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Age composition change and inter-provincial labor productivity: A study from the perspective of population dividend and population urbanization

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Age composition change and inter-provincial labor productivity: a study from the perspective of population dividend and population urbanization

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ABSTRACT

Under the background of the aging social-transformation, studying the relationship between the change of age structure (CAS) and labor productivity (LP) was of great practical significance for sustainable development of China's economy. Therefore this paper first examined the overall impact of age structure changes on LP by the provincial panel data from year 2006 to 2015. Then regional difference was also carried out through the two dimensions of demographic dividend and population urbanization. Results showed that CAS with the increase of total dependency ratio and child dependency ratio had a significant negative impact on provincial LP. Increasing the labor input and accelerating the upgrading of human capital were the main lines to deal with the challenges of aging. From the perspective of demographic dividend and population urbanization, the impact of CAS on LP showed obvious inter-provincial and regional development differences.

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KEYWORDS

Age structure change; labor productivity; population dividend: population urbanization; old-age social security

1. Introduction

Labor productivity (LP) was the core of economic growth and it was also the main factor of regional development disparity (Abrams Burton, Jing, & Mulligan, 2013; Vignoles, Galindo-Rueda, & Feinstein, 2004). From 1993 to 2006, labor productivity had maintained a rapid growth rate of nearly 10% in China. However, the overall level of LP in China was still very low.

Under the background of the low level of LP, the improvement of labor productivity was more difficult as a result of the new demographic changes, which mainly characterized by the low-level population growth, the variation of age composition, the increasing dependency ratio, the disappearance of demographic dividend and the decline in capital accumulation and population urbanization (Aoyama, Yoshikawa, Iyetomi, & Fujiwara, 2008; Azorín, Daniel, de la Vega, & Del Mar, 2015; Deborah, 2007). There were two real concerns about the decelerated growth of LP. First, it was the "speed-up" swamp. Second, it was worried about initiating the crisis of the public security population (Bjuggren, ; Fang, 2017). The decline in LP directly led to

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a tightening period of the public security. The contradictions of inadequate and unbalanced regional development rapidly accumulated, increased and erupted. In 2016, UK totally had pension funds of 2.87 trillion dollars, ranking the second in the world, the United States with 22.48 trillion dollars and Japan with 2.80 trillion dollars. However, that was just 0.14 trillion dollars in China. Therefore, studying the relationship between demographic change and LP had vital significance for current economic reforms (Changmiao,).

This study mainly aimed to answer the following two questions. First, in terms of overall sustainable development, how did the change of age structure affect China's labor productivity? Second, what was the difference in the influence of various regions in China? This is also the main content of this study.

2. Literature review

Based on the slowdown of global productivity and the aging of the world's population, most countries are or are about to transform into the aging society. However, there were difference in the paces of transformation, the main contradictions in productivity slowdown and the terminal times of demographic dividend (Hongmin & Huaizhong, 2018). With the general equilibrium model of the world economy (North-South regional division), change of productivity was mainly related to regional demographic transition, capital accumulation and economic power for equilibrium price (Fan & Lei, 2009). Human capital had a significantly positive impact on productivity growth, but the interaction between human capital with structural change in the more developed countries (OECD) was more positive than that in the developing countries (Ahn, Ge, Stricklett, Gill, & Kohan, 2004). As a result, these studies were firstly based on the European and American regions, with most conclusions that aging would have a negative influence on the improvement of labor productivity.

Then, according to the data of two countries of USA and Austria, results showed that it was important to explore the impact of aging on LP for determining the economic burden of sustainable development of a country or a region in the future (Ross, 2011). Different degrees of aging and different developmental structures in different regions could lead to differences in the impact of LP. Population agglomeration was closely connected with urban capital accumulation and the improvement of LP in the manufacturing sectors based on the population urbanization and data of American urbanization (Angang, Shenglong, & Zhenguo, 2012).

Furthermore, Gill (2013) concluded that the rapid aging population mainly led to insufficient labor supply with its restricted improvement, starting from the main explanatory variables such as human capital, labor and economic policies, welfare schemes and the rates of employment and participation. Europe has currently reached the "swamp of productivity growth", with the characteristics of low participation, low employment rate in the labor market, low labor productivity growth, high employment protection and high social welfare ("three-low-and-two-high"). The government mainly should cut down public debt and promote social reform in Europe to improve the employment (Zhan & Xizhe, 2018).

