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Analysis of the Impact of Artificial Intelligence Technology on Intergenerational Income Flow

-- Empirical Research based on CFPS Data

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Abstract

The development of artificial intelligence technology has brought new occupations, new jobs and new models. Paying attention to its impact on intergenerational income flow is conducive to improving the income distribution system and helping achieve common prosperity. After collecting the relevant patent data of prefecture-level cities from 2010 to 2020, this paper uses the two-stage range entropy method to measure their artificial intelligence level and combines the China Household Tracking Survey (CFPS) database to sort out and generate mixed cross-section data for empirical analysis. The research results show that the development of artificial intelligence technology significantly promotes the intergenerational income flow, and has significant heterogeneity in different individual gender, household registration, and regional marketization levels. Finally, according to the research conclusions, the corresponding policy recommendations are put forward.

Keywords

Artificial Intelligence Technology; Intergenerational Income Mobility; Two-Stage Range Entropy Method; CFPS Data.

1. Introduction

The Chinese-style modernization is a modernization of common prosperity for all the people. The report to the 20th National Congress of the Communist Party of China pointed out that the distribution system is a basic system for promoting common prosperity, and it is necessary to standardize the income distribution order and wealth accumulation mechanism in China, narrow the income gap, and promote fair opportunities and balanced income distribution. As an important index to measure the fairness and balance of income distribution, intergenerational income mobility is of great significance to explore its influencing factors for the realization of common prosperity. As the engine leading a new round of scientific and technological revolution, the development of artificial intelligence has an important impact on intergenerational income flow. Therefore, it is particularly important to study the impact analysis of artificial intelligence on promoting China's intergenerational income mobility. This paper aims to explore the impact of artificial intelligence technology on intergenerational income flow. By measuring the level of artificial intelligence in prefecture-level cities and analyzing the data of China Household Tracking Survey (CFPS), the paper reveals the mechanism and heterogeneity of the impact of artificial intelligence technology on intergenerational income flow and provides theoretical support for promoting upward intergenerational income flow and realizing common prosperity.

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2. Mechanism Research and Hypothesis

This paper argues that the intergenerational income flow is affected by household consumption, individual age, household registration type, gender, education level and personal income gap, which makes the income flow between families significantly different. Therefore, the following assumptions are made: To ensure the accuracy and depth of the research, the following key assumptions are proposed:

Non-mobile population hypothesis: Based on questionnaire data, this study assumes that individuals participating in the questionnaire did not move across provinces and cities during the data collection period, that is, the geographical location of individuals or families was relatively fixed during the study period. This hypothesis helps to control the variables of the impact of external migration on intergenerational income mobility, so as to more accurately analyze the impact of other internal factors such as education and career choice on income mobility.

Market stability assumption: During the period of questionnaire data collection, it is assumed that no major economic or policy changes have occurred that affect the stability of the market and the employment status of individuals. By controlling for this variable, the long-term effects of AI developments on intergenerational income flows can be more effectively assessed, rather than those caused by temporary economic fluctuations. This paper argues that the intergenerational income flow is affected by household consumption, individual age, household registration type, gender, education level and personal income gap, which makes the income flow between families significantly different.

3. Index Selection and Data Acquisition

3.1. Indicator Description

(1) Design of core indicators

1) Artificial Intelligence Level (aiit)

Patent is an important output of industrial innovation activities, and patent technology provides a feasible method to measure the level of artificial intelligence. Therefore, referring to Cui Rong et al. (2021), two-stage entropy method is adopted to measure the development level index of artificial intelligence in China, and it is further expanded to two-stage range entropy method. Based on the number of artificial intelligence patent applications, artificial intelligence invention patent applications, artificial intelligence utility model patent applications and the number of artificial intelligence appearance design patent applications in 293 prefecture-level cities in China from 2010 to 2022, the artificial intelligence level of prefecture-level cities in China is identified and measured. Specific indicators are shown in the following table.

