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A study of the effect of population aging on the savings rate—An empirical analysis of the mediating and moderating effects based on 35 Asian countries

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Abstract: *This paper first analyzes the impact of population aging on national saving rate and the influence mechanism of related factors, and then selects the data of macroeconomic indicators of 35 Asian countries from 2001 to 2020 to establish a panel data regression model to study the impact of population aging on national saving rate. The results show that population aging has a significant inhibitory effect on the growth of savings rate, and the mediating variable per capita consumption expenditure plays a part in the process of influence, while the moderating variable deposit interest rate plays a reverse moderating effect on this influence.*

Keywords: *population aging; savings rate; Asian countries*

1. Introduction

According to the definition of the United Nations, it is considered that a country or region enters a society with an aging population when the number of people aged 60 and above accounts for more than 10% of the total population or when the number of people aged 65 and above accounts for 7% of the total population. With the development of society, the world is rapidly deepening the degree of aging. Population aging has caused a certain level of impact on the overall macroeconomy [1]. Some studies show that population aging will have an impact on the structure of a country's national savings rate, affecting the total savings rate [2]. It becomes an urgent issue to determine the relationship between population aging and savings rate, and how various countries in the world can regulate the impact of population aging on savings rate through policy adjustments.

2. Literature Review and Research Hypothesis

National savings are mainly composed of residential savings, corporate savings and government savings. In terms of residential savings, the studies points out that the elderly dependency ratio and child dependency ratio are inversely related to the residential savings rate [3]. In terms of corporate savings, the deepening of population aging will affect the development of the labor market. There is a study that uses the panel data of 31 Chinese provinces, cities, and autonomous regions from 2002 to 2013 as a prototype of economic growth theory, and talk about the negative impact of population aging on the labor force [4]. In terms of government savings, Gouveia argues that the proportion of public spending gradually decreases as the population ages [5]. This paper integrates them to study the effect of population aging on national saving rate and the first hypothesis is proposed in this paper.

H1: The increasing aging of the population has a dampening effect on the growth of the savings rate.

A study builds a model based on consumer life-cycle theory and finds that population aging leads to lower interest rates and reduces the cost of business financing and boosts business demand for labor [6]. The aging population will affect the interest rate, and the interest rate will also affect the consumption intention of the elderly (Figure 1). Based on this, the second hypothesis is proposed in this paper.

H2: Interest rates play an inverse moderating role in the process of population aging affecting the savings rate.

Demery conducted an empirical study on the relationship between population aging and residential consumption rate in the UK using UK household data from 1969-1998 and concluded that population aging is positively related to residential consumption rate [7]. Accordingly, this paper proposes the third

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research hypothesis.

H3: Per capita consumption expenditure has a mediating role in the process of population aging affecting the growth of the savings rate.

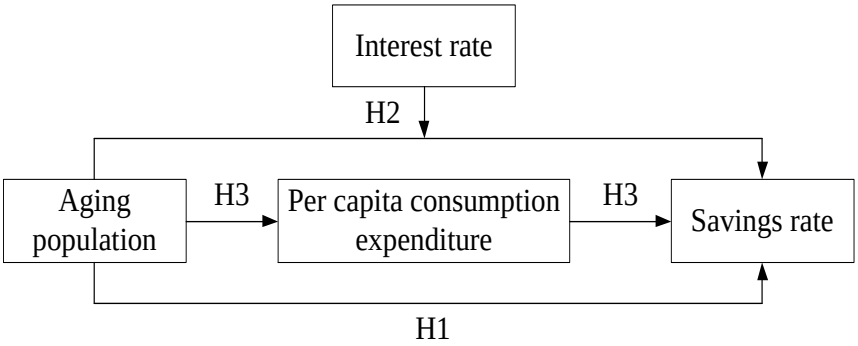

Figure 1: Mechanism diagram

3. Variables and Data

(1) Variable selection

In this paper, the aggregate savings rate of 35 Asian countries is selected as the explanatory variable, the old-age dependency ratio as the explanatory variable, per capita consumption expenditure as the mediating variable, interest rate as the moderating variable, GDP per capita, juvenile dependency ratio, urbanization as control variables, and to exclude the effect of changes in price factors, per capita consumption expenditure and GDP per capita are in constant 2015 U.S. dollars.

3.1. Explained variables

Savings rate (SR): theoretically, the most direct effect of demographic structure on savings rate is the residential savings rate, the national savings rate is chosen as the explanatory variable in this paper.

3.2. Explanatory variables

Old Age Dependency Ratio (ODR): indicates the proportion of the population aged 65 years or older to the population aged 15-65 years. It visually reflects the change in a country's labor force population versus its aging population and can visually reflect changes in the age structure of the population.