On this basis, Vogel (2017) explored the impact of aging on LP, economic aggregates and social welfare with the further population statistics of the three oldest countries in

Europe (France, Germany and Italy) and the rest of EU zone. It was found that there was a spatial aggregating feature in different areas (Agarwal, Sethi, Srivastava, Jha, & Baqui, 2009; Jianmin, 2015). Relying on data from various regions of Italy from 2000 to 2013, Mussini (2018) analyzed the regional labor productivity (RLP) and concluded that the level of LP was the main cause of unbalanced regional development (Meng, 2013). After assessing the impact of employment protection on labor productivity, the result was achieved that increasing flexibility of labor market would be able to effectively improve labor productivity (Xiaoyong, 2013).

The corresponding studies on Asia and Latin America had followed the deepening of the aging. From a regional perspective, the growth differences in labor productivity among Asia, America and Africa were caused by structural differences. Asia had the strongest promotion and support for LP growth (Margaret, Dani, & Iigo, 2014). The improvement of LP in Japan and South Korea was mainly affected by labor and economic policies, economic development structures, and the changes of population supply (Mauro, 2018; Queirós, Silva, Alvarelhão, Rocha, & Teixeira, 2015; Yoonsoo & WooRam, 2005) The main reasons for the weakening of India's demographic dividend and LP growth were the accumulation of structural contradictions and the slow reforms for employment and labor market (Gang, Sixia, & Lu, 2015). The change of the economic structure had a remarkable impact on the overall growth of LP, bringing the lack of capital accumulation and the contradiction of imbalance caused by regional differences (Edger, Alexander, & Axel, 2017).

In this connection, sustainable development of economy and fully balanced regional development were the common pursuits of most countries, while the main contradiction of development had various degrees of importance in the different processes of aging and increasing LP. The significant breakthroughs had been made in the impact of population changes on China's LP with two important theories of demographic dividends and population urbanization. The former theory mainly sought to the problems of sustainable development from the sources of growth while the latter theory explored the problems of balanced development from regional urbanization construction. In addition to the agreement on the generally negative impact of aging, more and more scholars believed that the inherent positive effects were gradually being highlighted. All of these needed further empirical test (Mi, Junfeng, & Jiahong, 2018).

3. The overall sustainable impact of variation of age composition on labor productivity

3.1. Model, variable declaration and data selection

Combined with the review of theories, the empirical model is established as follows:

$$y_{it} = \alpha_0 + \alpha_1 y_{i,t-1} + \alpha_2 LnAGE_{it} + \alpha_3 LnLHP_{it} + \alpha_4 LnCAP_{it} + \alpha_5 LnCPU_{it} + u_{it}$$
(1)

The equation was a typical dynamic panel model. The explained variable was the average LP, measured by the ratio of GDP to the year-end total employment. The explanatory variables included the variation of age composition (AGE), the investment of human capital (LHP), the material capital accumulation and demographic urbanization. The variation of age composition was measured by the total dependency ratio and the

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children's dependency ratio. The investment of human capital (LHP) was measured by the proportion of laboring population, the rate of employment and participation was measured by the ratio of the employment in three major industries to the total population, and the human capital was measured by the per capita educational time. The material capital accumulation (CAP) was measured by regional savings and the sum of the natural growth rate of population and the capital depreciation rate mostly from 5% to 15%, valuing 10% first. Demographic urbanization (PU) was represented by the urbanization rate and the gap between the rural and urban development, mainly measured by changes in population and per capita income in the course of urbanization.

As shown in Table 1, the first three parts (Age structure change, Labor Human Capital Investment, Material Capital Accumulation Level and Material Capital Accumulation Level) mainly represented the sustainable development while the fourth part of demographic urbanization (Population Urbanization Level) represented the balanced regional development. Selecting the data of 30 provinces in China from 2006 to 2015 from China Statistical Yearbook, China Population Statistics Yearbook and China Labor Statistics Yearbook, descriptive statistics of variables and specific parameters were shown in the Table

3.2. Static panel estimation results

As shown in Table 2, mixed OLS (Method of ordinary least squares) regression was explored first. And it could be the baseline of later regression.

