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Can China's Aging Population Sustain Its Entrepreneurship? Evidence of Nonlinear Effects

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Abstract: This article examines the effects of China's aging population (in terms of the old-age dependency rate (OADR)) on entrepreneurship (in terms of dimensions of innovation (IE) and self-employment (BE)) using data from 30 provinces from 2003 to 2017. Contrary to a widespread pessimistic interpretation that describes an aging population as merely a burden on entrepreneurship, this paper illustrates some positive effects of China's aging population on entrepreneurship in terms of IE and BE. Moreover, we introduce and test the nonlinear relationship between OADR and IE/BE. Our simple panel regression model can be utilized not only to understand the inverted U-shaped effects of an aging population on entrepreneurship, by using the ordinary least squares (OLS) method and fixed-effects (FE) in our empirical studies and the system generalized method of moments (SYSGMM) in the robustness check, but also to provide managerial implications by pointing out the "optimal OADR" and the comparative regional aging situation.

Keywords: aging population; entrepreneurship; nonlinear effects; optimal old-age dependency rate

1. Introduction

Entrepreneurship has been recognized as playing an important role in creating new jobs and new markets, promoting innovations and maintaining sustainable competitive advantages in all economies [1]. It has mostly been discussed at the micro level for individuals or firms, as entrepreneurship entails the activities of individuals working within firms or for themselves [2]. As a highly context-dependent topic, entrepreneurship is affected by a series of so-called push and pull factors, among which age is one of the most discussed determinants, with a long history. Moreover, a few pioneer researchers have started to link findings about age and entrepreneurship at the micro level with those about demography and entrepreneurship at the macro level [3,4].

Aging populations are increasing in virtually every country [5], a demographic phenomenon that has raised anxiety levels in governments as well as in academic discourse. Scholars are worried about the negative impact of an aging population on entrepreneurship, especially in many developed countries with a high aging population ratio [6,7]. Few studies discuss the relationship between aging

and entrepreneurship in the context of developing countries. Seldom are researchers aware of the positive impacts an aging population can bring about, let alone regarding these impacts as double-sided.

China is utilized as an example in this study because its growth in both aging population [8] and entrepreneurship [9] enables relevant researches in the Chinese context to shed light on other developing countries. China has the largest aging population in the world. In 2018, the aging population rated by the old-age dependency rate for the world was 13.582% on average, with about 673 million people aged 65 and above, while for China, it was 15.338%, with over 152 million people aged 65 and above [8]. The figures indicate that China has a higher old-age dependency rate than the world average, as well as takes up over one-fifth of people aged 65 and above in the world. Although the trend of aging populations derived from increased life expectancy and decreased fertility emerged more in developed countries than that in developing ones. China, as the most aging developing country, has the additional accelerator of the one-child policy, generating a phenomenon of “growing old before getting rich” [10]. On the other hand, China has been making outstanding progress in terms of entrepreneurship among developing countries.

Entrepreneurship is particularly praised as a “panacea” for developing countries by academics [11]. However, developing countries are underrepresented in the field of entrepreneurship, since most theories and practices related to entrepreneurship arise in developed countries. As an emerging economy among developing countries, China has made an increasing amount of efforts over recent decades in both research and practices, and the quality of its entrepreneurial activities has been promoted as reviewed by the Global Entrepreneurship Monitor [9]. Although there is still a gap between what China has achieved compared with developed countries, China can be considered a good test case for whether findings derived from developed countries are applicable in the context of developing countries.

The objective of this present study is to propose a nonlinear impact of an aging population on entrepreneurship. We aim to empirically verify that an aging population is not merely damaging to entrepreneurship, and more importantly, to determine whether the nonlinear effects of age and individuals’ entrepreneurship at the micro level can also work for an aging population and entrepreneurship at the macro level.

