

Supplementary information

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Section 1: A detailed explanation of theoretical deduction.

A general equilibrium analysis

The general equilibrium analysis of local government fixed asset investment on the fiscal gap can be carried out from two aspects: fiscal revenue and expenditure. The influence mechanism of local government fixed asset investment on fiscal revenue includes the multiplier effect and the crowding-out effect. It's a mutually repulsive pair of forces. The influence mechanism of local government fixed asset investment on fiscal expenditure includes the expenditure preference effect and the policy attention effect. It's a pair of interacting forces.

Multiplier effect. The multiplier effect is one of the core mechanisms of Keynesian macroeconomic theory, which refers to the government's chain-pulling effect on the regional economy through infrastructure investment [S1]. Specifically, initial government investments directly increase aggregate demand, prompting businesses to expand production and create job opportunities. In turn, this increases the disposable income and consumption levels of workers. According to the national income identity, this ripple effect can amplify GDP growth by several times the amount of the initial investment. On the one hand, the expansion of GDP directly increases the tax base for turnover taxes, such as value-added tax and consumption tax. On the other hand, the growth in corporate profits and individual incomes correspondingly increase the collection of corporate income tax and individual income tax. Thus, the multiplier effect serves as a self-reinforcing mechanism for the fiscal revenue generated by local government investments in fixed assets.

Crowding-out effect. According to neoclassical economic theory, public investment by local governments in areas such as infrastructure development and industrial support may crowd out the private sector [S2]. Firstly, increasing public investment drives up factor prices. In the capital

1 market, the heightened demand for government financing may elevate local interest rates, crowd
2 out private sector credit resources, and increase the financing costs for enterprises. Secondly, the
3 creation of job opportunities through public projects in the labor market will draw workers to
4 government departments or public initiatives. This shift may result in a shortage of labor for
5 private enterprises, leading to upward pressure on wages and an increase in production costs. In
6 addition, the appropriation of land resources for public projects may further increase land prices
7 and limit the opportunities for private enterprises to invest. The crowding out of the private
8 sector by the fixed asset investment of local government would offset the revenue generated by
9 the multiplier effect.

10 **Fiscal expenditure preference effect.** According to public choice theory, the effect of
11 expenditure preference refers to the systematic structural bias of local governments in the
12 allocation of financial resources, which is characterized by an excessive preference for
13 productive investment and a relative neglect of expenditures related to people's livelihoods [S3].
14 Firstly, driven by the incentives of promotion tournaments, local government officials tend to
15 favor infrastructure investments that yield significant visibility in GDP. In contrast, public
16 services with long-term positive externalities, such as education and healthcare, are often
17 deprioritized due to assessment delays. This shift in fiscal expenditure structure can stimulate
18 short-term economic growth; however, it ultimately restricts the enhancement of total factor
19 productivity due to insufficient investment in human capital. Secondly, driven by the path
20 dependence, the sunk cost effect of the local government fixed asset investment and institutional
21 inertia collectively reinforce the continuity of the existing investment model [S4]. Based on the
22 above, fiscal expenditures and high debt deficits in short term may lead to a loss of future tax

revenue, resulting in a significant long-term fiscal gap that poses systemic risks to fiscal gap in medium and long term.

Policy attention effect. According to the signal transmission theory and the principal-agent framework, under the role of policy pilot demonstration, the central policy preference directly stimulates the pilot region to expand the scale of infrastructure investment, and the matching fund requirements aggravate the pressure on local fiscal expenditure and debt accumulation [S5]. Meanwhile, although the multiple indicators in the performance appraisal system (such as environmental protection and poverty alleviation) should theoretically optimize the expenditure structure, due to the strong incentive role of GDP assessment, local governments often adopt the "bottom line" strategy, and while meeting the minimum requirements of binding indicators, they still invest major resources in the infrastructure field with significant GDP pull effect, resulting in structural distortion of financial resource allocation. This mechanism exacerbates the fiscal gap through two channels: First, the demand for matching funds caused by the policy pilot directly increases fiscal expenditure; Second, to meet the requirements of the assessment of symbolic investment caused a waste of resources. In the end, a vicious circle of "policy response-investment expansion - fiscal imbalance" has been formed, which not only weakens the efficiency of the use of fiscal funds, but also threatens the long-term sustainability of local finance.

The perspective of spatial spillover

Spatial multiplier effect. According to the spatial fiscal interaction theory, local government investment magnifies regional economic growth through the spatial spillover effect and then forms a fiscal revenue multiplier effect through tax growth [S6]. Specifically, the industrial linkage effect can make local government infrastructure investment attract cross-regional

1 industrial chain agglomeration. It can promote specialized division of labor and economies of
2 scale, not only improves the profitability of enterprises in the region but also drives the
3 development of supporting industries in neighboring regions, and jointly expands the scale of the
4 tax base. The second is the factor flow effect. The regional advantage formed by investment
5 leads to the concentration of production factors such as labor and capital in high-return areas,
6 which indirectly improves the level of economic activities in surrounding areas through the
7 growth of factor returns and the expansion of consumption, producing cross-regional tax growth
8 effects [S7]. This spatial spillover mechanism realizes multiplier amplification through the tax
9 cycle. Finally, a cross-regional virtuous circle of "investment-industry linkage - factor flow - tax
10 revenue growth - reinvestment" would be formed, significantly improving the scale of fiscal
11 revenue.

12 **Spatial crowding-out effect.** Local government investment pushes up resource costs through
13 spatial spillover, crowds out private investment, inhibits economic growth, and reduces fiscal
14 revenue. First, the price linkage mechanism of the factor market. Government investment
15 projects trigger labor mobility across regions by providing more attractive employment
16 conditions. According to the theory of new economic geography, this process of factor
17 reallocation pushes up the labor cost in the surrounding area (labor competition effect) [S8-S9].
18 The price linkage mechanism of the factor market makes resource scarcity spread among regions.
19 The second is the expected transmission mechanism, in which enterprises form consistent
20 expectations of future cost increases and then reduce the scale of investment in advance. This
21 kind of spatial spillover effect shows an obvious difference over time. In the short run,
22 government investment generates tax revenue by directly creating GDP; but in the long run,
23 shrinking private investment will lead to a continued weakening of the tax base. In addition, the

shrinking of the tax base in neighboring regions will produce negative feedback effects through horizontal fiscal competition and eventually form a vicious circle of "investment expansion - factor extrusion - tax base contraction - fiscal revenue decline.

Spatial fiscal expenditure preference effect. The investment preferences of local governments cause imitation or competition in neighboring areas through spatial spillover and change the structure of regional fiscal expenditure. Based on performance promotion and path dependence, the effect of spending preference is changed by two mechanisms of spatial spillover. The first is the demonstration mechanism, that investment patterns in leading regions can induce imitation behavior in neighboring regions through policy learning effects [S10]. Local governments strive for central policy tilt by copying "successful experiences, leading to the convergence of regional investment structures. The second is competition mechanism. In order to maintain the relative competitive advantage between regions, a dynamic game pattern will be formed: (1) subsidy competition: attracting liquidity factors by increasing the intensity of subsidies; (2) infrastructure upgrading: continuing to increase infrastructure investment, such as transportation, to improve location conditions. Such a spatial spillover mechanism will intensify spending pressure and widen the fiscal gap.

Spatial policy attention effect. The central policy concern guides the direction of local fiscal expenditure through spatial spillover, forming policy diffusion or regional differentiation [S11]. Based on investment skew and performance appraisal, the policy attention effect is altered by two mechanisms of spatial spillover. The first is the policy response mechanism. When a given region receives preferential policies from the central government, its innovative policy tools (such as special debt financing models and PPP implementation plans) spread rapidly through intergovernmental learning networks. This leads to policy pilot areas with first-mover advantages

1 forming a resource siphon, while backward regions become more dependent on vertical transfer
2 payments, which increases financial pressure and widens the financial gap, resulting in the
3 “policy response - expenditure imbalance” dilemma. The second is the mandatory collaborative
4 adjustment mechanism: under the requirements of cross-regional governance (such as the
5 ecological compensation of the Yangtze River Economic Belt), the central government forces a
6 change in the local expenditure structure by establishing collaborative assessment indicators.
7 This situation can lead to the fiscal spending surging in areas of policy concern and contracting
8 in other areas.

Section 2: The classification of fiscal expenditure structure.

S1 Table The classification of fiscal expenditure structure.

Year	Productive fiscal expenditure	Consumptive fiscal expenditure
2003-2006	Expenditures for capital construction, funds for enterprises to tap potential for reconstruction, funds for geological exploration, expenses for science and technology, expenditures for agriculture, forestry, agricultural, forestry, water conservancy and meteorological departments, expenditures for industrial and transportation departments, and expenditures for distribution departments, expenditures for supporting underdeveloped areas, expenditures for Marine area development and construction and site use fees, and special expenditures	Cultural, sports and broadcasting expenses, education expenses, scientific expenses, public health expenses, other departments' expenses, pensions and social welfare assistance expenses, administrative and public institutions' retirement expenses, social security subsidies expenditures, national defense expenditures, administrative and administrative expenses, foreign affairs expenditures, armed police force expenditures, Public Security and Law Department expenditures, urban maintenance expenses, policy subsidies expenditures, debt interest expenditures
2007-2009	Expenditure on environmental protection; expenditure on urban and rural community affairs; expenditure on agriculture, forestry and water affairs; Expenditure on transportation; expenditure on industrial, commercial and financial affairs; Expenditure on the management of grain, oil and materials reserves (2009); Expenditure on post-earthquake recovery and reconstruction (2009)	Expenditure on general public services, national defense expenditure, foreign affairs expenditure, public security expenditure, education expenditure, science and technology expenditure, culture, sports and media expenditure, social security and employment expenditure, medical and health expenditure and family planning expenditure, financial supervision expenditure, debt service and interest expenditure
2010-2023	Expenditure on energy conservation and environmental protection, expenditure on urban and rural community affairs, expenditure on agriculture, forestry and water affairs, expenditure on transportation, expenditure on resource exploration and information, expenditure on business services, expenditure on post-earthquake recovery and reconstruction (2010-2013), expenditure on land, resources, Marine meteorology, expenditure on housing security, expenditure on grain, oil and materials reserve management, expenditure on disaster prevention and emergency management (2019-2023)	Expenditures on general public services, foreign affairs, national defense, public security, education, science and technology, culture, sports and media, social security and employment, medical and health care and family planning, financial expenditures, aid expenditures, and debt service and interest payments

Section 3: The data of all variables.

S2 Table - S13 Table presents the data for the six variables identified through empirical analysis, while the results in Table 3 - Table 6 of the manuscript are derived from this data.

S2 Table The ln FG of 31 provincial regions in China from 2003 to 2013.