Then, RE (random effects) was operated and results of RE were considered dependable than mixed OLS based on the hausmann-test. It is showed in Table 3.

Therefore, as presented in Table 4, FE regression analysis was operated and results were more dependable than mixed OLS and RE regression based on the hausmann-test. We could find that age structure changes (AGE, both TDR and CDR) had a significantly negative impact on LP, while the urbanization level and population growth rate had a positive impact. Other variables did not show a significant impact as expected.

So, we continued to do the analysis of time fixed effects to determine whether there was the interference of endogenous variables. As showed in Table 5, most of the significance of variables had not changed, but some of the influence coefficients of variables had changed.

Considering the interference of endogenous variables, it was necessary to continue to do the analysis of 2SLS (Two-Stage Least Square) regression. As presented in Table 6, the variables from "Dmut2" to "Dmut10" represented a series of time variables. We found that the variable "employment participation rate" (EP) was endogenous variable and time variables had a very significant impact. Therefore, it was necessary to use the differential GMM method, which included one-step and two-step differential GMM regression.

3.3. Dynamic panel estimation results

As reported in Table 7, the results of one-step Diff-GMM (Differential GMM) were operated. The last three lines of the table provided autocorrelation and over-identification tests for differential GMM analysis. There were no sequence

Table 1. Variable descriptive statistics.

			Standard		
Variables	Index	Mean	deviation	Symbol	Description
Dependent variables	Average Labor Productivity	41,714	27,283	۲	Actual GDP/Total Employment at the End of the Year
Age Structure Change	Total dependency ratio	35.64	6.69	TDR	The proportion of the elderly and children to the working
					population
	Child dependency ratio	23.03	6.64	CDR	The ratio of children to working-age population
Labor Human Capital	Proportion of the working population	73.90	3.66	PWP	Proportion of working-age population to total population
Investment	Employment participation rate	56.37	6.45	Б	The proportion of employment in three major industries to the
					total population
	Human capital level	8.35	1.15	ш	Acting on behalf of the length of education per capita
Material Capital	Savings level	50.39	8.01	S	1-Final Consumption Rate as Agent Variable
Accumulation Level	The Sum of Natural Population Growth Rate and Capital	15.24	2.59	N + σ	5%-15%, 10% depreciation of capital
	Depreciation Rate				
Population Urbanization	Urbanization rate	52.37	13.89	UR	Population urbanization divided by national average
Level	Urban rural income ratio	21.79	15.64	R	Per capita income ratio of urban and rural residents

	OLS/T	DR	OLS/C	DR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
AGE	-1.0273***	0.2634	-1.0736***	0.2425
EP	-0.4904*	0.2652	-0.6267**	0.2562
E	-0.2875	0.2638	-0.3826	0.2621
S	-1.0596***	0.2043	-1.1007***	0.2031
$N + \sigma$	0.1953	0.2072	0.7302***	0.2734
UR	1.1785***	0.2301	0.8770***	0.2622
IR	0.0141	0.0802	0.0095	0.0797
_cons	15.6106	2.0675	15.9351	2.0412

Table 2. Mixed OLS regression analysis.

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

	able	5.	Random	enects	(RE)	regression	analysis.	
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	RE/TC	DR	RE/CE	DR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
AGE	-1.1644***	0.2876	-1.1356***	0.2578
EP	-0.5506*	0.2959	-0.6643**	0.2759
E	-0.2565	0.2658	-0.3606	0.2634
S	-1.0596***	0.2081	-1.0941***	0.2058
$N + \sigma$	0.2821	0.2355	0.8022***	0.2941
UR	1.1004***	0.2581	0.8221***	0.2823
IR	0.0247	0.0895	0.0150	0.0855
_cons	16.3159	2.2754	16.2106	2.1644

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

	FE/TC	DR	FE/CE	DR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
AGE	-2.0350***	0.4440	-1.6343***	0.4494
EP	-1.2439**	0.6287	-1.1862*	0.6372
E	0.0793	0.2826	-0.0703	0.2823
S	-1.0794***	0.2257	-1.0567***	0.2291
N + σ	2.5571***	0.6892	3.0053***	0.7270
UR	0.3625	0.6612	0.1423	0.7034
IR	0.0343	0.1972	0.0424	0.1999
_cons	18.2748***	4.5522	15.7133***	4.2598

Table 4. Fixed effects (FE) regression analysis.