Our study makes a threefold contribution to the literature. First, it empirically compares the nonlinear effects at the micro-level to the relationship between aging population and entrepreneurship at the macro level to make up for the shortfall in aging population on entrepreneurship literature. To the authors’ knowledge, the only exception to this is the research of Guo et al. [12], who mentioned that an aging population harms entrepreneurship in China, which is quite the opposite of our findings in this paper. Findings yielded from the macro level in this paper expose different facts, possibly not visible at the micro level, that can serve regional policy makers.

Second, contesting the prevailing negative thought patterns about the effects of an aging population on entrepreneurship, derived from the stereotype that entrepreneurship is a realm of the young, and that a shrinking working age population means decreasing entrepreneurship [6,7,12,13], this study offers an alternative perspective by estimating the nonlinear nexus between an aging population and entrepreneurship. Note that the working-age population unsurprisingly has the greatest share of entrepreneurship, and a high aging population ratio will weigh against the working-age population ratio, damaging entrepreneurship. Before that, the demographic transition will grow with entrepreneurship, as part of the aging population still makes significant contributions to entrepreneurship, as proved in European countries [14,15]. Together with the discussed findings at the micro level and some similar studies at the macro level, we have reasons to believe that there is a nonlinear relationship between an aging population and entrepreneurship.

Finally, the methodology used in this paper is improved in terms of variables and the model. For variables, unlike most of the previous literature, where only one proxy of entrepreneurship is utilized, we followed a few recent studies to have two proxies, Innovations in Entrepreneurship (IE) and Business for Entrepreneurs (BE), to describe the diversified dimensions of entrepreneurship. As for

the model, we use both the ordinary least squares (OLS) method and fixed-effects (FE) for testing the empirical models, as the two methods account for the error term and the omitted variables bias. We also use the system generalized method of moments (SYSMM) for checking the robustness of the results, as this method corrects for serial correlation, measurement error, and endogeneity.

The rest of this paper is arranged as follows. The next section illustrates previous literature about both the micro level and the macro level to support our conceptual framework. Section 3 describes the data and variables and establishes empirical models. The empirical results for the OLS and FE models with a robustness check using SYSMM are presented in Section 4. Section 5 concludes the paper with discussions and implications. Finally, Section 6 outlines some limitations and directions for future research.

2. Literature Review

2.1. Nonlinear Effects of Age on Entrepreneurship at the Micro Level

Controversial discussions about the relationship between age and entrepreneurship at the micro level can be traced back to the origin of entrepreneurship. Frank Knight and Joseph Schumpeter, two of the very first scholars to define and introduce the concept, debated whether capital flows should be included in the connotation of entrepreneurship. This debate essentially started a chain reaction of discussions about age and entrepreneurship at the micro level.

Knight [16] proposed that entrepreneurs are risk takers and that capital flows are a prerequisite for entrepreneurs, as they need capital to take risks. Given Knight's idea, older people are more likely to succeed as entrepreneurs since they are more likely to have accumulated more capital as time goes by. Additionally, Hatak et al. [17] noted that, when old entrepreneurs start a new business, they pass obstacles such as a lack of financial support or relevant information more quickly than any other age group, because of their financial, social, and human capital accumulated over time. Following Knight's idea, a simple positive correlation between capital and entrepreneurship is generalized [18].

Meanwhile, Schumpeter [19] argued that entrepreneurs are different from capitalists, in that capitalists need capital flows to take risks, whereas entrepreneurs make profits from their innovations. Given Schumpeter's idea, young people would seem to have advantages over the old in entrepreneurship, if it is the case that innovative thinking fades away with age [20]. In addition, people need time to accumulate capital, but the time discount rate compared to their future income will magnify with age, which explains why older people have a high-risk aversion and low intentions in entrepreneurial activities [21].

Recently, until the series of empirical studies considered above, a nonlinear association between age and entrepreneurship at the micro level has been widely accepted. Parker [22] suggested that there is a clear inverted U-shaped relationship between age and entrepreneurship and that the so-called "golden age" of entrepreneurship is around 40. Researchers have also determined the "golden ages" in their own countries [3,23].