Table 1. Comprehensive index system of artificial intelligence variables

Variable	Indicator	Direction
Artificial intelligence development level	Number of artificial intelligence patent applications	Forward
Artificial intelligence development level	Number of patent applications for artificial intelligence inventions	Forward
Artificial intelligence development level	Number of artificial intelligence utility model patent applications	Forward
Artificial intelligence development level	Number of artificial intelligence design patent applications	Forward

The specific steps of the two-stage range entropy method are as follows:

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① Standardized processing of raw data. Because of the different nature of each index, the expression of different meanings. Therefore, the original data is processed without dimension. Among them, the calculation formulas of positive and negative indicators are shown in (1) and 2) respectively:

$$X'_{itjk} = \frac{X_{itjk} - \min(X_{jk})}{\max(X_{jk}) - \min(X_{jk})} \quad (1)$$

$$X'_{itjk} = \frac{\max(x_{jk}) - x_{itjk}}{\max(x_{jk}) - \min(x_{jk})} \quad (2)$$

Among them, xitjk represents the k indicator value in the *j* evaluation dimension of the city *i* in the *t* year. (i=1, 2, …, m; t =1, 2, …, n; j =1, 2, …, h; k =1, 2, …, r), max (X_{jk})represents the maximum value of Xjk among all years and prefecture-level cities, min (X_{jk}) represents the minimum value of B among all years and prefecture-level cities.

②Calculate the proportion of the k indicator in the j dimension of province i in year t.

$$P_{itjk} = \frac{x'_{itjk}}{\sum_{i=1}^{m}\sum_{t=1}^{n} x'_{itjk}} \quad (3)$$

③Calculate the entropy. In order to calculate the index entropy of different dimensions, the artificial intelligence level of each region is measured.

$$e_{jk} = -\frac{1}{\ln mn}\sum_{i=1}^{m}\sum_{t=1}^{n} P_{itjk} \ln P_{itjk} \quad (4)$$

$$f_{itj} = \frac{x_{itj}}{\sum_{i=1}^{m}\sum_{t=1}^{n} x_{itj}} \quad (5)$$

$$e_j = -\frac{1}{\ln mn}\sum_{i=1}^{m}\sum_{t=1}^{n} P_{itj} \ln f_{itj} \quad (6)$$

Among them, (4) is the entropy value of the k indicator in the j dimension, (5) is the weight of the j dimension of province i in year t among all dimensions, and (6) is the entropy value of the j dimension.

④ Calculate the comprehensive index of artificial intelligence level.

$$ai_{it} = \sum_{j=1}^{h} \frac{1-e_j}{\sum_{k=1}^{r}(1-e_j)} f_{itj} \quad (7)$$

Among them, aiit is the artificial intelligence level index of province i in year t. The larger aiit is, the higher the artificial intelligence level of the city is. Conversely, if aiit is smaller, the artificial intelligence level is lower.

3) Intergenerational income flow (im)

The variable data of intergenerational income come from the data of China Family Tracking Survey (CFPS). CFPS samples cover a wide range and are representative to a certain extent. The questionnaire covers both family and individual levels, which can provide data support for the analysis of income changes between parents and children. The intergenerational income flow variable constructed in this paper is based on the data of the six rounds of CFPS2010-2020

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survey. The intergenerational relationship is identified by matching the personal codes of the respondents and other family members, and the data is processed as follows by referring to the research of Wei Xiahai et al. (2024) : Non-school samples with children over 16 years old and 6 non-retired samples with parents under 70 years old were selected. The samples whose age difference between parents and children was less than 15 years were deleted; The samples with missing key information such as income and occupation of parents and children were excluded.

In this paper, referring to the study of Fang Fuqian et al. (2023), the income index used is the total income from work, and the intergenerational income flow is defined as whether the income range of children and parents' changes. If the income of the parents in the current year is in the bottom 50% of the income distribution of the same generation, and the income of the children is in the top 50% of the income of the same generation, the value is 1; if the income of the parents and the income of the children in the same generation is in the same range, it is considered that no intergenerational income flow has occurred, and the value is 0.

