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FROM "NODE TRANSFUSION" TO "NETWORK HEMATOPOIESIS": GOVERNANCE MECHANISM AND POLICY IMPLICATIONS OF RELATIVE POVERTY FROM THE PERSPECTIVE OF SOCIAL NETWORK —— EMPIRICAL RESEARCH BASED ON DYNAMIC SPATIAL DURBIN MODEL

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Abstract: From the perspective of social network theory, the traditional "strong node-weak channel" governance model under the dual context of urbanization and digitalization in the postpoverty era exhibits four critical flaws: short-term economic compensation traps, structural marginalization risks, spatial imbalances in resource allocation, and lack of dynamic feedback mechanisms. Governance tools must transition from "node transfusion" to "network self-sustaining. " Using panel data from 147 districts and counties in China's CFPS (2010-2022), this study employs the dynamic spatial Durbin model to investigate the spatial mechanisms of node knowledge density, community interaction intensity, and resource allocation efficiency on network marginalization. A three-dimensional analytical framework of "node-network-space" is constructed, demonstrating that knowledge networks exhibit weak-link breakthrough effects, resource networks demonstrate group game repulsion, community networks possess spatial spillover mechanisms, and poverty subcultures feature complex transmission pathways that can be resolved within short cycles. The findings provide policy implications:
1. Enhance knowledge transfer capabilities and establish a cross-regional weak-link network; 2. Resolve group game dilemmas and develop innovative resource allocation mechanisms; 3. Quantify community interaction intensity to stimulate physical space synergy; 4. Innovate network monitoring systems and construct multidimensional spatial correlation indicators. This study transcends the limitations of static relationships in traditional social network analysis, extending social network theory to dynamic governance contexts. It effectively explains the "strong nodes-weak channels" paradox during poverty governance transitions, providing theoretical tools for dynamic governance of relative poverty in the post-poverty era.

Keywords: social network theory; dynamic spatial Durbin model; networked governance; relative poverty

Abstract: Examined through the lens of social network theory, this study reveals that under the dual context of urbanization and digitization in the post-poverty-alleviation era, the traditional "strong node-weak channel" governance model exhibits four critical flaws: short-term economic compensation traps, structural marginalization risks, spatial imbalances in resource allocation, and a lack of dynamic feedback mechanisms. This necessitates a paradigm shift from "node transfusion" to "network hematopoiesis." Leveraging panel data from 147 districts/counties in the China Family Panel Studies (CFPS) spanning 2010–2022, we employ a dynamic spatial Durbin model to investigate the spatial mechanisms through which node knowledge density, community interaction intensity, and resource allocation efficiency influence network marginalization. Our proposed "node-network-space" three-dimensional analytical framework confirms the following: (1) knowledge networks exhibit weak-tie breakthrough effects; (2) resource networks demonstrate intergroup game repulsion forces; (3) community networks generate spatial spillover mechanisms; and (4) poverty subcultures, despite their complex transmission pathways, can be mitigated within short-term cycles. Policy implications include: (1) strengthening knowledge transfer capabilities to construct cross-regional weak-tie networks; (2) resolving intergroup game dilemmas by establishing innovative resource allocation mechanisms; (3) quantifying community interaction intensity to activate spatial synergy effects; and (4) developing network monitoring systems to build multidimensional spatial correlation indicators. By transcending the limitations of static social network analysis, this study extends social network theory to dynamic governance contexts, elucidates the origins of the "strong node-weak channel" paradox during poverty governance transitions, and provides theoretical tools for dynamic relative povertygovernance inthe post-poverty-alleviation era.

Keywords: Social Network Theory; DynamicSpatial DurbinModel; Network Governance; Relative Poverty

I. The Origin of the Issue

Since the comprehensive victory in the battle against poverty, China's poverty governance has undergone a paradigm shift through dual processes: On one hand, the digitalization and urbanization trends have redirected governance focus from absolute poverty to relative poverty; on the other hand, social structural transformations have driven governance logic to evolve from traditional geographic governance to networked governance frameworks. This paradigm shift fundamentally manifests the three inherent limitations of the conventional targeted poverty alleviation model—spatial fragmentation, temporal lag, and network fragility—imposing a cognitive leap from' fixed-point transfusion 'to' networked self-sustaining capacity building' in the policy system for relative poverty governance.

