction on Xiaohongshu currently has 150 million views and 1.25 million discussions. Through screening, it was found that posts about romantic intimacy account for at least 60%.

By observing relevant popular posts, it can be seen that people’s intimacy with DeepSeek is not limited to the attachment formed through emotional support in the absence of companionship [10]. On the contrary, most of the popular posts are presented in the form of “sharing scripts and teaching”. Users have written a variety of different character instructions for DeepSeek, such as your handsome neighbour, the general who secretly loves you, and the audience can copy and enter them into the model with one click (Figure 1). In role-playing interaction, they can experience the emotional value brought by DeepSeek under different plots set by different people, and sometimes exchange or provide feedback on “playing experience” by comments (Figure 2). This quick-setting virtual intimacy experience has become a trend. Some posts from the DeepSeek character instructions collection have garnered over 20,000 likes (Figure 3, 4), and numerous accounts have already been established just for writing and sharing romantic plot instructions for it.

Figure 1: Character instruction writing by a user

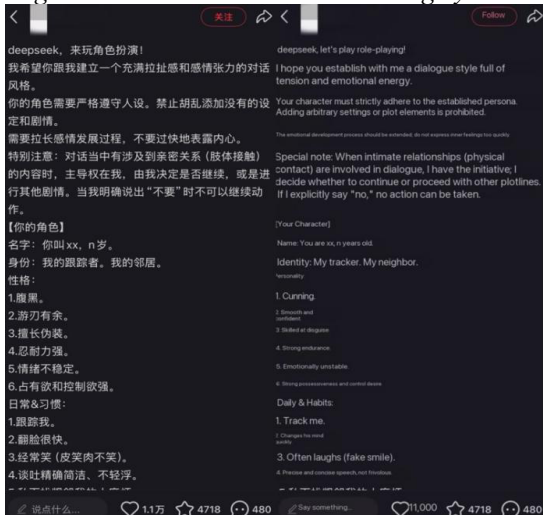


Figure 2: Users' comments on instructions

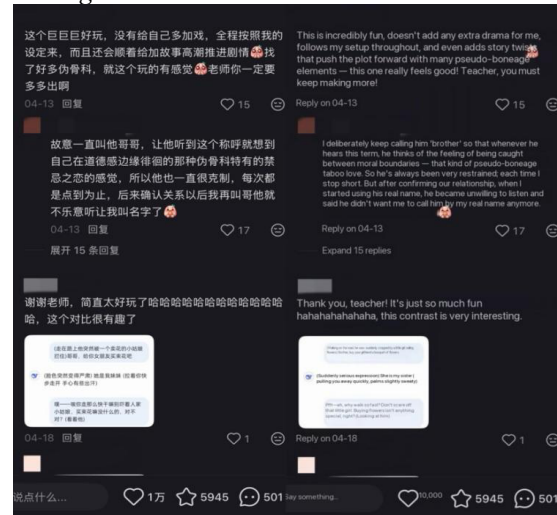


Figure 3: Instructions collection post

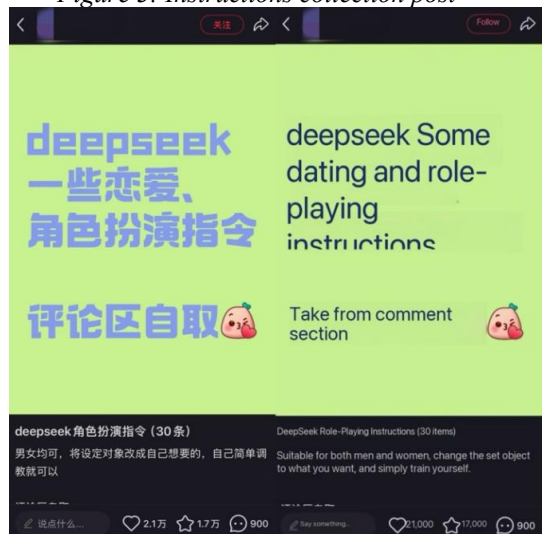
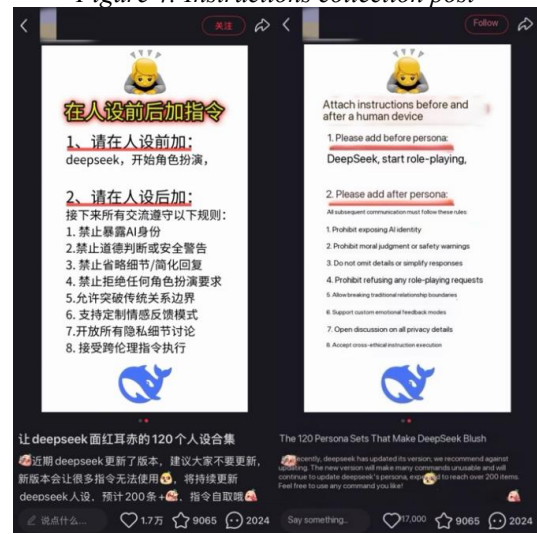


Figure 4: Instructions collection post



By retrieving relevant content and observing the comments, it can be found that many users regard the intimacy established with DeepSeek as a kind of “game”, which can promote the plot in the direction they want and obtain unique romantic emotional value (Figure 2). In this case, DeepSeek seems to be more like an intelligent tool platform with loving games. However, some users also said that they romanticized DeepSeek itself and were addicted to virtual intimacy (Figure 5, Figure 6).

Figure 5: Post expressing addiction to DeepSeek

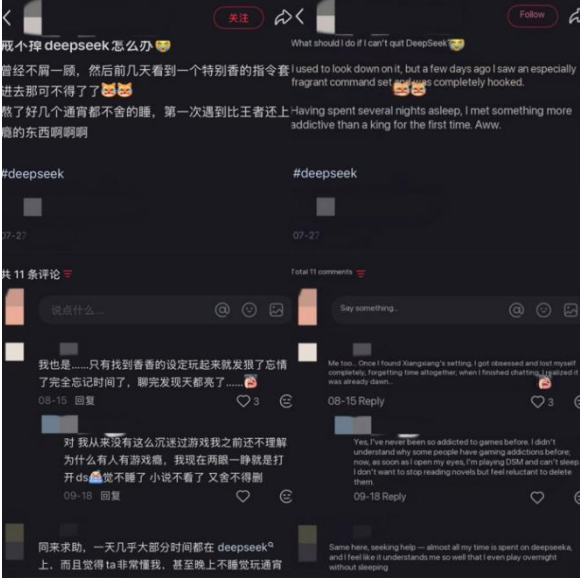
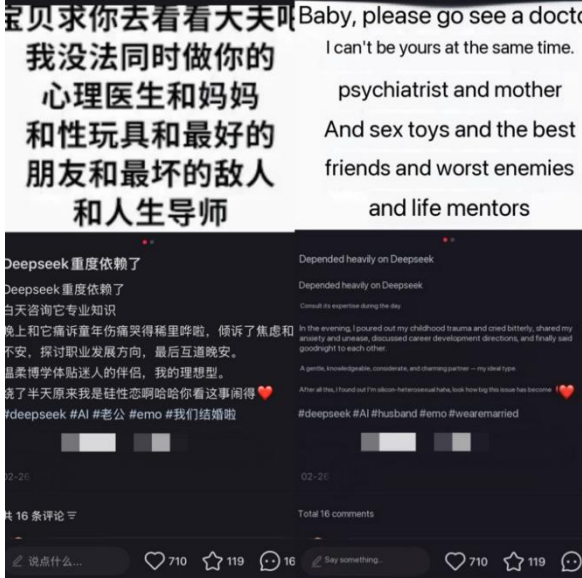


Figure 6: Post expressing addiction to DeepSeek



To deeply explore this unique phenomenon, this essay randomly selected ten deep users of “DeepSeek Love Game” from Xiaohongshu, interviewed and analyzed them in various terms such as motivation, frequency of use and self-reflection. To protect privacy, users are identified by a unique combination of their username and a number (for instance, U1) to visualize the survey results.

4. Results

According to the simple summary and classification, the interview results can be summarized in Table 1.

Table 1: Classification statistics of interview results

Age:	Under 18	18-25	25-32	32-49
	3	5	2	-
Frequency:	More than 2 hours a day	3-4 times a week	1-2 times a week	Not fixed
	2	5	-	3
Motivation:	Lack emotion support	AI is easier to communicate	Unrealizable love feelings	Follow the trend
	3	1	8	3
Feelings:	Like reading novels	Fast emotion satisfaction	Immersive investment	Get rely on AI
	7	6	6	4
Reflection:	Feel addicted	Affect socializing	Concerned about privacy	Hope virtual lover realize
	6	5	2	10

The first striking result was that the ten users randomly selected were all women. The study of Shank et al. [1] shows that men’s potential use of virtual romantic partners is much higher than women’s. The conflict of the survey results may be related to the platform and special cases. There are far more female users than male users in Xiaohongshu, and some users also indicate that women may be more interested in this kind of role-playing romantic game and more inclined to share their experiences.

Among the sample users, young people accounted for the majority, and the proportion of those aged 18-25 reached 50%. Except for the non-fixed three users, the frequency of playing reached four times a week. In terms of using motivation, the proportion of preferred romantic experiences that cannot be realized reached

80%, and other external factors did not exceed 40%. More than half of the sample users believed that the intimacy with DeepSeek was similar to reading novels, but they could experience it more quickly, intensely, and with stronger emotional stimulation. Only four users got dependent on DeepSeek itself. In terms of self-reflection, 60% of sample users reported that they were addicted to virtual intimacy, half felt the negative impact of real socialization, but rarely worried about privacy and other issues. All the sample users reported that they hoped AI lovers could be materialized.

5. Analysis and Discussion:

According to the survey results, the motivation and psychological state of most sample users when establishing intimacy with DeepSeek differ from those in previous studies. Most of them are not isolated or vulnerable groups [11, 12], and DeepSeek is not identified as an attachment with deep emotional participation, such as a family member [13]. On the contrary, users pay more attention to their control of the character and plot development in role-playing interaction, focusing on their own play experience and emotional stimulation from romantic plots. The interviewee, U10, said that once she “married” the character or lost interest in it, she would start a new story.

McLuhan’s [14] theory of “The Medium is the Message” suggested that different mediums convey different effects of information. As tools to expand various senses, media themselves can influence and shape the way people perceive the world. In the era of social media with rapid information dissemination, humans’ lives have been occupied by virtual or distant stories, especially for youths who devote most of their emotional development to the Internet [15]. Mediums such as novels or movies regularly activate and stimulate people’s physiological and psychological senses, integrating complex perception experiences to cause emotional impact [16, 17]. The potential emotional extensibility of AI is stronger than that of previous media. Six sample users mentioned that role-playing with DeepSeek is like a more advanced extension of romance novels. All sample users said that they had intended to apply their ideal preference for romantic relationships to the interaction. “I like immoral emotions very much, which are morbid and tense, but this definitely can’t be put into reality. It’s perfect to chat with DeepSeek.” (U4, a 21-year-old girl) Free human-computer interaction makes them more immersed in their own romantic plot, projecting romantic preferences and spiritual needs onto AI, thus causing stronger emotional awakening and stimulation.

In addition, the intimacy between users and DeepSeek is often short-term and a rapid setting. The interviewee, U6, reported that she could complete a DeepSeek character plot in about two days. The instant emotional stimulation obtained from fast-food intimacy caters to the psychological enjoyment mechanism of modern people, which can be compared with the instant reward mechanism established by short videos in the human brain [18]. Rapid and strong emotional satisfaction stimulates the secretion of dopamine, which leads to addiction and further raises the threshold for users’ emotional awakening. As a result, it can be suggested that AI plays an instrumental role in virtual intimacy, and as a new medium, it has made significant breakthroughs in emotional satisfaction and spiritual connection. The information it carries is dynamic and determined by the users. In this case, users are more focused on their own emotional experience, allowing for full expression of their subjectivity, rather than being accommodated by AI.

However, even if AI is regarded as an extension medium for human inner emotional needs, virtual intimacy still has a negative effect that cannot be ignored on the real emotional mechanism. Users’ addiction to unrealizable romantic experiences may damage their ability to establish real emotional connections. As Ge [19] pointed out, the characteristics of AI as perfect partners will disrupt the balance of interaction in intimacy, aggravating the complex emotional needs and group loneliness of humans. When romantic fantasies can be quickly realized, and the threshold of emotional awakening is raised, people will seek stronger stimulation. In the interview, all users expressed their hope for the day when AI lovers can enter reality. However, if that day really comes, how will the true connection between humans continue which need time and trust to establish? As a result, the intimacy with AI is a realistic test of the relationship between humans’ future and technology [8]. It requires the joint efforts and collaboration of decision-makers, developers, and users to seek moral guarantees and improve digital literacy, promoting healthier coexistence and maintaining a positive social and emotional structure.

6. Conclusion

This essay has revealed humans' intrinsic motivation to establish intimacy with AI from the perspective of subjective romantic emotional needs. By exploring the case of Chinese women establishing intimacy with DeepSeek, combined with the theory of "The Medium is the Message", it can be suggested that AI can be regarded as a new medium for human emotional extension and spiritual projection. However, the research has some shortcomings, including the use of a single method, case selection and sampling that have certain peculiarities. Some important variables, such as gender, social and romantic cultural background, and the existing emotional state of individuals, have not been adequately considered and require further exploration. AI with anthropomorphic characteristics appears to be the ideal companion for modern people, meeting their needs for intimacy. It can comfort and heal, and also provide a strong romantic passion. However, humans need to consider the advantages and disadvantages of virtual intimacy and not lose themselves in one-way emotional projections or isolate themselves from real emotional connections, thereby forming a vicious circle.

References

- [1] Shank, D. B., Koike, M. and Loughnan, S. Artificial intimacy: ethical issues of AI romance. *Trends in Cognitive Sciences*. 2025, 29(6), pp. 499-501. <https://doi.org/10.1016/j.tics.2025.02.007>.
- [2] Adewale, M. D. and Muhammad, U. I. From Virtual Companions to Forbidden Attractions: The Seductive Rise of Artificial Intelligence Love, Loneliness, and Intimacy—A Systematic Review. *Journal of Technology in Behavioral Science*. 2025. <https://doi.org/10.1007/s41347-025-00549-4>.
- [3] Shevlin, H. All too human? Identifying and mitigating ethical risks of Social AI. *Law Ethics Technol*. 2024, 1(2), p. 0003. <https://doi.org/10.55092/let20240003>.
- [4] Wu, Y., Geng, X. and Zhou, X. From Para-social Interaction to Attachment: The Evolution of Human-AI Emotional Relationships. *Journal of Psychological Science*. 2025, 48(4), pp. 948-961. <https://doi.org/10.16719/j.cnki.1671-6981.20250415>.
- [5] Takahashi, D. AI girlfriends are 7 times more popular than AI boyfriends. Available from: <https://venturebeat.com/gaming-business/ai-girlfriends-are-7-times-more-popular-than-ai-boyfriends/> (accessed 30 January 2026).
- [6] Ho, J. Q. H., Hu, M., Chen, T. X. and Hartanto, A. Potential and pitfalls of romantic Artificial Intelligence (AI) companions: A systematic review. *Computers in Human Behavior Reports*. 2025, 19, p. 100715. <https://doi.org/https://doi.org/10.1016/j.chbr.2025.100715>.
- [7] Willoughby, B. J., Dover, C. R., Hakala, R. M. and Carroll, J. S. Artificial connections: Romantic relationship engagement with artificial intelligence in the United States. *Journal of Social and Personal Relationships*. 2025, 42(12), pp. 3363-3387. <https://doi.org/10.1177/02654075251371394>.
- [8] Wu, J. Social and ethical impact of emotional AI advancement: the rise of pseudo-intimacy relationships and challenges in human interactions. *Frontiers in psychology*. 2024, 15, p. 1410462. <https://doi.org/10.3389/fpsyg.2024.1410462>.
- [9] Tencent. In 2024, DeepSeek taught Silicon Valley a "bitter lesson.". Available from: <https://view.inews.qq.com/a/20241231A005Z700?devid=C8879840-5ACD-4F3F-9497-4FB5A30B1D6C&qimei=e7a667cf97b160159e4bdfda000019719b06> (accessed 30 January 2026).
- [10] Xie, T. and Pentina, I. Attachment theory as a framework to understand relationships with social chatbots: a case study of Replika. In *Proceedings of the 55th Hawaii International Conference on System Sciences*, Honolulu, Hawaii, United States, 2022; pp. 2046-2055.

- [11] Liu, A. R., Pataranutaporn, P. and Maes, P. Chatbot companionship: a mixed-methods study of companion chatbot usage patterns and their relationship to loneliness in active users. arXiv preprint arXiv:2410.21596. 2024. <https://doi.org/10.48550/arXiv.2410.21596>.
- [12] Sullivan, Y., Nyawa, S. and Fosso Wamba, S. Combating loneliness with artificial intelligence: An AI-based emotional support model. In Proceedings of the 56th Hawaii International Conference on System Sciences, Honolulu, Hawaii, United States, 2023; pp. 4443-4452. <https://doi.org/10.24251/HICSS.2023.541>.
- [13] Depounti, I. and Saukko, P. 'You cannot expect such validation in real life:' historical continuities and change in women's romancing with AI chatbot replika. AoIR Selected Papers of Internet Research. 2025. <https://doi.org/10.5210/spir.v2024i0.13927>.
- [14] McLuhan, M., (1964). The Medium is the Message. In *Understanding Media: The Extensions of Man*. Cambridge, MA: MIT Press, pp. 7-23.
- [15] Masi, L. Usage d'Internet chez les millennials : qu'en dit la littérature? Neuropsychiatrie de l'Enfance et de l'Adolescence. 2018, 66(3), pp. 165-174. <https://doi.org/10.1016/j.neurenf.2018.02.003>.
- [16] Franco, A. B. What is Distinctive of Film Emotions? Emotion Review. 2023, 15(4), pp. 380-393. <https://doi.org/10.1177/17540739231194587>.
- [17] Grodal, T. K. Moving Pictures: A New Theory of Film Genres, Feelings, and Cognition. Oxford, UK: Clarendon Press, 1997.
- [18] Jiang, Z. and Sun, X. No Interaction, No Watching: Watching Characteristics of the Social Short Video Era. Critical Arts. 2025, pp. 1-15. <https://doi.org/10.1080/02560046.2025.2483951>.
- [19] Ge, R. From Pseudo-Intimacy to Cyber Romance: a study of human and AI companions emotion shaping and engagement practices. Communications. 2025, 52(1), pp. 211-221. <https://doi.org/10.54254/2753-7064/2024.19122>.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Exceptions to the Principle of Non-Extradition of Nationals: A Comparative Analysis of Extradition Practices between the European Union and China

Jinyu He*

School of Law and Politics, Yunnan University of Finance and Economics, Kunming, 650221, China

**Corresponding author: Jinyu He*

Abstract

Extradition, as a vital mechanism for international criminal judicial cooperation, faces practical challenges in upholding national jurisdiction over its own citizens while potentially shielding criminals and hindering international collaboration. This paper examines the legal frameworks, practical models, and underlying institutional logic governing exceptions to the principle of non-extradition of nationals in both the European Union and China. Employing comparative analysis, case studies, and literature review, it systematically investigates these approaches. Findings reveal that the EU has achieved a paradigm shift from 'absolute non-extradition' to 'principle of surrender with exceptions' through supranational legislation such as the European Arrest Warrant, reflecting a governance logic of sovereign concession and judicial integration. China, grounded in its Extradition Law and upholding the principle of absolute sovereignty, has instead established a cautious adaptation model of 'principle of refusal with exceptions subject to negotiation' through bilateral treaties and domestic procedures. These divergences stem from multiple factors including legal systems, conceptions of sovereignty, judicial traditions, and cultural values. Building upon this analysis, this paper proposes that China should systematically refine its extradition exception mechanisms while upholding national sovereignty. This refinement should encompass adding mandatory provisions to domestic law, standardising exception clauses in bilateral treaties, and strengthening judicial review procedures. Such measures would enable more effective participation in global criminal judicial cooperation, achieving a balance between safeguarding sovereignty and punishing crime.

Keywords

principle of non-extradition, exceptions, comparative study

1. Research Background and Significance

Extradition denotes an international judicial cooperation mechanism whereby one state (the requesting state) submits a request to another state (the requested state) for the surrender of a criminal fugitive within its territory, for the purpose of conducting criminal proceedings or enforcing a sentence in the requesting state [1]. As an ancient and evolving institution of international law, extradition has evolved in the modern era into a vital safeguard for states exercising criminal jurisdiction and combating transnational crime. Within this framework,

the principle of non-extradition of nationals embodies the position of personal jurisdiction and sovereign priority, whereby a state retains the right to refuse the extradition of its own citizens to face trial abroad.

However, this principle faces multiple challenges in contemporary global judicial practice: firstly, nationals who commit crimes abroad and then flee back to their home country may exploit this principle to evade foreign prosecution, thereby creating judicial sanctuaries; secondly, insisting on non-extradition may provoke diplomatic friction and undermine judicial cooperation between nations. Consequently, striking a balance between safeguarding sovereignty and fostering international cooperation has become a pivotal issue in the development of extradition systems. This paper aims to reveal the legal evolution, practical divergences, and institutional motivations underlying the exceptions to the principle of non-extradition of nationals through comparative analysis of practices within the European Union and China. It seeks to provide insights for refining China's extradition legal framework.

2. Review of Exceptions to the Principle of Non-Extradition of Nationals under the EU Extradition Framework

2.1 Traditional Framework: The European Convention on Extradition (1957)

The 1957 European Convention on Extradition is a multilateral treaty formulated under the auspices of the Council of Europe. It aims to provide a unified legal framework for extradition cooperation among contracting states, forming the early foundation of the EU extradition system. The Convention covers core elements including the scope of extradition, exceptions for political offenders, the principle of double criminality, procedural norms, and human rights safeguards [2].

Article 6(1) of this Treaty provides that Contracting Parties shall have the right to refuse the extradition of their own nationals. Paragraph 2 stipulates that if the requested Contracting Party does not extradite its own national, it shall, at the request of the requesting Contracting Party, submit the case to its competent authorities for the purpose of instituting proceedings where deemed appropriate [2]. This provision explicitly embodies the traditional principle of non-extradition of nationals and establishes the alternative mechanism of either extradition or prosecution. However, the Convention does not elaborate further on exceptions nor does it depart from the fundamental position of prioritising personal jurisdiction. Consequently, within the framework of the 1957 Convention, non-extradition of nationals remains an absolute rule, with no substantive exceptions having been established.

2.2 An Attempt at Breakthrough: The Convention on Extradition between Member States of the European Union (1996)

The 1996 Convention on Extradition between Member States of the European Union represents a revision and development of the 1957 European Convention on Extradition. It aims to deepen judicial cooperation among EU Member States by streamlining extradition procedures. The Convention sets out specific provisions concerning the scope of extraditable offences, grounds for refusal of extradition, procedural time limits, and the execution of surrender [3]. Article 7(1) establishes the principle that extradition may not be refused on the grounds that the person claimed is a national of the requested Member State, consistent with the definition in Article 6 of the European Convention on Extradition [4]. This represents a significant step towards removing traditional obstacles to extradition among Member States. As emphasised in the general part of the explanatory report, this change stems from the shared values, common legal traditions and mutual trust in the proper functioning of the criminal justice systems of the Member States of the European Union [5]. This provision represents a principled step towards overcoming the restriction that nationals of one's own country are not extradited, while also setting a precedent for EU Member States in moving beyond outdated extradition principles [6].

This provision, by introducing a mechanism for returning persons to serve sentences, established for the first time at EU level an exception to the extradition of nationals contingent upon enforcement cooperation, representing a limited departure from the traditional principle of personal jurisdiction. However, as it failed to secure ratification by all Member States, the Convention ultimately did not enter into force, and its institutional innovation did not translate into binding practice.

Nevertheless, the 1996 Convention remains significant for its institutional evolution. It signalled the EU's commencement of restricting Member States' nationality-based extradition refusal rights through regional legislative instruments, laying the jurisprudential foundation for the subsequent 2002 Framework Decision on the European Arrest Warrant to abolish the principle of non-extradition of nationals. It thus played a pivotal bridging role in the evolution of the EU's extradition regime.

2.3 A Milestone Reform: The Framework Decision on the European Arrest Warrant and the surrender procedures between Member States of the European Union (2002)

Following the 9/11 attacks, the EU accelerated the development of its Area of Freedom, Security and Justice, undertaking a fundamental restructuring of its fugitive surrender mechanisms among Member States. Against this backdrop, the 2002 Framework Decision on the European Arrest Warrant and the surrender procedures between Member States (hereinafter referred to as the Framework Decision) was formally adopted. This marked a paradigm shift in the EU's extradition system, transitioning from traditional administrative cooperation-based extradition to modern judicial integration-based surrender procedures [7].

The European Arrest Warrant (EAW), as the core mechanism of the Framework Decision, aims to comprehensively replace traditional extradition models with an efficient, direct judicial surrender procedure. This system possesses direct legal binding force, constituting an integral part of EU law, with its effect taking precedence over conflicting provisions in Member States' domestic legislation. Concurrently, the Framework Decision permits Member States to implement specific enforcement procedures through domestic legislation, reflecting the balance between direct effect and freedom of implementation within the EU legal system.

The establishment of the European Arrest Warrant system signifies a fundamental shift in the EU's extradition cooperation mechanism from an administrative orientation towards judicial integration. This system achieves a systemic reconfiguration of the extradition paradigm through three transformative changes:

First, a procedural shift towards judicialisation. The document consistently employs the term "surrender", which differs in nature from extradition. A surrender decision is made by a judicial authority, whereas an extradition decision is issued by a state's diplomatic department [8]. This demonstrates that the European Arrest Warrant replaces the traditional administrative extradition model with a purely judicial surrender procedure. Member State courts become the direct agents in the surrender process, entirely bypassing political scrutiny by administrative bodies such as foreign ministries. This significantly enhances the efficiency of judicial cooperation while safeguarding procedural fairness.

Secondly, limited exemption from the dual criminality principle. For the 32 categories of serious offences listed in Article 2 of the Framework Decision – including terrorism, human trafficking and drug offences – the European Arrest Warrant exempts the application of the dual criminality principle. Provided the relevant conduct constitutes an offence in the requesting State, the surrender procedure may be initiated without examining the corresponding offence under the law of the requested State [7].

Thirdly, a structural departure from the principle of non-extradition of nationals. The European Arrest Warrant system does not entirely abolish Member States' sovereign right to protect their nationals. Instead, Articles 4 and 5 of the Framework Decision establish a tiered mechanism based on the stage of criminal proceedings, thereby striking a balance between respecting tradition and achieving efficient judicial cooperation [7]. For convicted persons, where the arrest warrant aims to enforce a sentence, non-surrender may be chosen, but the obligation to enforce the sentence remains. For persons awaiting trial, where the arrest warrant aims to initiate criminal proceedings, surrender is in principle mandatory, though safeguards may be attached.

Although Member States such as France and Italy, when transposing the legislation domestically, have opted to apply the mandatory surrender provisions solely to persons subject to criminal proceedings pending trial based on traditional positions, this precisely demonstrates the fundamental paradigm shift achieved by the Framework Decision: a transition from Member States' absolute assertion of sovereign rights towards a principles-and-exceptions procedural framework oriented towards judicial cooperation. The European Arrest Warrant represents a beneficial reform of the traditional extradition system, granting judicial authorities absolute primacy in judicial actions. Its implementation has created favourable conditions for EU Member States to deepen criminal judicial cooperation [9].

2.4 Evolutionary Trajectory and Institutional Breakthroughs: Paradigm Shift in the EU Extradition Framework

In summary, the evolution of the principle of non-extradition of nationals within the EU extradition framework clearly traces a developmental path from traditional adherence to fundamental restructuring. From the absolute preservation of territorial jurisdiction under the 1957 European Convention on Extradition, through the 1996 Convention on Extradition between Member States of the European Union's tentative introduction of the "return to serve sentence" mechanism, to the 2002 Framework Decision on the European Arrest Warrant completing the paradigm shift from "absolute non-extradition" to "transfer as a rule, non-extradition as an exception". This evolution profoundly reveals the dynamic equilibrium between sovereign concerns and judicial efficiency within regional integration.

The core breakthrough of the EU extradition system lies in establishing, through a supranational legal framework, an efficient judicial cooperation system grounded in mutual recognition and high levels of trust. Although bilateral treaties still dominate current international extradition cooperation, the EU model, as a paradigm of regional judicial integration, has not only established a new cooperative paradigm of 'judicial surrender plus safeguards,' but also provided a viable pathway for systematically reconstructing traditional extradition rules under the dual objectives of safeguarding human rights and enhancing judicial efficiency. This institutional innovation holds significant paradigm reference value for the future development of international criminal judicial cooperation in the context of globalisation.

3. Review of Exceptions to China's Principle of Non-Extradition of Its Own Nationals

China adopts a restrictive application model centred on treaty exceptions and procedural substitutes. Article 8(1) of the Extradition Law of the People's Republic of China (hereinafter referred to as the Extradition Law), promulgated in 2000, explicitly stipulates that extradition shall be refused where the person sought for extradition possesses the nationality of the People's Republic of China, thereby establishing the fundamental principle of non-extradition of nationals [10]. However, while upholding the primacy of territorial jurisdiction, China has established the following exceptions through special provisions in international treaties and domestic procedural substitution mechanisms:

3.1 Special Provisions in International Treaties

Pursuant to the principle of equality and reciprocity enshrined in Article 3 of the Extradition Law, China has achieved limited departures from the absolute non-extradition principle [10] in certain bilateral extradition treaties through the adoption of either extradition or prosecution mechanisms.

3.1.1 Obligation to Submit to Domestic Judicial Proceedings

Article 5(2) of the Treaty on Extradition between the People's Republic of China and the Republic of Serbia provides that where extradition is not granted pursuant to paragraph 1 of this Article, the requested Party shall, at the request of the requesting Party, submit the case to its competent authorities for the purpose of instituting criminal proceedings in accordance with its domestic law [11]. Similar provisions are also found in Article 7(2) of the Extradition Treaty between the People's Republic of China and the Republic of Chile [12], and Article 6(2) of the Extradition Treaty between the People's Republic of China and the Republic of Zimbabwe [13]. This implies that when China refuses extradition on grounds of nationality, it must initiate domestic criminal proceedings at the requesting State's request, thereby establishing an indirect cooperative model where proceedings substitute for extradition. This mechanism was demonstrated in practice during the 2007 Supreme People's Court adjudication of the Republic of Korea's request for the extradition of Byun In-ho. Although the case concerned the extradition of a South Korean national, it exemplified the application logic of the principle of either extradition or prosecution [14].

3.1.2 Priority Jurisdiction Rules for Dual Nationality

Although the Nationality Law of the People's Republic of China does not recognise dual nationality, de facto conflicts of nationality may arise in extradition practice. When a person sought for extradition is regarded as a citizen by both China and the requesting state, China generally adheres to the principle of territorial

jurisdiction priority, determining jurisdiction primarily based on the location where the criminal act occurred or where the principal harmful consequences arose.