(2) Control variables

1) Individual level

In the questionnaire, "May I ask your date (year) of birth?" This problem calculates the age of the child; In the questionnaire, "Are you from a village or a town?" This question is calculated to obtain the household registration type (urban), and the value of "urban" is 0, and the value of "rural" is 1; In the questionnaire, "Is your gender male or female?" "Male" is assigned a value of 0, "female" is assigned a value of 1; In the questionnaire, "personal maximum education" is calculated by the specific years of response. The maximum education years of illiteracy/semi-illiteracy are 0, the primary school education is 6, the junior high school education is 9, the high school and vocational school is 12, the junior college education is 15, the undergraduate education is 16, the postgraduate education is 19 and the doctoral education is 23. In addition, in the individual control variable, the income of the children and the parents is increased.

2) Regional level

Considering the impact of regional feature differences on intergenerational income flow, in order to reduce the endogeneity problem caused by missing variables, the following control variables are selected: Control variables such as economic development level (PGDP), transportation infrastructure level (Tra), research and development intensity (R&D), industrial structure upgrading (Ind) and government intervention level (Gov) are used to measure the impact of artificial intelligence level on intergenerational income.

3) Data sources

The original data of artificial intelligence (aiijt) comes from the number of artificial intelligence patent applications, the number of artificial intelligence invention patent applications, the number of artificial intelligence utility model patent applications and the number of artificial intelligence design patent applications in prefecture-level cities from 2010 to 2022. Through our patent database and One patent (Patyee) data platform search keywords to obtain artificial intelligence related patent data collation.

The original data of Intergenerational Income Mobility (imijt))comes from the China Household Tracking Survey (CFPS), which covers the survey data of 293 autonomous regions and municipalities in China in 2010, 2012, 2014, 2016, 2018 and 2020, and is combined to form a mixed cross-section data. The data are processed as follows: First, the child's id is matched with the parent's id. Secondly, the questionnaire data were sorted out and sorted out such data as age, urbanization level, gender, education background and personal income. Finally, 13,690 valid samples were obtained by eliminating the data samples of the father's death and missing variables.

The control variable economic development level (PGDP) is measured by the per capita gross domestic product of each region, the transportation infrastructure level (Tra) is measured by

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the per capita road freight volume of each region, the research and development intensity (R&D) is measured by the ratio of R&D expenditure in each region to the regional gross national product, and the industrial structure upgrading (Ind) is measured by the added value of the secondary industry and the tertiary industry in each region The proportion of added value in regional GNP is measured, and the degree of government intervention (Gov) is measured by the proportion of local general budget expenditure in regional GNP. The control variable data source is 8 from the China Economic Network statistical database and the Guotai An database. The results of descriptive statistical analysis of all variables are shown in the table below.

Table 2. Descriptive statistics of variables

Variable	Definition	Mean value	Standard deviation	Maximum value	Minimum value
Ai	Entropy value method construction	0.092	0.113	0.769	0
Im	Changes in the income ranges of parents and children	0.137	0.650	1	-1
Age	Individual age	38.588	15.120	70	16
Urban	Town =0, rural =1	0.463	0.498	1	0
Gender	Male =0, female =1	0.487	0.5	1	0
Education	Blind/semi-literate =0, primary school =6, junior high school =9, high school and vocational school =12, junior college =15, undergraduate =16, postgraduate =19, doctoral degree = 23	7.916	5.116	19	0
Lnincome	The logarithm of an individual's monthly wage income	9.634	10.52	14.926	0
PGDP	The logarithm of per capita GDP of each region.	4.212	2.466	16.415	1.288
Lntra	The per capita road freight volume of each region is taken as logarithm	2.466	0.0568	2.563	2.296
R&D	The ratio of R&D expenditure to regional GNP in each region	0.017	0.012	0.0647	0.0001
Ind	The sum of the added value of the secondary and tertiary industries accounted for the proportion of the regional GNP	1.058	0.544	5.244	0
Gov	The proportion of general budget expenditure of local finance to regional GNP	0.109	0.0328	0.237	0.058

4. Model design and empirical test

(1) Model setting

Based on the above theoretical analysis, the Probit fixed effect model is constructed, and the influence of individual characteristics on the results is controlled by introducing individual variables, so as to avoid the missing variable deviation of the results caused by individuals. Therefore, taking intergenerational income flow as the explained variable and artificial intelligence as the explanatory variable, adding a series of relevant control variables, further focusing on the study of the effect of artificial intelligence on intergenerational income mobility, the econometric model is established as follows (8) :