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	-2.71	-2.75	-2.71	-2.54	-2.43	-2.33	-2.14	-2.22	-2.18	-2.14	-2.20
beijing	-3.61	-3.71	-3.94	-3.84	-4.19	-4.46	-3.70	-3.64	-4.28	-3.94	-3.64
chongqing	-2.65	-2.75	-2.72	-2.65	-2.67	-2.59	-2.33	-2.36	-2.23	-2.15	-2.24
fujian	-3.52	-3.44	-3.69	-3.68	-3.79	-3.58	-3.25	-3.32	-3.25	-3.19	-3.17
gansu	-1.89	-1.88	-1.81	-1.74	-1.71	-1.51	-1.26	-1.31	-1.28	-1.25	-1.30
guangdong	-3.74	-3.78	-3.85	-4.27	-4.45	-4.37	-4.07	-3.94	-3.81	-3.91	-3.86
guangxi	-2.46	-2.55	-2.50	-2.51	-2.33	-2.20	-2.05	-2.05	-2.00	-1.97	-2.04
guizhou	-1.93	-1.81	-1.75	-1.77	-1.72	-1.60	-1.40	-1.42	-1.34	-1.35	-1.45
hainan	-2.59	-2.44	-2.37	-2.40	-2.20	-1.93	-1.66	-1.87	-1.73	-1.71	-1.77
hebei	-3.01	-3.00	-2.94	-2.89	-2.83	-2.72	-2.48	-2.49	-2.48	-2.45	-2.44
heilongjiang	-2.44	-2.31	-2.31	-2.21	-2.10	-2.00	-1.76	-1.71	-1.71	-1.70	-1.73
henan	-2.91	-2.93	-2.87	-2.76	-2.69	-2.63	-2.38	-2.41	-2.34	-2.28	-2.30
hubei	-2.83	-2.83	-2.80	-2.60	-2.62	-2.50	-2.34	-2.39	-2.47	-2.46	-2.45
hunan	-2.73	-2.65	-2.61	-2.56	-2.51	-2.37	-2.26	-2.29	-2.28	-2.25	-2.22
jiangsu	-3.91	-3.80	-3.95	-4.09	-4.41	-4.07	-3.77	-3.90	-3.82	-3.83	-3.87
jiangxi	-2.58	-2.64	-2.57	-2.49	-2.53	-2.20	-2.05	-2.10	-2.06	-2.06	-2.05
jilin	-2.13	-1.97	-1.88	-1.92	-1.98	-1.85	-1.70	-1.69	-1.74	-1.80	-1.78
liaoning	-2.86	-2.78	-2.62	-2.63	-2.72	-2.72	-2.46	-2.46	-2.56	-2.51	-2.34
neimongol	-2.05	-2.08	-2.16	-2.18	-2.17	-2.05	-1.89	-1.92	-1.76	-1.72	-1.76
ningxia	-1.76	-1.80	-1.64	-1.65	-1.69	-1.60	-1.37	-1.36	-1.38	-1.27	-1.33
qinghai	-1.37	-1.39	-1.30	-1.22	-1.16	-1.12	-0.86	-0.59	-0.52	-0.45	-0.53
shaanxi	-2.38	-2.35	-2.38	-2.33	-2.30	-2.17	-2.00	-2.08	-2.17	-2.13	-2.13
shandong	-3.60	-3.61	-3.70	-3.68	-3.66	-3.59	-3.32	-3.19	-3.23	-3.15	-3.10
shanghai	-3.52	-3.38	-3.71	-3.88	-4.79	-4.12	-3.56	-3.70	-3.72	-3.88	-4.01
shanxi	-2.52	-2.59	-2.61	-2.65	-2.57	-2.54	-2.25	-2.23	-2.25	-2.24	-2.20
sichuan	-2.60	-2.52	-2.48	-2.44	-2.45	-1.90	-1.77	-1.85	-2.08	-2.07	-2.04
tianjin	-3.04	-3.01	-3.36	-3.34	-3.44	-3.29	-2.94	-3.10	-3.17	-3.16	-3.05
xinjiang	-2.06	-2.10	-2.01	-1.86	-1.93	-1.80	-1.50	-1.51	-1.43	-1.41	-1.46
xizang	-0.30	-0.56	-0.34	-0.43	-0.30	-0.11	0.00	0.01	0.14	0.14	0.13
yunnan	-2.00	-2.06	-2.04	-2.07	-2.06	-1.95	-1.66	-1.70	-1.66	-1.60	-1.64
zhejiang	-3.94	-3.80	-4.18	-4.48	-4.77	-4.35	-3.80	-3.82	-3.83	-3.86	-3.69

S3 Table The ln FG of 31 provincial regions in China from 2013 to 2023.

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	-2.22	-2.15	-2.22	-2.17	-2.27	-2.18	-2.21	-2.35	-2.24	-2.30
beijing	-3.76	-3.12	-2.96	-3.00	-2.89	-3.10	-3.10	-3.45	-3.17	-3.20
chongqing	-2.34	-2.27	-2.30	-2.24	-2.19	-2.16	-2.19	-2.39	-2.35	-2.35
fujian	-3.27	-2.91	-2.91	-2.89	-2.98	-3.04	-3.02	-3.29	-3.12	-3.18

gansu	-1.30	-1.12	-1.11	-1.13	-1.04	-1.03	-1.01	-1.22	-1.21	-1.22
guangdong	-4.15	-3.06	-3.27	-3.18	-3.29	-3.14	-3.20	-3.40	-3.20	-3.37
guangxi	-2.03	-1.89	-1.85	-1.82	-1.69	-1.66	-1.60	-1.82	-1.83	-1.84
guizhou	-1.44	-1.46	-1.47	-1.51	-1.54	-1.39	-1.51	-1.69	-1.63	-1.62
hainan	-1.85	-1.81	-1.71	-1.77	-1.66	-1.63	-1.57	-1.82	-1.68	-1.72
hebei	-2.43	-2.18	-2.19	-2.20	-2.04	-2.04	-1.94	-2.16	-2.09	-2.11
heilongjiang	-1.74	-1.41	-1.35	-1.29	-1.33	-1.29	-1.16	-1.36	-1.34	-1.29
henan	-2.35	-2.28	-2.24	-2.23	-2.21	-2.18	-2.18	-2.38	-2.26	-2.20
hubei	-2.48	-2.27	-2.31	-2.35	-2.36	-2.30	-1.99	-2.38	-2.31	-2.30
hunan	-2.28	-2.20	-2.16	-2.11	-2.07	-2.07	-2.04	-2.20	-2.11	-2.08
jiangsu	-3.96	-3.74	-3.73	-3.56	-3.42	-3.27	-3.10	-3.24	-3.08	-3.18
jiangxi	-2.06	-2.01	-2.01	-1.95	-1.93	-1.85	-1.82	-2.01	-2.00	-1.98
jilin	-1.76	-1.62	-1.50	-1.47	-1.48	-1.43	-1.40	-1.65	-1.41	-1.40
liaoning	-2.36	-2.15	-2.15	-2.17	-2.16	-2.09	-2.01	-2.18	-2.05	-2.07
neimongol	-1.79	-1.73	-1.71	-1.66	-1.69	-1.73	-1.68	-1.99	-2.02	-1.88
ningxia	-1.32	-1.22	-1.17	-1.21	-1.27	-1.31	-1.31	-1.54	-1.50	-1.45
qinghai	-0.52	-0.48	-0.56	-0.65	-0.69	-0.63	-0.61	-0.79	-0.79	-0.74
shaanxi	-2.14	-2.05	-2.03	-2.05	-2.06	-2.02	-1.96	-2.20	-2.25	-2.20
shandong	-3.16	-3.01	-3.01	-2.99	-2.91	-2.83	-2.75	-2.93	-2.86	-2.89
shanghai	-4.32	-3.64	-4.01	-3.52	-3.37	-3.63	-3.60	-4.18	-3.22	-3.57
shanxi	-2.26	-1.89	-1.85	-2.04	-2.08	-1.97	-1.84	-2.32	-2.36	-2.19
sichuan	-2.05	-1.99	-1.97	-2.00	-2.00	-2.01	-1.95	-2.12	-2.09	-2.12
tianjin	-3.07	-2.96	-2.47	-2.55	-2.60	-2.51	-2.44	-2.74	-2.92	-2.59
xinjiang	-1.52	-1.33	-1.22	-1.23	-1.25	-1.29	-1.22	-1.45	-1.28	-1.27
xizang	0.14	0.19	0.22	0.13	0.16	0.15	0.04	-0.14	0.12	0.07
yunnan	-1.63	-1.64	-1.63	-1.57	-1.63	-1.60	-1.62	-1.83	-1.81	-1.88
zhejiang	-3.65	-3.17	-3.34	-3.41	-3.35	-3.03	-3.13	-3.29	-2.97	-3.09

1 **S4 Table The ln GI of 31 provincial regions in China from 2003-2013.**

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	-2.40	-2.99	-2.97	-3.02	-2.90	-3.04	-2.87	-2.84	-2.98	-2.96	-3.08
beijing	-2.04	-3.41	-3.47	-3.83	-4.39	-4.03	-4.45	-4.51	-4.72	-4.29	-2.52
chongqing	-1.72	-2.88	-2.89	-2.93	-2.92	-3.11	-2.74	-2.62	-2.82	-3.22	-2.89
fujian	-2.01	-3.23	-2.77	-3.19	-2.90	-2.76	-2.62	-2.63	-2.69	-2.50	-2.60
gansu	-1.55	-2.11	-2.36	-2.33	-2.40	-2.16	-1.84	-1.76	-1.82	-2.08	-2.07
guangdong	-3.56	-4.29	-4.60	-4.46	-4.36	-4.03	-3.86	-3.92	-3.95	-3.16	-3.22
guangxi	-1.97	-2.86	-2.71	-2.76	-3.13	-2.90	-2.98	-3.11	-3.38	-3.19	-2.89
guizhou	-2.45	-3.08	-3.16	-3.06	-2.92	-2.67	-2.36	-2.52	-2.50	-2.55	-2.97
hainan	-2.46	-2.94	-2.62	-2.62	-2.81	-2.45	-2.37	-2.73	-2.89	-3.27	-3.47
hebei	-3.17	-3.61	-3.70	-4.05	-4.19	-3.90	-3.49	-3.79	-3.86	-3.75	-3.74
heilongjiang	-2.22	-2.84	-2.85	-2.94	-2.94	-2.82	-2.70	-2.95	-2.99	-3.07	-3.38
henan	-2.61	-3.23	-3.45	-3.92	-4.14	-3.89	-3.57	-3.84	-3.94	-3.96	-3.83
hubei	-2.00	-2.44	-2.51	-2.49	-2.43	-2.50	-2.52	-2.65	-3.10	-3.28	-3.34
hunan	-2.37	-3.20	-3.22	-3.24	-3.07	-2.73	-2.52	-2.71	-2.98	-2.87	-3.05
jiangsu	-3.15	-4.18	-4.67	-5.09	-4.63	-4.69	-4.40	-4.57	-4.49	-4.45	-4.41
jiangxi	-2.21	-2.89	-2.67	-2.60	-2.64	-2.68	-2.82	-3.05	-3.11	-3.15	-3.34

jilin	-2.52	-3.12	-2.92	-3.44	-3.55	-3.54	-3.22	-3.29	-3.48	-3.63	-3.55
liaoning	-2.24	-3.30	-3.21	-3.10	-3.01	-3.12	-3.06	-3.43	-3.06	-3.18	-3.08
neimongol	-1.94	-2.72	-2.89	-3.09	-3.32	-3.18	-2.85	-3.18	-3.24	-3.22	-3.28
ningxia	-1.73	-2.66	-2.29	-2.30	-2.52	-2.64	-2.62	-2.79	-2.52	-2.42	-2.40
qinghai	-1.37	-2.30	-1.82	-1.89	-2.04	-1.93	-1.82	-1.99	-1.61	-1.68	-1.83
shaanxi	-2.00	-2.25	-2.29	-2.46	-2.43	-2.39	-2.27	-2.43	-2.62	-2.62	-2.94
shandong	-3.17	-3.94	-3.97	-4.01	-4.08	-3.93	-3.86	-3.87	-3.82	-3.94	-4.04
shanghai	-3.45	-4.54	-4.50	-4.19	-4.02	-4.21	-4.29	-4.01	-4.43	-2.93	-3.06
shanxi	-2.63	-3.46	-3.38	-3.36	-3.08	-2.90	-2.60	-2.60	-2.90	-2.90	-2.74
sichuan	-2.87	-3.44	-3.29	-3.45	-3.71	-3.52	-2.51	-2.37	-2.71	-2.38	-2.58
tianjin	-3.60	-4.30	-4.16	-4.61	-4.83	-4.17	-4.42	-4.87	-4.89	-4.45	-4.47
xinjiang	-1.50	-1.85	-1.86	-2.01	-2.13	-1.90	-1.72	-1.85	-2.15	-2.09	-2.19
xizang	-0.51	-0.54	-0.51	-0.81	-0.53	-0.53	-0.56	-0.48	-0.48	-0.58	-0.57
yunnan	-2.24	-2.57	-2.67	-2.59	-2.64	-2.39	-2.22	-2.49	-2.74	-2.48	-2.58
zhejiang	-3.13	-4.05	-3.86	-4.17	-3.96	-3.44	-3.36	-3.47	-3.18	-3.03	-3.00