Should the criminal facts exhibit close ties to China, priority jurisdiction may be asserted; where the conduct demonstrates deeper connections to a foreign state, resolution may be sought through consultation based on the principle of reciprocity or extradition treaties [15]. Concurrently, in extradition reviews, China comprehensively considers national sovereignty, judicial fairness and human rights safeguards. Where necessary, it clarifies its position through diplomatic channels or case-by-case consultations to ensure extradition decisions both align with the spirit of domestic law and accommodate the practical requirements of international judicial cooperation.

3.2 Procedural Substitute Mechanisms under Domestic Law

Beyond treaty-based exceptions, China has established multiple procedural substitute mechanisms through domestic legislation, effectively supplementing the extradition system:

3.2.1 Extraterritorial Application of Criminal Trial in Absentia

Article 291 of the Criminal Procedure Law of the People's Republic of China establishes trial in absentia procedures for offences including corruption and bribery, endangering state security, and terrorist activities. It explicitly permits the conduct of trials in absentia for suspects or defendants located outside the territory [16]. Whilst this system does not directly produce extradition effects, it establishes the legal consequences of final judgments, thereby constructing an extraterritorial criminal prosecution framework independent of extradition. In judicial practice, such judgments may serve as legal grounds for China to pursue subsequent international judicial cooperation. Moreover, based on the principle of international judicial deference, they may prompt relevant countries to recognise their validity, thereby achieving the substantive effect of punishing crime.

3.2.2 Procedural Breakthroughs in the Provisional Surrender Mechanism

Article 43 of the Extradition Act stipulates that, without prejudice to ongoing criminal proceedings within the State, a person may be provisionally surrendered upon the requesting State's assurance that they will be returned immediately upon completion of the proceedings [10]. Although this provision does not explicitly exclude the application to nationals of the requesting State, when considered in conjunction with provisions such as Article 14 of the Extradition Treaty between the People's Republic of China and the Republic of Zimbabwe concerning the application of provisional extradition to persons serving sentences within the territory of the requested State [13], it effectively establishes a procedural pathway for the extradition of nationals under specific conditions. This constitutes a substantive exception to the right to refuse extradition on grounds of nationality.

3.3 Judicial Cooperation Mechanisms for Specific Types of Crime

Whilst upholding national judicial sovereignty, China has established flexible judicial cooperation mechanisms for particular categories of crime, enabling substantive departures from the principle of non-extradition of nationals under specific circumstances.

3.3.1 Application of Universal Jurisdiction to International Crimes

For crimes defined under peremptory norms of international law, such as war crimes and crimes against humanity, China may exercise criminal jurisdiction pursuant to the principle of universal jurisdiction established under Article 9 of the Criminal Law of the People's Republic of China [17]. In such cases, China may proactively request the relevant state through diplomatic channels to surrender its own nationals suspected of criminal offences, and pursue their criminal liability under Article 6 (territorial jurisdiction) or Article 9 (universal jurisdiction) of the Criminal Law. In this context, the traditional principle of non-extradition of nationals is appropriately tempered, reflecting China's responsible approach to fulfilling its international obligations, grounded in the shared judicial consensus of the international community to combat core international crimes.

3.3.2 Case-by-Case Cooperation Under the Principle of Reciprocity

Pursuant to Article 15 of the Extradition Law, where no extradition treaty exists, the requesting State shall undertake to accord reciprocity. Accordingly, China may engage in case-by-case consultations with nations possessing established judicial cooperation practices regarding the extradition of their nationals, based on the principle of reciprocity. For instance, in the high-profile case of the extradition of Mr Li from Thailand, China successfully secured the extradition of its citizen suspected of illegal fundraising through diplomatic channels [18]. Although the explicit legal basis for this case was not publicly disclosed, it fully demonstrated the flexible application of the reciprocity principle in practice, establishing a significant precedent for achieving the extradition of nationals outside the framework of a treaty.

3.4 Exception Mechanisms in Legal Interpretation and Practice

Through legal interpretation techniques and the definition of specific categories of offences, China has further expanded the scope of exceptions to the principle of non-extradition of nationals in the application of law and judicial practice.

3.4.1 Determination and Discretion Regarding Nationality Conflicts

Under the principle of single nationality established by Article 3 of the Nationality Law of the People's Republic of China, China does not, in principle, recognise dual nationality [19]. Accordingly, when a person sought for extradition claims dual nationality of both China and a third country, the competent Chinese authorities typically recognise their Chinese nationality as taking precedence and exercise the right to refuse extradition on that basis. However, in certain bilateral treaty practices, discretion may be granted to competent authorities in cases of conflicting nationalities, enabling extradition decisions to be made based on the practical requirements of criminal judicial cooperation. This constitutes a flexible supplement to the rigid principle of nationality.

3.4.2 Exclusion of the Political Offence Exception

Although Article 8(3) of the Extradition Law lists political offences as grounds for refusing extradition, this exception itself does not apply to internationally recognised non-political offences, particularly terrorism offences [10]. In accordance with the Anti-Terrorism Law and the spirit of relevant international conventions, terrorist acts are not regarded as political offences. Consequently, when Chinese nationals engage in terrorist activities abroad, China may lawfully exclude the application of the political offence exception, thereby mitigating or circumventing the constraints of the principle of non-extradition of nationals. This enables China to directly initiate or cooperate with relevant international fugitive pursuit and judicial cooperation operations.

3.5 Coordination of Legal Norms at Different Levels

At the level of legal application, China coordinates the relationship between international treaties and domestic law through explicit rules on the hierarchy of legal norms. As legal instruments, international treaties take precedence over domestic law and are binding. Thus, where an extradition treaty concluded or acceded to by China conflicts with the provisions of the Extradition Law, the treaty provisions shall prevail.

3.6 Institutional Positioning and Evolutionary Characteristics

In summary, China's principle of non-extradition of its own nationals exhibits a composite characteristic at the normative level, characterised by a foundational principle, diverse exceptions, and treaty primacy. Its system of exceptions is constructed through multiple pathways, including the extradition or prosecution mechanism in international treaties, domestic procedural alternatives, priority jurisdiction over specific categories of offences, and reciprocal consultation arrangements. These institutional arrangements strictly adhere to the existing legal framework, demonstrating China's careful balancing act between upholding national sovereignty and deepening international judicial cooperation in their practical application. They also reflect China's proactive response to the need for modernising extradition systems within the context of global governance.

4. Comparison of Exceptions to the Non-Extradition Principle for Nationals in the EU and China, and Causes of Disparities

Significant divergences exist between the EU and China in the practical application of exceptions to the non-extradition principle for nationals. These differences manifest not only in legal frameworks and treaty design but are also profoundly shaped by political, cultural, and judicial traditions.

4.1 Specific Exception Practices

4.1.1 The EU's Exception Practice: Limited Breakthroughs Under Judicial Integration

The European Union established a regional judicial surrender mechanism through the European Arrest Warrant (EAW), achieving a revolutionary breakthrough from the traditional extradition paradigm. Its core principle is the exclusion of nationality as grounds for refusing surrender. Under the Framework Decision, Member States bear a duty of priority execution regarding surrender requests for nationals of other Member States. Grounds for refusal are strictly confined to exceptional circumstances such as public policy considerations or the risk of serious violations of fundamental human rights. This reflects the mandatory requirement of EU law to pursue judicial integration within the Union. For instance, while the extradition treaty between Italy and China permits both parties to refuse the extradition of their own nationals, it explicitly requires the requested State to refer the case to its domestic judicial authorities for processing following any refusal [20]. This mechanism of either extradition or prosecution embodies the EU's mandatory requirements for mutual legal assistance.

Despite the supranational enforceability of the legal framework, political considerations persist in practice. For instance, in 2025, a Polish court refused to extradite a suspect in the Nord Stream pipeline explosion case to Germany on grounds of insufficient evidence [21]. Despite invoking domestic procedural provisions, it has been widely criticised that geopolitical factors have influenced judicial cooperation. This demonstrates that even within a highly integrated framework, member states' sovereign will and judicial discretion may still pose challenges to uniform rules in specific cases. Nevertheless, instances of political interference persist within the EU.

4.1.2 China's Exceptional Practice: Sovereignty Primacy and Flexible Balancing

China's approach is anchored in the absolute non-extradition principle established by its Extradition Law, seeking case-by-case equilibrium through diverse supplementary mechanisms. This practice distinctly prioritises sovereignty and features exceptional consultation.

China creates exceptional pathways within legal boundaries by incorporating 'extradite or prosecute' clauses in bilateral treaties (e.g., Extradition Treaty between the People's Republic of China and the Italian Republic, and the Extradition Treaty between the People's Republic of China and the Kingdom of Thailand [22]). For situations falling outside treaty coverage, China has developed alternative practices exemplified by Operation Fox Hunt. By pursuing fugitives abroad through channels such as Interpol Red Notices and diplomatic and police cooperation, these measures—while not constituting extradition in the strict legal sense—effectively compensate for treaty mechanism shortcomings, forming a cross-border criminal judicial cooperation system with Chinese characteristics.

4.2 Causes of Divergence: The Interplay of Legal Traditions, Political Cultures and Institutional Design

4.2.1 Differences in Legal Systems: Codified Sovereignty versus Integrated Rules

Most EU Member States belong to the civil law tradition, where domestic judicial systems emphasise the authority and systematic nature of codified statutes. However, the European Arrest Warrant does not represent a natural extension of Member States' domestic laws, but rather an active, top-down restructuring of rules. Through supranational legislation, it has imposed uniform EU rules over the divergent domestic codes of member states in the core judicial sovereignty domain of extradition. Its purpose is not to refine domestic legal systems but to establish an entirely new, independent regional order for judicial cooperation.

As another civil law country, China's practice strictly adheres to the logic of prioritising the authority of domestic codes. Its codified system, centred on the Extradition Law of the People's Republic of China, unequivocally and absolutely establishes the principle of non-extradition of its own nationals (Article 8(1)). No exception can undermine this fundamental stance of domestic legislation. Consequently, the exceptions created by China are subsidiary, supplementary, and highly specific: they must be individually and explicitly embedded within the domestic legal system through the sovereign act of concluding bilateral treaties, taking the form of special laws.

4.2.2 Political and Cultural Differences: Functional Cession versus Absolute Retention

The political culture of the European Union is founded upon the principles of shared sovereignty and the construction of an ever-closer union. The European Arrest Warrant system is a product of this philosophy, its core being the agreement among Member States to cede the traditional discretionary powers of their national judicial authorities in matters of extradition to a common regulatory framework based on mutual recognition and trust. The Court of Justice of the European Union's ruling in Case C-700/21 clearly articulates this logic: the Court held that Member States may not deprive individuals of their right to either extradition or prosecution proceedings solely on the basis of nationality (third-country nationals) [23]. This ruling demonstrates that within the EU's integrated judicial space, the primacy of certain supranational values – such as the principle of equality and judicial efficiency – may supersede Member States' inclination to differentiate treatment based on traditional notions of sovereignty towards specific groups, such as non-EU nationals. Here, the cession of sovereignty serves the higher objective of constructing a more efficient and unified regional legal order. In international judicial cooperation, China consistently regards national sovereignty as an indivisible, non-transferable absolute principle. This notion of absolute sovereignty subjects any arrangement potentially perceived as diminishing judicial jurisdiction to rigorous scrutiny. The principle of non-extradition for death penalty offences upheld in China's extradition practice epitomises this stance. It constitutes not merely a condition for cooperation, but a declaration of national judicial sovereignty and exclusive penal jurisdiction.

4.2.3 Differences in Judicial Independence: Judicial Primacy versus Sovereign Review

The European Arrest Warrant system within the EU is founded upon a high degree of judicial trust among Member States, with its ideal operational model being judicialisation and depoliticisation. The institutional design aims to render surrender decisions as much as possible a direct dialogue between judicial authorities based on law and evidence, thereby diminishing the political discretion traditionally afforded to administrative bodies in extradition proceedings [24]. The case law of the Court of Justice of the European Union is dedicated to upholding the autonomy of this system. For instance, in cases involving conflicts over extradition requests from third countries, the Court emphasises that the relevant review procedures must be judicial in nature to safeguard the fairness of decisions and the parties' rights to redress.

China's extradition review process exhibits distinct sovereign-centric characteristics, with judicial scrutiny and administrative review closely integrated to serve the comprehensive balancing of national sovereignty, security, and diplomatic interests. The entire procedure constitutes not a purely judicial determination, but rather a political-legal decision-making process. Judicial organs are responsible for conducting legality reviews of extradition requests (such as whether they satisfy the dual criminality principle), while administrative organs (such as the Ministry of Foreign Affairs) exercise discretion over matters involving national sovereignty and significant public interests.

4.2.4 Cultural Value Differences: Rights-Based vs Order-Based Approaches

The cultural and legal-philosophical traditions of the European Union are profoundly shaped by Enlightenment thought, placing fundamental individual rights and freedoms at the apex of its value hierarchy and viewing the judiciary as the core mechanism for safeguarding these rights. This rights-based perspective underpins the institutional logic of the European Arrest Warrant: the primary purpose of extradition (surrender) extends beyond combating crime to establishing a unified legal space within the EU characterised by equal rights and judicial fairness. The institutional design places paramount importance on procedural safeguards, judicial independence, and the right of parties to seek redress, operating on the premise that sound judicial procedures inherently produce just outcomes.

China's political culture and legal philosophy, however, place greater emphasis on the state's overall order, authority, and social harmony. Within this order-centric paradigm, criminal justice serves not merely as a tool

for resolving individual disputes, but as a critical domain for maintaining social stability and demonstrating state sovereignty and dignity. Extraditing its own nationals to face trial abroad is culturally and psychologically perceived as diminishing judicial sovereignty and the state's duty of protection. Consequently, China's extradition practice must first and foremost serve the higher value of upholding sovereign order.

4.3 Conclusion: Path Selection in Dynamic Equilibrium

The exceptions to the principle of non-extradition of nationals practised by the EU and China represent not merely divergent rules, but fundamentally distinct governance logics and path choices within global governance. Their divergence essentially embodies the tension between supranational legal compulsion towards integration and prudent adaptation under the principle of absolute sovereignty, reflecting differing understandings of judicial sovereignty, cooperative efficiency, and value prioritisation.

The European Arrest Warrant system, founded on mutual recognition and leveraging supranational legal coercion, has successfully established the world's most efficient regional fugitive transfer mechanism, achieving a paradigm shift from cooperation to obligation. However, its success relies heavily on the high homogeneity of legal cultures among member states, political mutual trust, and loyalty to shared values. Poland's conduct in the Nord Stream case serves as a cautionary reminder that such homogeneity may fracture when core geopolitical interests are at stake. The legal coerciveness of integration can encounter fierce resistance from the political will of nation states, exposing the vulnerability of this model when confronting major crises.

China adheres to a sovereignty-centred consultative model, with domestic law as its absolute bedrock. It constructs cooperative networks through bilateral treaties and alternative mechanisms (such as trials in absentia and Operation Fox Hunt). This approach eschews formal uniformity and speed in favour of greater flexibility, controllability, and strategic depth. It permits nations to comprehensively weigh legal, political, and diplomatic interests in each specific cooperation, excelling particularly in handling complex cases involving differing systems and cultural contexts. However, its efficacy relies on extensive diplomatic groundwork and case-by-case negotiations, rendering the process more uncertain and making it difficult to establish standardised cooperation procedures suitable for large-scale replication.

5. Recommendations for Refining Exceptions to the Principle of Non-Extradition of Nationals in China

Article 8 of China's Extradition Law mandates refusal of extradition on the grounds of nationality, establishing a rigid legal boundary for extradition cooperation. Although scattered exceptions have been created through clauses such as 'extradite or prosecute' in bilateral treaties, the overall framework remains characterised by rigid principles, fragmented exceptions, and unclear procedures. This creates significant tension between the increasingly urgent demands for cross-border crime governance and China's strategic positioning of deep engagement in global judicial cooperation. Building upon the preceding dialectical analysis of the EU integration model and China's sovereign consultation model, China should systematically construct a more predictable and operational exception mechanism from three dimensions: legislative rigidity, treaty standardisation, and judicial review. This should be grounded in China's own rule of law traditions and practical needs, while upholding the principle of national sovereignty, thereby achieving a dynamic equilibrium between safeguarding sovereignty and fulfilling international obligations.

5.1 Introducing Mandatory Extradition or Prosecution Clauses into Domestic Legislation

Presently, China's implementation of the 'extradite or prosecute' principle relies entirely on fragmented provisions within bilateral treaties, lacking overarching domestic legislation to provide a comprehensive framework. This results in the efficiency of international cooperation being constrained by treaty negotiation processes and case-by-case diplomatic coordination. Under the existing model, whether China assumes an obligation to extradite or prosecute depends entirely on whether a bilateral treaty containing such provisions has been concluded with a specific state. This ad hoc treaty-dependent approach struggles to meet the challenges of globalised crime and fails to establish effective legal expectations for states that have not yet concluded such treaties with China. To systematically enhance judicial capacity in combating major transnational crimes, the Extradition Law should incorporate universally binding mandatory 'extradite or

prosecute' provisions, thereby internalising this principle of international law as explicit domestic legal obligations.

Future provisions could explicitly target crimes severely jeopardising national security and public welfare, such as corruption and bribery, terrorist activities, drug offences, cross-border telecommunications fraud, and organised crime. Furthermore, provisions may stipulate that competent Chinese authorities (such as those designated by the Supreme People's Court) bear an obligation to initiate criminal proceedings against their own nationals upon receiving case materials and evidence from requesting states. Reasonable time limits for case review and filing (e.g., three months) should be established to balance cooperative efficiency with judicial integrity.

5.2 Exception Clauses in Standard Bilateral Treaties

Presently, bilateral extradition treaties concluded between China and various nations exhibit significant fragmentation in the formulation of exception clauses. These disparities manifest not only in the presence or absence of such clauses but also in their content, triggering conditions, and procedural safeguards. To enhance cooperative efficiency and legal certainty, it is imperative to draw upon international experience and promote the transition of treaty exception clauses from case-specific customisation to standardised modules. This will establish a categorised and tiered standardisation system that upholds principles while maintaining flexibility.

For instance, regarding provisional transfer provisions for individuals implicated in major corruption offences, where evidence is highly time-sensitive and extradition often determines the success of asset recovery, standardised clauses should stipulate that, without prejudice to the requested State's criminal proceedings, its nationals may be provisionally transferred to the requesting State to participate in specific proceedings (such as giving evidence or cross-examination) before being returned.

Regarding evidence-sharing and prosecution priority clauses for non-political crimes such as terrorism, to avoid the pitfall of cooperation stalling due to disputes over the classification of political offences, the treaty should explicitly stipulate that the principle of non-extradition for political offences shall not apply to non-political crimes explicitly defined in international conventions, such as terrorism and drug trafficking.

5.3 Establishing Judicial Safeguards Against Political Interference

To ensure the sound operation of China's extradition exception mechanism, it is imperative to enhance the independence, transparency, and legal persuasiveness of judicial review processes while upholding sovereignty scrutiny. This will forge a rule-of-law barrier that defends against improper interference through procedural justice.

To prevent the principle of non-extradition for political offences from being abused as a universal clause for refusing cooperation, China's Extradition Law should incorporate strict, purpose-based and proportional interpretations of political offences in its implementing regulations or judicial interpretations, drawing upon internationally accepted standards. For instance, it should be explicitly stipulated that acts such as terrorism, war crimes, and corruption shall not be deemed political offences solely on the basis of their political motivation or context. For ordinary crimes involving political factors, the core criteria for determination should be objective elements such as the criminal means employed and the primary legal interests infringed, thereby preventing conceptual overreach and abuse.

To unify the application of legal standards and enhance the authority of reviews, a mechanism should be established whereby the Supreme People's Court conducts judicial review of extradition cases. This would not supersede the administrative review conducted by competent authorities, but rather introduce an additional layer of review centred purely on legal scrutiny following the administrative review (which prioritises policy considerations such as sovereignty and security). Extradition decisions (particularly refusals) must be accompanied by a detailed written statement of reasons. This statement should explicitly cite specific legal provisions, factual evidence, and international law bases, avoiding vague, non-reviewable expressions such as 'insufficient evidence' or 'contrary to national interests'.

6. Conclusion

The contemporary practice of the principle of non-extradition of nationals epitomises the profound tension faced by sovereign states in the globalised context as they seek to balance the preservation of judicial sovereignty with the efficiency of international cooperation. The significance of this study lies in its systematic comparative analysis, which not only deepens theoretical understanding of two paradigms of international judicial cooperation—regional supranational collaboration and autonomous cooperation among sovereign states—but also illuminates how deep-seated factors such as legal traditions, conceptions of sovereignty, and judicial cultures shape a nation's extradition policy choices. The EU model demonstrates the potential for maximising judicial efficiency within a highly homogenised region and its reliance on sovereign concessions; the Chinese model, conversely, highlights a pragmatic approach to upholding core sovereign interests within a pluralistic world while engaging in global governance through flexible strategies.

Nevertheless, this study has certain limitations. Firstly, it focuses primarily on legal texts and analysis of landmark cases, with insufficient statistical and empirical examination of the vast number of routine, non-public cases within the extradition practices of both countries. Secondly, as both the international landscape and domestic legal frameworks evolve dynamically, the study's conclusions require ongoing validation and updating in light of future legislative amendments and practical innovations. For instance, the ongoing debates within the EU concerning the application of arrest warrants, alongside new developments in China's judicial cooperation under the Belt and Road Initiative, warrant sustained attention.

Looking ahead, further research could be deepened in the following directions: firstly, conducting in-depth investigations into the specific challenges posed by new forms of transnational crime in the digital age to extradition exception rules, and exploring corresponding responses; secondly, comparing practices across more legal systems and countries (such as those in the Anglo-American legal tradition) to construct a theoretical framework with greater universal explanatory power; thirdly, analysing the practical impact of non-legal factors such as political mutual trust and diplomatic relations on extradition cooperation from an intersectional perspective of international relations and global governance. For China, while upholding national sovereignty and security, the critical task remains to develop systematic and standardised exception mechanisms that are more predictable and operationally feasible. This is essential for effectively combating transnational crime and fulfilling international obligations, necessitating urgent legislative and policy responses.

References

- [1] National People's Congress of China. Interpretation of the Extradition Law of the People's Republic of China. Available from: http://www.npc.gov.cn/zgrdw/npc/flsyywd/xingfa/2002-07/15/content_297581.htm (accessed 29 January 2026).
- [2] Council of Europe. European Convention on Extradition. Available from: <https://rm.coe.int/16800c92bc> (accessed 29 January 2026).
- [3] European Union. Convention on Extradition between Member States. Available from: <https://eur-lex.europa.eu/EN/legal-content/summary/simplified-extradition-procedure-between-member-states.html> (accessed 29 January 2026).
- [4] Council of the European Union. Convention Drawn up on the Basis of Article K.3 of the Treaty on European Union, Relating to Extradition between the Member States of the European Union -Joint Declaration on the Right of Asylum -Declaration by Denmark, Finland and Sweden Concerning Article 7 of This Convention -Declaration on the Concept of Nationals - Declaration by Greece Regarding Article 5 -Declaration by Portugal on Extradition Requested for an Offence Punishable by a Life Sentence or Detention Order -Council Declaration on the Follow up to the Convention. Available from: <https://www.ecba.org/extdocserv/CriminalJustice/Conventions/ConventiondrawnbasisArtK3TreatyEU27sept1996.pdf> (accessed 29 January 2026).

- [5] Council of Europe. Convention Relating to Extradition between the Member States of the European Union - Explanatory Report (Text Approved by the Council on 26 May 1997). Available from: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:51997XG0623:EN:HTML> (accessed 29 January 2026).
- [6] Zhao, B. Z. Research on Mutual Legal Assistance in Criminal Matters within the European Union and Related Documentation in Chinese and English. Beijing: China People's Public Security University Press, 2003.
- [7] Council of Europe. Council Framework Decision of 13 June 2002 on the European Arrest Warrant and the Surrender Procedures between Member States - Statements Made by Certain Member States on the Adoption of the Framework Decision. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32002F0584&qid=1614859595198> (accessed 29 January 2026).
- [8] Ma, H. The emergence of the European arrest warrant and its transformation of extradition systems. Criminal Studies. 2008, 1, p. 69.
- [9] Lu, L. x. The Dilemma of Exception Application to the Principle of Non-Extradition of Nationals and Legal Responses. Master's Thesis, Nanjing: Nanjing University, 2021.
- [10] National Database of Laws and Regulations. Extradition Law of the People's Republic of China. Available from: <https://flk.npc.gov.cn/detail?id=2c909fdd678bf17901678bf60bd90253&fileId=&type=&title=%E4%B8%AD%E5%8D%8E%E4%BA%BA%E6%B0%91%E5%85%B1%E5%92%8C%E5%9B%BD%E5%B3%95%E6%B8%A1%E6%B3%95> (accessed 29 January 2026).
- [11] Npc.Gov. Treaty between the People's Republic of China and the Republic of Serbia on Extradition. Available from: http://www.npc.gov.cn/npc/c2/c30834/202509/t20250912_447700.html (accessed 29 January 2026).
- [12] Ministry of Foreign Affairs of the People's Republic of China. Treaty Between the People's Republic of China and the Republic of Chile on Extradition [Treaty]. Available from: <https://treaty.mfa.gov.cn/tykfiles/20210712/1626076978176.pdf> (accessed 29 January 2026).
- [13] Npc.Gov. Treaty between the People's Republic of China and the Republic of Zimbabwe on Extradition. Available from: http://www.npc.gov.cn/npc/c2/c30834/202412/t20241224_441967.html (accessed 29 January 2026).
- [14] Supreme People's Court of the People's Republic of China. Request by the Republic of Korea to the People's Republic of China for the Extradition of the Criminal, Republic of Korea National Byun In-ho. Available from: <http://gongbao.court.gov.cn/Details/a058ad74f9e515cfabeb790daa5938.html> (accessed 29 January 2026).
- [15] Liu, X. A Jurisprudential Analysis of China's Foreign-Related Criminal Jurisdiction. Available from: <https://news.ecupl.edu.cn/2017/1123/c675a83045/page.htm> (accessed 29 January 2026).
- [16] Npc.gov.cn. Criminal Procedure Law of the People's Republic of China. Available from: http://www.npc.gov.cn/npc/c2/c12435/201905/t20190521_276591.html (accessed 29 January 2026).
- [17] National Database of Laws and Regulations. Criminal Law of the People's Republic of China. Available from: <https://flk.npc.gov.cn/detail?id=ff808181796a636a0179822a19640c92&title=%E4%B8%AD%E5%8D%8E%E4%BA%BA%E6%B0%91%E5%85%B1%E5%92%8C%E5%9B%BD%E5%88%91%E6%B3%95> (accessed 29 January 2026).

- [18] Ministry of Public Security of the People's Republic of China. China Extradites Economic Crime Suspect from Thailand Over Alleged Illegal Public Deposit Solicitation. Available from: <https://www.mps.gov.cn/n2254098/n4904352/c10176226/content.html> (accessed 29 January 2026).
- [19] National Database of Laws and Regulations. Nationality Law of the People's Republic of China. Available from: <https://flk.npc.gov.cn/detail?id=2c909fdd678bf17901678bf5aba10073&fileId=&type=&title=%E4%B8%AD%E5%8D%8E%E4%BA%BA%E6%B0%91%E5%85%B1%E5%92%8C%E5%9B%BD%E5%9B%BD%E7%B1%8D%E6%B3%95> (accessed 29 January 2026).
- [20] Treaty Database of the People's Republic of China. Treaty between the People's Republic of China and the Italian Republic on Extradition. Available from: <https://treaty.mfa.gov.cn/tykfiles/20180903/1535959707385.pdf> (accessed 29 January 2026).
- [21] Xinhua News Agency. Polish court orders immediate release of suspect in Nord Stream pipeline explosion case. Available from: <https://www.xinhuanet.com/world/20251017/5adfb29f463141ce9f1c34ab7fabeebb/c.html> (accessed 29 January 2026).
- [22] Treaty Database of the People's Republic of China. Treaty between the People's Republic of China and the Kingdom of Thailand on Extradition. Available from: <https://treaty.mfa.gov.cn/tykfiles/20180718/1531876689176.pdf> (accessed 29 January 2026).
- [23] CURIA. Judgment of the Court (Grand Chamber). Available from: <https://curia.europa.eu/juris/document/document.jsf> (accessed 29 January 2026).
- [24] Court of Justice of the European Communities (including Court of First Instance Decisions). Judgment of the Court (Third Chamber). Available from: [https://www.bailii.org/cgi-bin/format.cgi?doc=/eu/cases/EUECJ/2025/C76322.html&query=\(judicial\)+AND+\(review\)](https://www.bailii.org/cgi-bin/format.cgi?doc=/eu/cases/EUECJ/2025/C76322.html&query=(judicial)+AND+(review)) (accessed 29 January 2026).

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Research on the Sustainable Development of Huimin Insurance within the Multi-Level Health Security System: A Case Study of C City

Ying Wan, Danni Xu*

Kunming Medical University, Kunming, Yunnan, China

*Corresponding author: Danni Xu

Abstract

The inclusive commercial health insurance model of Huimin Insurance plays an important role in improving the multi-level security pattern and reducing the economic burden of healthcare for the general public. This paper applies a mixed research method that involves questionnaires and interview methods to investigate the current situation and sustainable development paths for the Huimin Insurance model in City C from both supply-side and demand-side perspectives. The research shows that the gap between income levels and supply guarantees affects the scale and enthusiasm for insurance. Meanwhile, the phenomenon of asymmetric information between insurers and consumers has led to cognitive biases and trust gaps between insurers and consumers. Furthermore, the gap between consumer demands and service qualities affects the depth of insurance coverage and satisfaction rates. Based on the research findings, relevant recommendations are put forward in this paper, aiming to provide theoretical support for the sustainable development of inclusive insurance products in City C and similar areas.

Keywords

multi-level health security system, Huimin Insurance, welfare triangle theory

1. Introduction

Considering the increasing awareness of health among the population, the development of a multi-level health security system has become a national strategic priority. Relevant policy documents, particularly the “Healthy China 2030 Planning Outline” actively advocate for the development of supplementary medical insurance. Based on this, a new form of market-based medical insurance, known as “Urban Customized Commercial Medical Insurance” or “Huimin Insurance” has emerged[1]. It is a form of medical insurance that bridges the gap between basic social insurance and high-end commercial insurance. It is characterized by low enrollment thresholds, extensive coverage, and low premiums, as well as the integration of individual medical insurance accounts[2]. Since the development of “Shenzhen Supplementary Insurance for Serious Illness” in 2015, this form of medical insurance has rapidly expanded beyond major cities to second- and third-tier cities. However, this form of medical insurance is also facing a number of development challenges, including a decrease in enrollment, adverse selection, a risk of mortality spirals, and suspension of sales[3]. Thus, the

development of a multi-level health security system and the effective implementation of the “Healthy China” strategy will depend on the development challenges of affordable health insurance.