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$$im_{ijt} = \alpha_1 + \alpha_2 ai_{ijt} + \alpha_3 C_{it} + \alpha_4 Z_{it} + \mu_i + \lambda_t + \mathcal{E}_{it} \quad (8)$$

Where, i, j and t represent individual, region and time respectively, and (8) indicates whether artificial intelligence has a promoting effect on intergenerational income. Cit represents control variables at the individual level, including individual age, urban residents, years of education, and personal income. Zit represents control variables at the regional level, including the level of economic development (PGDP), the level of transportation infrastructure (Tra), the intensity of research and development (R&D), the upgrading of industrial structure (Ind), and the level of government intervention (Gov).

(2) Baseline regression

Based on the above variable measurement, data processing and econometric model, this paper further empirically measures the role of artificial intelligence in promoting the strength of intergenerational income mobility. Probit regression method was adopted to conduct an empirical test on artificial intelligence and intergenerational income flow. The regression results are shown in Table 3 below:

Table 3. Baseline regression results

Variation	(1)	(2)	(3)
ai	0.309***	0.308***	0.347***
	(2.77)	(2.76)	(2.98)
age		0.00491	0.00494
		(0.31)	(0.31)
urban		-0.0125	-0.0131
		(-0.87)	(-0.91)
gender		-0.00624	-0.00601
		(-0.55)	(-0.53)
education		0.0126*	0.0123*
		(1.71)	(1.68)
pgdp			0.291**
			(2.52)
lntra			0.0641
			(0.11)
ind			0.00502
			(0.18)
RD			-3.270
			(-0.85)
gov			0.0764
			(0.11)
_cons	0.123	0.0972	-2.953**
	(1.51)	(0.93)	(-2.00)
N	13689	13689	13689

Note: The data in brackets are regional clustering standard errors; * p<0.10, **p<0.05, ***p<0.01;

Through the regression of Probit model, the role of the development of artificial intelligence in promoting intergenerational income flow is specifically measured. The following two

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conclusions can be drawn from the regression results: First, the development of artificial intelligence can effectively promote the mobility of intergenerational income, and the impact is relatively significant, indicating that artificial intelligence has alleviated the problem of income consolidation to a large extent. Second, this conclusion is still valid after adding individual control variables and regional control variables.

(3) Robustness test

In order to further verify the robustness of the above research conclusions, Tobit model test, double-tailed 1% and 2020 data were respectively used to test the robustness of the benchmark regression. The regression results are shown in the following table:

Table 4. Robustness test results

Variation	Tobit (1)	Double tailed1% (2)	Eliminate 2020 (3)	Alternate explanatory variable (4)
ai	0.305**	0.485***	0.308**	0.016***
	(2.412)	(3.187)	(2.031)	(0.672)
Individual level control variables	Yes	Yes	Yes	Yes
Control variables at the regional level	Yes	Yes	Yes	Yes
Regional fixation	Yes	Yes	Yes	Yes
Fixed time	Yes	Yes	Yes	Yes
N	10497	13430	9887	13689

Note: The data in brackets are regional clustering standard errors; * p<0.10, **p<0.05, ***p<0.01;

In order to further verify the robustness of the above research conclusions, this paper conducted a robustness test, and the results are shown in the following table. First, the robustness of regression results is verified by changing the estimation method. In this paper, the Tobit model is used to re-estimate, and the results are shown in column (1) of Table 4. Second, outlier processing. The outliers in the data will cause bias to the influence of artificial intelligence on intergenerational income flow13. Therefore, this paper adopts 1% bilateral indent processing for variable data of artificial intelligence level and then carries out re-regression. The results are shown in column (2) of Table 4. Third, consider exogenous shocks. The global epidemic in 2020 May cause AI to have a structural impact on the intergenerational income flow, so the model estimate is carried out after excluding the samples in 2020, and the results are shown in column (3) of Table 4. Fourth, replace the core explanatory variable. In this paper, the number of artificial intelligence patents in prefecture-level cities is selected as a proxy variable of artificial intelligence to conduct robustness test, and the results are shown in column (4) of Table 4. It can be found that under each robustness test method, artificial intelligence variables are significantly positive at the 5% confidence level, indicating that artificial intelligence has a significant promoting effect on intergenerational income flow, which further validates the research conclusions of this paper.