1 **S5 Table The ln GI of 31 provincial regions in China from 2014-2023.**

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	-2.99	-3.06	-2.97	-2.78	-2.58	-2.71	-2.66	-2.59	-2.22	-2.22
beijing	-2.42	-2.38	-2.38	-2.30	-2.18	-2.26	-2.13	-2.44	-2.43	-2.44
chongqing	-2.93	-2.65	-2.89	-2.90	-3.17	-3.06	-2.68	-2.67	-2.16	-2.00
fujian	-2.66	-2.68	-2.49	-2.65	-2.63	-2.63	-2.45	-2.47	-1.96	-1.77
gansu	-2.20	-2.05	-2.00	-1.89	-1.94	-1.97	-1.52	-1.71	-1.46	-1.52
guangdong	-3.11	-3.04	-3.00	-2.85	-2.78	-2.71	-2.38	-2.41	-2.04	-2.04
guangxi	-2.78	-2.65	-2.40	-2.34	-2.50	-2.69	-2.44	-2.49	-2.10	-2.30
guizhou	-2.98	-2.85	-2.82	-2.52	-2.56	-2.85	-2.75	-2.83	-2.58	-2.26
hainan	-3.02	-2.89	-2.52	-2.61	-2.26	-2.03	-1.50	-1.64	-1.40	-1.42
hebei	-3.65	-3.33	-3.20	-3.29	-3.24	-3.10	-2.66	-2.57	-2.25	-1.89
heilongjiang	-3.33	-3.07	-3.06	-3.06	-3.11	-2.77	-2.36	-2.05	-1.70	-1.87
henan	-3.58	-3.37	-3.42	-3.29	-3.05	-2.97	-2.89	-2.90	-2.58	-2.42
hubei	-3.28	-3.25	-2.79	-2.63	-2.73	-2.85	-2.68	-2.81	-2.66	-2.61
hunan	-2.98	-2.99	-2.99	-2.98	-3.20	-3.31	-3.12	-3.22	-3.27	-2.82
jiangsu	-4.32	-4.13	-4.01	-4.00	-3.99	-4.11	-3.87	-3.82	-3.66	-3.23
jiangxi	-3.42	-3.31	-2.83	-2.93	-3.20	-3.12	-3.24	-3.26	-2.82	-2.00
jilin	-3.68	-3.39	-3.20	-3.40	-3.60	-3.18	-3.47	-3.62	-2.47	-2.08
liaoning	-3.17	-3.10	-3.31	-3.15	-3.13	-3.20	-2.95	-2.75	-2.09	-2.13
neimongol	-3.01	-2.96	-2.56	-2.39	-3.09	-3.38	-3.38	-3.48	-3.21	-3.45
ningxia	-2.52	-2.31	-2.49	-2.44	-2.47	-2.53	-2.55	-2.19	-2.07	-2.31
qinghai	-1.66	-1.64	-1.42	-1.67	-1.26	-1.03	-1.34	-1.28	-1.24	-1.18
shaanxi	-2.78	-2.69	-2.48	-2.63	-2.78	-2.81	-2.64	-2.71	-2.34	-2.28
shandong	-4.00	-4.20	-3.92	-3.73	-3.86	-3.51	-3.06	-3.31	-2.81	-2.78
shanghai	-2.95	-2.79	-2.79	-2.31	-2.23	-2.24	-2.03	-2.12	-2.08	-2.06
shanxi	-2.84	-2.82	-2.83	-2.79	-2.73	-2.64	-2.55	-2.21	-1.98	-1.95
sichuan	-2.92	-2.77	-2.61	-2.66	-2.58	-2.93	-2.80	-2.72	-2.44	-2.08
tianjin	-4.23	-4.38	-4.11	-4.23	-3.96	-4.00	-3.02	-3.34	-2.91	-3.28
xinjiang	-1.94	-1.93	-1.67	-1.76	-1.70	-1.62	-1.08	-1.20	-1.13	-1.35

xizang	-0.43	-0.38	-0.37	-0.43	-0.69	-0.99	-1.40	-1.15	-0.71	-0.93
yunnan	-2.34	-2.09	-2.00	-2.06	-2.06	-2.18	-1.47	-1.62	-1.31	-1.34
zhejiang	-2.94	-2.85	-2.94	-2.54	-2.60	-2.79	-2.91	-3.07	-2.79	-2.36

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2 **S6 Table The ln ME of 31 provincial regions in China from 2003 to 2013.**

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	8.40	8.09	8.24	8.35	8.58	8.74	8.85	9.04	9.28	9.50	9.61
beijing	8.59	8.67	8.76	8.93	9.15	9.17	9.25	9.42	9.64	9.78	9.83
chongqing	8.37	8.31	8.41	7.78	7.92	8.10	8.26	6.11	8.54	8.78	9.04
fujian	8.20	8.18	8.19	8.35	8.55	8.73	8.85	9.05	9.22	9.41	9.53
gansu	7.35	7.10	7.20	7.42	7.57	7.55	7.65	7.85	8.02	8.22	8.37
guangdong	9.21	9.42	9.52	9.68	9.85	10.01	10.05	10.18	10.31	10.45	10.55
guangxi	7.48	7.67	7.79	7.95	8.19	8.35	8.39	8.66	8.86	9.06	9.17
guizhou	6.87	7.01	7.20	7.37	7.61	7.83	7.91	8.05	8.12	8.41	8.61
hainan	6.22	6.40	6.51	6.65	6.83	7.04	7.15	7.39	7.60	7.80	7.90
hebei	8.73	8.59	8.75	8.89	9.11	9.28	9.33	9.49	9.63	9.76	9.80
heilongjiang	7.89	8.01	8.17	8.26	8.40	8.50	8.47	8.65	8.82	8.99	9.04
henan	8.44	8.58	8.76	8.93	9.19	9.38	9.43	9.58	9.73	9.94	10.04
hubei	8.62	8.25	8.44	8.55	8.77	9.00	9.11	9.28	9.42	9.70	9.82
hunan	7.92	8.13	8.26	8.43	8.63	8.80	8.95	9.12	9.23	9.54	9.66
jiangsu	9.53	9.43	9.54	9.69	9.90	10.04	10.13	10.30	10.48	10.68	10.79
jiangxi	7.46	7.67	7.79	7.96	8.33	8.33	8.50	8.70	8.89	9.13	9.25
jilin	7.49	7.49	7.54	7.68	7.93	8.09	8.21	8.36	8.50	8.76	8.85
liaoning	8.58	8.19	8.28	8.37	8.55	8.70	8.69	8.79	8.91	9.21	9.27
neimongol	7.93	7.60	7.82	8.00	8.16	8.35	8.39	8.58	8.76	8.93	8.98
ningxia	5.91	6.01	6.06	6.17	6.42	6.79	6.90	7.11	7.29	7.44	7.50
qinghai	6.11	5.83	5.96	6.10	6.29	6.55	6.63	6.84	6.98	7.12	7.21
shaanxi	7.93	7.75	7.94	8.14	8.33	8.60	8.65	8.87	8.91	9.24	9.37
shandong	8.72	8.94	9.10	9.28	9.48	9.66	9.71	9.87	9.98	10.18	10.29
shanghai	8.74	8.93	9.01	9.14	9.34	9.47	9.50	9.63	9.75	9.86	9.96
shanxi	7.80	7.87	7.99	7.87	8.34	8.59	8.52	8.73	8.94	8.98	8.98
sichuan	7.79	7.67	7.77	8.69	8.87	9.02	9.17	9.35	9.56	9.80	9.90
tianjin	7.56	7.69	7.79	7.88	8.04	8.26	8.25	8.40	8.54	8.64	8.74
xinjiang	7.32	7.38	7.56	7.72	7.86	8.08	8.09	8.40	8.56	8.66	8.73
xizang	5.06	5.11	5.17	5.27	5.34	5.48	5.59	5.85	6.23	6.35	6.41
yunnan	7.98	7.71	7.80	8.04	8.24	8.39	8.46	8.64	8.80	9.08	9.17
zhejiang	9.17	9.05	9.07	9.23	9.44	9.57	9.63	9.81	9.96	10.14	10.22

3 **S7 Table The ln ME of 31 provincial regions in China from 2014 to 2023.**

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	9.75	9.77	9.83	9.94	10.10	10.15	10.90	11.00	10.24	10.34
beijing	9.92	9.93	10.02	10.08	10.16	10.28	11.38	11.50	10.48	10.54
chongqing	9.17	9.27	9.35	9.45	9.57	9.74	10.39	10.52	9.78	9.81
fujian	9.61	9.63	9.68	9.79	9.87	10.01	10.78	10.94	10.05	10.48
gansu	8.52	8.50	8.50	8.55	8.67	8.69	9.51	9.65	8.87	9.02

guangdong	10.61	10.60	10.68	10.80	10.91	10.99	11.77	11.89	11.02	11.52
guangxi	9.29	9.35	9.42	9.50	9.48	9.51	10.39	10.58	9.55	9.71
guizhou	8.83	8.97	9.05	9.20	9.32	9.34	10.08	10.17	9.23	9.42
hainan	8.01	8.03	8.11	8.20	8.32	8.36	8.92	9.24	8.51	8.63
hebei	9.86	9.86	9.91	9.94	10.07	10.11	10.77	10.89	10.03	10.18
heilongjiang	9.13	9.09	9.06	9.10	9.19	9.21	9.92	9.96	9.20	9.19
henan	10.10	10.15	10.23	10.32	10.46	10.54	11.15	11.24	10.50	10.53
hubei	9.93	9.95	10.05	10.15	10.35	10.44	11.20	11.30	10.56	10.61
hunan	9.75	9.77	9.81	9.97	10.12	10.22	10.97	11.08	10.34	10.40
jiangsu	10.89	10.96	11.05	11.12	11.26	11.32	12.07	12.21	11.41	11.54
jiangxi	9.35	9.37	9.46	9.52	9.67	9.76	10.47	10.60	9.93	9.97
jilin	8.90	8.86	8.89	8.95	9.00	9.03	9.90	9.96	9.06	9.08
liaoning	9.29	9.32	9.32	9.37	9.46	9.51	10.30	10.44	9.58	9.93
neimongol	9.01	9.07	9.12	9.33	9.40	9.46	9.98	10.21	9.76	9.83
ningxia	7.52	7.49	7.50	7.64	7.79	7.78	8.51	8.72	8.05	8.23
qinghai	7.30	7.36	7.45	7.52	7.64	7.65	8.28	8.40	7.82	7.94
shaanxi	9.43	9.33	9.45	9.69	9.85	9.94	10.60	10.74	10.18	10.18
shandong	10.38	10.44	10.46	10.52	10.62	10.67	11.38	11.58	10.78	11.07
shanghai	10.04	10.01	10.11	10.19	10.36	10.40	11.38	11.55	10.55	10.61
shanxi	8.92	8.93	8.97	9.29	9.34	9.46	10.00	10.28	9.90	9.85
sichuan	9.99	9.96	10.05	10.15	10.34	10.40	11.11	11.20	10.49	10.60
tianjin	8.80	8.77	8.84	9.06	9.24	9.16	10.33	10.42	9.40	9.48
xinjiang	8.78	8.72	8.79	8.86	9.04	9.09	9.80	10.03	9.30	9.39
xizang	6.45	6.53	6.60	6.76	6.91	7.09	8.04	8.16	7.10	7.37
yunnan	9.22	9.20	9.27	9.39	9.61	9.69	10.61	10.68	9.67	9.87
zhejiang	10.29	10.30	10.38	10.46	10.56	10.63	11.35	11.53	10.82	11.13