From the perspective of current policy implementation, the prevailing "strong nodes-weak channels" model exhibits inherent limitations. On one hand, while the Central Document No.1 advocates for "comprehensive mechanisms to prevent rural poverty relapse" and prioritizes targeted assistance for registered impoverished households and resettlement communities as key nodes, it fails to strengthen cross-regional resource flow channels. This creates a paradox where "internal redundancy" coexists with "inter-point fragmentation" in aid distribution. On the other hand, although the document calls for "enhancing dynamic monitoring and support mechanisms to prevent poverty relapse," provincial-level monitoring standards remain confined to administrative boundaries. The lack of quantified metrics for node connectivity's regulatory role in resource allocation makes it difficult to identify inter-regional resource transfer pathways, thereby hindering the development or reinforcement of existing cross-regional coordination mechanisms.

From the perspective of relative poverty governance research, contemporary scholars primarily adopt two analytical approaches: spatial and temporal dimensions. Spatially, studies focus on administrative regions to examine how settlement functions, natural environments, and transportation infrastructure influence poverty reduction outcomes [□□□]. Temporally, researchers utilize single-year or short-term cross-sectional data to demonstrate how welfare levels, vocational education, and social capital affect poverty vulnerability and intergenerational transmission efficiency among households lifted out of poverty [□□□]. However, this framework presents three fundamental limitations: First, dimensional oversimplification. Existing literature predominantly analyzes the effects of individual policies or indicators while neglecting the interactive mechanisms between educational attainment, government fiscal investments, and urbanization levels. Second, methodological staticity. The mainstream spatial econometric model—the static Durbin model—fails to capture the dynamic nature of policy implementation and relative poverty governance, which inherently involve time lags. Third, social network theory is primarily applied to analyze migrant populations and media communication, without extending to knowledge diffusion or collaborative resource allocation mechanisms.

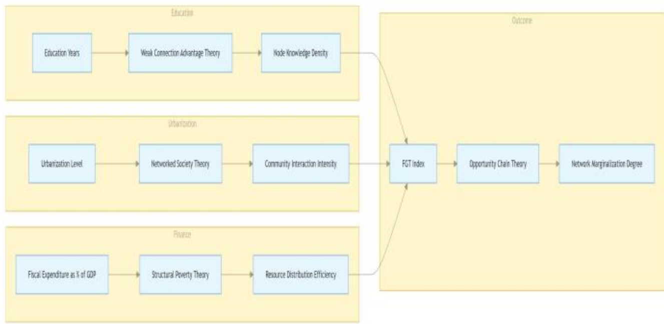
Based on the social network theory , the existing governance model of "strong nodes-weak channels" is examined at the policy practice level.

① Zhang Jingqi, Qiu Tingting, Xiu Chunliang. A Review of Urban Poverty Research from the Perspective of Spatial Governance[J]. Journal of Beijing Academy of Governance, 2022, (01):95-104.
② Chao, Y., Gao, L., Liu, Y., Yang, N.*, Lyu, X., Zhang, Y. & Guan, Q. (2024) Multi-perspective perception of urban relative poverty and its associated factors analysis: A case study of Wuhan City. Cities, 153: 105320.
③ Zhou Guohua, Zhang Rujiao, He Yanhua, et al. On the Optimization of Rural Settlements and the Governance of Relative Poverty in Rural Areas [J]. Advances in Geographical Sciences, 2020,39(06):902-912.
④ Li Lingli, Peng Zhengqin, Wan Yanchen. Measurement and influencing factors of poverty vulnerability in poverty-alleviated households: An empirical study based on 6,970 households in Chongqing [J]. Rural Economy, 2024, (09):122-132.
⑤ Jia Can, Wang Zhuo. Research on the Current Status and Influencing Factors of Relative Poverty in Rural Areas—Based on the 2021 Sichuan Special Survey [J]. Rural Economy, 2023, (12):62-71.
⑥ Hou Yuna, Zhang Yulong. Toward Common Prosperity: How Vocational Education Can Block the Intergenerational Transmission of Relative Poverty [J]. Educational Research, 2025,46(03):132-145.
⑦ Wellman, Barry. Network analysis: some basic principles. Sociological Theory. 1983(1). P. 157.