(4)Endogeneity test

Considering that there may be a causal relationship between the development of artificial intelligence level and the intergenerational income flow, the endogeneity test is conducted using the instrumental variable method. Therefore, based on the selection of instrumental variables by Huang Qunhui et al. (2019), this paper uses the interaction between the number

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of fixed telephones per capita and time in each region in 1984 as instrumental variable. The regression results are shown in the following table:

Table 5. Results of endogeneity test

	Number of landline telephones per capita in 1984(histel)	
	The first stage	The second stage
ai		1.538***
		(3.071)
iv1	0.373***	
	(16.401)	
Control variables at the Individual-level	Yes	Yes
Control variables at the regional level	Yes	Yes
Regional fixation	Yes	Yes
Time fixation	Yes	Yes
F statistic	269.020	
N	13,686	13,686

Note: The data in brackets are regional clustering standard errors; * p<0.10, **p<0.05, ***p<0.01;

Based on the above regression results, the following two conclusions can be drawn: First, the regression results of the first stage of instrumental variables show that the number of fixed telephones per capita in China in 1984 has a positive promoting effect on the development of artificial intelligence level. Second, the regression results of instrumental variables in the second stage are basically consistent with those in the first stage. The development of artificial intelligence has a significant promoting effect on inter-generational income mobility, both upward and downward, and the sign of the regression coefficient is consistent with the baseline regression, which proves the credibility of the baseline regression results.

(5) Heterogeneity test

Considering the differences between the micro and macro levels, there may be individual or regional heterogeneity of AI on intergenerational income flows. Therefore, in this part, gender (male/female) and household registration (urban/rural) in micro individual characteristics and marketization level in macro regional characteristics (low/medium/high marketization level) are selected for heterogeneity analysis.

1) Individual gender and household registration

Table 6. Results of individual-level heterogeneity test

Variation	Male	Female	Urban individual	Rural individual
ai	0.428***	0.235	0.426**	0.413***
	(2.63)	(1.34)	(2.02)	(2.68)
Control variables at the Individual-level	Yes	Yes	Yes	Yes
Control variables at the regional level	Yes	Yes	Yes	Yes
Regional fixation	Yes	Yes	Yes	Yes
Time fixation	Yes	Yes	Yes	Yes
R-squared	0.039	0.033	0.034	0.033
N	4,952	5,661	5,429	5,065

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In the questionnaire, "Are you from a rural area or a town?" This question is calculated to obtain the urban level (urban), and the answer "town" is assigned 0, and "non-town" is assigned 1; In the questionnaire, "Is your gender male (female)? "Male" is assigned a value of 0, "female" is assigned a value of 1; According to the answers, the samples were divided into male and female sample groups, and non-rural and farmer sample groups for regression analysis. According to the regression results, first, the development of artificial intelligence technology significantly promoted the intergenerational income flow of men to a large extent, but artificial intelligence did not have a significant impact on the intergenerational income flow of women. Second, the development of artificial intelligence technology has a significant role in promoting the intergenerational income flow of both urban and rural individuals, but the impact of the development of artificial intelligence technology on rural individuals is slightly greater than that of urban individuals

2) Regional marketization level

The market is the key force to promote the development of artificial intelligence, and the region with a higher degree of intelligence and marketization has a higher allocation efficiency of digital factors, creating a favorable market environment for the research and development and promotion of artificial intelligence technology. Does the impact of AI technology on intergenerational income mobility differ depending on the level of regional marketization? By referring to the method of Fan Gang et al. (2011), the marketization level of each region is divided into samples. Samples with marketization level ranging from 1% to 30% are characterized as low marketization level, samples with marketization level ranging from 31% to 70% are characterized as medium marketization level, and samples with marketization level ranging from 71% to 100% are characterized as high marketization level. First, AI has the most significant impact on the intergenerational income mobility of individuals in regions with higher marketization level, while it has no significant effect on the intergenerational income mobility of individuals in regions with low and medium marketization level.