1 **S8 Table The ln CE of 31 provincial regions in China from 2003 to 2013.**

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	-0.71	-0.47	-0.53	-0.47	-0.42	-0.33	-0.37	-0.36	-0.34	-0.34	-0.32
beijing	-0.62	-1.15	-1.15	-1.16	-1.03	-0.94	-1.25	-0.94	-0.84	-0.99	-1.08
chongqing	-1.02	-0.82	-0.79	-0.84	-0.87	-0.67	-0.70	-0.77	-0.68	-0.61	-0.65
fujian	-0.88	-0.69	-0.71	-0.77	-0.72	-0.60	-0.70	-0.57	-0.54	-0.54	-0.51
gansu	-1.22	-0.67	-0.61	-0.59	-0.57	-0.61	-0.61	-0.59	-0.51	-0.45	-0.45
guangdong	-0.54	-0.65	-0.64	-0.69	-0.66	-0.54	-0.60	-0.56	-0.52	-0.56	-0.59
guangxi	-0.94	-0.64	-0.64	-0.63	-0.58	-0.49	-0.53	-0.44	-0.37	-0.37	-0.38
guizhou	-0.73	-0.67	-0.62	-0.61	-0.60	-0.60	-0.72	-0.69	-0.57	-0.56	-0.50
hainan	-1.08	-0.69	-1.00	-0.95	-0.60	-0.83	-0.93	-1.12	-0.91	-0.71	-0.82
hebei	-0.46	-0.34	-0.32	-0.29	-0.28	-0.26	-0.29	-0.29	-0.24	-0.19	-0.19
heilongjiang	-0.46	-0.35	-0.35	-0.37	-0.32	-0.30	-0.31	-0.27	-0.25	-0.20	-0.17
henan	-0.74	-0.46	-0.38	-0.31	-0.27	-0.24	-0.24	-0.25	-0.26	-0.26	-0.26
hubei	-1.06	-0.54	-0.52	-0.55	-0.54	-0.40	-0.47	-0.44	-0.36	-0.32	-0.33
hunan	-0.72	-0.43	-0.41	-0.45	-0.43	-0.39	-0.45	-0.43	-0.37	-0.36	-0.32
jiangsu	-0.61	-0.54	-0.49	-0.46	-0.49	-0.44	-0.47	-0.44	-0.38	-0.38	-0.38
jiangxi	-0.93	-0.51	-0.48	-0.47	-0.42	-0.36	-0.35	-0.32	-0.28	-0.27	-0.26
jilin	-0.53	-0.41	-0.46	-0.33	-0.23	-0.18	-0.21	-0.19	-0.22	-0.17	-0.18

liaoning	-0.58	-0.40	-0.39	-0.36	-0.40	-0.33	-0.38	-0.36	-0.39	-0.35	-0.35
neimongol	-0.66	-0.41	-0.42	-0.27	-0.23	-0.19	-0.22	-0.23	-0.23	-0.23	-0.22
ningxia	-1.16	-0.68	-0.63	-0.65	-0.65	-0.65	-0.75	-0.72	-0.63	-0.62	-0.58
qinghai	-0.76	-0.55	-0.68	-0.78	-0.60	-0.63	-0.73	-0.66	-0.64	-0.71	-0.64
shaanxi	-0.93	-0.63	-0.58	-0.55	-0.46	-0.42	-0.47	-0.42	-0.38	-0.30	-0.27
shandong	-0.45	-0.34	-0.32	-0.32	-0.32	-0.30	-0.33	-0.32	-0.29	-0.26	-0.26
shanghai	-0.69	-0.88	-0.78	-0.79	-0.85	-0.70	-0.81	-0.70	-0.64	-0.76	-0.87
shanxi	-0.73	-0.51	-0.49	-0.45	-0.40	-0.38	-0.46	-0.44	-0.33	-0.28	-0.26
sichuan	-0.70	-0.50	-0.43	-0.47	-0.50	-0.45	-0.57	-0.57	-0.47	-0.45	-0.43
tianjin	-0.66	-0.71	-0.69	-0.66	-0.68	-0.56	-0.59	-0.54	-0.46	-0.41	-0.45
xinjiang	-0.80	-0.55	-0.58	-0.53	-0.52	-0.54	-0.69	-0.63	-0.51	-0.50	-0.45
xizang	-1.57	-1.49	-1.70	-1.29	-1.42	-1.41	-1.18	-1.18	-1.30	-1.25	-1.04
yunnan	-0.96	-0.71	-0.73	-0.77	-0.74	-0.63	-0.72	-0.65	-0.53	-0.54	-0.47
zhejiang	-0.65	-0.66	-0.63	-0.57	-0.57	-0.52	-0.62	-0.59	-0.56	-0.51	-0.52

1 **S9 Table The ln CE of 31 provincial regions in China from 2014 to 2023.**

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	-0.30	-0.26	-0.34	-0.38	-0.44	-0.41	-0.43	-0.41	-0.31	-0.28
beijing	-1.10	-1.02	-1.15	-1.11	-1.04	-1.21	-1.17	-1.04	-1.07	-0.97
chongqing	-0.60	-0.53	-0.50	-0.55	-0.59	-0.63	-0.59	-0.56	-0.39	-0.29
fujian	-0.41	-0.37	-0.44	-0.42	-0.35	-0.31	-0.31	-0.29	-0.28	-0.24
gansu	-0.42	-0.43	-0.44	-0.64	-0.65	-0.66	-0.71	-0.61	-0.52	-0.49
guangdong	-0.52	-0.54	-0.64	-0.66	-0.71	-0.69	-0.65	-0.62	-0.53	-0.53
guangxi	-0.39	-0.40	-0.43	-0.49	-0.50	-0.53	-0.57	-0.48	-0.43	-0.44
guizhou	-0.48	-0.50	-0.52	-0.57	-0.61	-0.54	-0.54	-0.48	-0.48	-0.58
hainan	-0.66	-0.61	-0.69	-0.99	-0.80	-0.75	-0.80	-0.91	-0.88	-0.94
hebei	-0.19	-0.18	-0.19	-0.21	-0.22	-0.25	-0.32	-0.36	-0.31	-0.40
heilongjiang	-0.13	-0.15	-0.17	-0.20	-0.23	-0.27	-0.27	-0.26	-0.28	-0.33
henan	-0.26	-0.24	-0.23	-0.23	-0.20	-0.22	-0.22	-0.22	-0.20	-0.23
hubei	-0.28	-0.26	-0.35	-0.39	-0.38	-0.36	-0.38	-0.42	-0.34	-0.25
hunan	-0.28	-0.25	-0.31	-0.33	-0.35	-0.33	-0.26	-0.23	-0.16	-0.15
jiangsu	-0.34	-0.32	-0.40	-0.41	-0.43	-0.49	-0.45	-0.42	-0.23	-0.16
jiangxi	-0.25	-0.21	-0.28	-0.31	-0.29	-0.32	-0.27	-0.23	-0.21	-0.29
jilin	-0.15	-0.14	-0.16	-0.16	-0.15	-0.32	-0.19	-0.28	-0.39	-0.43
liaoning	-0.30	-0.30	-0.46	-0.60	-0.71	-0.62	-0.61	-0.59	-0.50	-0.47
neimongol	-0.23	-0.26	-0.32	-0.27	-0.12	-0.21	-0.31	-0.32	-0.25	-0.27
ningxia	-0.61	-0.59	-0.64	-0.65	-0.67	-0.77	-0.77	-0.77	-0.59	-0.52
qinghai	-0.72	-0.69	-0.84	-0.76	-0.93	-0.94	-1.05	-0.80	-0.73	-0.71
shaanxi	-0.28	-0.29	-0.32	-0.32	-0.29	-0.31	-0.37	-0.37	-0.32	-0.36
shandong	-0.23	-0.20	-0.26	-0.30	-0.28	-0.40	-0.41	-0.40	-0.31	-0.25
shanghai	-0.90	-1.00	-1.12	-1.06	-0.92	-0.90	-0.85	-0.84	-0.82	-0.80
shanxi	-0.25	-0.20	-0.23	-0.45	-0.47	-0.41	-0.41	-0.44	-0.45	-0.45
sichuan	-0.40	-0.40	-0.43	-0.45	-0.51	-0.56	-0.55	-0.54	-0.45	-0.52
tianjin	-0.41	-0.36	-0.49	-0.50	-0.35	-0.31	-0.34	-0.25	-0.21	-0.23

xinjiang	-0.49	-0.50	-0.51	-0.66	-0.63	-0.59	-0.70	-0.69	-0.60	-0.59
xizang	-1.22	-1.29	-1.52	-1.46	-1.31	-1.31	-0.91	-1.00	-1.47	-1.29
yunnan	-0.45	-0.51	-0.69	-0.69	-0.66	-0.67	-0.77	-0.64	-0.62	-0.54
zhejiang	-0.47	-0.44	-0.53	-0.59	-0.65	-0.69	-0.72	-0.72	-0.63	-0.56

1 **S10 Table The ln FEPE of 31 provincial regions in China from 2003 to 2013.**

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	-0.95	-0.85	-0.83	-0.75	-0.70	-0.54	-0.46	-0.28	-0.32	-0.32	-0.31
beijing	-0.56	-0.70	-0.72	-0.69	-0.81	-0.76	-0.47	-0.56	-0.52	-0.54	-0.48
chongqing	-0.53	-0.53	-0.48	-0.53	-0.57	-0.49	-0.45	-0.10	0.07	0.01	-0.08
fujian	-0.88	-0.87	-0.84	-0.85	-1.02	-0.89	-0.64	-0.48	-0.34	-0.42	-0.31
gansu	-0.79	-0.61	-0.70	-0.66	-0.74	-0.54	-0.45	-0.25	-0.32	-0.41	-0.41
guangdong	-0.66	-0.65	-0.66	-0.74	-1.18	-1.10	-0.85	-0.64	-0.64	-0.66	-0.64
guangxi	-0.86	-0.72	-0.70	-0.86	-0.88	-0.72	-0.62	-0.51	-0.39	-0.43	-0.51
guizhou	-0.77	-0.60	-0.73	-0.76	-0.79	-0.78	-0.55	-0.35	-0.28	-0.41	-0.41
hainan	-0.81	-0.77	-0.80	-0.88	-0.92	-0.57	-0.50	-0.41	-0.38	-0.38	-0.44
hebei	-1.19	-0.89	-0.89	-0.94	-0.95	-0.86	-0.66	-0.54	-0.44	-0.51	-0.47
heilongjiang	-0.91	-0.75	-0.78	-0.90	-0.64	-0.50	-0.52	-0.14	-0.09	-0.20	-0.16
henan	-1.17	-0.99	-0.87	-0.93	-0.94	-0.84	-0.71	-0.58	-0.59	-0.69	-0.70
hubei	-1.16	-1.03	-1.04	-1.14	-0.99	-0.85	-0.68	-0.45	-0.41	-0.53	-0.42
hunan	-0.89	-0.77	-0.74	-0.86	-0.85	-0.80	-0.65	-0.43	-0.35	-0.46	-0.41
jiangsu	-0.63	-0.57	-0.51	-0.53	-0.67	-0.50	-0.35	-0.27	-0.27	-0.34	-0.30
jiangxi	-0.94	-0.76	-0.74	-0.75	-0.79	-0.60	-0.45	-0.31	-0.29	-0.32	-0.31
jilin	-1.13	-1.07	-0.98	-0.95	-0.68	-0.54	-0.62	-0.29	-0.24	-0.34	-0.28
liaoning	-0.85	-0.71	-0.61	-0.70	-0.87	-0.73	-0.63	-0.36	-0.32	-0.33	-0.16
neimongol	-0.45	-0.36	-0.22	-0.29	-0.44	-0.34	-0.32	-0.14	-0.02	-0.02	0.02
ningxia	-0.28	-0.09	0.04	-0.08	-0.59	-0.35	-0.24	0.05	0.03	0.10	0.13
qinghai	-0.38	-0.50	-0.59	-0.54	-0.79	-0.78	-0.55	-0.34	0.02	-0.07	0.16
shaanxi	-0.77	-0.55	-0.73	-0.62	-0.76	-0.72	-0.55	-0.46	-0.31	-0.51	-0.43
shandong	-0.74	-0.74	-0.73	-0.72	-0.77	-0.69	-0.53	-0.41	-0.51	-0.52	-0.44
shanghai	0.21	0.24	0.24	0.16	-0.39	-0.30	-0.23	-0.27	-0.29	-0.28	-0.26
shanxi	-1.01	-0.87	-0.70	-0.32	-0.98	-0.80	-0.71	-0.37	-0.37	-0.37	-0.34
sichuan	-0.83	-0.67	-0.71	-0.77	-0.74	-0.16	-0.10	0.02	-0.28	-0.36	-0.37
tianjin	-0.16	-0.11	-0.14	-0.17	-0.44	-0.41	-0.21	-0.08	-0.02	-0.07	-0.04
xinjiang	-0.65	-0.65	-0.61	-0.83	-0.72	-0.62	-0.66	-0.38	-0.21	-0.22	-0.20
xizang	0.23	-0.29	-0.03	-0.07	-0.50	-0.29	-0.28	-0.12	0.06	-0.05	-0.06
yunnan	-0.68	-0.71	-0.64	-0.76	-0.82	-0.73	-0.62	-0.44	-0.35	-0.33	-0.27
zhejiang	-0.60	-0.64	-0.61	-0.66	-0.89	-0.80	-0.55	-0.51	-0.51	-0.61	-0.53