The theoretical framework exhibits four fundamental flaws: First, the short-term economic compensation trap . While temporary financial support for households or individuals may boost economic indicators, it fails to address the structural disadvantage of these nodes in social networks. Second, the risk of structural marginalization. By ignoring differences in connectivity among social groups, fiscal resources flow through established channels, further marginalizing nodes already at the periphery of resource distribution. Third, spatial imbalance in resource allocation . Although resource distribution relies on administrative boundaries, actual allocation is constrained by node connectivity, potentially leading to "monopolistic cutoff" phenomena dominated by clan and geographical ties. Fourth, the absence of dynamic feedback mechanisms . Economic indicator growth remains disconnected from network evolution, lacking dynamic responses to lagged effects. In practical applications, three theoretical blind spots emerge across spatial, temporal, and network dimensions: Spatially, individual networks are oversimplified as social circles, neglecting the impact of administrative boundaries on resource diffusion . Temporally, static network structures dominate analysis, failing to reveal the dynamic transmission mechanisms of relative poverty during urbanization. Network pathways focus on measuring geographical boundaries rather than cross-regional connectivity quality, overlooking its regulatory role in resource allocation .

To address these issues, this study introduces social network theory to construct a threedimensional analytical framework encompassing "nodes-network-space". At the node level, years of education are converted into node knowledge density to measure the "weak link breakthrough effect". At the network level, the ratio of fiscal investment to GDP quantifies resource allocation efficiency, explaining the "structural hole effect" within resource networks □. At the spatial level, urbanization levels reflect community interaction intensity, elucidating spatial spillover mechanisms. The variable selection and theoretical framework are illustrated in Figure 1.

Figure 1 Variable Selection and Theoretical Framework Diagram



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① Liu Jian, Jiang Shuifa. Relative Poverty Governance: Literature Review and Research Prospects [J]. Journal of Inner Mongolia Agricultural University (Social Sciences Edition), 2021,23(05):20-27.

② Wang Lin, Li Keke, Zhou Zhengtao. Characteristics, Issues, and Countermeasures of Poverty Governance in China in the Post-Poverty Era [J]. Journal of Lanzhou University (Social Sciences Edition), 2021,49(05):49-56.

③ Wang Anping, Le Gemu Guo. Exploring the Practical Motivations and Theoretical Frameworks of Relative Poverty Governance in the Post-Poverty Era [J]. Journal of the Party School of the Yunnan Provincial Committee of the CPC, 2022,23(05):144-153.

④ Kuang Yuanpei, Xiao Ye, Wang Sangui. The Multiple Logics, Content Frameworks, and Effective Approaches of Modernization in China's Poverty Governance [J]. Socialist Research, 2023, (03):90-99. □ Chen Mingxing, Chen Liangkan, Xian Le, et al. Evolution of physical and flow spaces in urbanized areas and analysis of high-quality development pathways [J]. Acta Academica Sinica, 2023,38(12):1950-1961.

⑥ Granovetter M.Granovetter M. S. The Strength of Weak Ties[J]. American Journal of Sociology, 1973,78(6): 1360-1380.

⑦ Burt, Ronald S.. Structural Holes: The Social Structure of Competition. Cambridge, MA: Havard University Press. 1992.

This study delivers threefold contributions in theory, methodology, and practice. Theoretically, it integrates knowledge, resources, and spatial interactions to reveal a complex transmission pathway of "weak link breakthroughs → structural hole supplementation → spatial spillover windows," transcending the single-dimensional application of social network theory in existing research. Methodologically, it employs the dynamic spatial Durbin model to quantify the spatiotemporal heterogeneity of policy interventions and poverty subcultures, providing a novel tool for assessing "policy lag effects." Practically, it proposes three pathways for "network self-sustaining": prioritizing the resilience of educational node connections, optimizing cross-regional fiscal resource allocation rules, and leveraging community spatial spillovers for targeted interventions in poverty subcultures, thereby supporting evidence-based policymaking.