3.3. Mediating variables

Per capita consumption expenditure (PC): To a certain extent, residential consumption expenditure affects the level of savings rate, and since the effect of population aging on the savings rate is studied, the population-related per capita consumption expenditure is selected.

3.4. Regulating variables

Interest rate (I): In this paper, we choose the interest rate of deposits in each country. An increase in the interest rate of deposits attracts savings and thus increases the savings rate.

3.5. Control variables

Per capita GDP (PGDP): The level of economic development affects the level of national savings rate. In this paper, the per capita GDP is chosen to quantify the economic development.

Child Dependency Ratio (CDR): The child dependency ratio represents the proportion of the population aged 14 and under to the population aged 15-65.

Urbanization share (CITY): The level of urbanization affects the savings of actors.

Different types of variables in different panels are defined and explained, as shown in Table 1.

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Table 1: Variable definitions and descriptions

Variable Name	Symbols	Definition of variables
Panel A. Explained variables		
Savings Rate	SR	Total savings/GDP of a country
Panel B. Explanatory variables		
Old-age dependency ratio	ODR	Number of people aged 65 and over / Number of people aged 15-65
Panel C. Intermediate variables		
Per capita consumption expenditure	PC	Total personal consumption of the population/total annual population
Panel D. Moderating variables		
Interest Rate	I	Annual deposit rates by country
Panel E. Control variables		
GDP per capita	PGDP	GDP/total annual average population
Child Support Ratio	CDR	Number of people aged 14 and under / Number of people aged 15-65
Share of urbanization	CITY	Number of resident town population/total population

(2) Data sources

In this paper, 35 Asian countries from 2001 to 2020 are selected as the study sample, and the selected data are obtained from the World Bank, EPS database, and CEIC databases.

4. Empirical Analysis

The ADF test was performed on the selected data to check its stationarity. From the results of the ADF test, all six variables of the original data are not smooth, and differencing of the data is considered. After the first-order differencing of the data, the ADF test was continued and SR (1), ODR (1), I (1), PC (1), CDR (1), and CITY (1) were all first-order differenced data. The cointegration relationship between the pairs of data was tested by the Westerlund test. From the test result P=0.03943, it is seen that there is a cointegration relationship between variables at 5% significance level, so the model is regressed on cointegration.

(1) Panel fixed effects regression

To study the effect of population aging on the savings rate, this paper first develops a panel regression model.

$$SR=\beta_0+\beta_1 ODR+\beta_2 lnPC+\beta_3 I+\beta_4 lnPGDP+\beta_5 CDR+\beta_6 CITY+ u_i \quad (1)$$

The model was set up according to the Hausman test, F-test and BP-test, and the results showed that fixed effects should be used under the static panel data model. The regression results are presented in column (1) of Table 2. This paper obtains the standard error adjusted fixed effects model, and the regression results are shown in column (2) of Table 2. After using the Wooldridge test, this paper further considers the time effect in the fixed-effects model after the standard error adjustment, and obtains the two-way fixed-effects model after the standard error is robustly adjusted by clustering, and the regression results are shown in column (3) of Table 2.

The results of the model show that at the 5% level of significance, ODR is significantly negatively related to SR, i.e., an increase in aging is associated with a decrease in the savings rate. The coefficient of ODR is -0.34457, which means that for every 1% increase in the old age dependency ratio, the savings rate will decrease by 0.34457% and the empirical results are more fully demonstrated by robustness tests,testing, accordingly, hypothesis H1.

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Table 2: Panel regression results

	(1)	(2)	(3)
	SR	SR	SR
ODR	-0.29468**	-0.29468**	-0.34457**
	(0.12244)	(0.14324)	(0.23571)
lnPC	17.89899***	17.89899**	15.69459**
	(6.75074)	(7.58589)	(7.71366)
I	0.26458**	0.26458**	0.09008**
	(0.11223)	(0.13433)	(0.04109)
lnPGDP	10.30096***	10.30096***	12.54032***
	(4.17266)	(4.68549)	(5.08391)
CDR	0.58236***	0.58236*	0.15851*
	(0.13230)	(0.30089)	(0.10663)
CITY	-0.63173*	-0.63173*	-0.63830***
	(0.34591)	(0.35532)	(0.22455)
_cons	-38.94039	-38.94039	-37.64029
	(40.37355)	(42.16245)	(20.19937)
N	700	700	700
Country	control	control	control
year			control
adj.2	0. 649	0.647	0.584