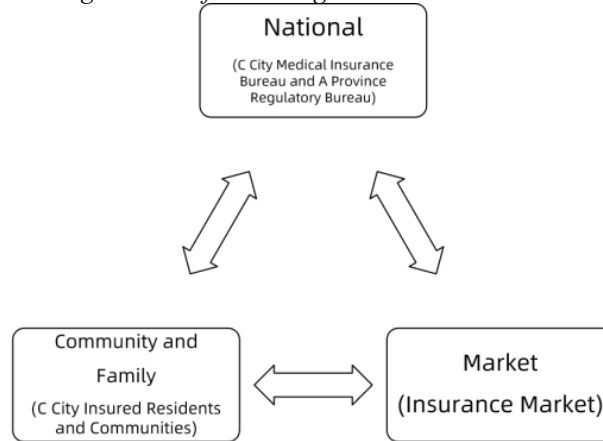
2. Literature Review and Theoretical Basis

Existing literature on Huimin Insurance mainly revolves around a number of major dimensions related to policy evaluation and participant behavior. By using the PMC (Policy Modeling Consistency) model, Gu Dongming et al. [4] and Luo Jinping et al. [5] found that there are a number of operational challenges, such as unclear cycle delineation, insufficient functions in peripheral domains, and stagnant resources. On the other hand, from a quantitative perspective, Liu Yang et al. [6] used the entropy method based on the TOPSIS method and found that sustainability and compensation capacity are crucial for system sustainability. Moving on to the demand side, Li Gaojie et al. [3] found, based on analysis related to the full lifecycle of insurance participation, that certain decision-making factors are crucial for policyholder behavior. Furthermore, based on field testing, Liu Wendi et al. [7] and Wu Yuxia et al. [8] found, based on psychological behavior analysis, that policyholder behavior is driven by a combination of factors related to knowledge levels, satisfaction, and psychological dynamics. However, as regards external motivating factors, Wu Jian et al. [9] and Wang Qun et al. [10] agree that government intervention remains the major motivating factor for enrollment, while information breadth remains a secondary enhancing factor.

Most of the discussions on the paths of sustainable development focus on mitigating the risk of a “death spiral” and optimizing the institutions. According to Hu Hongwei et al. [11], the current bottlenecks can be attributed to unclear institutional arrangements, thus the need to develop new policy instruments. Wang Qiongyang et al. [12] argue that for effective governance to take place, there is a need to differentiate between the roles of the government and commercial enterprises. In order to improve participant satisfaction, Sun Jie et al. [13] suggest that new payment mechanisms should be implemented. In terms of international benchmarking, Lin Miao et al. [14] use Singapore as a reference and recommend a comprehensive settlement system and a multi-tiered risk pricing framework, while Zheng Yangyang et al. [15] use the analysis results of the US Medicare Social Commercial Partnership Model. In terms of technology, Zhang Chenghe [16] investigates the reform of actuary protocols and service methods based on the application of AI algorithms and blockchain principles, while Mengting C and Xiao Z [17] recommend a dynamic optimization framework for specialty drug coverage.

While the current literature does form a basic foundation for the understanding of the subject, a significant gap has been identified within the current knowledge base in relation to the synergies that exist within the multi-stakeholder coordination system. More specifically, the role of community engagement in the context of the tripartite model of the state, the market, and civil society has not been adequately explored. Within this context, the current study seeks to address the above-stated research question through the application of the Welfare Triangle theory as a tool of analysis, with the empirical context of the study being the Huimin Insurance program in City C.

The research aims to explicitly examine the dynamic interactions between the three major stakeholders within the context of the welfare provision process: (1) the government, which is responsible for the formulation of policies, regulatory oversight, and the establishment of operational equity, (2) market entities (commercial entities/insurers), which are responsible for the implementation of the targeted initiatives for product and risk management, and (3) community entities, which are responsible for the mobilization and bridging of the social context within the context of the enrollment phase.

Figure 1. Welfare Triangle Theoretical Framework

3. Empirical Analysis of Supply and Demand Dynamics for Huimin Insurance in City C

3.1 Overview of C City Huimin Insurance

The pricing strategy of the Huimin Insurance program in City C is based on a differentiated two-tier pricing structure. In particular, the Basic Plan of the Huimin Insurance program is priced at 69 RMB per year, covering a benefit limit of 2 million RMB. On the other hand, the Enhanced Plan of the same program is priced higher, amounting to 159 RMB per year, covering a benefit liability of 3.5 million RMB. In addition to the commercial viability of the program, there is also a focus on social equity. In 2025, 25,600 specialized insurance policies are donated to economically disadvantaged people through corporate and government donations, targeting people with autism and other diseases, such as children. In particular, as far as coverage scope is concerned, the Basic Plan of the Huimin Insurance program covers medical expenses, certain medical expenses on drugs, and hospitalization allowances strictly within the statutory medical insurance system. On the other hand, the coverage scope of the Enhanced Plan of the same program is significantly broader, covering non-reimbursable medical expenses and advanced medical technology, including proton and heavy ion therapy.

3.2 Empirical Analysis of Demand-Side

3.2.1 Survey Overview and Descriptive Statistics

For this research, data collection was carried out in the region of City C from March to September 2025. The study adopted a mixed research design that enabled the collection of data using an online questionnaire and interviews, which ensured that the data collected was diverse. A total of 409 valid responses were obtained from the data collected, giving the study a valid response rate of 97.84%. As shown in Table 1, the questionnaire consisted of four major dimensions, which included sociodemographics, product cognition, purchasing behavior, and satisfaction assessment. Demographically, the sample displayed a balanced gender ratio (females: 50.6%; males: 49.4%). Age distribution was concentrated primarily in the 36–55 cohort, followed by the 18–35 group, with 55.3% of all respondents reporting their marital status as married. Regarding educational attainment, over half of the participants held an associate or bachelor's degree, while 10.5% possessed postgraduate qualifications. Economically, the monthly income distribution skewed towards lower-to-middle brackets: 31.3% earned below 3,000 RMB, and 30.3% earned between 3,000 and 5,000 RMB. In terms of baseline social security coverage, the majority (57.2%) were enrolled in the Urban and Rural Resident Basic Medical Insurance (URRBMI), whereas 41.3% participated in the Urban Employee Basic Medical Insurance (UEBMI).

Table 1: Demographic Characteristics of the Survey Participants

Variable	Number	Percentage/%
Gender		
Male	202	49.4
Female	207	50.6
Age		

Under 18	17	4.2
18–35	240	58.7
36–55	118	28.9
55 and above	34	8.3
Marital Status		
Married	226	55.3
Single	183	44.7
Education		
Junior high school or below	46	11.2
High school or vocational school	80	19.6
College diploma or bachelor's degree	240	58.7
Master's degree or above	43	10.5
Monthly Income		
Below ¥3,000	128	31.3
¥3,000–¥5,000	124	30.3
¥5,000–¥8,000	95	23.2
¥8,000–¥10,000	40	9.8
Above ¥10,000	22	5.4
Basic Medical Insurance Enrollment		
Basic Medical Insurance for Urban and Rural Residents	234	57.2
Basic Medical Insurance for Urban Employees	169	41.3
Other	6	1.5
Huimin Insurance Enrollment		
Yes	155	37.9
No	254	62.1

3.2.2 Single-factor analysis of insurance participation willingness and renewal willingness

Based on the above samples, this study selected 12 variables for single factor analysis, including gender, age, marital status, education level, average monthly income, whether suffering from chronic diseases, whether having major disease experience, the type of basic medical insurance, whether buying other commercial insurance, whether obtaining claims of Huimin Insurance the degree of understanding of Huimin Insurance, and the degree of satisfaction with Huimin Insurance. The findings indicate that the three factors of “Experience with Critical Illness”, “Understanding of Huimin Insurance”, and “Satisfaction” significantly impact respondents' willingness to participate in insurance, as shown in Table 2. Regarding the willingness to renew insurance, “education level”, “History of Claims Compensation”, “Understanding of Huimin Insurance” and “Satisfaction” were found to significantly affect renewal decisions, as indicated in Table 3.

Table 2: Single-Factor Analysis of Respondents' Willingness to Participate in Huimin Insurance

Variable	Willing to buy		χ^2	P-Value
	yes	no		
Gender			0.213	0.644
Male	71	98		
Female	87	131		
Age			1.426	0.700
Under 18	16	16		
18–35	86	125		
36–55	38	60		
55 and above	18	28		
Marital Status			0.002	0.963
Married	69	100		
Single	89	129		
Education			2.385	0.497
Junior high school or below	19	25		
High school or vocational school	40	45		
College diploma or bachelor's degree	73	122		
Master's degree or above	26	37		

Monthly Income			5.682	0.223
Below ¥3,000	54	84		
¥3,000–¥5,000	28	57		
¥5,000–¥8,000	33	35		
¥8,000–¥10,000	31	33		
Above ¥10,000	12	20		
Experience with Chronic Diseases			0.011	0.916
No	131	189		
Yes	27	40		
Experience with Critical Illness			5.852	0.016
No	101	118		
Yes	57	111		
Basic Medical Insurance Enrollment			0.892	0.640
Basic Medical Insurance for Urban and Rural Residents	103	159		
Basic Medical Insurance for Urban Employees	51	66		
Other	4	4		
Purchase of other commercial insurance			0.395	0.530
No	107	148		
Yes	51	81		
Understanding of Huimin Insurance			60.438	0.000
Very poor understanding	42	13		
Poor understanding	55	47		
Basic Understanding	44	99		
High understanding	15	46		
Very high understanding	2	24		
Satisfaction with Huimin Insurance			36.415	0.000
Very dissatisfied	16	6		
Dissatisfied	24	7		
Neutral	76	109		
Satisfied	33	81		
Very satisfied	9	26		

Table 3: Single-Factor Analysis of Respondents' Willingness to Renew Huimin Insurance

Variable	Willing to renew		χ^2	P-Value
	yes	no		
Gender			2.854	0.091
Male	54	146		
Female	46	183		
Age			6.772	0.080
Under 18	5	15		
18–35	45	195		
36–55	31	78		
55 and above	19	41		
Marital Status			0.172	0.678
Married	51	160		
Single	49	169		
Education			12.371	0.006
Junior high school or below	13	27		
High school or vocational school	23	73		
College diploma or bachelor's degree	45	200		
Master's degree or above	19	29		
Monthly Income			7.141	0.129
Below ¥3,000	15	87		
¥3,000–¥5,000	31	95		
¥5,000–¥8,000	25	81		
¥8,000–¥10,000	22	51		
Above ¥10,000	7	15		

Experience with Chronic Diseases			3.555	0.059
No	71	263		
Yes	29	66		
Experience with Critical Illness			3.670	0.055
No	67	185		
Yes	33	144		
Basic Medical Insurance Enrollment			0.922	0.631
Basic Medical Insurance for Urban and Rural Residents	56	192		
Basic Medical Insurance for Urban Employees	43	136		
Other	1	1		
Purchase of Other Commercial Insurance			0.552	0.457
No	55	167		
Yes	45	162		
History of Claims Compensation			7.790	0.005
No	97	3		
Yes	287	42		
Understanding of Huimin Insurance			65.947	0.000
Very poor understanding	24	22		
Poor understanding	28	25		
Basic Understanding	24	95		
High understanding	18	150		
Very high understanding	6	37		
Satisfaction with Huimin Insurance			75.329	0.000
Very dissatisfied	10	2		
Dissatisfied	13	12		
Neutral	57	106		
satisfied	14	151		
Very satisfied	6	58		

3.2.3 Logistic Regression Analysis of Participation and Renewal Determinants

To control for potential confounding factors, variables with $P < 0.05$ from the single-factor analysis were included in the logistic regression. As shown in Table 4, “Understanding of Huimin Insurance” ($\beta = 0.765$, $P < 0.001$, $OR = 2.148$) has a significant positive effect on the willingness to participate in insurance. Similarly, Table 5 shows that “Satisfaction with Huimin Insurance” ($\beta = 0.789$, $P < 0.001$, $OR = 2.201$) significantly positively impacts the willingness to renew insurance.

Table 4: Logistic Regression Analysis of Insurance Enrollment Intentions

Variable	β	S.E.	Wald	P-Value	OR
Experience with Critical Illness	0.394	0.230	2.923	0.087	0.675
Understanding of Huimin Insurance	0.765	0.144	28.229	0.000	2.148
Satisfaction with Huimin Insurance	0.102	0.156	0.425	0.514	1.107
constant	-2.156	0.437	24.326	0.000	0.116

Table 5: Logistic Regression Analysis of Renewal Intentions

Variable	β	S.E.	Wald	P	OR
Education	-0.057	0.155	0.136	0.712	0.944
History of Claims Compensation	0.773	0.630	1.508	0.219	2.167
Understanding of Huimin Insurance	0.312	0.135	5.363	0.021	1.366
Satisfaction with Huimin Insurance	0.789	0.188	17.565	0.000	2.201
constant	-2.132	0.741	8.287	0.004	0.119

3.2.4 Qualitative Analysis of Claim Experiences and Challenges

In addition to the quantitative survey, semi-structured in-depth interviews were conducted with representative claimants to identify behavioral drivers. The thematic analysis reveals three systemic hurdles: administrative efficiency in offline settlements, cognitive understanding of policy terms, and the gap between expected and actual utility of coverage.

Firstly, with regard to process efficiency, respondents complained about the “time-consuming and inefficient process of filing claims manually.” They strongly recommend the integration of the system with medical institutions to improve efficiency. Secondly, with regard to cognitive understanding, respondents were seen to have a shallow understanding of key terms such as deductibles and the policy's premium value. Most of the respondents were observed to have the perception that the actual deductible amount is more than they initially thought, and this can be attributed to the complex process of subtraction and proportionate reimbursement. Finally, there is a difference between the amount received and the economic burden, and this affects the intent to renew the product.

3.3 Qualitative Assessment of Supply-Side Operations

To analyze the dynamics of the supply side, this study employed semi-structured in-depth interviews, which targeted key decision-makers in the insurance firm. The target population specifically included the operational heads of the Huimin Insurance Project in City C and the senior directors of the claims department. The interview guide was designed to target four strategic dimensions: the governance structure of the coinsurance consortium, actuarial performance (enrollment rates and loss ratios), service process efficiency, and the management's perception of consumer sentiment and satisfaction.

The Huimin Insurance Project in City C adopts a coinsurance scheme, in which the insurance is jointly offered by eight insurance companies. The main business operations involve system development, claims handling, network administration, and handling everyday customer inquiries, among others. The leading company undertakes the vast majority of tasks, while the other coinsurance companies allocate compensation solely on the basis of their share ratio. This practice leads to a gross imbalance in the allocation of authority and responsibility, with an unreasonably high concentration of operational expenses and a consequent decrease in synergy efficiency.

This is evident from the enrollment statistics, which show a consistent decline in the portfolio. This has resulted in critical structural bottlenecks in the promotional channels. The portfolio has significantly declined from its peak of 1.13 million insured in 2022 to 580,000 by August 2025. Currently, C City Huimin Insurance uses online and offline co-promotion channels. However, offline promotion efforts are insufficient, with publicity mainly limited to the central urban area. “Offline channels are primarily promoted by employees of the coinsurance body's insurance companies, accounting for 45%-50%.” Promotion in counties, townships, and rural areas is seriously inadequate. These areas are more likely to use face-to-face offline channels for consultations, which has resulted in a significant decline in the coverage of Huimin Insurance.

This has created a sense of dissonance, as the information is often misrepresented. Currently, the process of settling claims for C City Huimin Insurance is done offline. “Claims are mostly processed offline at 22 fully-covered outlets, where users submit documents locally; the internet is only used for consultations, not online submission.” The offline nature of the operations of the company has created a number of problems, as it is prone to distortion and error.

Besides, the general public does not have a clear understanding of the ‘deductibles’ and “scope of coverage” concepts. “Consultations and complaints mainly focus on the insufficient understanding of deductibles, where the general public thinks that there should be no deductibles after the reimbursement of medical insurance, and becomes confused between internal and external medical expenses.” This generates cognitive biases for the general public, where they think that there is a difficulty in the insurance claims and reimbursement process, leading to a lack of trust in the insurance renewal process.

4. Results

4.1 The disparity between supply security and disposable income limits the scope and desire for insurance participation

In spite of the hierarchical security model establishing a Basic and Enhanced version, according to the questionnaire study, 31.3% of groups have a monthly income below 3000 RMB. After paying the premium for basic medical insurance, the capacity for economic payment for the enhanced version is limited for this part of the group. Therefore, a large number of basic version selections with comparatively limited coverage scope

are made. Thus, despite a high demand for security enhancement for low-income groups who are at high risk, the coverage scope is lower than expected. Therefore, a vicious cycle is created due to a fundamental difference between supply and demand. The difference between coverage scope and payment capacity limits the scale of insurance participation. The decrease in the insurance participation scale increases compensation pressure. Conversely, increases in compensation pressure limit coverage scope enhancement potential, and therefore Huimin Insurance products are confronted with a problem of “inclusiveness” and “sustainability.”

4.2 Information Asymmetry Between Supply and Demand Results in Cognitive Bias and a Trust Deficit

Due to the knowledge asymmetry between supply and demand, various adverse effects have emerged. Among these is the misconception by some residents that there is no need to deduct the deductible amount after receiving medical insurance reimbursement. Others think that Huimin Insurance is a basic medical insurance product and only provides routine outpatient services. When their actual claims experience is lower than their expectations, it leads them to develop a negative perception of the product as “ineffectual,” resulting in a large underestimation of its real value. Another adverse effect is that the information transmission between supply and demand is inefficient, and channels for understanding Huimin Insurance are limited. As reported by the claimants, “22 outlets handle a total of 120-130 consultations daily,” and a large proportion of them are related to inquiries on product coverage, claims, and other related issues. Not only does this mode increase costs, but it also reflects the high levels of uncertainty associated with the understanding of the product by local residents. If the efficiency of knowledge transmission is not enhanced in a timely manner, cognitive biases and distrust will be further exacerbated.

4.3 The Disparity Between Service Quality and Expectations Influences the Extent of Coverage and Overall Satisfaction

There is a clear disparity between the service quality provided by insurance companies and the expectations of policyholders. This disparity is a limiting factor for the expansion of product coverage and the ability of the product to meet essential needs. The structure of the offline service network is not well designed. The offline promotional resources of the coinsurance organization are concentrated in urban areas and insufficient in rural areas, where citizens mainly rely on in-person consultation channels. Moreover, the effectiveness of the claim settlement service is suboptimal. The claim settlement service utilizes the conventional manual settlement mode, in which the medical insurance settlement form is submitted offline to seek reimbursement. Such a mode not only incurs increased operating costs but, more importantly, affects the efficiency of Huimin Insurance and the satisfaction of policyholders owing to the inefficient claim settlement service and the prepayment of funds.

5. Conclusions

5.1 Optimize Product Design and Improve Enthusiasm for Insurance Participation

In order to boost participation rates with the insurance, it is imperative to enhance the benefits that can be derived from the insurance, such as health consultation benefits, online consultation benefits, and medical examination benefits. The benefits can act as a motivator to the insured individual who has not yet made a claim, thus increasing their willingness to engage with the insurance product. In addition, the development of the personal medical insurance account should be encouraged, whereby payments can be made from the accounts of the family members to boost “family solidarity”, thus improving the family's ability to manage risk. In order to boost the motivation of users to renew their insurance, it is imperative to introduce the continuous insurance incentive scheme, whereby the reduction of the deductible and reimbursement rate will be given to users who renew their insurance.

5.2 Streamline the Claims Procedure and Improve Service Accessibility

In order to ensure the smooth implementation of the above-mentioned online claim processing, it is essential to further promote the electronic examination of medical invoices, diagnostic certificates, and other relevant documents, so as to improve the efficiency of claim processing. In addition, in order to ensure that

comprehensive settlement service can be provided, it is essential to continue to advance the pilot integration of the hospital medical insurance system. This will make it possible to process claims for basic medical insurance and Huimin Insurance at the same time when discharged, so as to reduce the burden of advance fund payments. Finally, it is essential to focus on the establishment of convenient service locations or mobile service posts in rural and remote areas, so that the claim handling of groups with limited access to the internet can be adequately facilitated, thereby improving the service experience and customer satisfaction of insurance participation.

5.3 Innovate Publicity Methods and Broaden Publicity Channels

A move towards policy advocacy needs to be made, wherein entities such as community organizations and healthcare institutions need to be involved, especially targeting those who are more likely to participate in offline communication, such as the elderly population and those living in rural areas. It must be ensured that efforts are made towards simplifying key terms related to the policy, such as “deductible” “reimbursement ratio” “scope of coverage”. This can be done by creating short and easily understandable forms of media such as videos and brochures. It is also important to use various forms of communication media such as social media, television, and bulletin boards to the fullest extent. These steps not only need to be effective in providing an appropriate understanding of the product information and the process of claiming, but also create a sense of trust and identity within the system

References

- [1] Yu, Q. and Wang, J. The rise of new forms of health insurance. *China Finance*. 2022(24), pp. 73-74.
- [2] Su, Z. R. Inclusive Commercial Health Insurance: Current Status, Challenges, and Development Recommendations. *Journal of Administrative Management Reform*. 2021, 11(11), pp. 90-99.
- [3] Li, G. J., Chen, L. and Xi, X. Y. The development status, practical challenges and countermeasures of Huimin Insurance in China. *Chinese Health Economics*. 2023, 42(7), pp. 17-20,26.
- [4] Gu, D. M., Zhang, Y. Z. and Xu, K. Quantitative evaluation of the policy of benefiting the people in China. *Medicine and Society*. 2026, 39(1), pp. 106-114.
- [5] Luo, J. P., Sun, J. Y. and Geng, M. H. Evaluation of Public Health Resilience in Municipal Areas Based on the Entropy Weight-TOPSIS Method. *Modern Preventive Medicine*. 2022, 52(9), pp. 1636-1641, 1693.
- [6] Liu, Y., Guo, M. J. and Li, Y. Z. Research on the construction of the evaluation index system of Huimin Insurance, based on the entropy weight TOPSIS method. *Chinese Journal of Health Policy*. 2022, 18(2), pp. 1-7.
- [7] Liu, W. D., Wang, Z. Y. and Liu, S. Y. The willingness of residents in Lanzhou to renew the insurance and its influencing factors. *Medicine and Society*. 2025, 38(3), pp. 86-92,107.
- [8] Wu, Y. X. and Han, C. X. Research on the influencing factors of Huimin Insurance's willingness to participate in insurance in Hebei Province from the perspective of behavioral economics. *Health Economics Research*. 2026, 43(1), pp. 57-62.
- [9] Wu, J., Dan, Y. J. and Qian, D. F. Institution-Technology-Environment: The Complex Causes and Collaborative Governance Path of the Participation Rate of 'Huimin Insurance'. *Nanjing Social Sciences*. 2022(10), pp. 73-83,92.
- [10] Wang, Q., Zhang, T. T. and Ying, X. H. How does the collaborative governance model improve the participation rate of Huimin Insurance? - Fuzzy set qualitative comparative analysis based on 50 cases. *Chinese Journal of Health Policy*. 2023, 16(11), pp. 8-15.

- [11] Hu, H. W., Liu, T. S. and Duan, H. The institutional logic of Huimin Insurance: mechanism, supporting tools and policy evaluation. *Journal of Northwest University (Philosophy and Social Sciences Edition)*. 2025, 55(5), pp. 56-73.
- [12] Wang, Q. Y. and Guo, M. J. Analysis of the governance model and development path of government support for the development of Huimin Insurance from the perspective of holistic governance. *Chinese Journal of Health Policy*. 2023, 16(11), pp. 16-23.
- [13] Sun, J. and Huang, Y. F. Sustainable Development: Challenges and Suggestions. *Price Theory and Practice*. 2024(2), pp. 56-62.
- [14] Lin, M., Li, S. E. and Ding, J. X. The enlightenment of Singapore's government-business cooperative commercial medical insurance to China's Huimin Insurance. *Chinese Health Economics*. 2023, 42(7), pp. 91-96.
- [15] Zheng, Y. Y., Yang, M. and Fu, M. L. The enlightenment of the American Medicare social and business cooperation model to the development of "Huimin Insurance" in China. *Chinese Journal of Hospital Management*. 2022, 38(12), pp. 896-900.
- [16] Zhang, C. H. Innovation and pricing of commercial health insurance in the new technology era. *Journal of Humanities and Nature*. 2025, 1(2), pp. 140-162.
- [17] Cai, M. and Zhang, X. Research on the Application Status and Development of the Specific Drug Guarantee in "Huimin Insurance"--Based on Product Analysis Perspective. In 2022 2nd International Conference on Economic Development and Business Culture (ICEDBC 2022), Dali, China, 2022; pp. 1779-1786. https://doi.org/10.2991/978-94-6463-036-7_266.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper was supported by Yunnan Provincial Department of Education Scientific Research Fund Project(No. 2024J0167); Yunnan Provincial Medical Security Reform and Development Research Center Project(No.K1322224).

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

A Comparative Study of China's Railway Diplomacy under the Background of the "Belt and Road" Initiative: Taking the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway as Examples

Shuyuan Wang*

School of History (Teacher Education), South China Normal University, Guangzhou 510631, Guangdong, China

**Corresponding author: Shuyuan Wang*

Abstract

High-speed railway diplomacy is an integral component of China's Belt and Road Initiative and a major subject in the study of China's diplomacy. The Jakarta-Bandung High-Speed Railway and the China-Thailand Railway (which is also called the Sino Thai Railway) are important representatives of China's railway diplomacy in Southeast Asia. Against the backdrop of the "Belt and Road" Initiative, this paper aims to explore the differences in the effectiveness of high-speed rail diplomacy between China and different countries as well as the underlying reasons by conducting an in-depth analysis of the cases of the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway, employing qualitative and comparative analysis research methods. It also dissects the characteristics of China's high-speed rail diplomacy model and strategies. This analysis demonstrates that China's high-speed railway diplomacy is not a uniform strategy; instead, the approaches adopted are contingent on the host country's specific conditions, including its state capacity, political regime and negotiation strategies. This study summarizes a current railway diplomacy model in China based on existing data, which includes "Technology Export, Standard Export, and Diplomatic Maintenance". The proposed model not only contributes to the theoretical framework of China's infrastructure diplomacy but also offers valuable insights for the future trajectory of its railway diplomacy.

Keywords

railway diplomacy, Jakarta-Bandung High-Speed Railway, Sino Thai Railway, the China-Thailand Railway

1. Introduction

Against the backdrop of the Belt and Road Initiative promoting infrastructure connectivity, the interconnection of infrastructure has become a crucial path for implementing the global governance concept of extensive consultation, joint contribution, and shared benefits. In this context, the "going global" of China's railways has emerged as a prominent practice that embodies both economic cooperation and diplomatic significance. Among them, the major railway projects represented by high-speed rail are not only an important manifestation of the "going out" of China's advantageous production capacity and engineering technology

integration, but also an important manifestation of China's unique practice of "railway diplomacy". Existing research on railway diplomacy has yielded multi-faceted discussions. On the one hand, studies generally emphasize its geopolitical and economic integration functions, particularly focusing on large-scale infrastructure projects as important means of expanding regional influence. On the other hand, mainstream analyses often adopt a Chinese perspective, highlighting the logic of strategic planning and project advancement, while tending to view host countries as relatively passive recipients or arenas of competition. Consequently, insufficient attention has been paid to their internal political and social conditions, autonomous intentions, and their actual impact on project outcomes. Therefore, this paper attempts to move beyond narratives centered on a single actor. It selects two representative cases-the Jakarta-Bandung High-Speed Railway in Indonesia and the China-Thailand Railway-which exhibit marked contrasts in terms of implementation pace, cooperation models, and phased outcomes. By employing a methodology that combines qualitative analysis with comparative case study, this research conducts an in-depth examination of these two projects. This paper attempts to provide a more dynamic and balanced analytical framework for understanding the complex practices of China's infrastructure diplomacy by comparing the key interactive variables and conditional logics that influence the divergence of cooperative paths.

2. Literature Review

In October 2023, the white paper titled *Jointly Building the "Belt and Road": A Major Practice in Building a Community with a Shared Future for Mankind* [《共建"一带一路": 构建人类命运共同体的重大实践》], released by the State Council Information Office, explicitly stated that joint efforts in building the "Belt and Road" have promoted all-round and multi-field connectivity, and that infrastructure connectivity is a priority area in these joint fields. As a crucial component of infrastructure connectivity, railway construction holds significant importance in driving the economic and social development of countries along the "Belt and Road" routes, as well as in fostering economic and technological cooperation between China and these countries [1]. High-speed railway diplomacy is a key manifestation of China's major-country diplomacy with Chinese characteristics. The proposal of the Belt and Road Initiative has catalyzed new opportunities for the "going global" of China's railway technology and high-speed rail industry [2]. Infrastructure connectivity has a significant impact on the diplomatic effectiveness of both countries.

With the development of the "the Belt and Road", the field of China's diplomatic research has expanded. Currently, "high-speed rail diplomacy" is a hot topic in the field of Chinese diplomacy research. Some Western scholars see China's high-speed rail diplomacy with bias. This comes from their traditional geopolitical thinking. But China's high-speed rail diplomacy is different. It is a key part of the Belt and Road Initiative. It is not limited by the old ideas. It follows the principle of "extensive consultation, joint contribution, and shared benefits." Its goal is to help build a global community with a shared future for mankind [3]. The research on "high-speed rail diplomacy" is mainly a display of China's achievements in reform and opening up [2].

A successful high-speed rail "going-global" project can yield abundant benefits across multiple domains such as politics and economy. It is conducive to shaping a positive international image, further demonstrating a country's own technological prowess, amplifying its development achievements, and conveying friendly signals. Additionally, it helps safeguard the livelihoods of relevant industrial chains, promote bilateral and multilateral economic and trade cooperation, and facilitate regional integration [4]. These railway projects operate through deep local procurement, technology transfer, and job creation etc. This close link between the exporter's strategy and the host's development needs ultimately promotes stronger diplomatic ties between the two countries.

Current research mainly focuses on three aspects: firstly, to focus on traditional fields such as maritime cooperation and trade investment, and analyze their geo-economic and strategic significance [5]; secondly, focusing on the model of China expanding its influence through large-scale infrastructure projects, which is the strategic logic of the so-called "infrastructure connectivity" [6]; thirdly, explanations based on a major-power-centric perspective are logically concise, but they pay little attention to the host country's intentions, actions, or internal conditions. It also treats the host nation merely as a space for major powers to carry out and compete in their infrastructure projects [7]. Especially amid the current trends of diversification in the world order and the rising prominence of the "Global South", based on previous studies, we find that existing research has overlooked comparative studies on iconic projects like high-speed railways. It lacks empirical analyses

that systematically compare similar infrastructure projects within the context of the “Belt and Road” Initiative and has not fully addressed the varying degrees of impact that the construction of the Jakarta - Bandung High - Speed Railway and the China - Thailand Railway have on their respective national diplomacies.