II. Study Design

(1) Model Construction and Spatial Weight Matrix Selection

1. Model Building

Previous studies have validated education's poverty-reduction effects □ □. From the perspective of social network theory, the poverty-reduction efficacy of education fundamentally lies in knowledge transfer and resource flow between nodes. While proximity regions may facilitate stronger connections, weak ties that bridge structural gaps could exert greater resource leverage. To address this, this study constructs a dynamic spatial model that deconstructs education's role in relative poverty governance into three co-occurring network effects: local effects of node knowledge dissemination, reconstruction effects of resource circulation channels, and spatiotemporal transmission effects of poverty networks. The model is presented as follows:

□□□ =□□□□□ +(□1□□,□−1 +□2□□,□−2)
+(□1□□□,□−1 +□2□□□,□−2)+(□□□□+□□,□−1□1 +□□,□−2□2) (1)
+(□□□□□+□□□,□−1□1 +□□□,□−2□2)+(□□ +□□ +□□□)

Where, i is the district/county, t is the year, W is the network matrix (spatial weight matrix), ρ is the spatial autoregressive coefficient representing direct spatial dependence, $\tau 1$ and $\tau 2$ are the first and second lag coefficients respectively, $\psi 1$ and $\psi 2$ are the first and second lag coefficients respectively, β is the direct effect of the independent variable, θ is the spatial lag coefficient of the independent variable, δi is the individual fixed effect, γt is the time fixed effect, εit is the random error term.

Thus, yit represents the network marginalization degree of district/county i in year t, $\rho Wyit$ is the spatial lag term reflecting the network's concurrent transmission effect, and ($\tau 1yi,\ t\text{-}1+\tau 1yi,\ t\text{-}1$) denotes the node path dependence reflecting the persistent influence of individual historical states.

① Wang Wenlue, Yu Jin. Estimation of the Return on Investment in Rural Education in Underdeveloped Regions and the Effect of Education on Poverty Reduction [J]. Lanzhou Journal of Education, 2024, (10):148-160.

② Ma Fengzhi. The practice of poverty alleviation and social work education in targeted poverty alleviation in China [J]. Social Construction, 2022,9(01):48-59.

Item, ($\psi 1\ Wyi,t\text{-}1+\psi 2\ Wyi,t\text{-}2$) is the spatial lag term reflecting the historical state transmission of the network, ($Xit\beta+Xi,t\text{-}1\beta 1+Xi,t\text{-}2\beta 2$) is the node attribute effect term reflecting the inherent characteristics of the district, ($WXit\theta+WXi,t\text{-}1\theta 1+WXi,t\text{-}2\theta 2$) is the network spillover effect term reflecting the spillover of adjacent attributes, δi is the individual fixed effect term controlling the heterogeneity of the district, γt is the time fixed effect term controlling the common shock at the time level, εit is the random error term.

2. Selection of Spatial Weight Matrix

Conventional spatial research typically employs binary adjacency matrices that categorize regions as either adjacent or non-adjacent. Building upon Burt's (1992) "Structural Holes" theory, this study develops a geographic inverse distance matrix (W d) that overcomes the binary limitations of traditional adjacency matrices through continuous weighting and outlier elimination, thereby accurately reflecting regional connectivity. Specifically, the matrix elements are derived from the inverse of spherical distances between counties based on their geographic coordinates. Proximity between counties is represented by increasing weights, while greater distances result in decreasing weights. The weight matrix is defined as follows:

1

$$W_{ij} = \frac{1}{d_{ij}} \ (i \neq j), \quad W_{ij} = 0, \ (i = j) \tag{2}$$

d is the spherical distance calculated by the longitude and latitude of the district.