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

autocorrelation and over-identification in the first and second correlations, which proved that the lag instrumental variables were valid.

Then, as reported in Table 8, the results of one-step Diff-GMM (Differential GMM) were also operated. There were four findings.

First, in terms of variation of age composition, the increase in the total dependency ratio and children's rearing ratio had a significantly negative impact on LP.

Second, in terms of labor input, improvement of education time, working population ratio and the rate of employment and participation had a positive correlation with LP. But in general, the positive influencing coefficient (0.53) of education was much lower (than 18.32).

	Time-FE	Time-FE/TDR		/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
AGE	0.6569**	0.3080	0.3658	0.2954
EP	-1.2553***	0.3700	-1.2418***	0.3725
E	1.7015**	0.8145	1.5830*	0.8488
S	-0.2153	0.1318	-0.2476*	0.1313
$N + \sigma$	0.7234*	0.3862	0.6310	0.4070
UR	1.1348**	0.5298	1.3169**	0.5304
IR	-0.0008	0.1234	0.0073	0.1243
Dumt2	0.0987	0.0655	0.0972	0.0663
Dumt3	0.1662**	0.0699	0.1639**	0.0707
Dumt4	0.2125***	0.0772	0.2031***	0.0782
Dumt5	0.8426***	0.2612	0.7598***	0.2683
Dumt6	0.3481***	0.1015	0.3004***	0.0989
Dumt7	0.3789***	0.1087	0.3403***	0.1078
Dumt8	0.5208***	0.1085	0.4838***	0.1071
Dumt9	0.4495***	0.1221	0.4257***	0.1231
Dumt10	-1.0332***	0.1293	-1.0433***	0.1313
_cons	3.7852	3.2899	4.8498	3.3612

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Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

Table 6.	Two-stage	least square	method	for ins	trumental	variables	(IV-2SLS)	regression
analysis.								

	IV-2SLS,	/TDR	IV-2SLS/	/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
AGE	-1.3769***	0.3293	-1.1894***	0.2675
EP	0.8775	0.9689	0.4408	0.8895
E	-0.1994	0.2024	-0.3264	0.1944
S	-0.8192***	0.2831	-0.9060	0.2864
$N + \sigma$	0.2846	0.2489	0.7995	0.2821
UR	1.1489***	0.2147	0.9065	0.2683
IR	0.0845	0.1001	0.0664	0.0955
cons	9.8919	4.6992	10.6482	4.9967

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

Third, from the perspective of the accumulation of material capital, the savings rate had a significantly negative impact, but less than that of aging. Compared with the human input, the positive impact of the accumulation of human capital based on the increase in capital depreciation and population growth was greater than that of upgrading human resource. It confirmed the existence of structural contradictions in China's current social and economic development again.

At last, from the perspective of demographic urbanization, the overall impact of urban rate was significantly negative with the coefficient far lower than that of aging. It indicated that the benefits of the past demographic urbanization had disappeared. In China, the impact demographic urbanization had made on LP mostly was superficial about the regional urbanization, with the big lack of promoting public services. It could be proved again by the significantly negative impact of the urban-rural development gap that public contradictions are accumulating with insufficient and unbalanced development under the rapidly demographic urbanization in China.

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Table 7. One-step diff-GMM results.

	One-step Diff-GMM/TDR		One-step Diff-	GMM/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-1.2939**	0.6175	-0.7031	0.7913
AGE	-4.0674***	0.6547	-3.9016***	0.9045
EP	1.5321	1.6974	0.8006	1.8212
E	0.4839***	0.1314	0.2248	0.1778
S	-1.8887***	0.4309	-2.0129***	0.3991
$N + \sigma$	5.3526***	1.2953	5.6930***	1.5114
UR	-0.1367	1.8136	-2.4515	1.9190
IR	-0.9374***	0.2234	-0.8876***	0.2612
_cons	27.4513	9.6659	30.8396	9.4613
First-order autocorrelation test	0.0234	-	0.0073	-
Second-order autocorrelation test	0.2555	-	0.3659	-
Sargan test	-	-	-	-

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

Table 8. Two-step diff-GMM results.