Note: Standard errors corresponding to coefficients in parentheses, ***, **, * indicate passing significance test at 1%, 5%, 10% level, respectively

(2) Moderating effect of interest rate

For the elderly group with low income or even zero income, when the interest rate is in a rising state, their intention to save increases accordingly due to the increasing income. The established regulation effect model is shown in Formula (2), and the regression results under the regulation effect are shown in Table 3.

$$SR=\beta_0+\beta_1 ODR+\beta_2 I+\beta_3 ODR*I+\beta_4 lnPGDP+\beta_5 CDR+\beta_6 CITY+u_i \quad (2)$$

Table 3: Regression results of moderating effects

	(4)	(5)
	SR	SR
ODR	-0.25538**	-0.19816**
	(0.08540)	(0.07939)
lnPGDP	7.17577*	6.65169**
	(4.10436)	(3.22168)
CDR	0.73460**	0.73494***
	(0.19757)	(0.19699)
CITY	-0.20144*	-0.15619
I		1.42872***
		(0.46150)
ODR*I		0.06026**
		(0.02869)
_cons	-20.36896**	-18.30601*
	(9.18935)	(10.19152)
N	700	700
country	control	control
year	control	control
adj.2	0.645	0.723

Note: Standard errors corresponding to coefficients in parentheses, ***, **, * indicate passing significance test at 1%, 5%, 10% level, respectively

The results in column (4) show that the old-age dependency ratio is significant and has a negative coefficient at the 5% level. After the introduction of the moderating variable of interest rate, the coefficient of the cross term in column (5) is positive and significant at the 5% level, indicating that the moderating variable I weakens the negative effect of the old-age dependency ratio on the savings rate, thus verifying H2.

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(3) Mediation effect of per capita consumption expenditure

The previous analysis shows that population aging may have an indirect effect on the saving rate through per capita consumption expenditure. We will test whether per capita consumption expenditure plays a mediating effect in the process of the effect of population aging on the saving rate. The established mediation effect model is shown in formula (3) - (5), and the regression results under the mediation effect are shown in Table 4.

$$SR=\theta_0+\theta_1 ODR+\theta_2 lnPGDP+\theta_3 CDR+\theta_5 CITY+\theta_6 I+u_i \quad (3)$$

$$lnPC=\alpha_0+\alpha_1 ODR+u_i \quad (4)$$

$$SR=\theta_0'+\theta_1'ODR+\theta_2'lnPC+\theta_3'lnPGDP+\theta_4'CDR+\theta_5'CITY+\theta_6'I+u_i \quad (5)$$

Table 4: Mediated effects regression results

	(6)	(7)	(8)
	SR	lnPC	SR
ODR	-0.50336***	0. 08587***	-0.42239***
	(0.12184)	(0.00426)	(0.11542)
lnPGDP	7.17577**		0.67558***
	(4.10436)		(0.18207)
CDR	0.17972		0.12112
	(0.21849)		(0.21054)
CITY	-0.77503***		-0.74683***
	(0.21929)		(0.21268)
I	0.26981***		0.27044***
	(0.07595)		(0.07695)
lnPC			-11.40773***
			(3.65963)
_cons	47.16079***	7.06629***	45.96376***
	(12.43218)	(0.06554)	(12.02500)
N	700	700	700
Country	control	control	control
year	control	control	control
adj.2	0.678	0.903	0.680

Note: Standard errors corresponding to coefficients in parentheses, ***, **, * indicate passing significance test at 1%, 5%, 10% level, respectively

The regression results in Table 4 show that the old-age dependency ratio has a significant inhibitory effect on the saving rate at the 1% level, indicating that the increase in population aging can inhibit the growth of the saving rate. From the results in column (7), the effect of old-age dependency ratio on per capita consumption expenditure is significant and positive at the 1% significance level, indicating that the degree of population aging significantly promotes the growth of per capita consumption expenditure. Then the mediating variable consumption expenditure per capita is introduced, and from the fitted results in column (8), we know that both old age dependency ratio and consumption expenditure per capita are significant at 1% level, which proves that population aging can affect saving rate directly or indirectly through consumption expenditure per capita.

5. Conclusion

Through analysis and empirical evidence, this paper concludes the following: population aging has a significant inhibitory effect on saving rate, in which population aging can affect saving rate both directly and indirectly through per capita consumption expenditure. At the same time, the moderating variable interest rate also plays an inverse moderating role in the process of influence. Finally, the conclusions drawn suggest the following recommendations for the country: First, we need to improve the policies related to "two children" and "three children" to improve the population structure. Second, policy adjustments to the labor market impact of an aging population. Third, the central bank can adjust the interest rate reasonably.

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