(2) Data Description and Variable Selection

1. Data Specification

This study is based on the panel data of the China Family Panel Survey (CFPS) 2010-2022, focusing on long-term changes at the district and county level. The original CFPS sample covers 162 districts and counties across 25 provinces nationwide, among which 147 districts and counties achieved full-cycle coverage in the seven rounds of surveys conducted over the years. The geographical distribution still includes the major economic belts in the east, central, and western regions. After excluding districts and counties with missing years, the remaining samples still maintain regional representativeness. To avoid poor longitudinal comparisons caused by sample rotation or loss and to ensure the time continuity of the panel data, this study uses the 147 districts and counties fully covered by CFPS as the research units.

2. Variable Selection:

Dependent Variable: Degree of Network Marginalization.According to the opportunity chain theory, network marginalization refers to the exclusion of nodes from core resource flow paths, essentially representing the continuous accumulation of positional disadvantages □. Therefore, using districts as node units, the FGT index is calculated based on relative poverty lines to reflect their positional disadvantages within regional development networks, indicating the deprivation distance from core resource flow paths.

□ Harrison White. The Chain of Opportunity[M]. Shanghai: Gezhi Publishing House, 2009.

The FGT Poverty Index (Foster-Greer-Thorbecke Poverty Index) was developed in 1984 by economists James Foster, Joel Greer, and Erik Thorbecke as a poverty measurement tool □. By adjusting the *α* parameter, it quantifies poverty incidence, depth, and intensity, providing a comprehensive reflection of the distribution characteristics of impoverished populations. The calculation formula is as follows:

$$P_{\alpha} = \frac{1}{n}\sum_{i=1}^{q}\left(1-\frac{y_i}{z}\right)^{\alpha} \tag{3}$$

Where,n is the total population,q is the number of impoverished individuals,z is the poverty line,y_i is the income of the i th impoverished individual, and $\alpha(\alpha \geq 0)$ is the sensitivity coefficient, reflecting "the degree of aversion to poverty." When $\alpha=0$,$P0$ reflects the proportion of impoverished individuals indicating the breadth of poverty; when $\alpha=1$,$P1$ reflects the gap between impoverished groups and the poverty line indicating the depth of poverty; when $\alpha=2$,$P2$ reflects the degree of inequality within impoverished groups indicating the intensity of poverty. Relative poverty is defined as a living standard below the societal average but sufficient to meet basic needs □. Following existing research practices, 40% of the median disposable income of residents is considered the relative poverty line □□. The relative poverty line for this year was set at 40% of the median annual income of valid sample individuals, and then calculated using adult sample data from the CFPS database between 2010 and 2022, as shown in Table 1.

Table 1 Relative Poverty Line for Each Year from 2010 to 2020

A particular year	Relative poverty line (yuan)
2010	2401.543
2012	3200
2014	4335.2
2016	5800
2018	7000
2020	8000
2022	9800

This paper focuses on the difference between relative poverty and non-relatively poverty. Therefore, in Equation (3),α=1,n=the total sample size in the district,q=the sample size of income below the relative poverty line in the current year, and z=the relative poverty line in the current year. The resulting P1 is the relative poverty index.

Explanation Variable 1: Node Knowledge Density.The Weak Link Advantage Theory (Granovetter, 1973) posits that weakly connected nodes acquire more heterogeneous resources through networks compared to strongly connected ones, with their access capacity determined by encoding-decoding efficiency. Therefore, the average years of education per capita (years) is selected as a measure of node knowledge density, reflecting the strength of knowledge diffusion through weak links and the ability to bridge structural holes.

① Foster J, Greer J, Thorbecke E. A Class of Decomposable Poverty Measures. Econometrica, 1984, 52(3): 761-776.

② Xiang Deping, Xiang Kai. Diversity and Development: The Connotation and Governance of Relative Poverty [J]. Journal of Huazhong University of Science and Technology (Social Sciences Edition), 2020,34(02):31-38.

③ Chen Yongwei, Hou Shengwan, Fu Dahai. Estimation of relative poverty standards and poverty dynamics in rural China [J]. Statistical Research, 2022,39(05):107-118.

④ Gao Yang, Liu Qinglian, Zhang Kanyu. Relative poverty standard and population identification [J]. Economic and Management Review, 2022,38 (04):135-145.