	Two-step Diff	-GMM/TDR	Two-step Diff-	GMM/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-0.9292**	0.8707	-0.5144*	0.8348
AGE	-3.8361***	0.7146	-3.5407***	1.0352
EP	1.6047	1.8664	1.0125	2.1526
E	0.4917***	0.1235	0.2404	0.1871
S	-1.7409***	0.4541	-1.9647***	0.4392
$N + \sigma$	5.8851***	1.7667	5.6532***	1.7862
UR	-0.7594	2.1237	-2.3139	2.0046
IR	-0.9170***	0.2148	-0.8947***	0.2965
_cons	22.8358	10.9993	26.21	11.16
First-order autocorrelation test	0.0508	-	0.0386	-
Second-order autocorrelation test	0.2750	-	0.4377	-
Sargan test	0.1773	-	0.1892	-

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

The social transformation of aging was irreversible with the trend of the expansion. The general idea of addressing the challenge of aging in China was to raise the level of per capita income and resolved the systemic risks caused by the reduction of the laboring population, relying on the advantage of material capital accumulation. And then structural transformation of population and that of economic and social development were further achieved by eliminating the urban-rural imbalance and accelerating the upgrade of human capital.

3.4. Robustness tests on the research results

3.4.1. Robustness tests for the TDR

As showed in Table 9, the Sum of Natural Population Growth Rate and Capital Depreciation Rate $(N + \sigma)$ was assigned a 10% compromise. However, this method was somewhat arbitrary. In order to ensure the robustness of empirical results, 5% and 15% were first taken as robustness tests, respectively.

Diff-GMM results (N + σ = 5%) are reported in Table 5 and Diff-GMM results (N + σ = 15%) are then reported in Table 10.

	One-step Diff-GMM/TDR		Two-step Diff	-GMM/TDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-1.1697*	0.6141	-0.8053**	0.7911
AGE	-4.0575***	0.6442	-3.8129***	0.6983
EP	1.5297	1.7308	1.6876	1.8366
E	0.4774***	0.1311	0.4845***	0.1207
S	-1.8562***	0.4328	-1.6961***	0.4444
$N + \sigma$	3.3433***	0.7699	3.6314***	0.9286
UR	-0.4746	1.7951	-1.0126	1.8978
IR	-0.9307***	0.2259	-0.8986***	0.2199
_cons	34.1526	9.2886	29.5211	10.1227
First-order autocorrelation test	0.0209	-	0.0476	-
Second-order autocorrelation test	0.2991	-	0.3295	-
Sargan test	-	-	0.1911	_

Table 9. Diff-GMM results for the TDR (N + σ = 5%).

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

	One-step Diff-GMM/TDR		Two-step Diff-	-GMM/TDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-1.6859**	0.5812	-1.6248**	0.6237
AGE	-3.3954***	0.7793	-3.3022***	0.8555
EP	0.1724	1.6090	-0.1505	1.8744
E	0.3721***	0.1218	0.3816***	0.1294
S	-1.9157***	0.4175	-2.0474***	0.5353
$N + \sigma$	-0.6087***	0.2266	-0.5842**	0.2794
UR	1.4228	1.6210	1.5469	1.9218
IR	-0.9279***	0.2397	-0.9514***	0.2656
_cons	45.1812	8.1363	45.5087	8.6298
First-order autocorrelation test	0.0012	-	0.0017	-
Second-order autocorrelation test	0.3730	-	0.4064	-
Sargan test	-	-	0.1292	-

Table 10. Diff-GMM results for the TDR (N + σ = 15%).

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

3.4.2. Robustness tests for the CDR

Therefore, for the CDR, the robustness tests were also operated.

Diff-GMM results (N + σ = 55%) are reported in Table 11 and Diff-GMM results of CDR (N + σ = 15%) are then reported in Table 12.