2 **S11 Table The ln FEPE of 31 provincial regions in China from 2014 to 2023.**

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	-0.23	-0.23	-0.34	-0.34	-0.44	-0.42	-0.49	-0.53	-0.62	-0.65
beijing	-0.46	-0.25	-0.14	-0.30	-0.29	-0.51	-0.66	-0.67	-0.74	-0.59
chongqing	-0.14	-0.14	-0.21	-0.21	-0.31	-0.35	-0.46	-0.63	-0.65	-0.55
fujian	-0.30	-0.28	-0.24	-0.30	-0.45	-0.47	-0.60	-0.64	-0.73	-0.70
gansu	-0.41	-0.30	-0.38	-0.36	-0.25	-0.29	-0.33	-0.41	-0.46	-0.45

guangdong	-0.57	-0.22	-0.42	-0.49	-0.66	-0.73	-0.83	-0.85	-0.86	-0.91
guangxi	-0.53	-0.45	-0.52	-0.51	-0.52	-0.46	-0.46	-0.65	-0.70	-0.81
guizhou	-0.28	-0.33	-0.42	-0.51	-0.50	-0.36	-0.46	-0.59	-0.56	-0.51
hainan	-0.40	-0.40	-0.38	-0.29	-0.28	-0.34	-0.46	-0.46	-0.58	-0.68
hebei	-0.44	-0.41	-0.46	-0.55	-0.48	-0.49	-0.49	-0.55	-0.67	-0.65
heilongjiang	-0.20	-0.10	-0.08	-0.13	-0.22	-0.20	-0.31	-0.45	-0.49	-0.45
henan	-0.62	-0.51	-0.52	-0.51	-0.52	-0.53	-0.61	-0.72	-0.77	-0.84
hubei	-0.49	-0.30	-0.50	-0.58	-0.50	-0.47	-0.61	-0.69	-0.64	-0.59
hunan	-0.40	-0.36	-0.40	-0.49	-0.48	-0.47	-0.54	-0.59	-0.59	-0.53
jiangsu	-0.26	-0.20	-0.33	-0.43	-0.48	-0.48	-0.52	-0.53	-0.58	-0.58
jiangxi	-0.30	-0.30	-0.40	-0.46	-0.54	-0.45	-0.46	-0.44	-0.50	-0.57
jilin	-0.20	-0.20	-0.16	-0.19	-0.31	-0.31	-0.37	-0.50	-0.54	-0.49
liaoning	-0.18	-0.48	-0.71	-0.78	-0.78	-0.73	-0.78	-0.86	-0.88	-0.83
neimongol	0.02	0.03	-0.01	-0.21	-0.10	-0.10	-0.22	-0.28	-0.24	-0.22
ningxia	0.07	0.08	0.00	0.06	0.00	-0.04	-0.19	-0.27	-0.27	-0.16
qinghai	0.13	0.11	0.01	-0.18	-0.19	-0.10	-0.20	-0.31	-0.20	-0.13
shaanxi	-0.29	-0.28	-0.39	-0.43	-0.47	-0.43	-0.52	-0.55	-0.52	-0.56
shandong	-0.44	-0.39	-0.49	-0.54	-0.57	-0.69	-0.74	-0.82	-0.88	-0.87
shanghai	-0.20	0.02	0.01	-0.01	-0.62	0.01	-0.04	-0.06	-0.25	-0.15
shanxi	-0.28	-0.35	-0.44	-0.48	-0.43	-0.29	-0.35	-0.52	-0.38	-0.39
sichuan	-0.32	-0.38	-0.47	-0.49	-0.46	-0.48	-0.51	-0.62	-0.59	-0.59
tianjin	-0.03	0.02	0.14	-0.13	-0.41	-0.15	-0.32	-0.48	-0.69	-0.51
xinjiang	-0.25	-0.21	-0.28	-0.41	-0.944	-0.35	-0.36	-0.44	-0.47	-0.38
xizang	0.06	-0.06	-0.10	-0.15	0.09	0.08	-0.04	-0.12	-0.17	0.04
yunnan	-0.25	-0.26	-0.39	-0.45	-0.51	-0.31	-0.42	-0.53	-0.55	-0.63
zhejiang	-0.53	-0.32	-0.45	-0.57	-0.55	-0.51	-0.65	-0.64	-0.70	-0.74

1 **S12 Table The ln FAE of 31 provincial regions in China from 2003 to 2013.**

Province	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
anhui	0.56	0.73	0.82	0.84	1.25	0.95	1.35	1.47	1.67	2.30	2.38
beijing	0.75	0.95	0.99	1.02	1.21	1.22	1.42	1.75	1.86	1.95	2.24
chongqing	-0.16	0.01	0.04	0.21	0.34	0.76	1.15	1.21	1.51	1.79	1.76
fujian	0.16	0.45	0.52	0.49	0.74	0.65	1.00	1.19	1.40	1.51	2.16
gansu	-0.22	0.28	0.00	0.07	0.42	0.57	1.01	0.63	1.25	1.49	1.59
guangdong	1.35	1.17	1.28	1.50	1.80	1.77	2.15	2.22	2.35	2.63	2.72
guangxi	0.34	0.11	0.33	0.39	0.66	0.97	1.17	1.27	1.43	1.70	1.69
guizhou	-0.42	-0.01	0.09	0.10	0.29	0.79	1.18	1.25	1.36	1.82	1.83
hainan	-1.26	-0.96	-0.66	-0.99	-0.46	-0.47	0.41	0.55	0.59	0.96	0.89
hebei	0.37	3.27	0.86	2.44	1.22	1.23	1.52	1.95	2.08	2.07	2.09
heilongjiang	0.58	0.93	0.87	0.93	0.99	1.18	1.32	1.49	1.80	1.97	2.03
henan	0.77	0.91	0.97	1.20	1.39	1.42	1.66	1.79	2.03	2.19	2.43
hubei	0.18	0.60	0.79	0.61	1.14	1.17	1.55	1.51	1.79	1.98	2.13
hunan	0.56	0.66	0.68	0.89	1.03	1.13	1.34	1.58	1.75	1.94	2.10
jiangsu	0.81	1.21	1.32	1.27	1.55	1.61	2.15	2.32	2.44	2.63	2.76
jiangxi	0.30	0.27	0.66	0.63	0.57	0.75	1.02	1.27	1.60	2.05	2.04
jilin	-0.10	-0.12	0.67	0.56	1.22	1.32	1.49	1.79	1.76	1.72	2.07

liaoning	0.73	1.19	1.34	1.46	1.73	1.74	2.30	2.57	2.78	2.75	2.65
neimongol	0.54	0.75	0.90	0.72	1.01	1.07	1.61	1.64	1.89	2.08	2.01
ningxia	-1.31	-1.70	-0.99	-0.88	-0.80	-0.39	-0.06	0.36	0.57	0.67	0.78
qinghai	-0.93	-1.48	-0.60	-1.21	-0.40	-0.24	0.17	0.59	0.89	1.21	1.41
shaanxi	0.24	0.39	0.48	0.51	0.72	0.96	1.38	1.87	1.89	2.19	2.19
shandong	0.83	1.18	1.49	1.24	1.66	1.55	1.81	2.09	2.16	2.61	2.81
shanghai	2.86	1.28	1.53	1.30	0.78	1.49	1.79	1.80	1.88	2.00	2.42
shanxi	0.07	1.48	0.57	0.68	0.66	0.96	1.15	1.43	1.58	1.78	1.86
sichuan	0.32	1.03	1.13	0.68	1.43	1.88	2.10	2.35	2.19	2.44	2.59
tianjin	0.12	0.16	0.25	0.48	2.05	0.61	0.95	1.07	1.36	1.83	1.87
xinjiang	-0.25	0.04	0.18	0.33	1.80	0.89	1.16	1.47	1.65	1.70	1.75
xizang	-0.81	-1.35	-0.37	0.26	0.87	-0.21	0.06	0.26	0.41	0.99	0.79
yunnan	0.31	0.82	0.69	0.35	0.38	0.96	1.40	1.60	1.82	1.96	2.16
zhejiang	0.84	0.91	1.03	1.19	1.41	1.35	1.72	1.95	1.90	2.17	2.41

1 **S13 Table The ln FAE of 31 provincial regions in China from 2014 to 2023.**

Province	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
anhui	2.45	2.55	2.42	2.55	2.47	2.77	2.88	2.77	2.64	2.63
beijing	2.21	2.53	2.51	2.82	2.66	2.67	2.49	2.99	2.96	2.75
chongqing	1.94	1.95	1.88	2.19	2.36	2.46	2.34	2.09	1.80	1.82
fujian	2.25	2.55	2.18	2.72	2.22	2.62	2.58	2.46	2.35	1.94
gansu	1.54	1.60	1.68	1.90	2.02	2.16	2.19	2.13	2.18	1.99
guangdong	2.77	3.05	2.90	3.19	3.32	3.34	3.31	3.48	3.19	3.12
guangxi	1.96	2.11	2.03	2.26	2.42	2.55	2.84	2.84	2.39	2.12
guizhou	2.01	2.21	2.01	2.39	2.21	2.50	2.64	2.57	2.38	2.22
hainan	1.04	1.16	0.88	1.09	1.17	1.59	1.82	1.58	1.66	1.43
hebei	2.30	2.46	2.35	2.67	2.78	3.01	3.02	3.10	2.92	3.03
heilongjiang	2.47	2.60	2.60	2.85	2.59	3.02	3.01	2.32	2.30	2.34
henan	2.32	2.45	2.58	2.98	2.89	2.80	3.13	2.58	3.18	3.34
hubei	2.24	2.59	2.59	2.74	2.88	3.13	3.17	3.13	2.94	2.79
hunan	2.49	2.66	2.71	2.74	2.66	2.86	2.85	2.85	2.73	2.72
jiangsu	2.89	3.01	2.89	3.31	3.05	3.45	3.46	3.73	3.27	3.01
jiangxi	2.18	2.24	2.26	2.41	2.34	2.57	2.76	3.09	2.74	2.65
jilin	2.08	2.24	2.39	2.61	2.11	2.36	2.49	2.17	1.92	1.71
liaoning	2.76	2.38	2.42	2.92	2.60	2.96	3.12	2.99	2.55	2.36
neimongol	2.03	2.31	2.33	2.66	2.64	2.83	2.94	2.80	2.58	2.71
ningxia	1.05	1.30	1.23	1.28	1.24	1.45	1.33	1.34	1.44	0.82
qinghai	1.05	1.26	1.20	1.57	1.30	1.63	1.53	1.53	1.35	1.54
shaanxi	2.55	2.51	2.43	2.58	2.62	2.95	3.04	2.66	2.50	2.40
shandong	3.06	3.18	3.11	3.26	3.07	3.15	3.45	3.36	3.09	3.05
shanghai	2.49	2.59	2.80	3.04	2.86	3.31	3.17	3.17	2.86	2.80
shanxi	1.82	1.88	1.72	1.86	2.07	2.38	2.42	2.66	2.31	2.02
sichuan	2.79	2.87	3.02	3.30	3.11	3.44	3.40	3.12	2.90	2.90
tianjin	2.01	2.28	2.34	2.46	2.03	2.09	2.21	2.08	1.49	1.51
xinjiang	1.97	2.15	2.11	2.20	2.21	2.45	2.35	1.85	2.02	2.04
xizang	1.13	1.56	1.37	1.86	1.48	1.75	1.75	1.66	2.08	2.00

yunnan	2.35	2.44	2.09	2.66	2.56	2.93	3.22	3.01	2.64	2.46
zhejiang	2.88	2.91	2.74	3.15	2.97	3.38	3.24	3.25	3.35	2.82

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Section 4: Coefficient of correlation between variables.