Table 7. Results of regional heterogeneity test

Variation	im (Low marketization level)	im (Medium marketization level)	im (High level of marketization)
ai	2.159	0.63	0.655***
	(1.63)	(1.22)	(3.49)
Control variables at the Individual-level	Yes	Yes	Yes
Control variables at the regional -level	Yes	Yes	Yes
Regional fixation	Yes	Yes	Yes
Time fixation	Yes	Yes	Yes
R-squared	0.022	0.036	0.021
N	3,466	4,132	3,012

5. Conclusion and Suggestions

(1) Conclusion

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First, the development of artificial intelligence technology has effectively promoted the intergenerational income flow; Second, the development of artificial intelligence technology significantly promoted the intergenerational income mobility of men, but had no significant impact on the intergenerational income mobility of women; Third, the development of artificial intelligence technology has a significant role in promoting the intergenerational income flow of both urban and rural individuals, but the impact of the development of artificial intelligence technology on rural individuals is slightly greater than that of urban individuals; Fourth, AI has the most significant impact on the intergenerational income mobility of individuals in regions with higher marketization level, while it has no significant effect on the intergenerational income mobility of individuals in regions with low and medium marketization level.

(2) Suggestions

Based on the theoretical analysis and empirical research of the development of artificial intelligence technology on the intergenerational income mobility, combined with the spirit of the Party's 20th National Congress report, the following three aspects of countermeasures and suggestions are given:

First, strengthen the participation of women in the artificial intelligence industry and the provision of educational resources. The government and relevant institutions should design artificial intelligence education and training for female practitioners that meet the requirements of women and increase women's representation and participation in the field of AI. Female practitioners always receive various types of limitations and hidden inequalities in employment and future development, and solving the problem of "starting point fairness" allows more female practitioners to show their skills in the artificial intelligence industry. Therefore, it is necessary to enhance the competitiveness of women in new formats, new environments and new employment, help them use big data and artificial intelligence to enhance digital skills, improve professional skills, and encourage women to actively participate in training through schools, families and society to enhance women's skills in the development of artificial intelligence technology. At the same time, improve relevant public policies, create a fair and just employment environment, break the inherent situation of traditional female employment difficulties, so that female employees enjoy the same rights in employment opportunities and salaries, narrow the gender difference in intergenerational income mobility, and increase the staying power and vitality of female intergenerational income mobility.

The second is to enhance the intensity of artificial intelligence education and resource investment in rural areas. First of all, considering that the positive impact of artificial intelligence on intergenerational income mobility of rural individuals is slightly greater than that of urban individuals, infrastructure construction in rural areas, especially the popularization of information technology, has an important role in promoting upward intergenerational income mobility. Second, strengthen basic courses in computer science and artificial intelligence. Through the mode of government-enterprise cooperation, enterprise resources and experts are introduced to provide students with remote real-time online lectures and practical summer camps, and a cooperative network between rural and urban areas is built to promote resource sharing and experience exchange. Finally, in the social environment with weak intergenerational educational mobility, the level of after-school services in rural areas is significantly lower than that in urban areas, so that everyone can enjoy compulsory education and receive fair opportunities for education, and there will be no large income difference and unequal opportunities due to factors such as family income gap and parents' cognitive level, so as to reduce intergenerational transmission. We will enhance the mobility of intergenerational income among all strata.

Third, focus on the coordinated development of horizontal policy integration and vertical policy deepening. Horizontal policy integration and vertical policy deepening can ensure the consistency of policies in the goals and implementation of various departments, and affect the

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education, science and technology, finance and social welfare sectors from many aspects, along with the popularization and application of AI technology, and reduce the income inequality caused by the difference in the level of artificial intelligence technology. The two-wheel linkage drives horizontal and vertical policies, builds cross-departmental organizations, coordinates the impact of the development of artificial intelligence technology on the labor market, education and social welfare, and develops a comprehensive policy response mechanism. For regions with low and medium marketization levels, the government should increase infrastructure construction, especially investment in education and technology access, and fully stimulate the development of artificial intelligence technology to promote the dividend of upward intergenerational income mobility, so as to narrow the income gap between generations.

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