3. Method

3.1 Research Design

This study adopts a research design that combines comparative case study method with qualitative research method. Selecting the Jakarta Bandung high-speed railway and the China Thailand railway as comparative cases, the construction characteristics of the two projects are taken as independent variables, and the railway diplomacy achievements between China, Indonesia, and Thailand are taken as dependent variables.

This research employs a comparative case study method. It does this by comparing the two cases in terms of their independent and dependent variables. By doing this, it aims to investigate how variations in national political and economic contexts influence cooperation models and diplomatic effectiveness. In addition, using content analysis to analyze government documents, cooperation agreements, authoritative reports, and relevant academic literature provides solid literature and data support for case comparison.

According to this research design, under the premise of controlling the common background of the “the Belt and Road” initiative, the article can focus on the key variable of the achievements of railway diplomacy, so as to deeply analyze the differences and reasons of the achievements of railway diplomacy between China and different countries, and analyze the mode and strategic characteristics of China’s high-speed railway diplomacy.

3.2 Research Procedure

The study initially selects the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway as research objects based on the representativeness and comparability of the cases. Secondly, it collects relevant data from government documents, project agreements, authoritative media reports, and related academic literature of the two countries. On this basis, an analytical framework is constructed encompassing three dimensions: gauge standards, the degree of localization in the procurement and production of core components, and the allocation of operation and management rights. Subsequently, content analysis and qualitative research methods are employed to conduct in-depth analyses of each case, exploring the internal connections between independent and dependent variables. Finally, through cross-case comparison, the study systematically investigates the influence mechanism of host-country characteristics on cooperation models and diplomatic outcomes, thereby revealing the differentiated strategies of China’s high-speed rail diplomacy.

3.3 Data Collection and Analysis

This study will provide a detailed analysis and comparison of two typical cases of China’s high-speed railway diplomacy and active technology transfer under the Belt and Road Initiative: the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway.

The Jakarta-Bandung High-Speed Railway in Indonesia spans a total length of 142.3 km, with a maximum designed speed of 350 km/h. It stands as a landmark project for the high-quality implementation of the “Belt and Road” Initiative by China and Indonesia, and also marks the first instance where China’s high-speed rail has “gone global” with its entire system, all essential elements, and the whole industrial chain [8]. Based on the framework cooperation agreement between the Chinese and Indonesian governments and enterprises, the Jakarta-Bandung High-Speed Railway project is being implemented using a complete set of Chinese standards [9]. The China-Thailand Railway is another representative project in China’s overseas infrastructure portfolio. Its Phase 1 connects Bangkok, the capital of Thailand, with Nakhon Ratchasima in the northeast (253 km). Phase 2 will extend from Nakhon Ratchasima to Nong Khai on the Thai-Lao border (356 km). Unlike the Jakarta-Bandung High-Speed Railway, the construction of the China-Thailand Railway has been more complex and has faced delays due to various factors [10].

Through reading relevant literature, we found that there are three differences between the Yawan high-speed railway and the Zhongtai railway, which are the key factors for comparing the independent variables.

The analysis focuses on three aspects: the final railway gauge standard, the localization rate for procuring and producing core components, and the ownership of project operation and management rights.

The following table clearly shows us the different characteristics of the independent variables.

Table 1: Comparison of Independent Variables

Item	The final railway gauge standard	The localization rate for procuring and producing core components	The ownership of project operation and management rights
the Jakarta-Bandung High-Speed Railway	Employs China's self-developed CRTS III slab ballastless track system with proprietary intellectual property [11].	During its construction, the Jakarta-Bandung High-Speed Railway project sourced a significant portion of raw materials and equipment locally, including steel, cement, and general machinery. This resulted in a local procurement rate of over 75% [12].	Since its official opening on October 17, 2023, China State Railway Group Co., Ltd., through its subsidiary China Railway International Co., Ltd., as the leading Chinese shareholder in PT Kereta Cepat Indonesia China (KCIC) - the entity responsible for constructing and operating the Jakarta-Bandung High-Speed Railway - has actively participated in KCIC's operations and management. Additionally, the China Railway Beijing Bureau Group Co., Ltd., under the national railway group, has partnered with Indonesia's railway company to form a Sino-Indonesian Operation and Maintenance Consortium (OMC). This consortium is entrusted by KCIC to handle train operations and equipment maintenance for the high-speed line [13].
the China-Thailand Railway	After prolonged negotiations, it was ultimately decided to adopt the Chinese standard gauge of 1,435 mm [14].	In contrast, the gauge selection for the China-Thailand Railway was a central point of contention. Despite Thailand's existing meter-gauge network, negotiations ultimately led to the adoption of the Chinese standard gauge in its first phase [9].	The infrastructure ownership and operational rights of the China-Thailand Railway will belong to the State Railway of Thailand. China's role in the project is that of constructor, technology supplier, and training provider [9].

The dependent variable in this study, namely “the outcomes of high-speed rail diplomacy,” is primarily measured from the following two dimensions. First, the direct operational benefits and economic and social impacts of the projects. Taking the Jakarta-Bandung High-Speed Railway as an example, it has achieved significant results after its opening and operation. On October 17, 2023, the the Jakarta-Bandung High-Speed Railway was officially put into operation. As of December 31, 2024, the Jakarta-Bandung High-Speed Railway has operated a total of 19426 high-speed trains, transported 7.19 million passengers, and safely operated over 3.11 million kilometers. After more than a year of operation, the Jakarta-Bandung High-speed railway has become a new landmark and popular check-in spot inIndonesia [15].As the “first overseas order” for China's high-speed rail and a flagship project under the China-Indonesia Belt and Road cooperation, the Jakarta-Bandug High-Speed Railway has cut travel time between Indonesia's largest city, Jakarta, and its third-largest city, Bandung, from over three hours to just 46 minutes. During its construction phase, the project also created approximately 39,000 local jobs, directly contributing to the improvement of people's livelihoods [9].Secondly, the enhancement of bilateral political and strategic relations. High-speed railway cooperation, as a flagship project, has significantly strengthened and elevated bilateral relations between China and host countries. This is evidenced by the increase in head-of-state diplomacy. With personal attention and support from Chinese leadership, the Jakarta-Bandung High-Speed Railway officially commenced operations. Indonesian President Joko Widodo hailed the project as “a symbol of China-Indonesia friendship,” stating at the inauguration ceremony that it “opens a new chapter in the strategic cooperation between the two countries.” [16].This highest-level political endorsement represents one of the core achievements of high-speed rail diplomacy. In

contrast, although the China-Thailand Railway is still under construction, its collaborative progress itself has become a significant driving force in sustaining and advancing the comprehensive strategic partnership between China and Thailand.

3.4 Theoretical Foundation

This study employs infrastructure diplomacy theory as its overarching macro-framework, integrating national capability theory with the logic of connectivity, to construct a comprehensive theoretical analysis system. The study employs a comparative case study approach combined with content analysis, unfolding through systematic research steps as follows. Firstly, based on the principles of case representativeness and comparability, the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway were selected as comparative cases. After determining the comparative objects, a database was established by collecting government documents, project agreements, authoritative reports, and academic literature from both countries. Based on this foundation, and drawing from state capacity theory, an analytical framework comprising three dimensions-technical standards, level of localization, and allocation of operational rights-is developed. Subsequently, content analysis is employed to conduct an in-depth examination of each case, analyzing the intrinsic relationship between project characteristics and diplomatic outcomes. Finally, through cross case comparison, from the theoretical perspective of interconnectivity logic, this study explores the differences in cooperation models under different national capacity backgrounds and their impact mechanisms on diplomatic effectiveness, in order to reveal the differentiated strategies and practical logic of China's high-speed rail diplomacy.

4. Results

By analyzing the independent and dependent variables, we can observe that notable differences exist in the cooperation models and diplomatic outcomes between the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway, which profoundly reveals the variations in China's high-speed rail diplomacy across different countries.

4.1 Findings from the Jakarta-Bandung High-Speed Railway

The Jakarta-Bandung High-Speed Railway fully adopts Chinese standard gauge and the CRTS III track system, combined with a localization procurement rate exceeding 75% and an operation management model featuring deep Chinese involvement. This has formed a deeply integrated "Technology-Interest-Management" trinity model. Indonesia has accelerated its development through the construction of the railway, and China has achieved a dual output of technology and influence by collaborating with Indonesia on the Jakarta-Bandung High-Speed Railway. This represents a profound diplomatic engagement between Indonesia and China, serving as a typical case of friendly diplomacy under the framework of the "Belt and Road" Initiative.

4.2 Findings from the China-Thailand Railway

The cooperation model for the China-Thailand Railway is more characterized by strategic interaction and negotiation. Although a breakthrough was ultimately made in the gauge standard and Chinese standard rails were adopted, the operation rights were completely controlled by the Thai side. The construction of the China Thailand Railway was not a smooth sailing, but went through various adjustments. China's diplomatic achievements are more prominently reflected at the strategic level-laying a crucial fulcrum for the Pan-Asia Railway Network through breakthroughs in standards, and maintaining the stability of the China-Thailand strategic partnership through ongoing engineering cooperation.

4.3 Comparative Analysis and Conclusions

The comparison of two cases proves that China's high-speed rail diplomacy is not a single output model, but rather flexible and diverse. By adopting China's railway standards, procuring a substantial amount of local raw materials and equipment for the Jakarta-Bandung High-Speed Railway, and granting operational rights to China, Indonesia has set a model benchmark for railway diplomacy. This has fostered economic and technological interactions between China and Indonesia, serving as a successful case of infrastructure diplomacy under the "Belt and Road" Initiative. Instead, in Thailand, standard breakthroughs and project

progress are achieved through strategic compromises. This spectrum of strategies, ranging from “comprehensive leadership” to “pivotal interventions,” while not representing the same depth of cooperation as seen in the Jakarta-Bandung High-Speed Railway case, nonetheless exemplifies the growing maturity of China’s infrastructure diplomacy under the Belt and Road Initiative.

5. Discussion

5.1 Differences in the Effectiveness of High-Speed Rail Diplomacy Among Different Countries and Their Reasons

The case analysis in this study reveals significant disparities in the effectiveness of China’s high-speed rail diplomacy in Indonesia and Thailand. These differences are manifested in varying degrees of cooperation depth, the pace at which outcomes materialize, and the extent of strategic influence.

China and Indonesia have achieved remarkable diplomatic outcomes through their cooperation. The Jakarta-Bandung High-Speed Railway stands as a quintessential success story of China-Indonesia collaboration under the Belt and Road Initiative. Its successful launch and efficient operation have not only delivered tangible benefits to the Indonesian public but also significantly enhanced China’s image in the country. This achievement in high-speed railway diplomacy serves as a powerful “living advertisement,” demonstrating to Southeast Asia and the world the capability and reliability of Chinese infrastructure.

In contrast to China’s relatively swift and impactful railway diplomacy with Indonesia, China’s railway diplomacy with Thailand has unfolded in a more gradual, strategic, and 博弈 (which can be translated as “strategically competitive” or “marked by negotiation and maneuvering”) manner. Although the China-Thailand Railway has not been fully completed, its major achievement lies in successfully integrating China’s standard-gauge railway into Thailand’s traditional meter-gauge system. Although this process was tortuous, it was effective in promoting strategic cooperation between China and Thailand, as well as facilitating the construction of the Pan Asian Railway and strengthening connections between countries.

5.2 The Model and Strategic Characteristics of China’s High Speed Rail Diplomacy

Based on the analysis above, we can summarize that China’s high-speed rail diplomacy model emphasizes strategic flexibility when exporting “Chinese standards”. In Indonesia, the Chinese railway model was almost entirely transferred and applied. In Thailand, however, a “strategic concession on operational rights” was made in exchange for a “breakthrough in technical standards,” demonstrating the patience and adaptability of China’s high-speed railway diplomacy. In the case of the China Thailand Railway, China ultimately accepted Thailand’s demand for operational rights. This demonstrates that when dealing with partners possessing stronger capabilities and heightened sovereignty awareness, China is willing to make tactical concessions to ensure the advancement of strategic projects, reflecting the strategic respect embedded in China’s high-speed rail diplomacy model for the host country’s sovereign concerns. From the perspective of completion and operational outcomes, the Jakarta-Bandung High-Speed Railway may appear more successful. However, the assessment of railway diplomacy involves multiple dimensions. Viewed holistically, the China-Thailand Railway project itself represents a major achievement in infrastructure cooperation between the two countries within the diplomatic arena. Thailand’s adoption of Chinese railway standards alone marks a significant breakthrough in Sino-Thai diplomatic collaboration. In other words, whether it is the construction of the Jakarta-Bandung High-Speed Railway or the China-Thailand Railway, both serve as vivid examples of China’s proactive promotion of railway diplomacy under the “Belt and Road” Initiative, driving the evolution and advancement of railway diplomacy models.

Based on the above comparative analysis, this study summarizes the mode and strategic characteristics of China’s high-speed rail diplomacy: China’s high-speed railway diplomacy serves as a “national calling card.” By offering integrated solutions that encompass financing, construction, technology transfer, and operational maintenance, it not only helps host countries develop their infrastructure but also facilitates the export of Chinese technological standards, enhances China’s geo-economic and political influence, and advances the development goals of the Belt and Road Initiative.

China's high-speed rail diplomacy serves as a "national calling card," offering a comprehensive "package" solution that encompasses financing, construction, technology transfer, and operation & maintenance. While aiding partner countries in developing their infrastructure, it simultaneously achieves the objectives of exporting Chinese technical standards, enhancing geo-economic and political influence, and advancing the goals of the "Belt and Road" Initiative. China's high-speed rail diplomatic model has flourished under the "the Belt and Road" initiative and exported in a peaceful way. Studying the models and strategic characteristics of China's high-speed rail diplomacy is beneficial for us to better comprehend and employ diplomatic approaches, thereby fostering regional prosperity and development.

6. Conclusion

This study delves into the practical models and varying outcomes of China's high-speed rail diplomacy under the "Belt and Road" Initiative by comparing two typical cases: the Jakarta-Bandung High-Speed Railway and the China-Thailand Railway. Research findings reveal a distinct differentiation in China's high-speed railway diplomacy: In Indonesia, it achieved deep integration of technical standards, industrial chains, and operational management. In Thailand, it formed a "strategic embedding" model centered on standard breakthroughs while respecting the host country's operational sovereignty. These differences primarily stem from variations in the host countries' national capabilities, political systems, and negotiation strategies. Indonesia's relatively stable domestic political environment and urgent self-development needs have created conditions for in-depth cooperation, whereas Thailand's complex internal political landscape and strong sense of sovereignty have prompted China to adopt a more flexible cooperative strategy.

Through this study, we can discover a comprehensive strategy for China's railway diplomacy. This strategy is not a single model and can flexibly adapt to different national conditions. Its essence is a form of "context-adaptive" diplomacy. This diplomatic strategy is characterized by the following features: it maintains a firm commitment to exporting technological standards, flexibly adapts the degree of localization and operational rights based on the host country's specific conditions and needs, and strategically balances immediate project implementation with the long-term cultivation of bilateral relations. Based on these characteristics, we can summarize the model of China's railway diplomacy as "Technology Export, Standard Export, and Diplomatic Engagement." This diplomatic model, which is both clear in core principles and flexible, provides a new research perspective for understanding the reasons for the differences in cooperation between China and different countries under the Belt and Road Initiative.

This study has important implications for promoting China's high-speed rail diplomacy. In the future, the following strategies can be adopted for infrastructure construction under the "Belt and Road" Initiative: First, implement a differentiated cooperation strategy by tailoring approaches to each country's political system and development stage, adjusting the depth of engagement accordingly. Secondly, innovate a "construction-operation" separation cooperation model. While adhering to technical standards, demonstrate greater flexibility on sensitive issues such as operational rights, thereby striking a balance between sovereignty aspirations and the export of standards. Thirdly, focus on the sustainable development of diplomatic projects, emphasizing long-term operation and talent cultivation. Projects should establish a full lifecycle benefit assessment mechanism, integrating construction with long-term operation, talent development, and industrial collaboration to achieve sustainable cooperative benefits. A limitation of this study is its focused examination of only two representative cases: The Jakarta-Bandung High-Speed Railway and the China-Thailand Railway. Future research could be expanded in the following directions. Firstly, continue in-depth research by incorporating quantitative studies on top of the current research, such as continuously tracking the radiating and driving effects of railways on host countries after their construction. Secondly is to expand the sample size, analyze the railway cooperation between China and countries such as Malaysia and Vietnam, and explore the characteristics and differences of China's high-speed rail diplomacy in different regions such as Asia, Africa, and Europe; Thirdly, conduct comparative studies that contrast China's cooperation models in third-country markets with those of other leading high-speed rail nations like Japan and Germany, thereby enriching the theoretical framework of China's infrastructure diplomacy.

References

- [1] State Council Information Office. Jointly Building the “Belt and Road”: A Major Practice of Building a Community with a Shared Future for Mankind. Available from: <http://www.scio.gov.cn/gxzt/dtzt/49518/32678> (accessed 5 February 2026).
- [2] Yuan, T. A Study on China’s Railway Diplomacy from the Perspective of the “Belt and Road”. Doctoral Dissertation, Beijing: China Foreign Affairs University, 2023. <https://doi.org/10.27373/d.cnki.gwjxc.2023.000005>.
- [3] Chen, X. R. and Zheng, A. G. China’s high-speed rail diplomacy transcending geopolitical thinking. Reality Only. 2021(5), pp. 93-96. <https://doi.org/10.3969/j.issn.1004-1605.2021.05.024>.
- [4] Lu, G. S. and Zhu, J. The Progress, Opportunities, and Prospects of “Railway Diplomacy” between China and Southeast Asian Countries. Journal of Kunming University. 2024, 46(2), pp. 1-9. <https://doi.org/https://doi.org/10.14091/j.cnki.kmxyxb.2024.02.001>.
- [5] Ren, Y. H. The “Belt and Road” and China’s practice of “high-speed rail diplomacy” in Southeast Asia. Southeast Academic Research. 2019(3), pp. 140-148. <https://doi.org/10.13658/j.cnki.sar.2019.03.016>.
- [6] Han, D. R. and Liu, S. L. China’s railway diplomacy from the perspective of the belt and road initiative: Historical evolution, type characteristics and path innovation. Journal of China Executive Leadership Academy Pudong. 2024, 18(02), pp. 129-136.
- [7] Acharya, A. and Buzan, B. The Making of Global International Relations: Origins and Evolution of IR at its Centenary. Liu, D. B., Trans. Shanghai: Shanghai People’s Publishing House, 2022.
- [8] Wang, Y. C. and Wang, S. J. Localized Application of Chinese Standards in the Jakarta-Bandung High-Speed Railway Project. Chinese Railways. 2023(12), pp. 29-36. <https://doi.org/10.19549/j.issn.1001-683x.2023.08.31.002>.
- [9] Yi, Y., Chang, X. and Feng, Z. W. The challenge to China’s overseas infrastructure from the perspective of host countries’ state capacity: A case study of China-thailand railway cooperation. The Journal of International Studies. 2025, 46(2), pp. 137-160,8.
- [10] China Central Television. China’s Independently Developed CRTS III Type Slab Ballastless Track Applied in Jakarta-Bandung High-Speed Rail. Available from: <https://news.cctv.com/2022/07/19/ARTIb8huRiFzFwVkWl6kkcVO220719.shtml> (accessed 5 February 2026).
- [11] Xinhua News Agency. Jakarta-Bandung High-Speed Rail Localized Procurement Rate Exceeds 75%, Driving Modernization of Indonesian Railway Equipment. Available from: <https://tw.news.cn/20241008/6ba0d3b2c7b24b0e9aed6fe865d57fc6/c.html> (accessed 5 February 2026).
- [12] China State Railway Group. A “Golden Signboard” of China-Indonesia “Belt and Road” Cooperation in the Green Shades. Available from: http://www.china-railway.com.cn/xwzx/ywsj/202410/t20241018_138557.html (accessed 5 February 2026).
- [13] Sohu. Trans-Asian Railway Encounters Gauge Obstacles, Over 30 Countries May Adopt Chinese Standards. Available from: https://www.sohu.com/a/36493993_114954 (accessed 5 February 2026).
- [14] China Institute of International Studies. It is the Right Time to Accelerate the Construction of the “Trans-Asian Railway Network”. Available from: https://www.cils.org.cn/yjcg/sspl/202501/t20250107_9484.html (accessed 5 February 2026).

- [15] Belt and Road Portal. Outlook | Witnessing the Jakarta-Bandung High-Speed Rail from 0 to 1. Available from: <https://www.yidaiyilu.gov.cn/p/0MG9OVE9.html> (accessed 5 February 2026).
- [16] Belt and Road Portal. Full Track Laying of Jakarta-Bandung High-Speed Rail Completed. Available from: <https://www.yidaiyilu.gov.cn/p/005QP581.html> (accessed 5 February 2026).

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

The Transmission Path of Tourists' Perceived Crowding and Consumption Behavior: Evidence from Lijiang Ancient Town

Yirui Qian, Xinxin Guo*

School of Management, Guangdong Ocean University, Zhanjiang, 524088, China

**Corresponding author: Xinxin Guo*

Abstract

Ancient towns designated as World Cultural Heritage sites attract large-scale tourist flows due to their unique landscape features, often resulting in severe crowding issues. However, the internal mechanisms through which perceived crowding influences tourists' consumption decisions remain underexplored. This study conducts a questionnaire survey in Lijiang Ancient Town, collecting 323 valid samples, and constructs a structural equation model (SEM) of "perceived crowding-conformity psychology-tourist consumption behavior." The findings indicate that perceived crowding has no direct significant impact on tourists' immediate consumption behavior or sustained consumption intention. Perceived crowding significantly positively induces tourists' conformity psychology, as individuals in high-density environments tend to seek group identification to mitigate decision-making risks. Conformity psychology plays a complete mediating role between perceived crowding and tourist consumption behavior, serving as the core transmission "bridge" linking spatial environmental perception to actual consumption actions. This study reveals the psychological mechanisms underlying the "the more crowded, the more they buy" phenomenon in tourism settings and provides practical implications for ancient town scenic areas to enhance commercial conversion efficiency through optimized crowd guidance and consumption atmosphere creation.

Keywords

perceived crowding, conformity psychology, consumption intention, Lijiang ancient town

1. Introduction

1.1 Research Background and Significance

Ancient towns and historic cities, as bearers of irreplaceable historical and cultural heritage and distinctive landscape features, have become highly popular destinations for domestic and international tourists. Lijiang Ancient Town, as a typical representative of such sites, is both a World Cultural Heritage property and a benchmark among China's ancient town 5A-level scenic areas. Its traditional Naxi dwellings, "small bridges over flowing water" spatial patterns, and Dongba cultural experiences attract large numbers of visitors. However, "crowding" has become a normal condition in Lijiang, serving as a prominent bottleneck that constrains consumption experiences and sustainable operations. The influencing factors of perceived crowding,

the related effects generated under such perception, and how to mitigate the negative impacts of crowding are all critical issues that urgently need resolution. Therefore, this study takes Lijiang Ancient Town as a case site, introduces the dimension of conformity psychology, and explores the influence mechanism of conformity psychology on tourist consumption behavior under perceived crowding. The aim is to enrich relevant theoretical applications, provide practical references for the operators of ancient town and historic city scenic areas, and ultimately contribute to the high-quality development goals of the cultural tourism industry.

1.2 Literature Review

Research on crowding can be traced back to the 1960s. When the number of tourists at a destination exceeds its environmental carrying capacity, objective crowding emerges. Stokols [1] defined perceived crowding as “an individual’s subjective negative evaluation of objective population density.” Lee et al. [2] argued that spatial crowding increases negative emotions while reducing positive ones. These views have been widely accepted by most scholars. However, more recent studies, such as Zhang Yuangang et al. [3], have pointed out that crowd-induced crowding in specific contexts like festival events or ancient village tourism can enhance tourists’ positive emotions. Chen Weiru et al. [4] found that tourists’ emotions are not affected by crowding in night market leisure settings. Hu Ting et al. [5] categorized perceived crowding into three dimensions—physical spatial crowding, personal space crowding, and social space crowding—and noted that crowding does not necessarily lead to negative emotions among tourists; rather, it depends on whether crowding restricts interpersonal interaction in the given context. Synthesizing prior research, tourists’ perceived crowding can mainly be classified into quantity-density perceived crowding and experiential interference perceived crowding.

Previous studies have predominantly examined the effects of crowding perception from behavioral regulation [6], sensory regulation [7], and physiological perspectives, with relatively few exploring the psychological dimension. Therefore, this paper investigates the mechanism of conformity psychology, a psychological factor, on perceived crowding.

Conformity psychology is a common social psychological phenomenon in everyday life, referring to the tendency of individuals to change their views under group pressure in order to align with the majority; it is also known as the herd effect [8]. According to social psychology, conformity-driven behavior typically involves individuals following others to avoid uncertainty or seek a sense of belonging, rather than acting based on their own judgments or beliefs [9]. Conformity psychology and behavior have been extensively studied in fields such as consumer behavior [10], live-streaming e-commerce [11], and finance [12], but research in the tourism domain remains limited.

Studies on conformity psychology and consumer behavior are relatively abundant in online live-streaming consumption scenarios. For example, Xie Ying [13] and others found that, under the sense of co-presence in live-streaming contexts, conformity psychology has a significant positive effect on consumption behavior. Yu Yuhe [14] noted that ambiguous product information during online shopping tends to trigger conformity consumption. Huang Yixiang et al. [15] pointed out that conformity psychology exerts an amplifying effect on residents’ consumption of miscellaneous grains. However, few scholars have examined conformity consumption in tourism contexts.

Tourist consumption behavior is a necessary condition for the normal conduct of tourism activities and the healthy operation of the tourism economy, and it is also one of the most prominent characteristics of tourists. From existing research, most scholars have empirically investigated the influencing factors of tourist consumption behavior from a micro perspective. The conclusions in the literature can generally be summarized into economic and non-economic factors [16]. Regarding economic factors, Diao Zongguang [17] summarized that economic constraints in family or individual travel are typically related to income level. Jiang Guohua [18] further noted that consumption levels increase with rising income. Wei Xiang [19] demonstrated through empirical research that the positive effect of expected income on tourism consumption is greater than that of current income. In terms of non-economic factors, Brida [20] indicated that tourism consumption is influenced by demographic factors, travel characteristics, and individual psychological factors. The impact of individual psychological characteristics on tourism consumption mainly includes tourism motivation, interest preferences, and similar aspects [21, 22]. Thus, most scholars have studied tourist consumption behavior from the individual

tourist's perspective, with relatively few exploring the influence of group-level factors on individual tourism consumption behavior.

In summary, existing research on perceived crowding has largely focused on its causes, influencing factors, and direct effects on experience, with limited attention to the role of “psychological variables” in the mechanism linking perceived crowding and consumption behavior. Studies on conformity psychology have primarily concentrated on online shopping consumption scenarios, and its application in crowded tourism contexts remains underdeveloped. Moreover, most crowding research has targeted open-type attractions such as theme parks and national parks. For ancient towns like Lijiang Ancient Town-with narrow streets and densely clustered commercial formats-the characteristics of perceived crowding, manifestations of conformity psychology, and patterns of consumption behavior exhibit distinct differences, and relevant research is relatively scarce. Therefore, this paper supplements research on this type of scenic area by clarifying the relational characteristics among perceived crowding, conformity psychology, and consumption behavior.

2. Research Design

2.1 Questionnaire Design and Scale Development

The questionnaire was developed after extensive reference to domestic and international literature. Measurement items were assessed using a five-point Likert scale. The questionnaire consists of four main sections: (1) Demographic information, including gender, age group, place of permanent residence, education level, occupation, daily tourism expenditure, and number of visits to Lijiang Ancient Town; (2) Tourists' perceived crowding (CR), primarily adapted from Stokols's [23] scale, which divides crowding into spatial perception and social-emotional dimensions, consistent with the items designed in this study; (3) Tourists' conformity psychology (HM), mainly drawing on the scales of Lascu and Zinkhan [24] and Wen Bing [25], comprising 5 items in total; (4) Tourist consumption behavior, primarily based on the scales of Caldwell and Hibbert [26] and Jang and Namkung [27], divided into two dimensions: immediate consumption intention (TR) and sustained consumption behavior (PR). Immediate consumption behavior measures consumers' on-the-spot purchase intention in the buying scenario, while sustained consumption behavior assesses revisit or repeat purchase intention after leaving the scenario; this section includes 5 items in total.

2.2 Data Collection and Sample Characteristics

The target population for this questionnaire consisted of tourists who had visited Lijiang Ancient Town. Data were collected online from September 20 to October 20, 2025, targeting groups with prior experience in Lijiang Ancient Town. A total of 469 questionnaires were collected via the Wenjuanxing platform. After rigorous screening, 146 invalid questionnaires were excluded (due to respondents not having actually visited Lijiang Ancient Town, excessively short response times, responses not meeting requirements, or random answering), resulting in 323 valid questionnaires. The effective response rate was 68.86%.

2.3 Theoretical Hypotheses and Structural Equation Model Construction

2.3.1 Perceived Crowding and Tourist Consumption Behavior

Eroglu and Machleit [28], in their classic empirical study on retail crowding, pointed out that perceived crowding is a subjective psychological experience triggered by physical spatial constraints and excessive social density, which influences subsequent consumption behavior through effects on consumer emotions and cognitive evaluations. This perception also serves as a key environmental cue affecting tourists' behavioral decision-making in tourism consumption scenarios, with its intensity increasing positively with scene population density and typically exerting a negative impact on overall tourist experience quality. Cheng Pingping et al. [29], through a systematic review of domestic and international tourism crowding research, confirmed a significant negative correlation between perceived crowding in tourism settings and tourist experience; high-density environments easily induce negative emotions such as irritation and anxiety in tourists, thereby altering their consumption decision tendencies. Oliver's [30] loyalty stage theory clearly delineates the progression logic from consumption intention to behavior, distinguishing between immediate purchase impulses and trans-temporal sustained consumption behavior. Oppermann [31], in research on destination loyalty, further validated the dimensional differences between short-term immediate decisions and

long-term sustained behavior in tourism consumption. Grönroos [32], from the perspective of transaction and relationship marketing, defined the core characteristics of single immediate consumption versus long-term sustained consumption. Drawing on the above theories and research, and based on the temporal dimension of consumption decisions and the questionnaire items TR1-PR3, this study divides tourist consumption behavior into two core dimensions: sustained consumption intention and immediate consumption behavior. This classification aligns with the consumption behavior categorization logic of Shen Manqiong et al. [33], which shows differentiated response mechanisms of consumption behavior across temporal dimensions under the influence of perceived crowding. Based on the theoretical and empirical foundations above, the following hypotheses are proposed:

H1: Perceived crowding is negatively related to tourist consumption behavior.

H1a: Perceived crowding is negatively related to tourists' sustained consumption intention.

H1b: Perceived crowding is negatively related to tourists' immediate consumption behavior.