S14 Table presents the Coefficient of correlation between six variables, as illustrated in Fig 3.

S14 Table Coefficient of correlation between six variables.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) lnFG	1.000					
(2) lnGI	0.683*	1.000				
	(0.000)					
(3) lnME	-0.503*	-0.370*	1.000			
	(0.000)	(0.000)				
(4) lnCE	-0.127*	-0.473*	0.437*	1.000		
	(0.001)	(0.000)	(0.000)			
(5) lnFEPE	0.360*	0.133*	-0.133*	-0.124*	1.000	
	(0.000)	(0.001)	(0.001)	(0.002)		
(6) lnFAE	-0.169*	-0.172*	0.863*	0.383*	0.144*	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	

Note: *** p<0.01, ** p<0.05, * p<0.1.

Section 5: Methodology

Spatial auto-correlation.

From the perspective of spatial spillover, we should verify whether the research object has spatial dependence in the first place. Spatial dependence is often measured by spatial auto-correlation, which means that regions with similar locations have similar variable values. It is a positive spatial auto-correlation if high values cluster with high values and low values cluster with low values. Conversely, it is a negative spatial auto-correlation if the high value is adjacent to the low value. If the high and low values are distributed completely randomly, there is no spatial auto-correlation. Consider the complexity of spatial auto-correlation of spatial sequences.

The equation (3-1) is as follows:

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

(3-1)

where $S^2 = \frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}$ is the sample variance; w_{ij} is the element of the spatial weight matrix (i, j) , and $\sum_{i=1}^n \sum_{j=1}^n w_{ij}$ is the sum of all the spatial weights. If the spatial weight matrix is row normalized, then $\sum_{i=1}^n \sum_{j=1}^n w_{ij} = n$. In this case, Moran's I can be rewritten the equation (3-2), which is as follows:

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

(3-2)

The value of the Moran's I is generally $[-1, 1]$. A value greater than 0 indicates a positive auto-correlation, while a value less than 0 indicates a negative auto-correlation. We can also plot the Moran's I as a scatter plot to show the correlation between observations and their spatial lag. The

Moran's I is the slope of the regression line of the scatter plot. It must be noted that the space matrix needs to be set when the Moran's I test the spatial auto-correlation.

Spatial weight. The spatial weight matrix is a crucial tool for modeling spatial relationships and capturing spatial effects (Getis A, 2009). This means that for each spatial unit, the influence of other spatial units on that unit must be considered. The use of the spatial weight matrix typically requires quantifying the spatial connections between N spatial units into a numerical table that represents the spatial units of the grid or region of the observed sample unit. The specific format is as follows:

$$W = \begin{pmatrix} w_{11} & \cdots & w_{1n} \\ \vdots & \ddots & \vdots \\ w_{n1} & \cdots & w_{nn} \end{pmatrix}$$

(3-3)

which is an $n \times n$ matrix that each element w_{ij} in the matrix W represents the spatial relationship between space unit i and space unit j . The binary adjacency matrix is utilized in our study. Its primary advantage is that the binary adjacency method can be easily generalized to accommodate irregular spatial units, which is particularly beneficial for our research objects. The specific format is as follows:

$$w_{ij} = \begin{cases} 1, & \text{bound}(i) \cap \text{bound}(j) \neq \emptyset \\ 0, & \text{bound}(i) \cap \text{bound}(j) = \emptyset \end{cases}$$

(3-4)

where $\text{bound}()$ represents the boundary of a spatial unit. Generally there are three types of adjacencies among spatial units: Rook adjacency, Bishop adjacency, and Queen adjacency (Elhorst JP, 2001; Kelejian HH et al., 2010). This paper employs a k-proximity matrix ($k=2$) as the spatial weight matrix. The equation is as follows:

$$w_{ij} = \begin{cases} 1, & j \in N_k(i) \\ 0, & j \notin N_k(i) \end{cases}$$

(3-5)

where $N_k(i)$ is represented the set of k spatial units closest to i spatial unit.

The setting of the spatial weight matrix in this study (the knn matrix with $k=2$) is based on the “bounded rationality” decision theory [S12]. This theory states that decision-makers are limited by their cognitive abilities and information and cannot seek the optimal solution, but can only seek the satisfactory solution within constraints. Researchers further interpret attention as a scarce cognitive resource [S13-S14]. In the multi-objective and high-pressure situations of local governance in China, the attention resources of local government officials are particularly scarce, and their allocation often presents the selective focus that they prioritize the few areas that can bring obvious political achievements or respond to key evaluations. Based on this, the setting of $k = 2$ essentially operationalizes the limited attention decision-making model of local governments. It depicts that local officials are unable and do not need to track all neighboring provinces in spatial strategic interactions. Instead, they actively screening and locking onto a small number (such as 1 - 3) of key neighboring provinces that are most comparable in economic development level, administrative hierarchy, or resource endowment, and where competition is the most direct or the imitation success rate is the highest, as the main reference system for their decisions.

Spatial panel econometric model. The fundamental spatial econometric models include the spatial panel lag model (SPLM), the spatial panel error model (SPEM), and the spatial panel Durbin model (SPDM). The spatial panel lag model accounts for the spatial correlation of the dependent variable; the spatial panel error model addresses the impact of error on the dependent variable factors beyond the independent variable. The spatial panel Durbin model elucidates the spatial effects between the dependent variable and the independent variable (Burridge P, 1981;

LeSage JP, 2014). If the time lag term of the independent variable or the time lag term of the dependent variable is introduced, it constitutes a dynamic spatial panel model. The three models are expressed as follows:

$$Y = \rho W y + X\beta + \varepsilon, \varepsilon \sim N(0, \sigma^2 I_n) \quad (3-6)$$

which is the spatial panel lag model. Y is dependent variable, X is the exogenous argument matrix of $n \times k$ dimensions, ρ is the spatial lag coefficient of the explained variable, which reflects the influence of Wy in the adjacent region on y in the local region. W is $n \times n$ dimensional space weight matrix. Wy is the spatial lag explained variable. β is represented the effect of the independent variable X on the dependent variable Y . ε is the random error term.

$$Y = X\beta + \varepsilon \quad (3-7)$$

$$\varepsilon = \lambda W \varepsilon + \mu, \varepsilon \sim N(0, \sigma^2 I_n) \quad (3-8)$$

which is the spatial panel error model. The definition of the variables is the same as equation (3-6). And λ is $n \times 1$ dimensional spatial error correlation coefficient, which is represented the effect of y of adjacent regions on y of the local region. The spatial panel Durbin model is derived from the residual autocorrelation time series model, and its expression is as follows:

$$(I_n - \rho W)y = (I_n - \rho W)X\beta + \varepsilon \quad (3-9)$$

$$y = \rho W y + X\beta - \rho W X\beta + \varepsilon \quad (3-10)$$

$$Y = \rho W y + X\beta + \theta W X + \varepsilon, \varepsilon \sim N(0, \sigma^2 I_n) \quad (3-11)$$

which WX is the independent variable of spatial lag argument. The definition of the variables is the same as equation (3-6). If we convert the spatial Durbin model to matrix form, which is as follows:

$$y = (I - \lambda W)^{-1} \alpha + (I - \lambda W)^{-1} (X\beta + \theta W X) + (I - \lambda W)^{-1} \varepsilon \quad (3-12)$$

1 The partial differential equation of dependent variable to the m-th independent variable is as
2 follows:

$$\left[\frac{\partial y}{\partial x_{1m}} \quad \cdots \quad \frac{\partial y}{\partial x_{mm}} \right] = (1 - \lambda W)^{-1} \begin{pmatrix} \beta_m & \theta_m W_{12} & \cdots & \theta_m W_{1n} \\ \theta_m W_{21} & \beta_m & \cdots & \theta_m W_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \theta_m W_{n1} & \theta_m W_{n2} & \cdots & \beta_m \end{pmatrix} \quad (3 - 13)$$

3 which is the homogeneity of the main diagonal elements of the right end matrix, β_m is the
4 direct effect of the independent variable, and the mean of the sum of the non-diagonal elements
5 in each row or column is the spillover effect.

6

Section 6: The results of Moran's I.

S15 Table – S20 Table presents the Global Moran's I data for the six variables from 2003 to 2023, as illustrated in Fig. 4. S21 Table – S26 Table presents the Local Moran's I data for the lnFG and lnGI in 2003, 2013 and 2023, as illustrated in Fig. 5.

S15 Table. The results of Global Moran's I of lnFG from 2003-to 2023.

Year	Moran's I	E(I)	SD(I)	Z-Value	P-Value
2003	0.097	-0.033	0.173	0.752	0.226
2004	0.036	-0.033	0.175	0.395	0.346
2005	0.312	-0.033	0.176	1.963	0.025
2006	0.317	-0.033	0.173	2.027	0.021
2007	-0.177	-0.033	0.176	-0.818	0.207
2008	0.236	-0.033	0.176	1.525	0.064
2009	0.145	-0.033	0.172	1.041	0.149
2010	0.181	-0.033	0.174	1.233	0.109
2011	0.251	-0.033	0.173	1.647	0.05
2012	0.166	-0.033	0.167	1.194	0.116
2013	0.112	-0.033	0.168	0.865	0.194
2014	-0.145	-0.033	0.168	-0.665	0.253
2015	-0.266	-0.033	0.168	-1.381	0.084
2016	0.171	-0.033	0.172	1.187	0.118
2017	-0.025	-0.033	0.165	0.053	0.479
2018	-0.118	-0.033	0.159	-0.533	0.297
2019	-0.044	-0.033	0.171	-0.064	0.475
2020	0.209	-0.033	0.172	1.41	0.079
2021	0.378	-0.033	0.168	2.453	0.007
2022	-0.180	-0.033	0.169	-0.872	0.192
2023	0.371	-0.033	0.167	2.415	0.008

S16 Table. The results of Global Moran's I of lnGI from from 2003-to 2023.