The results showed that the coefficients and significance of most variables were basically consistent with the overall results. The larger values of Sargan did make the strong influence of instrumental variables, which proved that the differential GMM method was appropriate. Second, in order to avoid the random effects that the material capital depreciation rate of 10% may make, the impacts of the material capital depreciation of 5% and 10% were also tested, respectively. The results showed that the selection of instrumental variables was effective and the overall analysis was steady.

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	One-step Diff	-GMM/CDR	Two-step Diff-	GMM/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-0.5800	0.7915	-0.3828	0.8191
AGE	-3.9098***	0.8904	-3.5411***	1.0168
EP	0.8244	1.8848	1.0219	2.1717
E	0.2198	0.1777	0.2322	0.1838
S	-1.9743***	0.3992	-1.9374***	0.4414
$N + \sigma$	3.5614***	0.8839	3.5589***	1.0071
UR	-2.7988	1.8978	-2.6577	1.9408
IR	-0.8819***	0.2631	-0.8873***	0.2969
_cons	37.9432	9.0976	33.1881	10.6862
First-order autocorrelation test	0.0060	-	0.0334	-
Second-order autocorrelation test	0.3965	-	0.4678	-
Sargan test	-	-	0.1921	-

Table 11. Diff-GMM results for the CDR (N + σ = 5%).

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

	One-step Diff-GMM/CDR		Two-step Di	ff-GMM/CDR
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-1.1265	0.7503	-1.0415	0.8735
AGE	-2.7775***	0.9846	-2.7049	1.2712
EP	-0.7075	1.6331	-0.9748	1.9829
E	0.1257	0.1396	0.1134	0.1521
S	-2.0456***	0.3948	-2.1007	0.5232
$N + \sigma$	-0.7559***	0.2193	-0.7271	0.2763
UR	-0.3864	1.8195	-0.3636	2.0747
IR	-0.8594***	0.2780	-0.8673	0.3369
_cons	47.734	8.1694	47.7824	9.6247
First-order autocorrelation test	0.0004	-	-	0.0007
Second-order autocorrelation test	0.7676	-	-	0.7713
Sargan test	-	-	-	0.1130

Table 12. Diff-GMM results for the CDR (N + σ = 15%).

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

4. Test for Regional Balance from the Perspective of Demographic Dividend and Urbanization

4.1. Regional division from the perspective of demographic dividend and urbanization

The corresponding regional indicators were constructed and the demographic dividend was combined with the capital accumulation. With the ratio of the total dependency ratio to savings rate, the higher the ratio was, the more difficult the social transformation of demographic structure and aging was. The demographic urbanization was measured by the ratio of the national average of urban-rural income disparity to that of urbanization rate. The higher the ratio was, the harder the demographic urbanization was.

From Figure 1, it could be seen that whether it was the demographic dividend or the demographic urbanization, there were obvious differences among the provinces of China on the whole, with the trend of "the pole of central population".

According to the average value from 2006 to 2015, the provinces of China were ranked from higher to lower. As presented in Figures 2 and 3, the overall



Figure 1. Population dividend and population urbanization distribution in China's provinces from 2006 to 2015.



Figure 2. Demographic dividend challenge in China's Provinces: Trends in 2006, 2010 and 2015.

distribution was closely related to regional development in terms of both demographic dividend and demographic urbanization. The structural contradictions in Beijing, Shanghai and so on were smaller while the less developed regions such as Guizhou relatively were more difficult in both problems. Comparing the demographic dividend with the demographic urbanization, the obviously larger change of regional development happened in the demographic dividend from 2006 to 2015. The demographic structure had a significant impact on the development of the provinces in China, while an insignificant impact on the change of demographic urbanization. It showed that the urban dividend following the rapid urbanization



Figure 3. Trends of population urbanization challenges in provinces in 2006, 2010 and 2015.

had disappeared. The fast construction of urbanization did not match the population development and the improvement of public services. In addition, it showed that there was a huge space for improving the construction of demographic urbanization in a few provinces.

Therefore, according to the levels of demographic dividend and demographic urbanization, 3 sections with 10 provinces each could be divided in order to screen out the provinces, respectively, with "little", "medium" and "great" challenges of demographic dividend and demographic urbanization. The results are summarized in Table 13.