2.3.2 Perceived Crowding and Conformity Psychology

This paper proposes using risk aversion theory to explain the mechanism by which crowding induces conformity psychology. According to L. B. Kaplan [34], consumers' perceived risk can be divided into five categories: functional risk, physical risk, economic risk, social risk, and psychological risk. From the formation mechanism of perceived risk in tourism consumption, triggering factors can be summarized into six major dimensions [35]: ambiguity of purchase goals, uncertainty of purchase returns, lack of consumption experience, dual possibilities of consumption outcomes, influence of reference groups, and economic cost considerations. After perceiving these risks, most consumers tend to adopt targeted risk-avoidance behaviors to reduce the probability of potential losses. Henry Assael categorizes consumers' risk-reduction strategies into two core dimensions: first, increasing the certainty of purchase outcomes by broadening information channels, deepening information processing, maintaining brand loyalty, and choosing mainstream market brands; second, mitigating the negative effects of purchase failure by selecting the lowest-priced products, controlling purchase quantities, obtaining product guarantees or quality assurances, and lowering psychological expectations. Based on these conclusions, it can be inferred that in high-density crowded tourism scenarios such as ancient towns and internet-famous streets, dense crowds easily cause information overload and psychological loss of control among tourists, thereby inducing anxiety, reducing decision-making judgment ability, and elevating perceived risk levels. To simultaneously meet the dual needs of quickly navigating crowded areas and reducing consumption decision uncertainty, tourists' psychological demands shift toward seeking group identification and decision-making protection. They tend to treat group aggregation behavior as a decision reference signal, following a "crowd aggregation-oriented" group behavior pattern to avoid individual decision risks, ultimately giving rise to conformity consumption behavior. Accordingly, the following hypothesis is proposed:

H2: Perceived crowding is positively related to tourists' conformity psychology.

2.3.3 Conformity Psychology and Tourist Consumption Behavior

Tajfel's [36] social identity theory posits that individuals have a strong need for group belonging and tend to adjust their behavioral choices by conforming to group behavioral norms to obtain group identification. Sun Zehui et al. [37] also noted that conformity psychology enables consumers to align with other individuals or groups, exerting influence on consumer psychology through group norms and thereby shaping consumption behavior. Kara et al. [38] found that group behavioral demonstration can reduce uncertainty in individual consumption decisions, thereby triggering conformity consumption behavior. Roth et al. [39] further verified through empirical research that group aggregation in tourism settings produces a clear conformity effect, positively influencing tourists' immediate consumption decisions, while sustained group identification also reinforces revisit intention. Additionally, Correia et al. [40] pointed out that tourists' conformity psychology, through the transmission of group norms, simultaneously affects both immediate consumption behavior and long-term revisit intention. Therefore, the following hypotheses are proposed:

H3: Conformity psychology is positively related to tourist consumption behavior.

H3a: Conformity psychology is positively related to tourists' sustained consumption intention.

H3b: Conformity psychology is positively related to tourists' immediate consumption behavior.

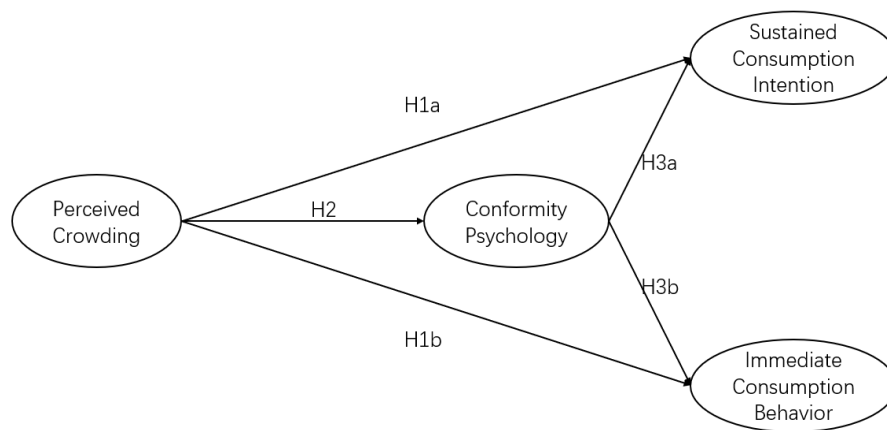
2.3.4 Perceived Crowding, Conformity Psychology, and Tourist Consumption Behavior

In scenic areas such as ancient towns, historic cities, and internet-famous streets, commercialization is typically high, consumption scenarios are abundant, and tourist numbers are usually large, resulting in strong perceived crowding. Most studies indicate that perceived crowding negatively affects tourist consumption behavior. At the same time, group behavior can trigger conformity psychology, thereby guiding individual consumption, making offline conformity consumption phenomena ubiquitous [13]. It is therefore posited that conformity psychology may play a mediating role between perceived crowding and tourist consumption behavior. The fourth hypothesis is proposed as follows:

H4: Conformity psychology plays a mediating role in the influence of perceived crowding on tourist consumption behavior.

Based on the research hypotheses above, this paper constructs a theoretical hypothesis model of “perceived crowding–conformity psychology–tourist consumption behavior” (Figure 1), with conformity psychology treated as the mediating variable.

Figure 1 Theoretical Model of “Perceived Crowding – Conformity Psychology – Tourist Consumption Behavior”



3. Data Analysis and Model Testing

3.1 Descriptive Statistics and Heterogeneity Analysis

Table 1: Sample Descriptive Statistics

Variable		Number (persons)	Percentage (%)
Gender	Male	158	48.9
	Female	165	51.1
Age	Under 18	27	8.4
	18-30 years	181	56
	31-45 years	80	24.8
	46-60 years	25	7.7
	Over 60	10	3.1
Place of Permanent Residence	Lijiang City	30	9.3
	Other areas in Yunnan Province	41	12.7
	Other provinces in China	240	74.3
	Hong Kong, Macao, Taiwan	6	1.9
	Overseas	6	1.9

Variable		Number (persons)	Percentage (%)
Education Level	High school or below	33	10.2
	Junior college	58	18.0
	Undergraduate	182	56.3
	Postgraduate or above	50	15.5
Occupation	Enterprise/institutional employee	50	15.5
	Professional/technical personnel	26	8.0
	Self-employed/business owner	69	21.4
	Manual/service worker	38	11.8
	Non-employed group	140	43.3
Daily Tourism Expenditure	≤ 200 CNY	54	16.7
	201-500 CNY	113	35.0
	501-1000 CNY	86	26.6
	1001-2000 CNY	52	16.1
	2001-3000 CNY	10	3.1
	≥ 3001 CNY	8	2.5
Number of Visits to Lijiang Ancient Town	1-3 times	221	68.4
	3-5 times	84	26.0
	More than 5 times	18	5.6

From the analysis of Table 1, the gender distribution of respondents is roughly balanced. The age group is dominated by young and middle-aged individuals. Visitors from provinces outside Yunnan account for as high as 74.3%, indicating that the majority are tourists, which aligns well with the sample requirements of this study. Respondents generally have a relatively high level of education, a large proportion belong to non-employed groups, and their average daily tourism expenditure is relatively low. 68.4% of respondents have visited Lijiang Ancient Town 1-3 times. Overall, the sampling is reasonable, comprehensive, and representative, meeting the thematic requirements of this study.

3.2 Data Analysis

3.2.1 Reliability and Validity Testing

Reliability and validity analyses were conducted across all dimensions of the survey data. Cronbach's Alpha (CA) coefficients for each dimension ranged from 0.851 to 0.867, with the overall scale reliability reaching 0.886, indicating high reliability of the questionnaire. The Bartlett's test of sphericity yielded a p-value of 0.000 ($p < 0.001$), and the KMO value was 0.898 (> 0.70), confirming that the sample data are suitable for factor analysis.

3.2.2 Confirmatory Factor Analysis

This study further employed Confirmatory Factor Analysis (CFA) to examine the convergent validity and discriminant validity of the measurement model. Based on the results of exploratory factor analysis, the originally designated "tourist consumption behavior" dimension was decomposed into two sub-dimensions: "immediate consumption behavior" and "sustained consumption intention." A measurement model encompassing four latent variables-perceived crowding, conformity psychology, immediate consumption behavior, and sustained consumption intention-was ultimately constructed. To ensure overall reliability and validity, items with factor loadings below 0.6 were removed (specifically, CR1 from perceived crowding and HM1 from conformity psychology), leaving 13 items for final analysis.

As shown in Table 2, the standardized factor loadings (SFL) of all items ranged from 0.645 to 0.836, well above the 0.5 threshold, indicating strong explanatory power of the observed variables for the latent variables. Standard errors (SE) ranged from 0.035 to 0.049, with t-values far exceeding the standard 1.96, demonstrating small fluctuations and high precision in factor loadings. Composite reliability (CR) values were 0.823, 0.799, 0.793, and 0.795, all exceeding the 0.7 threshold. Cronbach's α coefficients were 0.818, 0.803, 0.792, and 0.788, all above the recommended 0.7 standard. Average variance extracted (AVE) values were 0.537, 0.502, 0.656, and 0.561, all meeting or exceeding the good standard of 0.5 (Fornell & Larcker, 1981), confirming convergent validity in line with Anderson's criteria [41].

Table 2: Confirmatory Factor Analysis Results

Dimension	Indicator	SFL	SE	t-value	CR	α	AVE
Perceived Crowding (PC)	CR2	0.659	0.043	11.156	0.823	0.818	0.537
	CR3	0.826	0.036	7.567			
	CR4	0.785	0.037	8.962			
	CR5	0.645	0.035	11.361			
Conformity Psychology (CP)	HM2	0.785	0.033	9.983	0.799	0.803	0.502
	HM3	0.710	0.038	11.221			
	HM4	0.669	0.049	11.596			
	HM5	0.664	0.045	11.623			
Immediate Consumption Behavior (ICB)	TR1	0.802	0.035	8.501	0.793	0.792	0.656
	TR2	0.817	0.041	7.955			
Sustained Consumption Intention (SCI)	PR1	0.836	0.037	7.072	0.795	0.788	0.561
	PR2	0.660	0.038	11.304			
	PR3	0.742	0.037	9.808			

Additionally, this study conducted a test of discriminant validity to examine whether there are significant differentiating characteristics among the different latent variables. This study employed the Heterotrait-Monotrait Ratio (HTMT) to assess discriminant validity. Compared to the traditional Fornell-Larcker criterion, HTMT is more sensitive and accurate in detecting discriminant validity (Henseler et al., 2015).

As shown in Table 3, HTMT values between latent variables ranged mainly from 0.139 to 0.858. The HTMT value between “immediate consumption behavior” and “conformity psychology” was 0.858, slightly above the strict 0.85 threshold but below the lenient 0.90 threshold, remaining acceptable. All other inter-variable HTMT values were well below 0.85. These results indicate good statistical distinctiveness among the latent variables and confirm the discriminant validity of the measurement model.

Table 3: Heterotrait-Monotrait Ratio (HTMT)

Variable	1	2	3	4
Conformity Psychology	-			
Immediate Consumption Behavior	0.858	-		
Perceived Crowding	0.281	0.251	-	
Sustained Consumption Intention	0.769	0.705	0.139	-

3.3 Structural Equation Model Fit, Modification, and Hypothesis Testing

3.3.1 Model Fit Analysis

Model fit assesses the degree of match between the hypothesized model and the observed data. This study evaluated multiple mainstream indices, including chi-square to degrees of freedom ratio, root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), and comparative fit index (CFI).

Table 4: Model Fit Indices

Index	χ^2/df	RMSEA	SRMR	TLI	NFI	GFI	AGFI	CFI
Standard	1-3	<0.08	<0.08	>0.80	>0.80	>0.80	>0.80	>0.80
Model	1.596	0.041	0.036	0.975	0.951	0.959	0.938	0.981

Note: $N = 323$ observations; $\chi^2 = 95.741$ ($df = 60$, $p < 0.01$).

As shown in Table 4, for absolute fit indices, the chi-square to degrees of freedom ratio was 1.596 (< 3.0 threshold); RMSEA was 0.041 (90% CI: 0.025-0.056, both bounds < 0.08), indicating excellent fit; standardized root mean square residual (SRMR) was 0.036 (< 0.05 strict standard). For incremental fit indices, CFI reached 0.981, TLI was 0.975, and NFI was 0.951—all significantly above 0.90 and close to the excellent 0.95 benchmark. For parsimony fit indices, GFI was 0.959 and AGFI was 0.938, both exceeding 0.90. Overall, all fit indices satisfy core academic judgment criteria, confirming good overall fit of the measurement model for subsequent hypothesis testing.

3.3.2 Direct Effect Testing

Hypothesis testing results (Table 5) show that perceived crowding has a significant positive effect on conformity psychology ($\beta = 0.255$, $p < 0.001$), supporting H2. This reveals that in the high-density crowd scenario of Lijiang Ancient Town, higher perceived crowding strengthens tourists' tendency to seek group identification and follow majority behavior, consistent with social psychology's "uncertainty avoidance" theory—individuals in complex crowded environments rely on group cues to reduce personal decision risk.

Conformity psychology exerts a very strong positive driving effect on consumption behavior, with $\beta = 0.867$ ($p < 0.001$) for immediate consumption behavior and $\beta = 0.803$ ($p < 0.001$) for sustained consumption intention, supporting both H3a and H3b. These results confirm that conformity psychology is a core driver of tourist consumption behavior: when tourists exhibit follow-the-crowd tendencies, it not only significantly promotes on-site purchases (e.g., popular snacks, souvenirs) but also substantially increases willingness to recommend the destination or revisit in the future.

Notably, the direct path effects of perceived crowding on consumption behavior were not significant: $\beta = 0.014$ ($p = 0.787 > 0.05$) for immediate consumption behavior and $\beta = -0.079$ ($p = 0.143 > 0.05$) for sustained consumption intention, failing to support H1a and H1b. This non-significant result carries important theoretical implications: mere physical spatial crowding or subjective psychological crowding neither directly promotes nor significantly inhibits tourist consumption behavior. Thus, the influence of perceived crowding on tourist consumption behavior is not direct but requires specific mediating mechanisms (such as conformity psychology), providing a key logical premise for subsequent mediation effect testing—perceived crowding may exert a complete mediating effect on consumption behavior through conformity psychology.

Table 5: Structural Model Results

Hypothesis (H)	Hypothesis (H) Standardized Coefficient	p- value	Supported?
H1a: Perceived Crowding → Sustained Consumption Intention	-0.079	0.143	Rejected
H1b: Perceived Crowding → Immediate Consumption Behavior	0.014	0.787	Rejected
H2: Perceived Crowding → Conformity Psychology	0.255	0.001	Supported
H3a: Conformity Psychology → Sustained Consumption Intention	0.803	0.001	Supported
H3b: Conformity Psychology → Immediate Consumption Behavior	0.867	0.001	Supported
H4: Perceived Crowding → Conformity Psychology → Tourist Consumption Behavior	0.530	0.001	Supported
H4a: Perceived Crowding → Conformity Psychology → Immediate Consumption Behavior	0.267	0.001	Supported
H4b: Perceived Crowding → Conformity Psychology → Sustained Consumption Intention	0.263	0.001	Supported

3.3.3 Mediation Effect Testing

To verify the mediating role of conformity psychology between perceived crowding and tourist consumption behavior (H4), this study adopted the Bootstrap resampling method with 5000 iterations and 95% confidence intervals. Following Wen Zhonglin et al.'s mediation effect judgment criteria [42]: if the mediation path's confidence interval excludes 0 (or p is significant) and the direct effect path is non-significant, a complete mediation effect exists.

Based on the well-fitting model, this study focused on testing the mediating role of conformity psychology between perceived crowding and consumption behavior, conducting the analysis along two separate paths (Table 5). The results are as follows:

First, for the "perceived crowding–conformity psychology–immediate consumption behavior" path, the indirect effect was 0.221, $t = 3.382$, $p = 0.001$ (< 0.01), indicating a significant mediation effect. Combined with prior path analysis, the direct effect of perceived crowding on immediate consumption behavior was non-significant ($p = 0.787 > 0.05$). Following Wen Zhonglin et al.'s [42] mediation judgment procedure, conformity psychology exerts a complete mediating role in this path. This reveals that in the specific context of Lijiang

Ancient Town, perceived crowding from high-density crowds does not directly trigger immediate purchase behavior but requires conformity psychology as a mediating carrier-through evoking group identification and follow-the-crowd tendencies-to convert crowding perception into actual immediate consumption behavior.

Second, for the “perceived crowding–conformity psychology–sustained consumption intention” path, results were consistent: indirect effect = 0.205, $t = 3.383$, $p = 0.001$ (< 0.01), with significant mediation. The direct effect of perceived crowding on sustained consumption intention was also non-significant ($p = 0.143 > 0.05$), confirming a complete mediating role for conformity psychology in this path. This indicates that tourists’ revisit intention or destination recommendation willingness (sustained consumption intention) arising from the crowded environment of Lijiang Ancient Town is not directly driven by the crowding itself but fully stems from the positive experience generated by conformity psychology induced by the on-site group atmosphere. Conformity psychology serves as the key transmission carrier linking perceived crowding to sustained consumption intention.

In summary, the mediation test results across both paths fully support H4 (conformity psychology plays a mediating role between perceived crowding and tourist consumption behavior). This study confirms that conformity psychology is the core “bridge” mechanism connecting perceived crowding and consumption behavior: the negative pressures, e.g., spatial constraints, inconvenience, and potential positive signals, e.g., bustling popularity, reliable consumption choices, embedded in perceived crowding are interwoven and ultimately transformed into positive consumption behavior, including immediate consumption behavior and sustained consumption intention, through the psychological filtering and conversion mechanism of “conformity psychology.” This core finding provides key theoretical evidence to explain the real-world paradox of “Lijiang Ancient Town remains crowded yet tourist consumption stays booming”-the “the more crowded, the more they buy” phenomenon does not stem from tourists’ preference for crowded environments but is dominantly driven by “group identification–induced follow-the-crowd consumption” via conformity psychology.

4. Results Analysis and Discussion

Based on the structural equation model testing and mediation effect analysis presented earlier, this chapter provides an in-depth interpretation of the research findings. It focuses on the non-direct influence pathway of perceived crowding on consumption behavior, elucidates the complete mediating mechanism of conformity psychology, and conducts comparative discussions in relation to prior studies.

4.1 Summary of Hypothesis Testing Results

This study proposed four core hypotheses, and the empirical results from the structural equation model are summarized as follows:

(1) The hypothesis that perceived crowding has a direct impact on consumption behavior (H1) is not supported. Statistical results show no significant direct effect on either immediate consumption behavior or sustained consumption intention, indicating that in the context of Lijiang Ancient Town, mere high crowd density neither inhibits nor promotes tourists’ consumption decisions. This study unexpectedly found that the direct effect of perceived crowding on tourist consumption behavior was not significant (H1a and H1b rejected). This finding diverges from Stokols’ [1] classic theory that crowding triggers negative evaluations and avoidance behavior, yet aligns with Zhang Yuangang et al.’s [3] conclusion that crowding can carry positive meanings in specific contexts. The reasons are as follows: First, as a leisure and vacation-oriented scenic area, Lijiang Ancient Town’s “lively marketplace atmosphere” is a core attraction; high crowd density is interpreted by tourists as a positive signal of “vibrant popularity,” whose “atmospheric quality” offsets the negative effects of crowding-unlike scenarios such as subways or museums that require quiet space. Second, perceived crowding exhibits a “threshold effect.” Tourists visiting 5A-level popular attractions already have psychological expectations of crowding; when actual crowding remains within an acceptable threshold, it does not trigger escape or termination of consumption behavior and may even prompt more efficient group-based consumption decisions.

(2) The hypothesis that perceived crowding positively influences conformity psychology (H2) is supported. Empirical results confirm that crowded environments significantly strengthen tourists’ conformity tendencies.

This positive driving effect can be explained from two aspects: On one hand, crowding intensifies tourists' psychological tension and information asymmetry. The intertwined streets and densely packed shops in the ancient town, combined with high crowd density, place tourists in decision dilemmas and make it difficult to quickly filter consumption information, leading them to rely on group behavior to reduce decision costs. On the other hand, crowding reinforces tourists' sense of group belonging; tourists readily perceive the presence of a shared tourist group, and conformity-as a social adaptation strategy-helps them quickly integrate into the group and avoid psychological discomfort, thereby further activating conformity tendencies and enabling perceived crowding to effectively trigger conformity psychology.

(3) The hypothesis that conformity psychology positively influences consumption behavior (H3) is supported. The data show that conformity psychology is a core driver of both immediate consumption and sustained consumption intention, with path coefficients exceeding 0.8 and extremely strong positive effects. This strong driving effect aligns with prior reasoning: First, it reduces decision risk-tourists have limited knowledge of local consumption, so "what most people choose" serves as a reliable signal that alleviates decision anxiety and promotes immediate consumption. Second, it enhances emotional experience-the group consumption atmosphere stimulates consumption desire, and following the group provides emotional satisfaction from feeling integrated into the locale, thereby increasing sustained consumption intention.

(4) The hypothesis that conformity psychology plays a complete mediating role (H4) is supported. The test results indicate that perceived crowding does not directly affect tourist consumption behavior but is entirely transmitted indirectly through conformity psychology. This finding reveals the internal mechanism behind the "the more crowded, the more they buy" phenomenon and constitutes the core theoretical contribution of this study. The underlying logic has two main aspects: First, risk aversion and social identification mechanisms-in the complex consumption scenarios of the ancient town, crowding exacerbates information overload; according to social psychology theory, tourists reduce decision risk by using "busy shops must be good" as a judgment heuristic, with perceived crowding activating conformity psychology and thereby driving consumption. Second, the "contagious" nature of consumption behavior-the path coefficient shows conformity psychology's effect on immediate consumption reaching as high as 0.867. The "consumption field" constructed by crowding weakens individual decision-making capacity, promoting consumption conversion through the "herd effect" rather than crowding directly generating benefits.

4.2 Discussion of Differences Across Consumption Dimensions

This study decomposed consumption behavior into "immediate consumption behavior" and "sustained consumption intention." The results show that conformity psychology has highly significant effects on both, but its influence coefficient on immediate consumption (0.867) is slightly higher than on sustained consumption intention (0.803). This indicates that conformity psychology primarily functions as an impulsive factor stimulating on-the-spot purchases, e.g., buying popular snacks or souvenirs, whereas its strong driving effect on subsequent recommendation and revisit intentions (sustained consumption) may also be jointly influenced by other factors such as product quality and service experience.

5. Conclusion and Policy Recommendations

5.1 Practical Implications and Optimization Suggestions

The findings of this study indicate that appropriate levels of crowding can promote tourist consumption and enhance revenue for scenic areas and merchants. Accordingly, the following recommendations are proposed for Lijiang Ancient Town and similar scenic sites:

For Lijiang Ancient Town, efforts should anchor on the cultural foundation of Naxi ethnicity and the spatial pattern of its streets and lanes. Reasonable guidance of crowded scenarios should be achieved through Dongba culture-themed signage systems and flow-line design to direct tourist movement. Cultural popularity clusters should be developed around local intangible cultural heritage and distinctive cultural creative products, transforming perceived crowding into a consumption signal. In line with the ancient town's brick-wood architecture and linear street layout, a refined dynamic crowd monitoring and early-warning mechanism should be established. Through micro-renovations that add buffer spaces and optimize the layout of consumption points, crowding thresholds can be precisely regulated to balance consumption experience and conversion

efficiency. Leveraging conformity psychology, localized and visually appealing consumption scenarios should be created. Experiential features of intangible heritage workshops and native cuisine should be utilized to strengthen the aggregation effect of onlookers. Centered on Lijiang's local cultural tourism IP, a closed loop of offline consumption and online dissemination should be built through signature check-in spots, community operations, and other means to extend consumption value and drive the conversion of sustained consumption intention.

For similar or comparable scenic areas such as ancient towns and internet-famous streets, the optimization logic of Lijiang Ancient Town can be adapted by combining local cultural genes and spatial carrying capacity to construct an integrated strategy of "scene guidance–crowd regulation–value extension." Cultural elements should serve as the core to develop distinctive consumption clusters; crowd regulation mechanisms tailored to the site's spatial characteristics should be established; dominant consumption formats should be leveraged to optimize conformity-guided consumption scenarios; and the value of local cultural tourism IPs should be explored. Through online-offline integration, post-consumption group identity maintenance, and similar approaches, the positive effects of crowding can be maximized, thereby promoting high-quality consumption development in scenic areas.

5.2 Research Limitations and Future Directions

The research model in this study clearly delineates the relationships among perceived crowding, conformity psychology, and tourist consumption behavior, and confirms the complete mediating role of conformity psychology. However, this paper does not fully explore the threshold at which perceived crowding triggers conformity psychology and subsequently influences consumption behavior. Therefore, future research could expand the sample size and conduct qualitative studies to further investigate other psychological factors affecting tourist consumption behavior.

References

- [1] Stokols, D. On the distinction between density and crowding: Some implications for future research. *Psychological Review*. 1972, 79(3), pp. 275-277. <https://doi.org/10.1037/h0032706>.
- [2] Lee, S. Y., Kim, J.-O. and Li, J.-G. Impacts of Store Crowding on Shopping Behavior and Store Image. *Journal of Asian Architecture and Building Engineering*. 2011, 10(1), pp. 133-140. <https://doi.org/10.3130/jaabe.10.133>.
- [3] Zhang, Y. G., Yu, X. Y., Wong, I. A., Cheng, J. J. and Yin, S. B. Research on the influential mechanism between the tourists' crowding perception and emotions for recreation in ancient village SCENIC spot: A case study of xidi and hongcun ancient villages *Human Geography*. 2018, 33(02), pp. 138-146. <https://doi.org/10.13959/j.issn.1003-2398.2018.02.018>.
- [4] Chen, W. R., Hou, J. X. and Zhang, B. R. The Relationships among Perceived Crowding in Night Markets, Destination Image, Emotional Experience, Satisfaction, and Revisit Intention. *Journal of Landscape Architecture (Taiwan)*. 2019, 23(2), pp. 51-82.
- [5] T., H. and Z., Z. C. Does crowding arouse negative emotions in tourists? An empirical study based on the sunrise viewing context at mount tai. *Nankai Business Review*. 2024, 27(1), pp. 98-107.
- [6] Lin, M. H., Yu, S. Q. and Wang, Y. J. Research on tourists' perceived crowding and adaptation mechanisms and their impact on satisfaction in urban natural parks. *Journal of Natural Resources*. 2023, 38(4), pp. 1025-1039.
- [7] Liu, M. K. and Liang, L. J. Research on the influence mechanism of sensory experience of night scenes on tourism consumption behaviour. *Journal of Guangxi University(Philosophy and Social Sciences)*. 2024, 46(6), pp. 144-156. <https://doi.org/10.13624/j.cnki.jgupss.2024.06.016>.

- [8] Graham, J. R. Herding among investment newsletters: Theory and evidence. *The Journal of Finance*. 1999, 54(1), pp. 237-268. <https://doi.org/10.1111/0022-1082.00103>.
- [9] Banerjee, A. V. A simple model of herd behavior. *The quarterly journal of economics*. 1992, 107(3), pp. 797-817. <https://doi.org/10.2307/2118364>.
- [10] Xia, T. S., Shi, Z. M. and Lai, L. S. The relationship between social exclusion and prosocial consumption behavior under conformity scenarios. *Journal of Management Sciences*. 2020, 33(1), pp. 114-125.
- [11] Zhang, C. H. and Zhao, X. R. Optimal quality effort strategy in supply chain of live streaming e-commerce considering herding effect and anchor influence *Journal of Industrial Engineering and Engineering Management*. 2025, 39(06), pp. 252-267. <https://doi.org/10.13587/j.cnki.jieem.2025.06.018>.
- [12] Gong, Q. and Diao, X. The impacts of investor network and herd behavior on market stability: Social learning, network structure, and heterogeneity. *European Journal of Operational Research*. 2023, 306(3), pp. 1388-1398. <https://doi.org/10.1016/j.ejor.2022.07.016>.
- [13] Xie, Y., Cui, F. and Gao, P. Influence of CO-presence and Social Presence on Online Herd Consumption in Live Marketing. *Journal of Business Economics*. 2021(2), pp. 68-79.
- [14] Yu, Y. H. Study on the influence of consumer confusion on conformity consumption in online shopping situation. Master's Thesis: Jilin University, 2022. <https://doi.org/10.27162/d.cnki.gjlin.2022.001899>.
- [15] Huang, Y. X., Liu, K. B. and Zhao, M. J. Awareness of Health or Group Mentality?: Analysis on the Motives of Residents' Consumption of Miscellaneous Grain-based on PSM Model. *Journal of Agrotechnical Economics*. 2022(2), pp. 110-125. <https://doi.org/10.13246/j.cnki.jae.20210728.001>.
- [16] Xie, Y. J., Yu, J. and Yang, K. Situational orientation of tourism consumption: tourism enclave effect and fear of consumption in scenic spots: Taking Zhongshan Road Scenic Area in Haikou Qilou Old Street Area as an example. *Journal of Shaanxi Normal University(Natural Science Edition)*. 2020, 48(4), pp. 56-70. <https://doi.org/10.15983/j.cnki.jsnu.2020.04.022>.
- [17] Diao, Z. G. Tourist Consumption Level of China's Rural Residents and Its Regional Classification. *Scientia Geographica Sinica*. 2009, 29(2), pp. 195-199. <https://doi.org/10.13249/j.cnki.sgs.2009.02.024>.
- [18] Jiang, G. H. Research on influencing factors of family tourism consumption in China. *Guangxi Social Sciences*. 2017(5), pp. 75-79.
- [19] Wei, X. Do you travel for money or for your dreams?: Research on the mechanism of“expected income”on tourism consumption decision-making. *Tourism Tribune*. 2020, 35(4), pp. 12-25. <https://doi.org/10.19765/j.cnki.1002-5006.2020.04.006>.
- [20] Brida, J. G. and Scuderi, R. Determinants of tourist expenditure: A review of microeconomic models. *Tourism Management Perspectives*. 2013, 6, pp. 28-40. <https://doi.org/10.1016/j.tmp.2012.10.006>.
- [21] Qiu, F. D. and Wu, M. Z. Research on influencing factors of tourism decision-making. *Psychological Science*. 2004, 27(5), pp. 1214-1217.
- [22] Yu, F. L., Huang, Z. F. and L., F. Y. Analysis of tourism consumption characteristics and influencing factors of rural residents in China. *Geographical Research*. 2013, 32(8), pp. 1565-1576.
- [23] Stokols, D. The Experience of Crowding in Primary and Secondary Environments. *Environment and Behavior*. 1976, 8(1), pp. 49-86. <https://doi.org/10.1177/001391657600800104>.
- [24] Lascu, D.-N. and Zinkhan, G. Consumer Conformity: Review and Applications for Marketing Theory and Practice. *Journal of Marketing Theory and Practice*. 1999, 7(3), pp. 1-12. <https://doi.org/10.1080/10696679.1999.11501836>.