Year	Moran's I	E(I)	SD(I)	Z-Value	P-Value
2003	0.488	-0.033	0.174	2.991	0.001
2004	0.636	-0.033	0.17	3.936	0.000
2005	0.601	-0.033	0.172	3.698	0.000
2006	0.553	-0.033	0.174	3.372	0.000
2007	0.534	-0.033	0.173	3.288	0.001
2008	0.607	-0.033	0.172	3.719	0.000
2009	0.679	-0.033	0.174	4.102	0.000
2010	0.681	-0.033	0.173	4.137	0.000
2011	0.684	-0.033	0.172	4.179	0.000

2012	0.678	-0.033	0.171	4.161	0.000
2013	0.575	-0.033	0.168	3.618	0.000
2014	0.624	-0.033	0.166	3.956	0.000
2015	0.598	-0.033	0.167	3.782	0.000
2016	0.667	-0.033	0.168	4.167	0.000
2017	0.571	-0.033	0.168	3.592	0.000
2018	0.579	-0.033	0.172	3.553	0.000
2019	0.530	-0.033	0.172	3.267	0.001
2020	0.431	-0.033	0.176	2.64	0.004
2021	0.429	-0.033	0.177	2.618	0.004
2022	0.467	-0.033	0.175	2.859	0.002
2023	0.402	-0.033	0.175	2.493	0.006

1 **S17 Table. The results of Global Moran' s I of lnME from 2003-to 2023.**

Year	Moran' s I	E(I)	SD(I)	Z-Value	P-Value
2003	0.359	-0.033	0.173	2.271	0.012
2004	0.402	-0.033	0.173	2.519	0.006
2005	0.384	-0.033	0.172	2.421	0.008
2006	0.332	-0.033	0.172	2.125	0.017
2007	0.367	-0.033	0.172	2.332	0.010
2008	0.374	-0.033	0.171	2.384	0.009
2009	0.393	-0.033	0.171	2.491	0.006
2010	0.289	-0.033	0.173	1.864	0.031
2011	0.382	-0.033	0.172	2.410	0.008
2012	0.391	-0.033	0.172	2.466	0.007
2013	0.396	-0.033	0.172	2.506	0.006
2014	0.402	-0.033	0.171	2.541	0.006
2015	0.440	-0.033	0.172	2.755	0.003
2016	0.446	-0.033	0.172	2.786	0.003
2017	0.465	-0.033	0.172	2.896	0.002
2018	0.458	-0.033	0.172	2.846	0.002
2019	0.458	-0.033	0.173	2.836	0.002
2020	0.464	-0.033	0.174	2.855	0.002
2021	0.469	-0.033	0.174	2.890	0.002
2022	0.445	-0.033	0.173	2.766	0.003
2023	0.421	-0.033	0.174	2.613	0.004

2 **S18 Table. The results of Global Moran' s I of lnCE from 2003-to 2023.**

Year	Moran' s I	E(I)	SD(I)	Z-Value	P-Value
2003	0.296	-0.033	0.171	1.929	0.027
2004	-0.018	-0.033	0.159	0.097	0.461
2005	0.004	-0.033	0.153	0.244	0.404
2006	0.016	-0.033	0.171	0.285	0.388

2007	0.051	-0.033	0.165	0.511	0.305
2008	0.194	-0.033	0.162	1.408	0.079
2009	0.227	-0.033	0.172	1.508	0.066
2010	0.272	-0.033	0.172	1.773	0.038
2011	0.182	-0.033	0.163	1.320	0.093
2012	0.179	-0.033	0.167	1.267	0.102
2013	0.114	-0.033	0.172	0.857	0.196
2014	0.175	-0.033	0.168	1.240	0.108
2015	0.208	-0.033	0.167	1.441	0.075
2016	0.130	-0.033	0.166	0.985	0.162
2017	0.226	-0.033	0.169	1.533	0.063
2018	0.212	-0.033	0.174	1.416	0.078
2019	0.165	-0.033	0.172	1.150	0.125
2020	0.310	-0.033	0.176	1.951	0.026
2021	0.272	-0.033	0.177	1.728	0.042
2022	0.202	-0.033	0.164	1.434	0.076
2023	0.239	-0.033	0.169	1.613	0.053

1 **S19 Table. The results of Global Moran' s I of lnFEPE from 2003-to 2023.**

Year	Moran' s I	E(I)	SD(I)	Z-Value	P-Value
2003	0.231	-0.033	0.171	1.545	0.061
2004	0.180	-0.033	0.169	1.267	0.102
2005	0.064	-0.033	0.170	0.574	0.283
2006	0.095	-0.033	0.173	0.741	0.229
2007	0.152	-0.033	0.175	1.056	0.145
2008	0.026	-0.033	0.176	0.340	0.367
2009	0.043	-0.033	0.176	0.432	0.333
2010	0.052	-0.033	0.176	0.485	0.314
2011	0.138	-0.033	0.176	0.970	0.166
2012	0.014	-0.033	0.176	0.268	0.394
2013	0.055	-0.033	0.175	0.507	0.306
2014	0.114	-0.033	0.176	0.839	0.201
2015	-0.096	-0.033	0.176	-0.353	0.362
2016	-0.088	-0.033	0.177	-0.309	0.379
2017	-0.192	-0.033	0.176	-0.903	0.183
2018	-0.373	-0.033	0.172	-1.974	0.024
2019	-0.027	-0.033	0.175	0.039	0.485
2020	0.058	-0.033	0.175	0.518	0.302
2021	0.157	-0.033	0.173	1.099	0.136
2022	0.266	-0.033	0.176	1.698	0.045
2023	0.290	-0.033	0.174	1.856	0.032

1 **S20 Table. The results of Global Moran' s I of lnFAE from 2003-to 2023.**

Year	Moran' s I	E(I)	SD(I)	Z-Value	P-Value
2003	0.300	-0.033	0.166	2.011	0.022
2004	0.190	-0.033	0.169	1.315	0.094
2005	0.360	-0.033	0.175	2.250	0.012
2006	0.228	-0.033	0.171	1.529	0.063
2007	0.171	-0.033	0.174	1.173	0.120
2008	0.139	-0.033	0.173	0.995	0.160
2009	0.158	-0.033	0.174	1.099	0.136
2010	0.142	-0.033	0.176	0.996	0.160
2011	0.086	-0.033	0.173	0.689	0.245
2012	0.107	-0.033	0.174	0.806	0.210
2013	0.255	-0.033	0.173	1.665	0.048
2014	0.215	-0.033	0.175	1.420	0.078
2015	0.244	-0.033	0.175	1.584	0.057
2016	0.209	-0.033	0.175	1.385	0.083
2017	0.258	-0.033	0.174	1.673	0.047
2018	0.132	-0.033	0.175	0.948	0.172
2019	0.167	-0.033	0.176	1.140	0.127
2020	0.233	-0.033	0.175	1.519	0.064
2021	0.345	-0.033	0.177	2.142	0.016
2022	0.184	-0.033	0.177	1.226	0.110
2023	0.153	-0.033	0.175	1.063	0.144

2 **S21 Table. The results of Local Moran' s I of lnFG in 2003.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	0.099	-0.033	0.662	0.200	0.421
beijing	0.110	-0.033	0.532	0.270	0.394
chongqing	-0.010	-0.033	0.662	0.035	0.486
fujian	0.918	-0.033	0.662	1.437	0.075
gansu	1.313	-0.033	0.662	2.033	0.021
guangdong	-0.196	-0.033	0.662	-0.246	0.403
guangxi	-0.033	-0.033	0.532	0.000	0.500
guizhou	0.237	-0.033	0.453	0.597	0.275
hainan	0.000	0.000	0.000	/	/
hebei	0.107	-0.033	0.453	0.311	0.378
heilongjiang	0.165	-0.033	0.951	0.208	0.418
henan	0.090	-0.033	0.951	0.129	0.449
hubei	0.042	-0.033	0.532	0.141	0.444
hunan	0.063	-0.033	0.532	0.181	0.428
jiangsu	1.350	-0.033	0.532	2.601	0.005
jiangxi	-0.041	-0.033	0.662	-0.011	0.495

jilin	-0.013	-0.033	0.662	0.030	0.488
liaoning	-0.133	-0.033	0.662	-0.151	0.440
neimongol	0.000	0.000	0.000	/	/
ningxia	0.720	-0.033	0.662	1.138	0.127
qinghai	2.531	-0.033	0.532	4.821	0.000
shaanxi	0.209	-0.033	0.662	0.366	0.357
shandong	0.000	0.000	0.000	/	/
shanghai	1.875	-0.033	0.662	2.883	0.002
shanxi	0.049	-0.033	0.951	0.086	0.466
sichuan	0.046	-0.033	0.662	0.119	0.453
tianjin	0.433	-0.033	0.453	1.029	0.152
xinjiang	2.185	-0.033	0.951	2.332	0.010
xizang	2.185	-0.033	0.951	2.332	0.010
yunnan	0.000	0.000	0.000	/	/
zhejiang	1.324	-0.033	0.532	2.553	0.005

1 **S22 Table. The results of Local Moran' s I of lnFG in 2013.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	-0.043	-0.033	0.671	-0.014	0.494
beijing	0.262	-0.033	0.539	0.548	0.292
chongqing	0.006	-0.033	0.671	0.058	0.477
fujian	0.637	-0.033	0.671	0.999	0.159
gansu	1.389	-0.033	0.671	2.120	0.017
guangdong	-0.621	-0.033	0.671	-0.876	0.191
guangxi	-0.026	-0.033	0.539	0.013	0.495
guizhou	0.231	-0.033	0.458	0.577	0.282
hainan	0.000	0.000	0.000	/	/
hebei	0.089	-0.033	0.458	0.266	0.395
heilongjiang	0.268	-0.033	0.964	0.313	0.377
henan	0.012	-0.033	0.964	0.047	0.481
hubei	0.001	-0.033	0.539	0.064	0.474
hunan	-0.017	-0.033	0.539	0.031	0.488
jiangsu	1.559	-0.033	0.539	2.956	0.002
jiangxi	-0.099	-0.033	0.671	-0.098	0.461
jilin	0.111	-0.033	0.671	0.214	0.415
liaoning	-0.050	-0.033	0.671	-0.024	0.490
neimongol	0.000	0.000	0.000	/	/
ningxia	0.541	-0.033	0.671	0.857	0.196
qinghai	2.624	-0.033	0.539	4.934	0.000
shaanxi	0.061	-0.033	0.671	0.141	0.444
shandong	0.000	0.000	0.000	/	/
shanghai	3.026	-0.033	0.671	4.560	0.000

shanxi	0.006	-0.033	0.964	0.041	0.484
sichuan	0.266	-0.033	0.671	0.446	0.328
tianjin	0.568	-0.033	0.458	1.311	0.095
xinjiang	2.090	-0.033	0.964	2.203	0.014
xizang	2.090	-0.033	0.964	2.203	0.014
yunnan	0.000	0.000	0.000	/	/
zhejiang	1.416	-0.033	0.539	2.691	0.004

1 **S23 Table. The results of Local Moran' s I of lnFG in 2023.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	0.186	-0.033	0.668	0.328	0.371
beijing	0.158	-0.033	0.536	0.357	0.361
chongqing	-0.092	-0.033	0.668	-0.088	0.465
fujian	0.738	-0.033	0.668	1.155	0.124
gansu	1.426	-0.033	0.668	2.184	0.014
guangdong	-0.648	-0.033	0.668	-0.920	0.179
guangxi	-0.056	-0.033	0.536	-0.042	0.483
guizhou	0.042	-0.033	0.457	0.165	0.434
hainan	0.000	0.000	0.000	/	/
hebei	0.004	-0.033	0.457	0.082	0.467
heilongjiang	0.912	-0.033	0.960	0.985	0.162
henan	0.030	-0.033	0.960	0.066	0.474
hubei	0.034	-0.033	0.536	0.125	0.450
hunan	-0.014	-0.033	0.536	0.036	0.486
jiangsu	1.403	-0.033	0.536	2.678	0.004
jiangxi	-0.102	-0.033	0.668	-0.102	0.459
jilin	0.476	-0.033	0.668	0.763	0.223
liaoning	0.044	-0.033	0.668	0.115	0.454
neimongol	0.000	0.000	0.000	/	/
ningxia	0.413	-0.033	0.668	0.668	0.252
qinghai	2.817	-0.033	0.536	5.313	0.000
shaanxi	-0.044	-0.033	0.668	-0.016	0.494
shandong	0.000	0.000	0.000	.	.
shanghai	2.412	-0.033	0.668	3.661	0.000
shanxi	0.014	-0.033	0.960	0.049	0.480
sichuan	-0.022	-0.033	0.668	0.016	0.493
tianjin	0.359	-0.033	0.457	0.859	0.195
xinjiang	2.898	-0.033	0.960	3.054	0.001
xizang	2.898	-0.033	0.960	3.054	0.001
yunnan	0.000	0.000	0.000	/	/
zhejiang	1.433	-0.033	0.536	2.733	0.003