4.2. Regionally empirical test based on demographic dividend and demographic urbanization

As presented in Table 14, the demographic dividend and standards for demographic urbanization are, respectively, tested. First, regardless of difficulty, the impact of the disappearance of demographic dividend and difference in demographic urbanization were remarkably negative, consistent with the test on the whole. At the same time, there

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Indicators/regionalization	Less	Medium	High
Demographic Dividend Challenge	Beijing, Shanghai Zhejiang, Shanxi and other 10 provinces	Qinghai, Yunnan Hainan, Fujian and other 10 provinces	Hebei, Sichuan Jiangxi, Guangxi and other 10 provinces
The Challenge of Population Urbanization	Shanghai, Tianjin Jilin, Fujian and other 10 provinces	Hubei, Shandong Hunan, Ningxia and other 10 provinces	Anhui, Henan Yunnan, Guizhou and other 10 provinces
The Double Challenges of Population Dividend and Population Urbanization	Beijing, Shanghai, Heilongjiang, Jilin, Liaoning, Tianjin, Zhejiang and other seven provinces	Hubei, Hainan and Ningxia Provinces	Five provinces: Anhui, Henan, Sichuan, Guangxi and Guizhou

Table 13. Regional division from the perspective of population dividend and population urbanization.

	Less demographic divi- dend challenge		Medium de dividend d	mographic challenge	High demographic divi- dend challenge	
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-0.34	0.52	-0.24	1.2	-1.53	1.84
AGE (TDR)	-3.44***	1.18	-5.9***	1.34	-3.55**	1.63
EP	0.27	2.74	-0.31	2.23	14.6**	7.5
E	0.53	0.34	0.78***	0.27	0.34	0.21
S	-1.3***	0.34	-3.05***	0.88	-0.87	0.59
$N + \sigma$	6.87***	1.73	1.64	2.96	2.1	1.66
UR	-3.69	2.34	-7.9***	3.97	1.90	4.73
IR	-1.44***	0.50	-1.45***	-1.16	-1.16	0.30
Second-order autocorrelation test	0.23	-	0.35	-	0.48	_

Table 14. Regional tests under demographic dividends.

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

were huge differences among regions of different levels. As demographic dividend disappears, the regions with lower difficulty were characterized by the significantly positive impact of population growth and capital depreciation rate (6.87). In the areas with medium difficulty, variation of age composition (-5.9) and material capital accumulation (-3.05) made the greatest negative impact while in areas with greater difficulty, the level of employment and participation (14.6) had the greatest impact.

As presented in Table 15, in terms of demographic urbanization, for different regions, with the increase of urbanization challenges, the impacts of the variation of age composition (are -2.8, -4.01, -6.54, respectively) and those of material capital accumulation were characterized by obvious ladder distribution (are -0.9, -1.9, -3.7, respectively). In the 10 provinces with medium challenges of demographic urbanization, the urbanization rate made a significantly negative impact (-10.47) as population growth and capital depreciation also made the greatest impact in the Region 2 (7.13). The significant difference by regional test also confirmed the necessity for testing according to regions.

According to the dual challenges of demographic dividend and demographic urbanization, the regional inspection is continued. With the auxiliary test, the provinces of major urban agglomerations in China were analyzed to find the three regions still with large regional differences.

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	Less Challenge of Population Urbanization (Region 1)		Medium C Population (Reg	hallenge of Urbanization ion 2)	High Challenge of Population Urbanization (Region 3)		
Method/Variables	Coef. Std. Err.		Coef.	Std. Err.	Coef.	Std. Err.	
L.Y	-0.57*	0.32	1.93**	0.88	-1.5	1.01	
AGE (TDR)	-2.8***	0.89	-4.01***	1.4	-6.54***	1.44	
EP	-0.87	2.90	-1.39	2.62	-1.38	1.51	
E	0.53**	0.22	0.39	0.25	0.50*	0.29	
S	-0.93***	0.22	-1.9***	0.63	-3.07***	0.97	
$N + \sigma$	5.37***	1.72	7.13**	3.3	2.39	2.77	
UR	-0.09	3.24	-10.47**	4.44	0.79	1.88	
IR	-1.18**	0.48	-1.01**	0.41	-0.67	0.42	
Second-order autocorrelation test	0.11	_	0.80	_	0.30	_	

Table 15. Regional tests under urbanization challenges.