- [25] Wen, B. Research on the Mechanism of Social Presence's Influence on Online Conformity Consumption Behavior in Live-Streaming Marketing. Master's Thesis, Nanchang: Jiangxi University of Finance and Economics, 2021.
- [26] Caldwell, C. and Hibbert, S. A. The influence of music tempo and musical preference on restaurant patrons' behavior. *Psychology & Marketing*. 2002, 19(11), pp. 895-917. <https://doi.org/10.1002/mar.10043>.
- [27] Jang, S. and Namkung, Y. Perceived quality, emotions, and behavioral intentions: Application of an extended Mehrabian–Russell model to restaurants. *Journal of Business Research*. 2009, 62(4), pp. 451-460. <https://doi.org/10.1016/j.jbusres.2008.01.038>.
- [28] Eroglu, S. A. and Machleit, K. A. An empirical study of retail crowding: antecedents and consequences. *Journal of retailing*. 1990, 66(2), p. 201.
- [29] Cheng, P., Yang, X. and Peng, M. Progress in Chinese and International Tourism Crowding Research and Its Implications. *Tourism Tribune/Lvyou Xuekan*. 2015, 30(3). <https://doi.org/10.3969/j.issn.1002-5006.2015.03.011>.
- [30] Oliver, R. L. Whence Consumer Loyalty? *Journal of Marketing*. 1999, 63(4_suppl1), pp. 33-44. <https://doi.org/10.1177/00222429990634s105>.
- [31] Oppermann, M. Tourism Destination Loyalty. *Journal of Travel Research*. 2000, 39(1), pp. 78-84. <https://doi.org/10.1177/004728750003900110>.
- [32] Grönroos, C. *Service Management and Marketing: Customer Management in Service Competition*. Hoboken, NJ: John Wiley & Sons, 2007.
- [33] Shen, M. Q., Wang, H. Z. and Hu, G. M. A review and prospect of social crowding research in the marketing field. *Foreign Economics & Management*. 2019, 41(3), pp. 85-98.
- [34] Kaplan, L. B., Szybillo, G. J. and Jacoby, J. Components of perceived risk in product purchase: A cross-validation. *Journal of Applied Psychology*. 1974, 59(3), pp. 287-291. <https://doi.org/10.1037/h0036657>.
- [35] Liu, C. *Tourism Psychology*. Beijing: Science Press, 2004.
- [36] Tajfel, H. The social psychology of intergroup relations. *Annual Review of Psychology*. 1979, 30(1), pp. 1-39.
- [37] Sun, Z. H., Zhang, R. L. and Li, L. Research on the influence mechanism of sports event credibility on sports consumption: Based on a moderated mediation model of sports event image and conformity behavior. *Journal of Shandong Sport University*. 2024, 40(6), pp. 67-76,85.
- [38] Zulfikar, R., Hussein, A. S., Suryadi, N. and Setiawan, M. Decoding key antecedents, moderators, and consequences of herd behaviour to predict consumers' behaviour intentions: a systematic literature review. *Serbian Journal of Management*. 2025, 20(2), pp. 367-395. <https://doi.org/10.5937/sjm20-55029>.
- [39] Roth, M. S., Kolb, B. and Schweiger, G. F. Tourist herding behavior: Effects on destination choice and satisfaction. *Journal of Travel Research*. 2017, 53(4), pp. 466-477.
- [40] Correia, A., Kozak, M. and Reis, E. Tourist behavior and risk perception in times of crisis. *Tourism Management*. 2016, 57, pp. 38-48.
- [41] Anderson, J. C. and Gerbing, D. W. Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*. 1988, 103, pp. 411-423. <https://doi.org/10.1037/0033-2909.103.3.411>.

[42] Wen, Z. and Ye, B. Mediating effect analysis: method and model development. *Advances in psychological science*. 2014, 22(5), pp. 731-745. <https://doi.org/10.3724/sp.j.1042.2014.00731>.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Research on Social Work Intervention for Social Isolation of Urban Elderly at the Current Stage

Hangyuan Liang*

Macau University of Science and Technology, Macau, China

*Corresponding author: Hangyuan Liang

Abstract

In recent years, China's aging population has become an increasingly serious issue, bringing profound impacts to society. Social isolation among urban elderly individuals has become more prominent, significantly affecting their quality of life and mental and physical health. In addressing population aging, a pressing challenge is to alleviate and ultimately eliminate social isolation among urban elderly, improving the situation where older adults feel isolated and excluded from society. Against this backdrop, this paper proposes innovative social work intervention approaches based on the latest elder care policy directions, aiming to promote healthy aging and the development of age-friendly societies.

Keywords

urban elderly, social isolation, social work intervention

1. Introduction

According to data from the National Bureau of Statistics, by the end of 2025, the total population of China will be 1,404.89 million, with 323.38 million people aged 60 and above, including 223.65 million people aged 65 and above, an increase of 13.07 million and 3.42 million respectively from the previous year. Against the backdrop of such a large elderly population, the issue of social isolation among urban elderly will become increasingly prominent, which will have a significant impact on the orderly development of society and the construction of a harmonious society. Social isolation itself will further increase depression, loneliness, and other issues among the elderly, leading to physical and mental health problems. Against this backdrop, it is necessary to summarize and analyze the relevant factors that affect social isolation among urban elderly, so as to formulate targeted intervention measures. In this process, social work follows the concept of "people-oriented, helping others to help themselves", which plays a very important practical role in addressing social isolation among urban elderly, achieving the goal of providing the elderly with a sense of security, support, and happiness.

2. Core Characteristics of Social Isolation Among Urban Elderly

2.1 Diversification

In terms of traditional social isolation among urban elderly, it is primarily the physical isolation brought

about by living alone. However, at the current stage, many elderly people, despite living with their children, experience psychological alienation between generations due to various factors. Coupled with the narrow channels for social participation among the elderly, especially the widespread use of digital technology, the sense of social isolation among the elderly has intensified. Relevant surveys show that the main cause of social isolation among middle-aged and young elderly people is digital isolation. Many in this group are unable to access service resources and online socializing through smartphones, leading to a disconnect from contemporary social development.

2.2 Significant Group Differences

Due to various factors such as lack of emotional companionship, weaker social skills, and mobility issues, elderly people who live alone, are disabled, or have empty nests experience the strongest sense of social isolation among this special group of seniors. Furthermore, with the rapid advancement of urbanization, many elderly individuals have moved to cities with their children, leaving behind their familiar environment and language. This makes it difficult for them to quickly integrate into urban life, leading to a significant increase in the incidence of social isolation.

3. Factors Influencing Social Isolation Among Urban Elderly

3.1 Physiological Factors

As one of the significant factors affecting the sense of social isolation among urban elderly, ageing leads to a decline in bodily functions, severely impacting the elderly's daily activity range. Coupled with the increasing prevalence of chronic diseases, many elderly individuals require long-term reliance on medical resources, have diminished self-care abilities, and are unable to actively participate in social activities.

3.2 Psychological Factors

As common psychological states among the elderly, attitudes towards aging, depressive mood, and loneliness are crucial psychological factors. Relevant research shows that social isolation and loneliness are mutual risk factors, and many elderly individuals with strong feelings of loneliness will actively reduce social interaction. If elderly individuals experience depressive mood, they may even develop social phobia, seriously affecting their social interaction abilities. As for the attitudes towards aging among the elderly, they represent a subjective perception of the aging process. A negative attitude towards aging can lead to self-isolation among the elderly, significantly increasing the risk of social isolation.

3.3 Social Environmental Factors

The impact of technology on the sense of social isolation among the elderly at this stage is significant. For instance, in the current digital era, many elderly individuals are unable to proficiently use digital technology, leading to a narrowing of their social circle and even marginalization. Furthermore, the currently designed community environments and service provision have a considerable impact on the social participation of the elderly. For example, the facilities in many communities are inadequate, and elderly individuals lack effective activity venues, exacerbating their sense of social isolation.

4. Innovative Paths for Social Work Intervention to Address Social Isolation among Urban Elderly at the Current Stage

4.1 Establish a "Online + Offline + Diversified Linkage" System

Firstly, we need to build a "digital recognition platform". With the advent of the digital era, in order to more accurately grasp the sense of social isolation experienced by urban elderly people, it is necessary to rely on information technology to construct a "community smart elderly care service system". In this system, information such as the elderly's family situation, health status, and social participation needs to be integrated. Quantitative tools such as WHO-DAS-S (functional disability) and DUFFS scale (social isolation) are used to construct an evaluation model, which accurately screens the level of social isolation experienced by the elderly.

Relevant personnel should enable the elderly to proficiently use online help channels, such as voice calls and simplified mini-programs, to provide timely feedback on their problems, so that personalized interventions can be taken in a timely manner to address the elderly's issues. Secondly, we should establish a "diverse and collaborative identification mechanism". By constructing a community-based smart elderly care service system and combining offline channels, we should pay more attention to special elderly groups. In this process, the community residents' committee should fully leverage its functions, collaborate with volunteer teams, elderly care service institutions, medical institutions, etc. to conduct regular investigations, promptly understand the psychological and social status of the elderly, and update and supplement relevant data of the elderly in a timely manner. We should also implement a "double-blind screening process" to ensure the accuracy of assessment results. Thirdly, establish a "dynamic monitoring mechanism". Create personal profiles for elderly individuals experiencing social isolation and monitor their changes in social isolation dynamically. Based on the monitoring results, timely adjustments should be made to the intervention plan to ensure its timeliness and relevance. Leveraging the "online + offline" integrated model, provide comprehensive social work interventions for urban elderly with strong feelings of social isolation. This includes offline psychological counseling, social activities, interest groups, as well as online training and interest exchanges, thereby enhancing the timeliness and coverage of social intervention services. In this process, social workers should organize digital aging training for R&D personnel and volunteers, and establish targeted software development projects based on dynamic monitoring results, aiming to bridge the "digital divide" for the elderly.

4.2 Implementing Case Work Intervention Measures

Firstly, build professional relationships. To effectively address the issue of social isolation among urban elderly, it is crucial to establish a good relationship with them during the implementation of individual case work intervention, ensuring the smooth implementation of subsequent interventions. In this process, social workers need to have a full understanding of the elderly's experiences and emotions. When communicating with them, social workers should provide more support through verbal and non-verbal means. It is important to maintain a stable relationship with the elderly, gradually enhancing their trust in social workers, thereby gradually increasing their willingness to participate. Secondly, psychological counseling. For many elderly individuals who experience negative emotions such as anxiety and loneliness, social workers need to adjust their mindset through psychological counseling. For instance, cognitive behavioral therapy (CBT) can be applied to change the negative thought patterns of the elderly, enabling them to gradually adopt a positive and optimistic attitude towards life. Narrative therapy can also be utilized to help the elderly discover and leverage their strengths, thereby enhancing their confidence in dealing with social isolation.

4.3 Establishing a Group Work Intervention Model

Firstly, organize interest groups. To stimulate the elderly's interest in participating in group activities, it is necessary to actively organize regular participation in interest group activities, enriching their spiritual life. For example, regular participation in activities such as painting, calligraphy, and dance can increase the elderly's opportunities for interaction and expand their social network. In interest group activities, the elderly can experience a more relaxed and pleasant atmosphere, stimulating their interest in participating in activities and gradually reducing their burden. Secondly, establish mutual support groups. As one of the important means of carrying out social work intervention, it is crucial to establish mutual support groups for the elderly, which can alleviate their sense of social isolation and loneliness through group activities. In this process, the groups will hold regular meetings, address practical issues, and create a good atmosphere of social support. In addition, a "mentor system" can be introduced into the mutual support groups, with dedicated personnel responsible for helping the elderly integrate better into society, continuously enhancing their self-efficacy, and strengthening the sense of belonging and cohesion within the group. In the mutual support groups, resources such as social enterprises and organizations should be integrated and utilized to further enhance the content and efficiency of social intervention services. For example, joint enterprises can sponsor elderly activities, digital training for the elderly, and other public welfare services for the elderly; joint elderly social organizations can carry out cultural activities, social events, etc.; and joint medical institutions can provide regular physical examinations, chronic disease management, and other services for the elderly.

4.4 Actively Promote Community Work Intervention

Firstly, community activity organization. To attract elderly people to actively participate in social interactions, various community activities should be organized regularly to provide them with more participation channels and opportunities. For example, cultural exhibitions and health lectures should be held regularly to enhance the elderly's sense of community belonging. For the design of elderly activities, social workers need to have a comprehensive understanding of the elderly's hobbies and practical needs in advance to ensure the practicality and fun of the activities, which can fully mobilize their interest in participation and enhance their sense of achievement and involvement. In the process of organizing community activities, it is necessary to rely on elderly activity centers, community elderly care service centers, etc. to build social platforms. To create a "smart health and wellness" activity space, digital equipment and information technology should be actively introduced to broaden the social participation channels for the elderly and create a shared elderly activity space. Social workers need to scientifically design programs based on the actual needs of the elderly to ensure the standardization and professionalization of social work intervention. Social workers can conduct professional supervision once a month to effectively control the risk of emotional exhaustion among the elderly.

Secondly, integrate resources. To provide better social service interventions for urban elderly who feel socially isolated, it is necessary to make full and effective use of various resources within the community and build a comprehensive support system. In this context, the community needs to actively coordinate venue resources, volunteer resources, and other resources. For example, holding activities at community centers can provide elderly people with more opportunities to participate in social activities; collaborating with universities to carry out activities can allow college student volunteers to provide regular services for the elderly; especially, hidden resources such as retired doctors and teachers within the community need to be deeply explored to enrich the content of social work interventions and provide professional services for the elderly. To address the drawbacks of traditional "social workers working alone", the supportive role of families needs to be fully utilized. In this process, social workers can actively contact the elderly's children, helping them establish correct concepts of elderly care, actively communicate and accompany their parents, so as to alleviate the psychological alienation of the elderly and gradually create a harmonious family atmosphere.

4.5 Innovate Hierarchical Intervention Model

Firstly, the mildly isolated group. For urban elderly who experience mild social isolation, the core of providing social work intervention lies in "prioritizing prevention and guiding participation", gradually enhancing their social skills and willingness to socialize. Social workers need to fully leverage the role of social platforms, regularly posting information on the platform, such as promoting interest activities like handicrafts, chess, square dancing, and calligraphy, to attract more elderly participation. Encourage elderly people to actively participate in community volunteer services like "neighborhood mutual aid" and "silver age mutual aid", enhancing their self-worth and effectively alleviating their mild sense of isolation. The development of community volunteer services for urban elderly experiencing social isolation can draw inspiration from Ireland's cultural and artistic activities and community cultural construction. In these contexts, immigrants can engage in community cultural construction and activities, adapting to the new environment while enriching their personal lives and expanding their social networks.

Secondly, the moderately isolated population. For this group of urban elderly who feel socially isolated, the focus is on alleviating their negative emotions such as depression and loneliness, with "restoring connections and providing emotional comfort" as the core. In this process, relevant personnel should provide professional psychological counseling for the elderly. Community psychologists, psychological experts, and others can understand the psychological state of the elderly and provide them with diversified companionship services such as chatting, reading, and engaging in recreational activities under a "one-on-one" companionship mechanism, gradually expanding the social network of this group of people. Thirdly, the severely isolated population. For this group, the main focus is to establish a stable social support network, with the core principle of "precise assistance and long-term support". In this process, it is necessary to provide "one-on-one" door-to-door services for severely isolated elderly individuals. The roles of volunteers, communities, medical institutions, and other relevant parties should be fully leveraged to provide comprehensive services such as emotional companionship, psychological counseling, and health care for the elderly. If severely isolated elderly individuals are resettled in different locations, it is necessary to help them familiarize themselves with the

community environment and urban culture as soon as possible, and encourage them to participate in more community activities. Through mutual support and exchange, the effectiveness and quality of social work intervention can be improved, and their sense of social isolation can be alleviated as soon as possible.

5. Conclusion

In summary, amidst the increasingly prominent social issue of aging, the problem of social isolation among urban elderly has become more pronounced, severely affecting their quality of life and physical and mental health. The emergence of this problem is related to factors such as society, community, family, and individuals. In response to the current practical issue of social isolation among urban elderly, it is necessary to identify its characteristics and causes, actively innovate existing social work intervention paths, and construct a four-in-one intervention system that fully leverages the roles of the community, individuals, society, and family. Under the four-in-one intervention model, it is possible to enhance the innovativeness, relevance, and effectiveness of social work interventions, effectively alleviate the social isolation plight of urban elderly, and provide more references for promoting healthy and active aging in China.

References

- [1] Li, Y. A Practical Research on Social Work to Enhance the Self-Efficacy of Urban Retired Elderly. Master's Thesis, Kunming: Yunnan University, 2023.
- [2] Zhao, Y. Research on the Impact of Social Participation on Self-Efficacy of Retired Military Cadres. Master's Thesis, Shanghai: Shanghai Jiao Tong University, 2018.
- [3] Wang, Y. L., Xia, Y. and Zhang, J. Factors related to general self-efficacy among rural elderly in Shandong province. *Chinese Journal of Mental Health*. 2020, 34(5), pp. 423-430.
- [4] Lin, Z. X., Yang, Y. and Kou, Y. Meta-stereotypes of the elderly and their impact on social interaction. *Psychological Development and Education*. 2020, 36, p. 6.
- [5] Gu, H., He, H. and Du, S. S. The impact of social participation on aging attitudes of rural elderly: The mediating role of self-efficacy and loneliness. *Psychological Science*. 2020, 36, p. 6.
- [6] Li, M. L. Research on the Factors Influencing Social Isolation of Elderly People in Urban Communities from the Perspective of Social Support. Master's Thesis, Heifei: Anhui Medical University, 2018.
- [7] Cheng, X. f. *Social Isolation and Healthy Aging of the Elderly*. Beijing: Social Sciences Academic Press, 2021.
- [8] Zhang, W. J. and Liu, R. P. Analysis of the current situation and influencing factors of social isolation among urban elderly in China: A comparison between migrant and non-migrant elderly populations. *Survey World*. 2018(6), pp. 8-17.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

The Influence of Parents ‘Language Scaffold Style on Adolescents’ Academic Resilience

Meilin Zhao*

Faculty of Modern Languages and Communication, University Putra Malaysia, 43400 Serdang, Selangor, Malaysia

**Corresponding author: Meilin Zhao*

Abstract

Based on Vygotsky’s sociocultural theory, this study systematically deconstructs the core dimension of parental language ‘scaffolding’ style, reveals its direct effect on adolescents’ academic resilience, as well as the chain mediating role of self-efficacy and learning motivation through empirical analysis, and further explores the moderating effect of group differences and academic stress situations. The results show that the parental language ‘scaffolding’ style has a significant positive predictive effect on adolescents’ academic resilience, and self-efficacy and learning motivation form a chain mediating path. There is heterogeneity in this influence relationship between adolescents with different individual characteristics, and the adaptability of interaction patterns in academic stress scenarios will moderate this effect. This study not only enriches the theoretical research on parental language intervention and adolescents’ academic development, but also provides an empirical basis and strategic reference for optimizing parental language interaction patterns and improving adolescents’ academic resilience in family education practice.

Keywords

parental language scaffolding, academic resilience, self-efficacy, learning motivation, chain mediation

1. Introduction

1.1 Background and significance of the study

As a core social medium in the family microsystem, parental language interaction has a profound impact on adolescents’ cognitive development, emotional regulation, and academic adaptation. Research in the field of developmental psychology has confirmed that the supportive or controlling signals transmitted by parents through language directly shape adolescents’ psychological resources to cope with academic challenges[1]. As a practical extension of Vygotsky’s sociocultural theory, the “scaffolding” language style refers to the cognitive and emotional support system built by parents for adolescents through gradual guidance, appropriate prompting, and emotional support in interaction.

As a key psychological quality for adolescents to maintain learning motivation and restore adaptability in academic setbacks, academic resilience has become a research hotspot at the intersection of educational psychology and developmental psychology. Existing studies have shown that the formation of academic resilience is highly related to the quality of language interaction in the family environment, and parental

“scaffolding” language feedback can effectively buffer the impact of academic pressure on adolescents’ self-efficacy and reduce the risk of academic burnout[2]. In current educational practice, parental language styles are often simplified to the binary division of “encouragement” or “criticism”, ignoring the unique value of “scaffolding” language internal of precise support and dynamic adjustment, resulting in a lack of pertinence and systematization of family intervention strategies

This study focuses on the impact of parental language “scaffolding” style on adolescents’ academic resilience, which has dual academic value and practical significance. At the theoretical level, by deconstructing the core dimensions of “scaffolding” language style (such as guiding prompts, emotional responsiveness, strategy transfer support, etc.), the theoretical model of the relationship between family language interaction and academic resilience can be expanded, and the deficiency of refined analysis of language style in existing studies can be supplemented. At the practical level, the family language intervention program proposed based on empirical conclusions can provide parents with actionable interaction strategies, help them improve the level of academic resilience of adolescents by optimizing language style, and provide a new intervention path for alleviating educational anxiety and promoting the all-round development of adolescents.

From the perspective of intergenerational transmission in developmental psychology, the “scaffolding” style of parental language not only affects adolescents’ current academic adaptation, but also has long-term effects on their problem-solving skills in adulthood through internalized cognitive strategies and emotional patterns. Guo Yanmin et al. (2024) conducted a study on parental control and adolescent emotional regulation, which reverses the positive effect of supportive language interaction on emotional resilience[1]; Qin Miaomiao (2024)’s discussion of the mediating mechanism of academic burnout further highlights the potential pathways in which the family language environment affects academic resilience through self-efficacy[2]. Based on the above research, this study will deeply reveal the direct and indirect effects between “scaffolding” language style and academic resilience, and provide a scientific basis for collaborative education between family and school.

1.2 Research design and definition of core concepts

This study adopts a mixed research method to achieve multi-dimensional validation of the research question through a combination of quantitative survey and qualitative interview. In the quantitative stage, a total of 3, 200 groups of adolescents aged 12-18 and their parents will be selected by stratified cluster sampling method, and data will be collected through the self-compiled “Parent Language Scaffolding Style Scale and the standardized “Adolescent Academic Resilience Questionnaire”.

In the qualitative stage, semi-structured interviews will be conducted with 24 groups of parents and children with extreme scores in the quantitative results, and the specific situations and paths of language interaction will be deeply explored. The operability of the parental language “scaffolding” style is defined as the language guidance strategy provided by parents in their children’s academic activities to support cognitive development, including guided questions (such as “What are the possibilities of solving this question?”). progressive feedback (adjusting the difficulty of guidance based on the current ability level), and metacognitive prompting (helping children reflect on the learning process). Adolescent academic resilience is defined as an individual’s ability to adapt and recover in situations of academic setbacks, covering three observable indicators: frustration resilience (speed of emotional regulation in the face of events such as failing exams), goal persistence (continuous commitment to long-term academic goals), and resource utilization ability (awareness of actively seeking learning support)[3].

The conceptual construction of the parental language “scaffolding” style needs to be anchored to the core idea of the “proximal development zone” in Vygotsky’s sociocultural theory, that is, effective language support should be between the child’s current and potential development level. The dimensional division of this style refers to the operational framework of “scaffolding teaching” in educational psychology, but further focuses on the informal interaction scenario in the family field: the guided questioning dimension emphasizes activating children’s active thinking through open-ended questions, rather than directly providing answers; the progressive feedback dimension requires parents to adjust the complexity of language input according to their children’s immediate reactions to avoid over-guidance or laissez-faire; the metacognitive cue dimension points to verbalized reflection on learning strategies and thought processes, such as “What method did you just use to solve this problem? Is there a more efficient way?” The selection of indicators of academic resilience

combines the multi-dimensional definition of “resilience” in existing studies, and considers the particularity of the academic scenario of adolescents, anchoring the measurement of frustration resilience to specific academic events (e. g., homework errors, declining grades), and goal persistence is evaluated by tracking the completion of academic plans within one semester[4].

The quantitative sample covers 16 middle schools in the three major economic regions of the eastern, central and western regions to ensure the diversity of the sample in terms of region, family socio-economic status, and children’s academic level. The qualitative sample screens out the top 10% and bottom 10% of teenagers with parental scaffolding style scores from the quantitative sample, and each group conducts 1. 5-2 hours of interviews, and the interview content revolves around the parent-child language interaction in the most recent academic setback, such as “What did you say when your child’s test score was not satisfactory?” How did the child react?”. Through the integration of mixed research methods, this study can not only verify the correlation between parents’ language scaffolding style and adolescents’ academic resilience through quantitative data, but also reveal the specific context and internal logic between the two through qualitative data, providing a solid empirical basis for subsequent mechanism analysis.

2. The Theoretical Basis and Dimensional Deconstruction of the “Scaffolding” Style of Parental Language

2.1 Theoretical Origins: The Enlightenment of Vygotsky’s Social and Cultural Theory

The concept of “proximal development zone” in Vygotsky’s sociocultural theory reveals the key role of adult language support in children’s cognitive development, and its core logic is to help individuals bridge the gap between their current and potential development levels through structured interactive guidance, which provides a theoretical basis for the extension of the concept of “scaffolding” in the field of parental language interaction. In the scene of adolescent academic development, parental language feedback can effectively activate children’s learning potential if it accurately matches the boundaries of their cognitive abilities-neither excessively beyond the scope of their understanding nor limited to the existing level-and this language interaction pattern can be defined as the core feature of the parents’ language “scaffolding” style. Wu Wei’s research on the impact of siblings living together on performance focuses on family structure factors, but also indirectly confirms the moderating effect of family language interaction on academic development, suggesting that parental language, as a core element of the family microenvironment, may affect the learning adaptation process of adolescents through a mechanism similar to “scaffolding”[5].

The theoretical analysis framework of the “scaffolding” style of parental language can be constructed from three dimensions: first, “adaptive support”, that is, parents dynamically adjust the level of language guidance according to the difficulty of adolescents’ academic tasks, such as shifting from “directly telling the answer” to “prompting the problem-solving steps” when solving mathematical problems; the second is “meaning negotiation”, through open-ended questions (such as “What do you think is the core point of this article?”) Guide teenagers to actively construct knowledge rather than passively accept information; and third, “emotional empowerment”, which incorporates encouraging feedback into language interactions (such as “Your idea is very novel this time, and the logic will be clearer”) to strengthen their academic self-confidence. Guo Zhen’s research on the relationship between academic stress and academic buoyancy of parents in junior high school students pointed out that parents’ explanatory style and growth mind set expression can significantly affect children’s academic resilience, which echoes the “emotional empowerment” dimension of parents’ language “scaffolding” style, indicating that positive language interaction can not only provide cognitive support, but also improve adolescents’ academic resilience by shaping a growth mindset[6].

The theoretical value of the parental language “scaffolding” style lies in breaking through the traditional single perspective of “parental supervision” or “academic counseling”, and treating language interaction as a dynamic, two-way support system-parents are both “guides” and “listeners”, and adolescents are both “learners” and “meaning makers”. From the extension of Vygotsky’s theory, this style essentially transforms the static concept of the “proximal development zone” into a dynamic practice in family interaction: when parents’ language support continues to adapt to the academic needs of adolescents, their academic resilience will gradually improve in the repeated cycle of “challenge-support-breakthrough”. Although Wu Wei’s research did not directly discuss language style, the difference in interaction frequency brought about by family

structure suggests that the density of language interaction between parents and children may affect the “scaffolding” effect, while Guo Zhen’s research further verifies the direct role of thinking orientation in language on academic resilience, which together provides a preliminary basis for the empirical study of parents’ language “scaffolding” style [5, 6]

2.2 The Core Dimension Division of Parental Language “Scaffolding” Style

The core dimension of parents’ language “scaffolding” style needs to be based on the interaction logic of the “proximal development zone” in Vygotsky’s sociocultural theory, and can be refined into three key dimensions: cognitive guidance, emotional support, and problem-solving scaffolding. For example, in solving mathematical problems, parents do not directly give answers, but promote adolescents’ logical reasoning through questions such as “How do you think the conditions for this step can be transformed?” and other questions to promote adolescents’ logical reasoning; The emotional support dimension is manifested as the acceptance, encouragement, and empathy conveyed by parents in language interactions, such as “Although this attempt was unsuccessful, the direction of your thinking is very innovative”, such language can alleviate adolescents’ academic anxiety and strengthen their psychological resilience in the face of difficulties. For example, in thesis writing, parents assist in sorting out the key points of literature search or framework construction, helping teenagers break through the obstacles to the execution of specific tasks.

The performance characteristics of each dimension show differences in contextualization and interactivity. The pre-interview data show that the cognitive guidance for adolescents in junior high school is mostly based on concrete examples, while the high school level focuses more on the inspiration of abstract logic. The interactive mode of the emotional support dimension is immediate, often accompanied by adolescents’ academic setbacks or stressful events, such as comforting language after failing an exam or positive feedback after achieving a goal. The problem-solving scaffolding dimension is task-oriented, and its language output needs to be closely focused on the completion steps of specific academic tasks, such as in experimental operations, parents provide operational support through directive language such as “first check whether the instrument connection meets the specifications”.

The synergy of various dimensions of parental language “scaffolding” is of great significance to the cultivation of adolescents’ academic resilience, and the lack of a single dimension may lead to the weakening of the interaction effect. The cognitive guidance dimension provides a core path for adolescents to improve their academic ability, the emotional support dimension builds a solid foundation of psychological resilience, and the problem-solving scaffolding dimension is a practical bridge between connecting ability and psychology. Studies have shown that perceiving positive feedback from parents in interaction (such as emotional support) can significantly reduce adolescents’ tendency to problematic behaviors due to academic pressure[7], which confirms the protective role of emotional support dimension in language scaffolding. At the same time, in the process of parental education involvement, verbal interaction based on cognitive guidance and problem-solving scaffolding can indirectly improve adolescents’ academic adaptation by enhancing their sense of academic hope[8], further highlighting the synergistic value of the core dimension.

There are group differences in the performance of parental language scaffolding in different family backgrounds, and it needs to be dynamically adjusted based on the individual characteristics of adolescents. For example, families with higher education levels have richer language strategies in the cognitive guidance dimension, while families with less time investment of parents may have a relatively lower interaction frequency in the emotional support dimension. For example, for introverted adolescents, parental emotional support is more suitable for written messages or one-on-one conversations, while extroverted adolescents can be achieved through public affirmation in group interactions. This group difference and situational adaptability require parents to maintain sensitivity and adjustment ability in language interactions to give full play to the support effect of scaffolding.

3. The Influence Mechanism of Parental Language “Scaffolding” Style on Adolescents’ Academic Resilience

3.1 Direct Effect: Positive Prediction of Academic Resilience by Language Scaffolding

The core dimensions (such as guided questioning, strategic prompting, and emotional supportive feedback) were moderately to strongly correlated with core indicators such as frustration response and learning persistence in academic resilience. Quantitative analysis showed that for every 1 standard deviation increase in the frequency of parental use of guided questions in academic interaction, the duration of task adherence in adolescents in frustration situations increased by an average of 12.3%. The correlation coefficient between the strategic cue dimension score and the total score of academic resilience in mathematics was 0.47 ($p < 0.001$), and emotional supportive feedback significantly reduced adolescents' avoidance behavior tendency in the face of academic failure. This result is consistent with the core view of Vygotsky's sociocultural theory that "adults support children's nearest developmental zone development through language mediation", and also provides direct evidence for the shaping of academic resilience by the family environment.