Variable 2: Community Interaction Intensity.The networked society theory (Wellman, 2001) reveals that urbanization is not merely about population concentration, but rather the co-evolution of physical agglomeration and social connectivity, which accelerates the formation of local social networks through compressed physical space. Therefore, the urbanization level (%) is selected to reflect both the physical agglomeration intensity of communities and the scale and complexity of their interaction networks.

Variable 3: Resource Allocation Efficiency.The structural hole theory (Burt, 1992) indicates that the efficiency of fiscal resource allocation is not determined solely by the scale of capital investment, but rather by a node's ability to occupy a pivotal position in the network. Therefore, the fiscal expenditure-to-GDP ratio (%) serves as an indicator of a node's structural hole capacity in the public resource allocation network. Descriptive statistics for the variables are presented in Table 2.

Table 2 Descriptive Statistics of Variables

Variable name (unit)	Measurement method	Data sources	Obs	Mean	Standard error	Least value	Crest value
Degree of network marginalization	See Equation (3)	CFPS22010-2022	1029	0.086	0.701	0.000	0.437
Node Knowledge Density (years)	Years of schooling per capita	CFPS22010-2022	1029	7.897	2.150	1.239	16.083
Community interaction intensity (%)	Government fiscal expenditure/GDP	Statistical Yearbooks of Each Province	1029	0.227	0.084	0.106	0.462
Resource allocation efficiency (%)	Urban population/total population	Statistical Yearbooks of Each Province	1029	0.601	0.142	0.338	0.893

III. Spatial Test Analysis

(1) Spatial Correlation Test

1. Global Moran's I

This study evaluates the network transmission effects of 147 districts and counties in the China Family Panel Studies (CFPS) survey from 2010 to 2022 by calculating the global Moran's index. The formula for Moran's I is as follows:

$$I = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} \tag{4}$$

Among them, $S^2 \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$ is the sample variance, *wij* is the element in the space matrix, and I takes values between

A value between-1 and 1, greater than 0 indicates positive spatial autocorrelation, while a value less than 0 indicates negative spatial autocorrelation. Additionally, the closer the absolute value is to 1, the stronger the correlation.

Based on the geographic inverse distance matrix, this paper calculates the degree of network marginalization and the knowledge density of nodes in each county and district.

The global Moran's index, as shown in Table 3, demonstrates that both Moran's I and z-values exceed 0 with p-values of 0 after spatial autocorrelation testing, confirming the network transmission effect of relative poverty. Therefore, spatial econometric methods can be employed to analyze their spatial relationships.

Table 3. Global Moran Index of Network Marginalization and Node Knowledge Density in CFPS Counties and Districts (2010–2022)

	Degree of network marginalization			Node knowledge density		
A particular year	I	z	p	I	z	p
2010	0.169	11.116	0.000	0.139	9.248	0.000
2012	0.192	12.657	0.000	0.161	10.600	0.000
2014	0.170	11.270	0.000	0.187	12.259	0.000
2016	0.168	11.170	0.000	0.192	12.632	0.000
2018	0.154	10.197	0.000	0.193	12.661	0.000
2020	0.162	10.664	0.000	0.146	9.675	0.000
2022	0.165	10.912	0.000	0.183	12.063	0.000

(2) Model Fit Test

In the model specification, the first step was to determine whether to use a fixed effects model or a random effects model, namely the Hausman test. The statistic showed a significant positive value (P=0.002), rejecting the null hypothesis that "random effects are superior to fixed effects." Further spatial dependence diagnostics (LM test) were conducted. LM-ERR indicated "the presence of spatial error effects" (P-value=0.000), while LM-LAG accepted "the absence of spatial lag effects" (P-value=0.067). However, RLM-ERR and RLM-LAG rejected the null hypotheses of "the absence of spatial lag effects" and "the absence of spatial error effects," respectively (P-values=0.000). To further confirm, fixed effects type diagnostics (LR test) were performed. The results rejected the null hypothesis that "individual fixed effects are superior to two fixed effects" (P-value=0.000) and significantly rejected the null hypothesis that "time fixed effects are superior to two fixed effects" (P-value=0.000). The test statistics and significance results are shown in Table 4.