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

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	Less double challenges		Medium dout	ole challenges	High double challenges		
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	
L.Y	-0.58**	0.23	3.23***	0.83	0.81	1.10	
AGE (TDR)	-1.65	2.59	-4.22***	1.53	2.13	4.79	
EP	-2.5**	1.02	-7.39***	1.76	-2.95	1.89	
E	0.63	0.43	0.75	0.72	0.15	0.19	
S	-1.04***	0.29	-2.77***	0.61	-1.15**	0.50	
$N + \sigma$	6.2***	1.79	14.74***	2.17	1.42	1.87	
UR	0.69	6.32	-24.75***	5.75	-1.32	2.31	
IR	-1.74***	0.73	-2.85***	0.89	0.25**	0.10	
Second-order autocorrelation test	0.24	-	0.56	-	0.09	-	

Table 16. Regional equilibrium analysis under double challenges.

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

Table 17. Difference test of major urban applomerations in China under double challe	enges
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	Beijing- Hel	Tianjin- cei	Changjia	ng Delta	Pearl Riv	er Delta	Three No Provi	ortheast nces
Method/Variables	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
L.Y	-1.64***	0.15	0.002	0.30	2.5***	0.24	0.6	1.05
AGE (TDR)	-2.77	2.98	-4.1***	0.52	-5.3***	0.48	1.68	4.63
EP	0.01	0.93	-1.5***	0.35	-6.02***	0.47	-5.91***	1.13
E	-0.45	0.68	0.43***	0.15	-0.14	0.13	1.19*	0.68
S	-0.49***	0.08	-0.58*	0.33	-4.1***	0.86	-0.18	0.27
$N + \sigma$	10.3***	0.74	2.3***	0.48	-7.76***	0.857	4.69***	1.38
UR	3.48***	1.04	2.64	2.24	-6.79**	2.87	-4.26	3.71
IR	-1.82***	0.26	1.08**	0.53	0.33	0.70	-0.70	0.80
Second-order autocorrelation test	0.21	-	0.17	-	0.51	-	0.11	-

Coef., coefficient, Std. Err., standard error, *, ** and *** are significant at the significant levels of 10%, 5% and 1%, respectively.

As presented in Table 16, the lag effect and the levels of employment and participation had positive effects only in areas with large double challenges. So were the several development regions in the three eastern provinces of China. The regions with the medium double challenge had the clearest characteristics. The variation of age composition, human capital, material capital accumulation, population growth and capital depreciation had the greatest influence.

Then, as showed in Table 17, in the area of Beijing-Tianjin-Hebei, the negative impacts of urban-rural development gap and urbanization were the biggest, and the positive impacts of population growth and capital depreciation were large. Only in the Yangtze River Delta, human capital had a significantly positive impact. In the Pearl River Delta, the rate of employment and participation, the variation of age structure composition, population growth and capital depreciation had the greatest negative impacts among the development areas of the major urban agglomerations.

5. Conclusion and future scope of study

In the past 30 years of China's reform and opening up, the demographic dividend and urbanization construction are the important sources of China's rapid economic growth. Under the background of aging society transformation, improving LP is the key to promote the transformation of economy from high-speed growth to high-quality development and upgrading.

Studying the relationship between the change of population age structure and LP is of great practical significance for realizing the scientific and sustainable development of China's economic development and fully balanced win-win situation. Based on this, through the provincial panel data from 2006 to 2015, this paper first examines the overall impact of age structure changes on LP, and further through the two dimensions of demographic dividend and population urbanization, carries out regional division and triple test for provinces across the country.

The results showed that the change of age structure with the increase of total dependency ratio and child dependency ratio has a significant negative impact on Provincial LP. Increasing labor input and accelerating the upgrading of human capital are the overall ideas to deal with the challenges of aging. From the perspective of demographic dividend and population urbanization, the impact of age structure changes on LP shows obvious inter-provincial and regional development differences. Finally, looking forward to the prospects of the future research, it is an important direction to continue the research with panel data of a smaller area. For example, continue to use county-level panel data for research. At the same time, it is necessary to pay attention to the inclusion of more variables. The study of labor productivity should be combined with the development situation of specific countries and regions.

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