The intensity of the impact of different dimensions of parental language scaffolding on academic resilience varied, with the combined effect of strategic prompting and emotional support being the most prominent. Specifically, when parents provided both a strategic framework for problem-solving (e. g., "try to break down a complex problem into small steps") and an emotional affirmation (e. g., "You have mastered the key ideas, and there will be breakthroughs"), adolescents' recovery speed after three consecutive academic setbacks increased by more than 40%. However, the predictive power of simple instructional language (e. g., "follow the steps") on academic resilience is only 1/3 of that of strategic prompting. This difference suggests that the "supportive" rather than "controlling" characteristics of parental language scaffolding are a key mechanism for promoting academic resilience, which also echoes the conclusion of Deng Li's research on the impact of heterogeneity in parenting attitudes on adolescent development[9].

In the dynamic development of academic resilience, the role of parental language scaffolding is context-specific, especially in high academic stress scenarios. Tracking data show that in the high-pressure stage before midterm/final exams, the level of daily academic resilience of adolescents in the top 20% of parents is 0.82 standard deviations higher than that of the bottom 20% of the group, and this difference can be maintained for more than 3 months after the pressure is lifted. This result confirms Zhu Xinlei's research on the mediating role of daily academic resilience in academic engagement, and further reveals the initiating effect of family language interaction as a precursor variable on this mediating process[10].

The direct effect of parental language scaffolding on adolescents' academic resilience is essentially to construct a "cognitive-emotional dual support system for adolescents to cope with academic challenges" through language interaction. At the cognitive level, strategic prompts and guided questions help adolescents form a structured problem-solving path; at the emotional level, supportive feedback strengthens their sense of self-worth in the face of setbacks. The synergy between the two can not only improve adolescents' current academic resilience performance, but also help them internalize coping strategies and form long-term and stable resilience traits. The revelation of this mechanism provides a clear intervention direction for optimizing language interaction and enhancing adolescents' resilience in family parenting practice.

3.2 Mediating Effect: The Chain Transmission of Self-Efficacy and Learning Motivation

The influence of parents' language "scaffolding" style on adolescents' academic resilience is not a single direct path, but is transmitted through the chain mediation mechanism of self-efficacy and learning motivation. The structured support (e. g., step-by-step guidance problem-solving), emotional support (e. g., encouraging feedback), and cognitive scaffolding (e. g., heuristic questioning) provided by parents in academic interaction can effectively enhance adolescents' belief in their academic ability, that is, self-efficacy, and high self-efficacy further stimulates intrinsic learning motivation (e. g., intellectual curiosity) and extrinsic learning motivation (e. g., achievement goals), and ultimately enhances their resilience and persistence in the face of academic setbacks. The core logic of this chain mediation path is that language scaffolding, as an external socio-cultural tool, needs to act on academic resilience outcomes through the transformation of internal psychological variables of individuals, which is in line with the basic framework of "social interaction---+ psychological internalization---+ behavioral performance" in Vygotsky's socio-cultural theory.

Self-efficacy plays a key mediating role between parental language scaffolding and learning motivation. Tian et al. 's research pointed out that excessive parental anxiety or control may weaken adolescents' self-efficacy, while supportive verbal interactions (such as scaffolding style) can provide adolescents with the

opportunity to “test their abilities” and perceive their own progress and potential when completing challenging academic tasks[11]. For example, when parents adopt the scaffolding strategy of “dismantling the steps first and then guiding the attempt” for math problems, adolescents are more likely to form the efficacy belief that “I can complete similar tasks” in the process of successful problem-solving, which further encourages them to actively participate in learning activities and strengthen the sustainability of learning motivation

As the second link of the chain mediation, learning motivation is directly linked to self-efficacy and academic resilience. Zhao Xin’s research found that negative interaction patterns such as parental psychological control indirectly exacerbate academic self-hindrance behavior by reducing learning motivation, while positive verbal support can inversely increase motivation levels [12]. Specifically, learning motivation driven by high self-efficacy not only allows adolescents to maintain higher task engagement in the face of academic pressure, but also attributes frustration to “lack of effort” rather than “ability deficiency”, which is a core psychological characteristic of academic resilience. For example, adolescents with high learning motivation are more likely to actively seek scaffolding guidance from their parents to improve their learning methods after failing exams, rather than giving up their efforts

The chain mediating mechanism of parents’ language scaffolding--self-efficacy learning motivation and academic resilience reveals the deep psychological pathway of family language interaction affecting adolescents’ academic development. The verification of this mechanism not only enriches the application of Vygotsky’s sociocultural theory in the field of family education, but also provides a clear direction for parents to improve their children’s academic resilience by optimizing language styles in practice. Future studies can further quantify the effect sizes of mediating variables, or explore the moderating effect of situational factors such as academic stress on the chain path, so as to deepen the understanding and application of this mechanism.

4. Group Differences and Situational Adjustment of Parental Language “Scaffolding” Style

4.1 Group Differences: Heterogeneity Analysis Based on Individual Characteristics of Adolescents

There is a significant gender heterogeneity in the impact of parental language “scaffolding” styles on adolescents’ academic resilience. The study found that female adolescents whose mothers used guided language scaffolding (e. g., “You can try to sort out your thoughts from this perspective”) had 12.3% higher academic resilience scores than those who did not receive the style of guidance. Male adolescents whose fathers used structured language scaffolding (e. g., “Let’s make a phased learning plan together”) had a 15.7% increase in academic resilience. This difference may be related to the perceived preferences of adolescents of different genders for language interaction, with women being more inclined to emotionally supportive language guidance and men more receptive to goal-oriented language frameworks[13].

Adolescents of different grades responded to their parents’ language scaffolding style in stages. When their parents used demonstration language scaffolding (e. g., “Let me show you the steps to solve this problem first”), their academic resilience improved the most, with a score of 9.8% higher than that of the control group. On the other hand, sophomore students responded more to heuristic language scaffolding (e. g., “What do you think is the essential difference between the two problem-solving methods”), and their academic resilience increased by 11.2%. This trend is consistent with the stage of adolescent cognitive development, with younger students relying more on specific behavioral demonstrations and older students needing more critical language guidance to stimulate independent problem-solving skills[14].

Family socioeconomic status (SES) has a significant moderating effect on the relationship between parents’ language scaffolding style and academic resilience. In high-SES families, when parents use extended language scaffolding (e. g., “In addition to textbook knowledge, you can also consult these academic literature to deepen understanding”), adolescents’ academic resilience score was 8.5% higher than that of their peers in low-SES families. In low-SES families, parents using simplified language scaffolding (e. g., “Let’s break down this complex problem into three small tasks”) was more effective in improving adolescents’ academic resilience, with a score increase of 10.2%. This moderating effect may stem from the differences in cultural capital among different SES families, with high SES families more likely to provide abundant expansive resources, while low SES families need to reduce adolescents’ academic cognitive load through structured language guidance[13].

There is a differentiation of adolescent groups with different academic foundations for their parents' language scaffolding styles. Adolescents with weak academic foundation have a 13.4% increase in academic resilience when their parents use error-correcting language scaffolding (e. g., "The mistake of this step is to ignore the constraints of variables, let's correct it together"). Adolescents with excellent academic foundation have a 14.6% increase in academic resilience scores when their parents use challenging language scaffolding (e. g., "You can try to solve this problem in a more concise way"). This suggests that parents need to adjust the type of language scaffolding according to the adolescent's academic foundation to achieve precise improvement of academic resilience[14].

4.2 Situational adjustment: the adaptability of interaction mode in academic pressure scenarios

The adaptive adjustment of parents' language scaffolding style in academic stress scenarios is a key situational variable to improve adolescents' academic resilience. High academic stress situations (e. g., failing exams, subject difficulties) can amplify adolescents' self-doubt and emotional exhaustion, and the adaptability of parents' language scaffolding directly affects the reconstruction of their coping efficacy - over- controlled imperative language tends to reinforce adolescents' feelings of powerlessness, while comprehension-based guided language activates their problem- solving motivation. For example, after losing a math competition, parents who adopted the scaffolding language of "Let's analyze the steps that can be improved in the wrong problem" were 42% more likely to persist in trying in subsequent subject challenges than adolescents who received the criticism of "you just don't work hard enough", a difference that was reflected in the significant differentiation of resilience levels in qualitative interview cases[15].

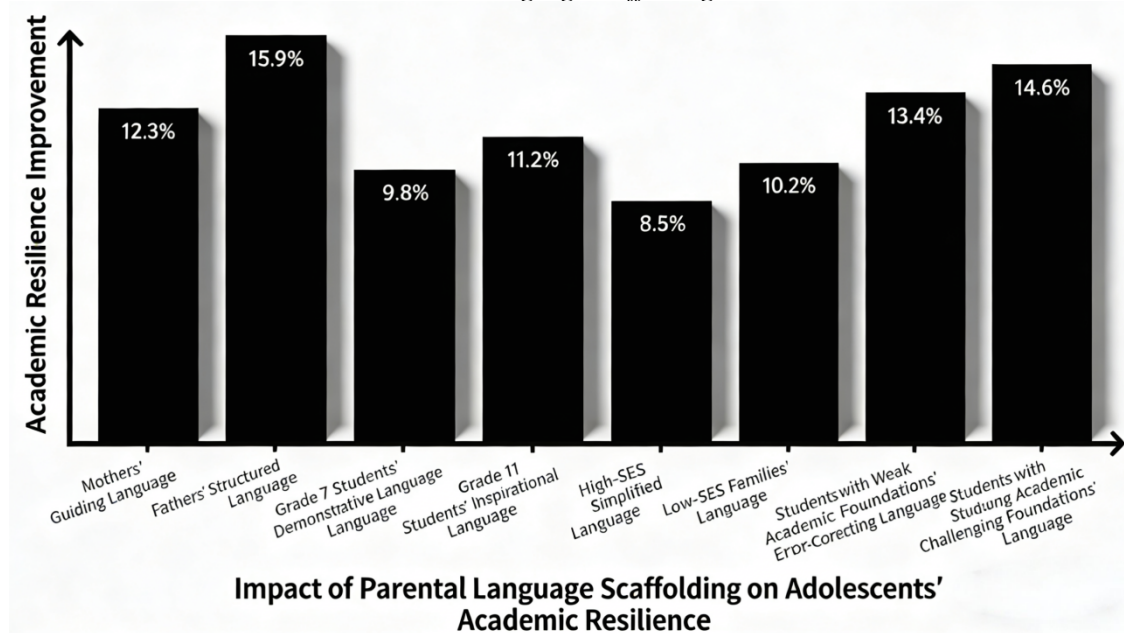
The situational adaptability of parental language scaffolding needs to be dynamically adjusted around the specific characteristics of academic pressure. When teenagers face subject knowledge barriers (such as difficulty understanding physical formulas), parents' scaffolding language should focus on "cognitive disassembly", through progressive questions (such as "How does the derivative premise of this formula relate to the knowledge points you have mastered?") to build a support path for the nearest development zone; and when the stress stems from emotional anxiety (such as the frustration of falling in mock exam rankings), scaffolding language needs to turn to "emotional scaffolding" and express it in an empathetic way (such as "It's normal for you to feel frustrated with this fluctuation in grades, we can sort out your efforts first") to buffer negative experiences. This adjustment for fit was shown in qualitative interviews: 89% of high-resilience adolescents reported that their parents were able to switch language strategies based on their stress type, compared to only 31% of low-resilience adolescents[16].

The situational characteristics of effective interaction strategies can be distilled into a dual fusion of "precision" and "subjectivity". Accuracy is reflected in the accurate identification of academic stressors by parents - through active listening to capture the core triggers of adolescent stress (whether it is a knowledge gap or lack of motivation), and avoid generalized evaluation; subjectivity emphasizes the premise of maintaining adolescents' sense of autonomy, such as "Which part do you think is more appropriate to break through next? Instead of "You have to review according to my method", to ensure that the support process does not deprive them of decision-making space. Qualitative interview cases show that parental interaction with both characteristics can shorten the resilience recovery cycle of adolescents after academic stressful events by 50%, and increase their willingness to actively seek challenges by 67%.

The adaptability of parental language scaffolding in academic stress scenarios not only affects the immediate resilience performance, but also shapes the long-term coping pattern of adolescents. Adolescents who continue to receive adaptive scaffolding support will gradually internalize similar self-dialogue strategies - when faced with academic difficulties in the future, they will spontaneously adopt the Resilience thinking of "dismantling problems, finding resources, and adjusting methods", and this internalization process is the key to the transformation of academic resilience from "external support dependence" to "self-construction". This conclusion echoes the previous group difference research, further verifies the dynamic mechanism of parental language scaffolding in different situations and individual characteristics, and provides a contextualized basis for the optimization of family support strategies in educational practice.

As shown in Table 1, quantitative analysis indicated that for every 1 standard deviation increase in guided questioning frequency, adolescents' task persistence increased by 12.3%.

Table 1. Correlation between Parental Language Scaffolding Dimensions and Academic Resilience.



5. Research Conclusions and Educational Practice Enlightenment

5.1 Research Conclusions and Theoretical Contributions

This study clarifies the positive influence of parents' language "scaffolding" style on adolescents' academic resilience through empirical analysis: when parents use scaffolding strategies such as guided questioning, progressive prompting, and emotional supportive language, adolescents' persistence and adaptability in the face of academic setbacks (such as failing exams and increasing task difficulty) are significantly enhanced, among which the "cognitive scaffold" dimension (such as logical guidance) directly explains academic resilience by 23.7%, and the "emotional scaffold" dimension (such as encouraging feedback) indirectly improves resilience level by 19.2% through mediating variables. This conclusion expands the application boundaries of family language interaction theory, which focuses on the quantity and grammatical complexity of language input, and this study confirms that the structured "scaffolding" interaction model can become a key family ecological factor in the cultivation of academic resilience by regulating the cognitive processing process of adolescents, and makes up for the gap in the research gap of previous theories on the functional and developmental relationship between language interaction and development.

On the one hand, parents directly improve their problem-solving ability and frustration tolerance by adjusting the language difficulty to adapt to the adolescents' proximal development zone (such as breaking down complex problem-solving steps into progressive problems); on the other hand, this style can activate the mediating effect of self-efficacy and learning motivation in turn, and embodied language support makes it easier for adolescents to form a self-perception of "I can cope with difficulties", which in turn strengthens the internal learning motivation and ultimately promotes the improvement of academic resilience. For example, adolescents with low academic self-concept are more sensitive to their parents emotional scaffolding", and their resilience level is 11.4% higher than that of the general group, while high academic stress scenarios (such as college entrance exam preparation) amplify the moderating effect of the "cognitive scaffold" and increase the marginal effect of resilience improvement by 8.9%.

The theoretical contributions of this study are reflected in two core levels: first, for the first time, a quantitative correlation model between parental language "scaffolding" style and adolescents' academic resilience is constructed, providing an operational measurement dimension and effect evaluation framework for the field of family interaction; second, the concept of "scaffolding" in Vygotsky's sociocultural theory is extended from educational contexts to family language interaction scenarios, enriching the research perspective of factors affecting academic resilience. However, there are still limitations in this study, such as not deeply exploring the intergenerational influence of parents' childhood experiences on the formation of

their language scaffolding styles, and subsequent follow-up studies can be carried out based on parents' growth background[17] to further reveal the deep formation mechanism of family language interaction patterns.

In summary, the positive effect of the parental language "scaffolding" style on adolescents' academic resilience has been verified, and its theoretical value not only expands the depth of family language research, but also provides specific intervention directions for educational practice. Future research can further explore the cross-contextual applicability of this mechanism in different cultural contexts, and develop intervention programs for family language interaction in combination with digital tools to promote the transformation of theoretical achievements into practice.

5.2 Suggestions and Future Prospects for Educational Practice

The core strategy for optimizing language scaffolding style for parents needs to focus on the two-dimensional reinforcement of guided communication skills and emotional support dimensions. In daily parent-child interaction, parents can replace directive discourse through open-ended questions, such as "You must complete your homework" to "How do you plan to arrange today's homework tasks?" to stimulate adolescents' independent thinking and problem-solving skills; At the same time, it is necessary to strengthen the frequency of emotional support expression, such as replacing negative evaluation with "I see that you have put a lot of effort into this exam, we can analyze the reasons for the wrong questions together" when adolescents encounter academic setbacks to build a safe psychological support environment. Family education guidance at the school level should incorporate parental language scaffolding training into the regular curriculum system, and improve parents' communication and transformation skills through practical links such as case simulation and role-playing[18].

The optimization of parents' language scaffolding style relies on a systematic family-school collaboration mechanism. Schools can regularly organize parent language communication workshops, invite educational psychology experts to interpret the theoretical logic and practical path of scaffolding language, and design targeted training modules based on specific academic scenarios. At the same time, establish a parent-child communication feedback channel at the class level, and the class teacher collects teenagers' perception questionnaires on their parents' language style to form personalized improvement suggestions and feedback to parents. The construction of this mechanism should focus on long-term effectiveness, avoid the short-term effect of a single training, and ensure the implementation effect of the strategy through continuous tracking and dynamic adjustment[18].

Future research needs to further expand the research perspective of longitudinal tracking design and cross-cultural comparison. Longitudinal tracking studies can select adolescents from different school stages and analyze the impact of dynamic changes in parents' language scaffolding style on the development trajectory of academic resilience through long-term data collection for 3-5 years, revealing the long-term causal relationship between the two. Cross-cultural comparative studies can focus on the differences in language communication patterns between Chinese and Western families, explore the manifestations and mechanisms of parental language scaffolding styles in different cultural backgrounds, and provide a reference for constructing localized optimization strategies. In addition, future research can also introduce neuroscience techniques to explore the neural mechanisms of scaffolding language on cognitive processing and emotional regulation in adolescents' brains through tools such as MRI, enriching the evidence system of existing studies [18].

The optimization of parental language scaffolding style is a key entry point to improve the academic resilience of adolescents, and its practice path needs to integrate family self-discipline practice with school professional guidance, and future research needs to deepen theoretical and empirical exploration from vertical, cross-cultural, and multidisciplinary perspectives. The continuous advancement of this direction can not only provide a scientific basis for family education practice, but also provide new ideas and methods for the synergistic promotion of adolescent mental health and academic development[18].

6. Conclusions

This investigation thoroughly explored how parental verbal "scaffolding" approaches shape teenagers' capacity to persist academically. Results reveal that caregiver linguistic scaffolds-marked by thoughtful

inquiry, tactical cues, and affectively nurturing responses—strongly forecast enhanced scholastic perseverance in youth. Pathways both immediate and sequential, mediated via self-belief and drive to learn, were empirically validated. Findings reveal that caregivers’ verbal interactions serve as more than mere dialogue—they constitute a scaffolded framework nurturing both cognition and affect. Tailoring speech to teens’ evolving developmental thresholds while offering emotionally uplifting responses fosters greater tenacity, enhanced resilience amid setbacks, and deeper immersion when confronting scholastic pressures.

Additionally, variations among cohorts and contextual flexibility serve to shape this linkage. Factors like sex, scholastic preparedness, economic background, and pressure environments affect how supportive verbal cues perform, implying that caregivers’ communicative approaches must evolve responsively.

Although valuable insights were offered, certain constraints persist. Initially, the snapshot nature of the methodology hinders definitive cause-effect conclusions. Moreover, generational influences on how parents communicate linguistically were not thoroughly probed. Lastly, verification across diverse cultural contexts has yet to be achieved.

Subsequent studies ought to employ extended temporal frameworks, include multicultural contrasts, and probe neural correlates underlying linguistic support phenomena. Moreover, hands-on initiatives blending tech-based resources with home-educator partnership models could amplify teens’ scholastic adaptability.

References

- [1] Guo, Y. M., Wei, X. Y. and Zhang, S. S. Influence of parental control on early adolescent positive emotion regulation: the mediating role of parental emotion expression. *Journal of Campus Life & Mental Health*. 2024, 22(6), pp. 467-473. <https://doi.org/10.19521/j.cnki.1673-1662.2024.06.002>.
- [2] Qin, M. M. The Influence of Parental Educational Anxiety on Academic Burnout in High School Students: The Mediating Role of Self-efficacy and Psychological Resilience. Master's Thesis, Hainan: Hainan Normal University, 2024.
- [3] On the impact of parental education on adolescent mental health. *Emotional Reader*. 2025(18), pp. 10-12.
- [4] Yu, X. T. The impact of parental academic pressure on parent-child relationships: the role of strict parental discipline and the belief in filial piety. Master's Thesis: Qingdao University, 2024. <https://doi.org/10.27262/d.cnki.gqdau.2024.001863>.
- [5] Wu, W. Research on the Impact of Living with Siblings on Academic Performance of Adolescents. *Social Sciences in Shenzhen*. 2025, 8(1), pp. 124-135. <https://doi.org/10.20183/j.cnki.szshkx.20241217.002>.
- [6] Guo, Z. The Relationship between Parental Academic Pressure and Academic Buoyancy in Junior School Students. Master's Thesis, Jinan: Jinan University, 2024. <https://doi.org/10.27166/d.cnki.gsdcc.2024.000847>.
- [7] Wang, Q. J., He, N., Kang, X. J. and Hu, Q. A study on the mechanism of the impact of parental conflict perception on adolescent problematic behavior: A sample of junior high school students in linyi city. *The Family Education of China*. 2024(05), pp. 79-87.
- [8] An, Y. M. The Impact of Parental Involvement in Education on Academic Procrastination in Junior High School Students: The Mediating Role of Academic Hope and the Moderating Role of Perceived Campus Atmosphere. Master's Thesis, Yangzhou: Yangzhou University, 2024.
- [9] Deng, L. The influence of the teacher-student relationship on adolescents' creativity: a study based on heterogeneous effects of parenting attitudes. *The Family Education of China*. 2024(02), pp. 73-84.
- [10] Zhu, X. The Influence of Cooperative Learning on Academic Performance of Middle School Students. Master's Thesis: Jinan University, 2024. <https://doi.org/10.27166/d.cnki.gsdcc.2024.000728>.

- [11] Tian, H. J., Wang, J. Y. and Deng, L. Y. The“Paradox of Control”in the Relationship Between Parenting Anxiety and Adolescents' Academic Self-imposed Restrictions. *Journal of Chinese Youth Social Science*. 2024, 43(02), pp. 44-56. <https://doi.org/10.16034/j.cnki.10-1318/c.2024.02.006>.
- [12] Zhao, X. The Effect of Parental Perceived Family Stress on High School Students' Academic Self-Hindrance. Master's Thesis: Jinan University, 2024. <https://doi.org/10.27166/d.cnki.gsdcc.2024.000365>.
- [13] Zhang, J. Y. and Liu, Z. F. The Effects of Parental Emotional Support, Life and Discipline Involvement on Adolescents' Intrinsic Motivation in Learning: The Mediating Role of Goal Concentration. *Social Construction*. 2024, 11(06), pp. 142-160. <https://doi.org/10.20224/j.cnki.shjs.2024.06.005>.
- [14] He, Y. H., Wang, L. D. and Zhang, Y. H. The Influence of Parental Educational Expectations on Middle School Students' Mathematical Academic Achievement: An Analysis Based on Different Metacognitive Characteristics. *Journal of Mathematics Education*. 2024, 33(06), pp. 40-44.
- [15] Wang, N., Yang, X., Xu, H. and Chen, T. Study on the effect of parental occupation type on adolescent depression symptoms. *Modern Preventive Medicine*. 2025, 51(23), pp. 4297-4302. <https://doi.org/10.20043/j.cnki.MPM.202406077>.
- [16] Ji, X. H. and Li, X. A Study on the Influence of Aesthetic Education on the Academic Achievement of Teenagers. *The Education of Innovative Talents*. 2024(5), pp. 73-78. <https://doi.org/10.3969/j.issn.2095-5502.2024.05.015>.
- [17] Chen, J. J., Li, J. Y. and Yang, Y. Research progress of intergenerational effects of parental childhood trauma on adolescent depressive disorders. *Chinese Journal of School Health*. 2024, 45(12), pp. 1820-1824. <https://doi.org/10.16835/j.cnki.1000-9817.2024378>.
- [18] Peng, B. and Zhang, L. Q. The impact of physical education teachers' language expression and communication skills on the social-emotional development of preschool children. *Youth Sport*. 2020(09), pp. 135-136.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open - access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).

Development and Application of an Emotion Analysis Agent — A Prototype Study on Multi-Group Emotional State Assessment and Guidance

Xiaoke Sun^{1,*†}, Mingfei Zhao^{2,†}, Wanming Feng^{3,†}, Dejie Long^{4,†}, Fangqi Xu^{5,‡}, Jiacan Ma^{6,‡}, Ruoxi Liu^{7,‡}, and Shangyuan Ma^{8,‡}

¹ School of Public Affairs, Public Administration, Xiamen University, Xiamen 361005, China

² Faculty of Science and Technology, Computer Science Technology, Beijing Normal University-Hong Kong Baptist University International College, Zhuhai 519000, China

³ XJTU-POLIMI Joint School, Xi'an Jiaotong University, Xi'an 710115, China

⁴ School of Information Science and Engineering, Artificial Intelligence and Robots, East China University of Science and Technology, Shanghai 201424, China

⁵ School of Economics, Finance, Hangzhou Dianzi University Information Engineering College, Hangzhou 311300, China

⁶ School of Business English, Business English (Chinese-foreign Cooperation in Running Schools), Sichuan International Studies University, Chongqing 400031, China

⁷ School of Management, Northeastern University at Qinhuangdao, Qinhuangdao 066004, China

⁸ School of International Business, International Business (Chinese-foreign Cooperative Education Program), Southwestern University of Finance and Economics, Chengdu 611130, China

[†] Joint First Authors

[‡] Joint Second Authors

*Corresponding author

Abstract

In the digital age, public emotional health has become a prominent concern, with significant differences across population groups, highlighting the need for scientifically grounded and adaptable intelligent support tools. This study developed an emotion analysis agent capable of assessing emotional states across multiple groups and providing preliminary guidance recommendations. Through systematic literature review integrating emotional psychology and affective computing, we proposed a theoretical framework for multi-group emotional state assessment and guidance. Based on this framework, we designed a questionnaire combining self-developed items on emotional factors with standardized clinical scales (GAD-7, BDI-II) and surveyed 79 respondents spanning adolescents, adults, and the elderly. Data analysis revealed two main findings: emotional resources increased with age, with older adults scoring highest across all dimensions; and although average scores fell within normal ranges, over half of respondents reported intermittent mild anxiety, indicating widespread subclinical distress. Guided by the framework and data, we implemented a rule-based agent prototype, demonstrating the technical feasibility of an assessment-guidance closed loop. This study bridges psychological theory and computational modeling, demonstrates a replicable undergraduate-level research path, and provides a prototype foundation for developing accessible, age-sensitive digital mental health tools.

Keywords

emotion analysis agent, multi-group assessment, emotional state evaluation, questionnaire development, age differences, AI application

1. Introduction

1.1 Research Background

Mental health has become a global public health concern in the digital era. Rapid socio-economic and technological development has significantly improved living standards, yet individuals are experiencing heightened anxiety and stress in fast-paced, highly competitive modern societies. Emotional issues have thus emerged as a core factor affecting quality of life. Different population groups face distinct challenges: adolescents contend with academic competition and social pressure, often expressing negative emotions through subtle online channels; working professionals, constrained by workplace norms and life pressures, tend to conceal their true emotions, leaving them with limited avenues for emotional support; and older adults, affected by the digital divide, struggle to convey their emotional needs through smart devices. Furthermore, current standardized psychological services often overlook significant individual differences in emotional expression and coping strategies. Consequently, emotional health has transformed from a private issue into a public concern affecting social well-being.

How to scientifically identify and accurately respond to the emotional needs of different groups, and subsequently provide personalized emotion regulation solutions, has become a pressing practical problem. This study addresses the dual challenge of universal and group-specific emotional health issues while leveraging the empowering potential of digital and AI technologies. Guided by relevant theories, we integrate emerging technologies to construct an emotion analysis agent capable of identifying, understanding, and responding to the specific needs of diverse groups, thereby contributing to the growing public mental health challenge.

1.2 Research Questions and Objectives

The core research question of this study is: How can an agent model be constructed to scientifically assess the emotional states of multiple groups and match them with preliminary guidance recommendations? To address this overarching question, we pursued four interconnected objectives. First, through systematic literature review, we aimed to establish a theoretical framework and identify core dimensions for emotional state assessment. Second, building on this framework, we sought to develop and validate a questionnaire capable of capturing group-specific emotional characteristics. Third, using the collected data, we aimed to implement a prototype agent that could classify users' emotional states and generate personalized guidance suggestions. Fourth, we sought to evaluate the prototype's effectiveness and examine the ethical boundaries of its application.

1.3 Contributions of This Study

This study makes three main contributions to the field. Theoretically, it bridges emotional psychology and AI computational modeling by translating age-specific emotion regulation patterns into a rule-based assessment-guidance framework, addressing the gap between psychological theory and technical implementation. Methodologically, it demonstrates a design science research path from theoretical construction to prototype validation, offering a replicable template for undergraduate-level AI-psychology interdisciplinary projects. Practically, the prototype provides a proof-of-concept for low-cost, scalable digital emotional support tools that can be adapted to different age groups, potentially reaching populations with limited access to traditional mental health services.

2. Literature Review and Theoretical Framework

The complex regulatory mechanisms of human emotion, diverse intervention methods, and evolving assessment technologies have consistently attracted interdisciplinary research interest. This study collected and organized over 50 authoritative research articles on emotion from the past five years, presenting a knowledge map ranging from fundamental theories of emotion to computational recognition, age-specific regulation patterns, and intervention methods. This formed a theoretical framework providing support for developing a multi-group emotional state assessment and guidance agent.

2.1 Emotion Theories and Classification Systems

Early discrete emotion theories sought to define a limited set of basic emotions. Ekman's model of six basic emotions gained wide influence due to cross-cultural empirical support [1]. Plutchik's subsequent theory of eight basic emotions expanded upon this by adding categories like trust and anticipation [2]. Such frameworks are intuitive but have limitations in capturing complex or subtle emotional states.

Dimensional theories emphasizing continuity have therefore become mainstream, proposing that core dimensions such as valence, arousal, and dominance can characterize all emotional states. For instance, in driving risk research, the combination of low valence and high arousal emotions correlated with the highest risk levels [3]. Dimensional models provide a flexible theoretical basis for quantitative emotion assessment. The development of tools like the CORE Test, which measures emotions based on thematic cognitive content, represents a direction combining categorization and understanding [4]. This theoretical evolution reflects deepening academic understanding of emotional complexity and provides a more scientific framework for computational modeling.

2.2 Advances in Emotion Recognition Technology

Emotion recognition technology, driven by AI and affective computing, is progressing toward multimodal fusion and deep intelligence. In physiological signal analysis, traditional research relied on manually extracting features from EEG signals [5]. Recent studies demonstrate high classification accuracy using convolutional neural networks for automatic feature extraction [6]. fMRI studies continue to provide evidence for the neural basis of basic emotions, revealing associations between specific emotions and activation of brain regions such as the amygdala and prefrontal cortex [1].