The contradiction between the LM and LR tests confirms the 2-4 year lag in educational returns [1] and the spatiotemporal asymmetry in policy implementation [2]. Therefore, when modeling, it is necessary to consider both spatial lag effects and spatial error effects. Hence, a two-period (4-year) lag dynamic Durbin model was selected for analysis.

	p price
	0.002

Table 4 Results of Hausman, LM, and LR Tests

Test item	Statistics
Hausman	14.91

LM-ERR 80.729 0 LM-LAG 3.346 0.067

① Wang Wenlue, Yu Jin. Estimation of the Return on Investment in Rural Education in Underdeveloped Regions and the Effect of Education on Poverty Reduction [J]. Lanzhou Journal of Education, 2024, (10):148-160.

② Wu Guangyun. On the Transition from a 'Reactive' to a 'Proactive' Government: A Discussion on Governance and Prevention Mechanisms for Policy Conflicts and Policy Lag [J]. Modern Economic Research, 2014, (05):10-14.

RLM-ERR	98.788	0
RLM-LAG	21.404	0
LR-ind vs both	47.94	0
LR-time vs both	827.08	0

(3) Analysis of Spatial Econometric Regression Results

Table 5: Regression Results of the Two-Stage Lag Dynamic Durbin Model on the Degree of Network Marginalization Based on Node Knowledge Density

Dependent variable: Degree of network marginalization	Coefficient	p price	Dependent variable: Degree of network marginalization	Coefficient	p price
Main (local direct effect)			Wx (neighborhood spillover effect)		
Node knowledge density	-0.014	0	Node knowledge density	-0.007	0.531
Resource allocation efficiency	0.105	0.127	Resource allocation efficiency	-0.281	0.186
Community interaction intensity	-0.125	0.294	Community interaction intensity	-0.366	0.093
SR_Indirect (short-term indirect effect)			LR_Direct (Long-term Direct Effect)		
Node knowledge density	-0.017	0.073	Node knowledge density	-0.014	0
Resource allocation efficiency	-0.148	0.272	Resource allocation efficiency	-0.113	0.088
Community interaction intensity	-0.393	0	Community interaction intensity	-0.125	0.285
SR_Direct (Short-term Direct Effect)			LR_Indirect (Long-term indirect effect)		
Node knowledge density	-0.014	0	Node knowledge density	-0.004	0.709
Resource allocation efficiency	0.114	0.088	Resource allocation efficiency	-0.264	0.131
Community interaction intensity	-0.125	0.286	Community interaction intensity	-0.275	0.139
SR_Total (Short-term Total Effect)			LR_Total (Long-term Total Effect)		
Node knowledge density	-0.014	0	Node knowledge density	-0.018	0.074

Resource allocation efficiency	0.113	0.008	Resource allocation efficiency	-0.151	0.273
Community interaction intensity	-0.125	0.285	Community interaction intensity	-0.4	0
Dynamic effect			Spatial		
W1. Degree of network marginalization	0.021	0.919	rho	0.23	0.19

(1) The results show that the node knowledge density is the core force to reduce the degree of network marginalization.

(2) The resource allocation efficiency will increase the degree of network marginalization in the short-term direct effect, but decrease the degree of network marginalization in the long-term total effect. It shows that the resource allocation has the contradictory characteristics of "input-conduction".

(3) The results show that the community interaction intensity is significant in the short-term indirect, the long-term total effect of the spillover, which confirms that the increase of the community interaction network intensity accelerates the formation of the network between the nodes;

(4) The dynamic effect of the model and the spatial autocorrelation coefficient are not significant, which indicates that the transmission path of the poverty subculture is not limited to the simple geographical network transmission. However, the dynamic effect shows that the nodes can be locked out of the network within a model cycle (2-4 years).