2 **S24 Table. The results of Local Moran' s I of lnGI in 2003.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	0.057	-0.033	0.670	0.135	0.446
beijing	-0.358	-0.033	0.538	-0.603	0.273
chongqing	-0.421	-0.033	0.670	-0.578	0.282
fujian	-0.232	-0.033	0.670	-0.297	0.383
gansu	1.347	-0.033	0.670	2.060	0.020
guangdong	-0.341	-0.033	0.670	-0.458	0.323
guangxi	-0.380	-0.033	0.538	-0.644	0.260
guizhou	-0.033	-0.033	0.458	0.001	0.499
hainan	0.000	0.000	0.000	/	/
hebei	0.354	-0.033	0.458	0.846	0.199
heilongjiang	-0.047	-0.033	0.963	-0.014	0.494
henan	-0.192	-0.033	0.963	-0.164	0.435
hubei	0.086	-0.033	0.538	0.222	0.412
hunan	0.011	-0.033	0.538	0.083	0.467
jiangsu	1.118	-0.033	0.538	2.139	0.016
jiangxi	0.045	-0.033	0.670	0.118	0.453
jilin	-0.042	-0.033	0.670	-0.014	0.495
liaoning	-0.005	-0.033	0.670	0.042	0.483
neimongol	0.000	0.000	0.000	/	/
ningxia	0.749	-0.033	0.670	1.167	0.122
qinghai	2.415	-0.033	0.538	4.549	0.000
shaanxi	0.127	-0.033	0.670	0.239	0.406
shandong	0.000	0.000	0.000	/	/
shanghai	1.847	-0.033	0.670	2.805	0.003
shanxi	-0.207	-0.033	0.963	-0.180	0.428
sichuan	-0.608	-0.033	0.670	-0.858	0.195
tianjin	0.820	-0.033	0.458	1.862	0.031
xinjiang	3.308	-0.033	0.963	3.468	0.000
xizang	3.308	-0.033	0.963	3.468	0.000
yunnan	0.000	0.000	0.000	/	/
zhejiang	0.448	-0.033	0.538	0.894	0.186

1 **S25 Table. The results of Local Moran' s I of lnGI in 2013.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	0.153	-0.033	0.649	0.287	0.387
beijing	-0.707	-0.033	0.521	-1.292	0.098
chongqing	0.044	-0.033	0.649	0.119	0.453
fujian	-0.120	-0.033	0.649	-0.134	0.447
gansu	1.468	-0.033	0.649	2.315	0.010
guangdong	0.067	-0.033	0.649	0.155	0.438
guangxi	-0.042	-0.033	0.521	-0.017	0.493
guizhou	0.015	-0.033	0.445	0.108	0.457

hainan	0.000	0.000	0.000	/	/
hebei	0.324	-0.033	0.445	0.803	0.211
heilongjiang	0.365	-0.033	0.931	0.428	0.334
henan	0.491	-0.033	0.931	0.564	0.286
hubei	0.152	-0.033	0.521	0.355	0.361
hunan	0.026	-0.033	0.521	0.114	0.455
jiangsu	0.970	-0.033	0.521	1.924	0.027
jiangxi	-0.105	-0.033	0.649	-0.111	0.456
jilin	0.221	-0.033	0.649	0.392	0.348
liaoning	0.065	-0.033	0.649	0.152	0.440
neimongol	0.000	0.000	0.000	/	/
ningxia	0.536	-0.033	0.649	0.878	0.190
qinghai	2.905	-0.033	0.521	5.634	0.000
shaanxi	0.052	-0.033	0.649	0.131	0.448
shandong	0.000	0.000	0.000	/	/
shanghai	0.066	-0.033	0.649	0.153	0.439
shanxi	0.031	-0.033	0.931	0.069	0.472
sichuan	0.594	-0.033	0.649	0.967	0.167
tianjin	0.891	-0.033	0.445	2.079	0.019
xinjiang	3.526	-0.033	0.931	3.824	0.000
xizang	3.526	-0.033	0.931	3.824	0.000
yunnan	0.000	0.000	0.000	/	/
zhejiang	0.000	-0.033	0.521	0.064	0.475

1 **S26 Table. The results of Local Moran' s I of lnGI in 2023.**

Location	Ii	E(Ii)	sd(Ii)	z	p-value*
anhui	0.154	-0.033	0.672	0.279	0.390
beijing	0.639	-0.033	0.539	1.247	0.106
chongqing	-0.014	-0.033	0.672	0.029	0.489
fujian	-0.042	-0.033	0.672	-0.013	0.495
gansu	0.722	-0.033	0.672	1.125	0.130
guangdong	0.081	-0.033	0.672	0.171	0.432
guangxi	-0.108	-0.033	0.539	-0.139	0.445
guizhou	-0.077	-0.033	0.459	-0.094	0.462
hainan	0.000	0.000	0.000	/	/
hebei	-0.475	-0.033	0.459	-0.963	0.168
heilongjiang	0.051	-0.033	0.966	0.087	0.465
henan	0.386	-0.033	0.966	0.435	0.332
hubei	0.374	-0.033	0.539	0.756	0.225
hunan	0.151	-0.033	0.539	0.342	0.366
jiangsu	0.675	-0.033	0.539	1.314	0.094
jiangxi	-0.066	-0.033	0.672	-0.048	0.481

jilin	0.026	-0.033	0.672	0.089	0.465
liaoning	0.005	-0.033	0.672	0.057	0.477
neimongol	0.000	0.000	0.000	/	/
ningxia	-0.121	-0.033	0.672	-0.131	0.448
qinghai	2.476	-0.033	0.539	4.652	0.000
shaanxi	-0.003	-0.033	0.672	0.044	0.482
shandong	0.000	0.000	0.000	/	/
shanghai	-0.160	-0.033	0.672	-0.189	0.425
shanxi	-0.075	-0.033	0.966	-0.044	0.483
sichuan	0.148	-0.033	0.672	0.269	0.394
tianjin	0.566	-0.033	0.459	1.307	0.096
xinjiang	2.814	-0.033	0.966	2.949	0.002
xizang	2.814	-0.033	0.966	2.949	0.002
yunnan	0.000	0.000	0.000	/	/
zhejiang	-0.081	-0.033	0.539	-0.088	0.465

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Section 7: The results and test of model selection.

In the empirical analysis section, we selected the time-fixed effects spatial Durbin model. We have provided a detailed explanation of the model selection process in the text; however, due to the limitation on the number of tables, the results of the model selection are presented in S27 Table, while the test results are listed in S28 Table.

To construct the spatial panel model be built, a series of regression analyses and tests to determine which type of model will serve as the final empirical analysis model should be conducted. Firstly, the regression of non-spatial panel model is carried out, including the mixed regression (OLS), spatial fixed effect regression, time fixed effect regression, double fixed effect regression and random effect regression. The regression results are shown in S27 Table (S1 Appendix). According to the results of the F-test, the null hypothesis is rejected; therefore, the fixed effects model should be selected over the mixed model. Meanwhile, the BP test rejects the null hypothesis of mixed regression, indicating that the random effects model should be employed. Additionally, the Hausman test also rejects the null hypothesis, suggesting that between the fixed effects model and the random effects model, the fixed effects model should be preferred. By synthesizing the results of these three tests, we can conclude that the fixed effects model is the appropriate choice. Secondly, in the fixed-effects model, it is generally accepted that a higher R^2 value indicates a better fit for the model, suggesting that the time fixed-effects model should be selected. The results of the LM test and the robust LM test indicate that both the spatial panel lag model (SPLM) and the spatial panel error model (SPEM) are valid. Consequently, the feasibility of employing the spatial panel Durbin model (SPDM) within the framework of spatial fixed effects warrants further consideration. Finally, the likelihood ratio test (LR test) and the Wald test are employed to assess whether the spatial panel Durbin model can be transformed into a spatial panel lag model or a spatial panel error model under the spatial

fixed effect. The results of the LR test and the Wald test are presented in S28 Table (S1 Appendix). Both the LR test and the Wald test reject the null hypothesis, indicating that the spatial panel Durbin model cannot be simplified to either the spatial panel model or the spatial panel error model. Therefore, it is more appropriate to select the Durbin model of space panel under the time fixed effect.

S27 Table. Non-spatial panel regression results.

Variables	OLS	Spatial Fixed Effects Model	Time Fixed Effect Model	Two-way Fixed Effects	Random Effects Model
ln GI	0.652***	0.164***	0.408***	0.127***	0.238***
	(25.047)	(9.530)	(15.048)	(6.838)	(12.098)
ln ME	-0.672***	0.009	-0.857***	-0.141***	-0.068***
	(-18.809)	(0.417)	(-26.347)	(-3.825)	(-2.882)
ln CE	1.199***	0.041	1.146***	0.100	0.130*
	(15.032)	(0.626)	(17.336)	(1.481)	(1.723)
ln FEPE	0.415***	0.403***	-0.074	0.339***	0.455***
	(5.346)	(9.279)	(-0.960)	(6.804)	(9.011)
ln FAE	0.521***	0.171***	0.327***	0.047*	0.204***
	(12.093)	(8.242)	(7.883)	(1.926)	(8.342)
Constant	5.542***	-1.990***	6.610***	-0.926***	-1.078***
	(23.631)	(-10.763)	(31.999)	(-3.075)	(-4.992)
R ²	0.768	0.650	0.846	0.725	0.633
F Test	/	228.22***	688.17***	86.50***	/
BP Test	/	/	/	/	1065.06***
Hausman Test	/	191.19***	2027.84***	84.99***	/
LM-lag	25.491***	/	/	/	/
RLM-lag	19.588***	/	/	/	/
LM-Err	6.166***	/	/	/	/
RLM- Err	0.264	/	/	/	/
VIF	3.44	/	/	/	/
N	651	651	651	651	651

The t-statistics is in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

1 **S28 Table. The results of LR tests and Wald tests.**

Variable	SPLM	SPEM	SPDM-FE	SPDM-RE
ln GI	0.142***	0.155***	0.114***	0.109***
	(8.714)	(8.880)	(6.752)	(6.214)
ln ME	-0.010	0.015	-0.123***	-0.161***
	(-0.505)	(0.715)	(-3.941)	(-4.980)
ln CE	0.035	0.050	0.069	0.117*
	(0.577)	(0.773)	(1.115)	(1.842)
ln FEPE	0.349***	0.394***	0.321***	0.169***
	(8.504)	(8.983)	(6.903)	(5.738)
ln FAE	0.134***	0.162***	0.063***	0.082***
	(6.689)	(7.713)	(2.793)	(3.604)
W ln GI			0.068***	0.062***
			(3.117)	(2.739)
W ln ME			0.078**	0.097***
			(2.237)	(2.670)
W ln CE			-0.146*	-0.153*
			(-1.749)	(-1.779)
W ln FEPE			0.065	0.102***
			(1.124)	(2.652)
W ln FAE			0.131***	0.139***
			(4.714)	(4.909)
Rho	0.251***		0.175***	0.179***
	(6.911)		(4.519)	(4.555)
Sigma	0.026***	0.028***	0.024***	0.026***
	(17.914)	(18.002)	(17.975)	(17.526)
Lambda	/	0.126***	/	/
	/	(2.983)	/	/
R2	0.189	0.130	0.398	0.405
LR SLM	/	/	56.28***	/
LR SEM	/	/	91.88***	/
Wald SLM	/	/	58.04***	/
Wald SEM	/	/	95.69***	/
Hausman	/	/	26.26***	

2 The z-statistics is in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

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