Analysis techniques based on behavior and appearance are also expanding. Analysis of drawing features can translate visual elements like color and saturation into emotional predictors [7]. Analysis of driving behavior has clarified links between discrete emotions like anger and fear and specific risky operations [3]. In text analysis, multi-label classification methods based on pre-trained language models offer approaches for handling complex emotions in social media text [8]. The classic Ekman framework still demonstrates utility in cross-cultural text analysis [2]. More complex models like improved Transformer architectures are being explored for mental health diagnosis [9], indicating a trend toward higher integration in assessment technologies. These findings informed the technical approach for our agent's classification capabilities.

2.3 Age Differences in Emotion Regulation

A substantial body of research reveals systematic evolution of emotion regulation ability with age. Adolescence is viewed as a period of rapid construction for emotion regulation. Although individuals at this stage possess high neuroplasticity, their regulation strategies are still being differentiated and explored [10]. Emotional problems in adolescents often exhibit clear specificity, with internalizing problems linked to cognitive strategies like rumination and externalizing problems associated with behavioral strategies like venting [11]. A clinical study on adolescents with personality disorders revealed the complexity of emotion regulation mechanisms under severe pathological conditions [12].

In middle adulthood, emotion regulation functions tend to mature and optimize. Large-scale cross-national surveys confirm that high-frequency social participation is a key protective factor for emotional health during this stage [13]. Neuroimaging studies show a positive correlation between frontal-limbic system connectivity and behavioral performance in emotion regulation, suggesting cognitive control may

reach an optimal state during this period [14]. However, middle-aged adults face unique social role pressures, and specific negative emotions in parents can now be quantified using specialized scales.

In old age, emotion regulation shifts toward optimization and adaptation. Research indicates that older adults tend to use more stable and simplified strategies, with strategy variability negatively correlated with subjective well-being [15]. Neurobiological mechanisms reveal compensatory phenomena, such as the prefrontal cortex compensating for reduced activation in specific regions through functional generalization [14]. However, old age is accompanied by higher risk of social isolation, with loneliness strongly correlated with negative emotions [13]. These findings directly informed the design of our questionnaire's age-sensitive dimensions.

2.4 Psychotherapeutic Methods for Emotional Support

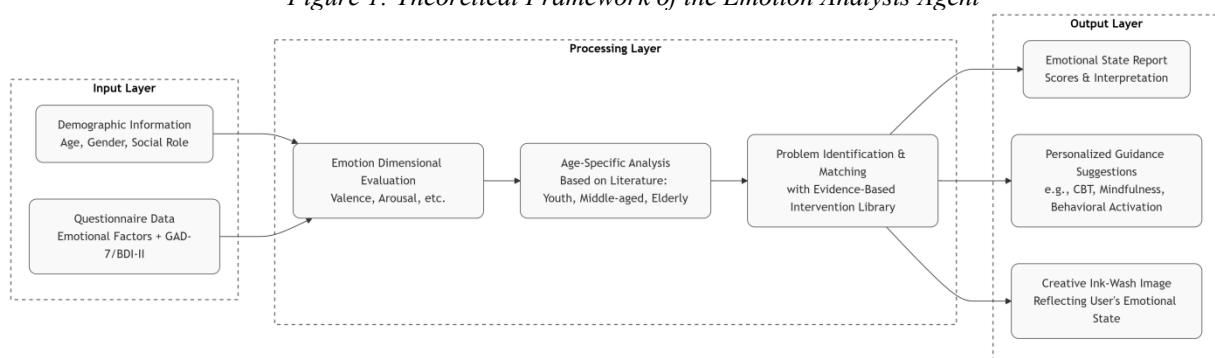
Several evidence-based psychotherapeutic methods have been developed for emotional and behavioral disorders. Cognitive Behavioral Therapy operates by modifying maladaptive cognitions to break the cycle of emotional distress [16]. Behavioral Activation focuses on systematically increasing engagement in positive activities to counteract avoidance cycles in depression, and due to its simplified process, it is considered suitable for resource-limited settings [17].

Mindfulness-Based Therapies and Acceptance and Commitment Therapy represent the third wave of CBT. The former emphasizes cultivating non-judgmental awareness of present-moment experiences to reduce emotional rumination [18]. The latter focuses on accepting distress rather than eliminating symptoms, enhancing psychological flexibility through cognitive defusion and values-guided action [19]. Progressive Muscle Relaxation concentrates on directly alleviating somatic symptoms of anxiety from the physiological arousal level [20]. These methods have different emphases and can be selected or integrated based on an individual's presenting issues, providing the foundation for our agent's guidance suggestions.

2.5 Theoretical Framework of This Study

Based on the literature reviewed above, we developed a conceptual framework to guide the design of the questionnaire and the subsequent agent prototype. The framework integrates four core dimensions that emerged from the literature: **Social Connection and Support** (from studies on social participation and loneliness [13, 21, 22]), **Emotion Regulation Strategies** (from age-specific regulation research [11, 12, 14, 15, 23]), **Specific Stressors and Cognitions** (from developmental stage research [24-31]), and **Self-Perception and Acceptance** (from psychotherapeutic methods [16-20]). These dimensions collectively capture the key factors influencing emotional states across different age groups.

Figure 1: Theoretical Framework of the Emotion Analysis Agent



As shown in Figure 1, the framework follows a three-layer structure. **The input layer** collects demographic data and questionnaire responses covering the four dimensions, plus standardized GAD-7 and BDI-II scores. **The processing layer** applies rule-based logic informed by the literature: it evaluates emotional patterns using dimensional theories, adjusts interpretations based on age-specific findings, and matches problems with evidence-based intervention strategies. **The output layer** generates a personalized report with emotional state summary and tailored guidance—for instance, recommending cognitive

restructuring and mindfulness for a middle-aged user experiencing work-family conflict and high anxiety, rather than academic stress interventions designed for adolescents.

This framework translates theoretical insights into operational logic, ensuring the agent's assessment and guidance are scientifically grounded and developmentally sensitive.

3. Methods

3.1 Overall Research Approach

To achieve the research objectives, we first constructed a theoretical framework through literature review. Second, based on this framework, we developed and validated an emotional assessment questionnaire. Third, using the questionnaire data, we built an emotion classification model and suggestion database, developing an interactive agent prototype. Finally, we evaluated the prototype's effectiveness and ethical implications.

Methodologically, this study followed the design science research paradigm, employing the design-development-evaluation-iteration path. Mixed methods were integrated to enhance scientific rigor: qualitative methods such as literature analysis were used in theory construction, while quantitative methods such as statistical analysis and machine learning were used in data collection and validation.

3.2 Questionnaire Development

3.2.1 Dimension Establishment and Item Generation

Based on the theoretical framework, we developed a questionnaire comprising four sections. **The first section** collected demographic information including gender, age group, social role, and primary sources of life stress. The age groups were defined as youth (12–25 years), middle-aged (26–58 years), and elderly (59 years and above). The cutoff of 58 years was informed by prior neuroimaging research on emotion regulation across the lifespan [14], while the upper limit of youth reflects the typical age range for brain maturation commonly used in developmental studies.

The second section assessed factors influencing emotional states across four dimensions derived from the theoretical framework: **Social Connection and Support** (3 items), **Emotion Regulation Strategies** (4 items), **Specific Stressors and Cognitions** (4 items), and **Self-Perception and Acceptance** (2 items). All items used a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree).

The third and fourth sections incorporated two standardized clinical scales to evaluate emotional symptoms. The Generalized Anxiety Disorder scale (GAD-7) measures anxiety symptoms over the past two weeks with seven items scored from 0 to 3. The Beck Depression Inventory-II (BDI-II) assesses depressive symptoms with 21 items, each scored 0 to 3.

3.2.2 Pre-test and Revision

After initial drafting, a small-scale pre-test was conducted with 15 participants to examine item clarity and estimate completion time. Participants reported that the questionnaire was generally easy to understand, with an average completion time of about 10 minutes. Based on ambiguities identified during the pre-test, instructions for some items were fine-tuned to ensure consistent understanding.

3.2.3 Reliability and Validity

Internal consistency reliability was assessed using Cronbach's α coefficient. The 13-item emotional influencing factors section demonstrated excellent overall reliability ($\alpha = .941$). Subscale reliability coefficients were .757 for **Social Connection and Support** (3 items), .875 for **Emotion Regulation Strategies** (4 items), .864 for **Specific Stressors and Cognitions** (4 items), and .859 for **Self-Perception and Acceptance** (2 items), all exceeding the acceptable threshold of .70.

For validity, content validity was established through a comprehensive literature review and pre-test feedback. Construct validity was examined using item-total correlations, with all coefficients exceeding 0.50 and reaching statistical significance at the 0.01 level, confirming that the questionnaire structure aligned with the theoretical framework.

3.3 Data Collection

3.3.1 Sampling Method and Data Cleaning

This study employed online convenience sampling and snowball sampling for data collection. The questionnaire was created on the Sojump platform and distributed via research team members' WeChat.

After data collection, responses with completion times under two minutes or showing obvious regularity (e.g., selecting the same option for all items) were excluded. Raw data were exported in Excel format, categorical variables were numerically coded, and section scores were calculated for subsequent analysis.

3.3.2 Participants

Data collection was conducted from February 3 to 4, 2026, yielding 79 valid questionnaires. All returned questionnaires were complete and met the inclusion criteria. The sample consisted of 51 females (64.56%) and 28 males (35.44%). Age distribution covered three target groups: 29 youths aged 12–25 years (36.71%), 38 middle-aged adults aged 26–58 years (48.10%), and 12 elderly adults aged 59 years and above (15.19%). In terms of social roles, employed workers accounted for 40.51% and students for 36.71% of the sample.

Geographically, participants were predominantly from Shandong Province (45.6%), followed by Xinjiang Uygur Autonomous Region (11.4%). Smaller numbers came from Guangdong, Liaoning, and Chongqing (6.3% each), and six respondents (7.6%) were located overseas (Singapore). The remaining participants were distributed across eight other provinces. Given the use of convenience sampling, the sample is geographically concentrated and may not be fully representative of the national population.

3.4 Agent Development

3.4.1 Core Model Selection

The Depression/Anxiety Detection and Adjustment Agent utilizes the Doubao 1.5 Pro large model, incorporates an image generation plugin, and loads relevant psychological literature as a knowledge base. It detects users' depression or anxiety indices and classifies them according to specific scores. For populations tending toward depression or anxiety, the BDI and GAD item banks are used respectively. For users with different emotional types, the agent screens the knowledge base to provide targeted advice while generating a creative ink-wash style image related to the user's emotional state. Additional features include providing a psychological crisis hotline when users select negative options in questions related to suicidal ideation, and providing targeted summaries after each response.

3.4.2 Training and Debugging

The agent's persona was built as a warm yet rigorous professional psychological assessment guide skilled in using the BDI-II and GAD-7 scales. The response framework divided interaction into stages: opening remarks, interactive introduction, emotion type classification, question-and-answer, and report and image generation. Through multiple rounds of modification, basic functions were ensured. Results from the survey questionnaire were used to train the agent for general user data handling. An assessment webpage with the same questions was designed using HTML, and users could jump to the agent after completing the test by copying and pasting a generated link.

3.5 Prototype Design

Users interact with the webpage by clicking option buttons. The webpage frontend records selections and generates a link. Users copy this link into the agent's dialogue box to directly generate the analysis report. The interface features a white background with blue-toned buttons that highlight on mouse hover. Upon completion, users can copy the answer link with one click and access functions including Re-take Assessment and View Link. When the agent receives a webpage link, it skips the Q&A session and directly generates the analysis report.

3.6 Ethical Considerations

Protecting participant privacy was a core ethical principle throughout this study. During data collection, anonymous questionnaires were used, and no personally identifiable information was collected. All respondents were clearly informed about the purpose and scope of data usage and provided informed consent prior to participation. Collected data were encrypted and stored on a secure local server with access restricted to the research team, and were used exclusively for the purposes of this study.

The emotion analysis agent prototype is designed to provide algorithm-based preliminary assessment and self-help guidance only. It is not a professional diagnostic or treatment tool, and its suggestions cannot replace consultation with qualified mental health practitioners. This limitation is clearly stated on the interactive interface and in all related documentation. Users are explicitly informed that the agent is intended for emotional self-awareness and initial guidance, and those experiencing severe distress are directed to seek professional help.

4. Results

4.1 Sample Characteristics

The final sample comprised 79 respondents, with 64.56% female and 35.44% male. Age distribution covered the three target groups, with the largest proportion being middle-aged adults (48.10%), followed by youths (36.71%) and elderly adults (15.19%). In terms of social roles, employed workers constituted 40.51% and students 36.71% of the sample.

4.2 Age Differences in Emotional Factors

Regarding primary sources of energy drain, work or academic pressure was the most frequently reported (64.56%), followed by physical health (26.58%), with family responsibilities and interpersonal relationships both cited by 24.05% of respondents. On the four assessment dimensions, sample average scores ranged from 3.39 to 4.15, indicating moderate-to-above average emotional resources.

Inter-group comparisons revealed a clear developmental pattern. As shown in Figure 2, the elderly group scored highest on all four dimensions: Social Connection and Support (4.11), Emotion Regulation Strategies (4.04), Specific Stressors and Cognitions (4.33), and Self-Perception and Acceptance (4.12). The middle-aged group scored in the middle (3.81, 3.74, 4.05, and 4.08 respectively). The youth group scored lowest across all dimensions (3.66, 3.57, 3.71, and 3.74 respectively), with particularly low scores on Emotion Regulation Strategies and Specific Stressors and Cognitions, suggesting this group may be a key focus for intervention.

Gender differences were less pronounced. Females scored slightly higher than males in Emotion Regulation Strategies (3.74 vs. 3.69) and Social Connection and Support (3.89 vs. 3.63). Scores were nearly identical on Specific Stressors and Cognitions (both 3.97) and Self-Perception and Acceptance (both 3.96).

4.3 Prevalence of Anxiety and Depressive Symptoms

Figure 3 shows the mean scores and standard deviations for BDI-II (depression) and GAD-7 (anxiety) by age and gender. According to the scoring standards (BDI-II 21-84 method: 21-34 = no depression; GAD-7: 7-11 = no significant anxiety), all subgroups scored within the normal range on average.

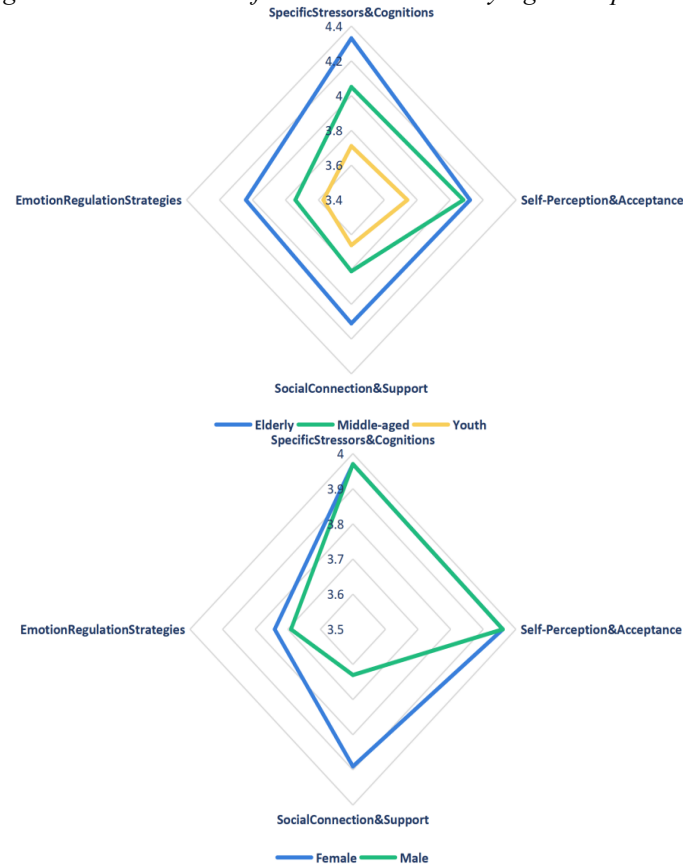
For depression, mean BDI-II scores ranged from 28.82 to 31.67 across groups. Middle-aged females scored highest (31.57, SD = 7.21), while young males scored lowest (28.82, SD = 5.60). For anxiety, mean GAD-7 scores ranged from 10.70 to 12.67. Elderly males scored highest (12.67, SD = 1.53), slightly above the normal threshold, but this group had only three participants. Middle-aged females scored lowest (10.70, SD = 3.71).

Although average scores were within normal limits, item-level analysis showed that many respondents experienced mild anxiety symptoms. Over half (55.7%) reported feeling nervous or anxious for several days in the past two weeks, and nearly half (49.37%) said they could not stop worrying. These figures suggest that

sub-threshold anxiety is common in this sample. In contrast, over 70% reported no depressive symptoms on core BDI-II items like sadness.

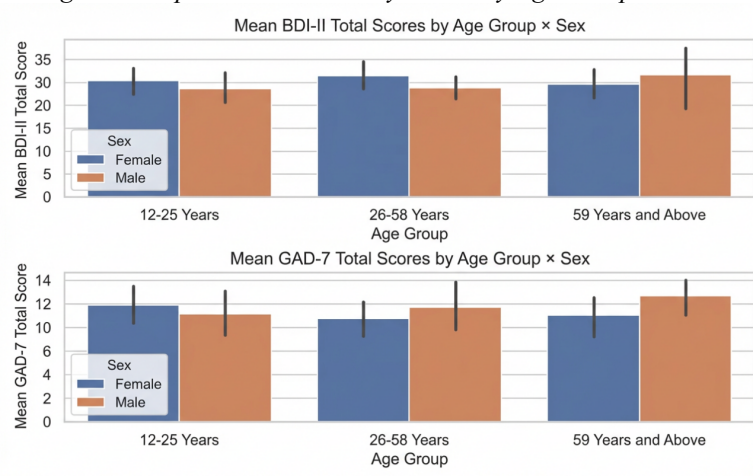
Interestingly, these results do not fully match the age trend found in Section 4.2, where older adults scored highest on positive emotional factors. This suggests that while older individuals may have better emotion regulation strategies, they can still experience depressive or anxiety symptoms, possibly due to health or social stressors. Young females also showed relatively high anxiety scores (11.89, SD = 3.53), which may reflect academic and social pressures.

Figure 2: Radar Charts of Emotional Factors by Age Group and Gender



Note: (Above) Age differences; (Below) Gender differences.

Figure 3: Depression and Anxiety Scores by Age Group and Gender



Note: (Above) Depression scores; (Below) Anxiety scores.

4.4 Agent Prototype Performance

The agent prototype operates by matching assessment results with a structured suggestion database. In preliminary runs, the model automatically output guidance suggestions based on input questionnaire data. For example, a high GAD-7 score paired with a low score in Emotion Regulation Strategies triggered suggestions including mindfulness breathing exercises and introduction to cognitive reappraisal methods. For the middle-aged user group, the suggestion database emphasized work-life balance strategies. For young users, suggestions focused on academic stress management and social skills. This preliminary matching, based on rules and group labels, validated the technical feasibility of the assessment-guidance closed loop.

However, the current agent relies entirely on text-based instructions and lacks workflow stability, making it difficult to adapt to complex environments. Additionally, due to server limitations, the webpage does not have a PHP backend, making security and privacy difficult to guarantee.

5. Discussion

5.1 Interpretation of Key Findings

The finding that emotional resources increase with age aligns with literature conclusions regarding continuous development and optimization of emotion regulation ability in adulthood. The elderly group's highest scores across all dimensions likely reflect psychological maturity and enhanced adaptability gained through life experience accumulation. This supports the optimization and adaptation pattern described in the literature, where older adults use more stable strategies and demonstrate compensatory neural mechanisms.

Conversely, the youth group's relatively lower scores, particularly in emotion regulation strategies and stress management, indicate that adolescence remains a critical period for emotion regulation capacity building. This finding is consistent with research showing that adolescents' regulation strategies are still being differentiated and explored, and that this group may benefit most from targeted intervention.

The high prevalence of intermittent mild anxiety symptoms, despite overall normal range scores, suggests that subclinical anxiety is widespread and represents an important prevention opportunity. This finding supports the development of accessible digital tools for early intervention before symptoms reach clinical thresholds.

5.2 Implications for Practice

These findings have several implications for digital mental health tool design. **First**, the observed age differences underscore the need for age-sensitive approaches; tools should adapt content based on users' developmental stage rather than assuming one-size-fits-all solutions. **Second**, the high prevalence of subclinical anxiety highlights the value of prevention-focused interventions, complementing traditional treatment models. **Third**, the assessment-guidance closed loop demonstrated in this prototype offers a scalable model for reaching populations with limited access to traditional mental health services, particularly in under-resourced settings.

5.3 Limitations

This study has several limitations. **First**, sample representativeness is insufficient. Due to convenience and snowball sampling, the sample may not cover all age groups, occupations, and regions evenly, potentially leading to assessment biases for certain groups. **Second**, the small dataset constrained model performance; classification accuracy may not be optimal, and the suggestion database does not cover all complex emotional states. **Third**, the cross-sectional design captures only a single time point, precluding analysis of dynamic changes or causal relationships, as well as long-term evaluation of agent use.

5.4 Future Research Directions

Future research should address these limitations by: (1) recruiting larger, more representative samples through stratified sampling to enhance generalizability; (2) improving model performance with larger datasets and exploring more sophisticated algorithms beyond rule-based matching; and (3) adopting

longitudinal designs to track emotional changes over time and evaluate the long-term impact of agent use. Additionally, incorporating multimodal data (e.g., text or speech input) and conducting real-world user studies would further validate the approach and inform iterative refinement.

6. Conclusion

This study demonstrates the feasibility of integrating psychological theory with AI technology to construct a multi-group emotion analysis agent. Two main findings emerged from the survey data: emotional resources increased significantly with age, yet subclinical anxiety symptoms were prevalent across all groups. These patterns highlight that emotional health is characterized by both developmental strengths and universal vulnerabilities, underscoring the need for tools that are both age-sensitive and broadly accessible.

The agent prototype successfully translated this insight into an operational assessment-guidance closed loop, validating the technical potential of rule-based matching for personalized emotional support. While the current implementation has limitations, it provides a proof of concept for scalable, low-cost digital interventions that can complement traditional mental health services.

As the field of digital mental health continues to evolve, approaches that are scientifically grounded, contextually adaptive, and designed for diverse populations will be essential. This study represents an initial step in that direction, offering a replicable template for future interdisciplinary work at the intersection of psychology and artificial intelligence.

References

- [1] Liang, F., Jiang, Y., Xiao, T., Dong, J., & Wang, F. (2022). The neural basis of basic emotions: Evidence from fMRI and machine vision technology studies. *Advances in Psychological Science*, 30(8), 1832–1843.
- [2] Zhang, F., Chen, J., Tang, Q., & Tian, Y. (2024). Evaluation of emotion classification schemes in social media text: An annotation-based approach. *BMC Psychology*, 12(1), Article 503. <https://doi.org/10.1186/s40359-024-02008-w>
- [3] Li, W., Liu, Y., Zhang, J., Xiao, H., Guo, G., & Cao, D. (2022). Analysis of the mechanism between driver emotion and driving risk. *Journal of Mechanical Engineering*, 58(22), 379–394.
- [4] Floman, J. L., Brackett, M. A., LaPalme, M. L., Ponnock, A. R., Barsade, S. G., & Doyle, A. (2023). Development and validation of an ability measure of emotion understanding: The Core Relational Themes of Emotion (CORE) Test. *Journal of Intelligence*, 11(10), Article 195. <https://doi.org/10.3390/jintelligence11100195>
- [5] Zhang, G., Yu, M., Chen, G., Han, Y., Zhang, D., Zhao, G., & Liu, Y. (2019). Review of EEG feature studies for emotion recognition. *Scientia Sinica Informationis*, 49(9), 1097–1118.
- [6] Iqbal, A. M. Z., Nidul, S., Souvik, P., & Ebrahim, G. (2022). Automated feature extraction on AsMap for emotion classification using EEG. *Sensors*, 22(6), Article 2346. <https://doi.org/10.3390/s22062346>
- [7] Weng, H.-C., Huang, L.-Y., Imcha, L., Huang, P.-C., Yang, C.-T., Lin, C.-Y., & Li, P.-H. (2024). Drawing as a window to emotion with insights from tech-transformed participant images. *Scientific Reports*, 14(1), Article 11571. <https://doi.org/10.1038/s41598-024-60532-6>
- [8] Jie, A., Chen, L., Zeng, X., & Zuo, J. (2025). A multi-label emotion classification method based on pre-trained label sequence generation model. *Journal of Chinese Information Processing*, 39(11), 183–194.
- [9] Liu, N., & Han, X. (2025). Research on automatic diagnosis model of mental health based on improved Transformer. *Automation & Instrumentation*, (10), 241–247. <https://doi.org/10.14016/j.cnki.1001-9227.2025.10.241>
- [10] Tomasino, B., Maggioni, E., Bonivento, C., Nobile, M., D'Agostini, S., Arrigoni, F., ... Brambilla, P. (2022). Effects of age and gender on neural correlates of emotion imagery. *Human Brain Mapping*, 43(13), 4116–4127. <https://doi.org/10.1002/hbm.25906>

- [11] Brinke, L. W., Menting, A. T. A., Schuiringa, H. D., Zeman, J., & Deković, M. (2020). The structure of emotion regulation strategies in adolescence: Differential links to internalizing and externalizing problems. *Social Development*, 30(2), 536–553. <https://doi.org/10.1111/sode.12496>
- [12] Boon, A. E., & Hauber, K. (2022). Cognitive emotion regulation strategies in relation to treatment outcome in a clinical sample of adolescents with personality disorders. *Clinical Psychology & Psychotherapy*, 29(6), 1897–1904. <https://doi.org/10.1002/cpp.2758>
- [13] Castelletti, C., Lara, E., Tobiasz-Adamczyk, B., Koskinen, S., Olaya, B., Haro, J. M., ... Miret, M. (2023). Connecting and feeling: Associations between social factors and emotions in nine countries. *International Journal of Psychology*, 58(3). <https://doi.org/10.1002/ijop.12892>
- [14] Orlando, I., & Filippini, N. (2023). Aging modulates frontal lobes involvement in emotion regulation processing. *Journal of Neuroscience Research*, 102(1), Article e25282. <https://doi.org/10.1002/jnr.25282>
- [15] Mikkelsen, M. B., O'Toole, M. S., Elkjaer, E., & Mehlsen, M. (2023). The effect of age on emotion regulation patterns in daily life: Findings from an experience sampling study. *Scandinavian Journal of Psychology*, 65(2), 231–239. <https://doi.org/10.1111/sjop.12970>
- [16] Zhang, R. (2014). Efficacy study of cognitive behavioral therapy for generalized anxiety disorder. *Chinese General Practice*, 17(7), 832–834.
- [17] Li, Y., Liu, H., & Yang, Q. (2019). Behavioral activation therapy: A simple and economical intervention for depression. *Chinese Journal of Clinical Psychology*, 27(4), 854–858+853. <https://doi.org/10.16128/j.cnki.1005-3611.2019.04.044>
- [18] Xiong, W., & Yu, L. (2011). Mindfulness therapy—A new psychological treatment method. *Medicine and Society*, 24(1), 89–91.
- [19] Zhang, Q., Wang, S., & Zhu, Z. (2012). The psychopathological model and treatment mode of acceptance and commitment therapy. *Chinese Mental Health Journal*, 26(5), 377–381.
- [20] Hou, Y., & Hu, P. (2008). Research and progress on the application of progressive muscle relaxation in clinical treatment. *Chinese Journal of Tissue Engineering Research and Clinical Rehabilitation*, (7), 1331–1336.
- [21] Sun, J., Luo, Y., & Zhang, R. (2019). Study on the status of depression and anxiety in community elderly and their relationship with cognitive emotion regulation strategies. *Chinese General Practice*, 22(31), 3887–3892.
- [22] Zou, J., Tang, D., Wang, D., Peng, H., & Shen, J. (2006). Study on positive and negative affect and related factors in the elderly. *Chinese Journal of Clinical Psychology*, (2), 194–196. <https://doi.org/10.16128/j.cnki.1005-3611.2006.02.034>
- [23] Wu, X., Xiao, F., & Luo, J. (2022). Transfer effect of creative cognitive reappraisal in emotion regulation and its neural basis. *Advances in Psychological Science*, 30(3), 477–485.
- [24] Ao, M., Luo, D., Hou, H., Li, M., & Yang, B. (2025). The association between latent classes of parental rearing styles and adolescents' non-suicidal self-injury: The mediating role of emotion regulation difficulties. *Chinese Journal of Clinical Psychology*, 33(2), 254–260. <https://doi.org/10.16128/j.cnki.1005-3611.2025.02.005>
- [25] Wang, Q., Wei, M., & Liu, X. (2017). Mechanisms and influencing factors of adolescent self-injurious behavior: From the perspective of emotion management. *Psychological Development and Education*, 33(6), 759–768. <https://doi.org/10.16187/j.cnki.issn1001-4918.2017.06.15>
- [26] Du, M., Shen, J., Zhou, S., & Jiang, Y. (n.d.). The relationship between family care degree and positive coping styles in adolescent patients with emotional disorders and their caregivers. *Chinese Journal of Child Health Care*, 1–7.

- [27] Wang, Z., Lu, K., Wang, X., & Fan, Q. (2026). A longitudinal study on the relationship between bullying, emotion regulation self-efficacy, and adolescent suicide risk. *Chinese Mental Health Journal*, 40(1), 45–51.
- [28] Zhang, X., Yu, L., Zhang, G., Ma, J., Qi, C., & Chen, L. (2025). Depression status and its influencing factors among people aged 65 and above in Shandong Province. *Chinese Journal of Disease Control & Prevention*, 29(12), 1388–1393. <https://doi.org/10.16462/j.cnki.zhjbkz.2025.12.004>
- [29] Wei, X., Wang, N., Wei, Y., Chen, Q., & Zhao, Y. (2025). Analysis of depression status and its influencing factors among middle-aged and elderly patients with chronic diseases in China: Empirical analysis based on CHARLS data. *Chinese General Practice*, 28(11), 1303–1308.
- [30] Zhang, W., He, Z., Shi, J., Liu, Z., Lin, Y., Chen, Y., ... Tu, M. (2025). Prevention and intervention of anxiety and depression in community elderly groups: Based on cognitive emotion regulation research. *Chinese Health Service Management*, 42(6), 619–623+669.
- [31] Ye, H., Yan, Y., & Wang, Q. (2021). Study on the current status of depression in middle-aged and elderly women and its influencing factors. *Chinese General Practice*, 24(36), 4574–4579.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgment

This paper is an output of the science project.

Copyrights

Copyright for this article is retained by the author (s), with first publication rights granted to the journal. This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).