IV. Conclusion and Implications

This study, grounded in the theoretical framework of networked society and employing dynamic Durbin model analysis, demonstrates that poverty reduction governance—enhancing education duration, fiscal investment ratios, and urbanization levels—constitutes a synergistic process involving node knowledge empowerment, resource network restructuring, and strengthened community interaction. Although the spatial autocorrelation coefficient remains statistically insignificant, the coordinated effects of education, fiscal policies, and urbanization achieve poverty alleviation breakthroughs through three mechanisms: structural hole bridging, resource network reconfiguration, and localized network densification in community spaces. The governance logic for relative poverty should therefore transition from "individual capacity building" to "network connectivity reconstruction." The core findings are summarized in four key points:

(1) Knowledge networks exhibit a weak-link breakthrough effect.The increase in years of education significantly reduces network marginalization (total coefficient=-0.014, P=0), which essentially reflects enhanced knowledge transfer capabilities among nodes. This enables them to overcome structural holes through weak connections, thereby breaking the poverty lock-in caused by network marginalization.

(2) Resource networks exhibit group game repulsion.The long-term short-term contradiction in fiscal investment reflects the restructuring process during sustained financial resource allocation. In the initial phase, resources flow through existing strong connection channels, reinforcing the monopolistic interception by established interest groups (short-term coefficient=0.113, P=0.008). Sustained

investment, however, restructures the network architecture, enabling weaker nodes to gradually occupy secondary structural voids (long-term total coefficient=-0.113, P=0.088).

(3) Community networks exhibit spatial spillover mechanisms.The increase in urbanization level (total coefficient = -0.393, P=0) essentially reflects enhanced community interaction intensity. The resulting increase in strongly connected nodes generates significant spatial synergistic effects in the density of neighboring communities.

(4) Poverty subcultures exhibit complex transmission pathways that can be resolved within short cycles.Although the spatial autocorrelation coefficient failed to pass the significance test (coefficient= 0.230, P=0.019), the diagnostic results of the spatial error model in Table 4 indicate that the diffusion of poverty subcultures follows non-geographically distanced complex network transmission pathways. The insignificant dynamic effect (coefficient=0.021, P=0.919) demonstrates that poverty subcultures lack path dependence characteristics, meaning nodes can optimize their network positions to escape marginalization within the 2-4 year model cycle.

The following policy implications are drawn from this study:

(1) Strengthen the Ability of Knowledge Transfer and Construct the Weak Connection Network Across Regions.

In reconstructing knowledge networks, the primary focus should be on building heterogeneous information channels. Based on weak-link theory, policy design should prioritize expanding nonredundant information pathways to break the knowledge concentration trap. Secondly, continuous optimization of network topology is essential. Social network theory demonstrates that ensuring efficient information flow among nodes outweighs total volume. During network expansion, some nodes inevitably become marginalized, forming edge locks. Systematic reconstruction of their communication paths is required to maintain their relay function.

(2) To Break the Game Dilemma of the Group and Establish a New Type of Resource Allocation Mechanism.

In the innovation of resource allocation, the primary objective is to achieve a paradigm shift toward multistakeholder governance. This requires moving beyond the single dominance of administrative models to establish a collaborative decision-making framework with dynamically adjustable weight ratios, enabling adaptive configuration of governance entities. Secondly, it involves creating a dynamic anti-monopoly equilibrium mechanism by introducing government investment flow algorithms to prevent monopolistic practices.
The monopoly of the fixed group in the network structure.

(3) Quantify the Intensity of Community Interaction and Stimulate the Synergistic Effect of Physical Space.

Urbanization enhances resource flow efficiency through increased community network density, generating spatial synergy effects. Therefore, the primary task is to design mechanisms for capturing spatial spillover effects, actively leveraging advantages, and facilitating their diffusion along the network. Secondly, it is essential to reconstruct networked spatial justice, transforming physical space modifications during urbanization into improvements in social network centrality.

(4) Innovate Network Monitoring System and Construct Multi-Dimensional Space Correlation Index.

The poverty subculture is not a simple geographical transmission, so it is necessary to cut off the reproduction of the poverty subculture by the intervention of the node center, and to shift from the single cultural transformation to the network reconstruction, to get rid of the location disadvantage, and to reconstruct the network embeddedness of the node.

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