2.2. Nonlinear Effects of Aging on Entrepreneurship at the Macro Level

This agreement on the nonlinear relationship between age and entrepreneurship at the micro level, however, is still too rudimentary to determine the relationship between an aging population and entrepreneurship at the macro level. Different factors at the macro level, such as culture, economics, and demographics can strongly influence entrepreneurship and may change the nexus of an aging population and entrepreneurship [3]. For instance, Kurek and Rachwał [6] proposed that social security can influence the relationship between an aging population and entrepreneurship: when the social security for the employed is higher than for the self-employed, entrepreneurship will be weakened as a population ages.

Consequently, many researchers are aware of the nonlinear relationship between age and entrepreneurship, but they leave an impression of a linear and negative effect of an aging population

on entrepreneurship. Kurek and Rachwał [6] stated that an aging population can be a challenge to entrepreneurship within the European Union, and Stangler and Spulber [7] found that an aging population causes a decline in the development of entrepreneurship in America. Liang et al. [13] even concluded in a multi-country study that an aging population is a burden on entrepreneurship at all age groups, by illustrating the rank effects that countries with young populations have more entrepreneurship than countries with old populations. It is debated that older countries are not good places to develop entrepreneurship compared with younger countries, since important positions are more likely to be dominated by the old, giving the young fewer opportunities to practice entrepreneurship in older countries [13].

Note that studies focusing on the negative impacts of aging on entrepreneurship in a country for a certain period, or those comparing aging population and entrepreneurship among several countries at a certain point, regardless of the different development stages of the countries, may ignore the possible positive impacts of an aging population on entrepreneurship within a country's long history of demographic transition. Fortunately, two studies on the inverted U-shaped relationship of age distribution and entrepreneurship boost our confidence in creating a similar trial for the relationship between an aging population and entrepreneurship. Bönte et al. [3] found an inverted U-shaped relationship between regional age distribution and start-ups in Western Germany using an aggregate data set and a count data model, reasoning that, due to age-specific peer effects, entrepreneurs need local networks, so they cluster in a region with more peers and are affected by age distribution. Similarly, Maritz [4] presented an inverted U-shaped relationship between age distribution and the entrepreneurial activity rate in Australia from single-year panel evidence, pointing out the peak at the age group 35–44. Given that an aging population directly changes the age distribution, which is proved to have nonlinear effects on different entrepreneurial activities, we have reason to assume the relationship between an aging population and entrepreneurship is nonlinear (inverted U-shaped) as well.

The literature discussed above reveals a space for further explorations, since the nonlinear effects of age and entrepreneurship at the micro level are sufficient and aligned but the relationship of an aging population and entrepreneurship at the macro level is divergent and uncertain; moreover, most of the research has been conducted in developed countries. An empirical study run on panel data in China can provide a diverse perspective to clarify the correlations between the aging population and entrepreneurship.

This study proposes that there might be a nonlinear (inverted U-shaped) relationship between an aging population (old-age dependency rate (OADR)) and entrepreneurship (innovation in entrepreneurship (IE) and business for entrepreneurs (BE)). As shown in the conceptual framework in Figure 1, entrepreneurship would grow until it reaches a threshold value, which we name the “Optimal OADR”, corresponding to the “golden age” at the micro level [22] (Phase I). When the aging population exceeds the “Optimal OADR”, the impact of an aging population on entrepreneurship could become negative (Phase II), as the share of the aging population takes up too much of the working age population in the overall demographic distribution, which would endanger entrepreneurship. In other words, this study hypothesizes that, as the aging population grows, entrepreneurship also grows, and once the level of an aging population reaches a threshold, it becomes harmful to entrepreneurship.

Figure 1. Theoretical connection between aging population and entrepreneurship.

3. Model

3.1. Data Collection

This article takes the panel data for 30 provinces between 2003 and 2017 from the National Bureau of Statistics of China. The data used to analyze the aging population were sourced from the China Statistical Yearbook. The data concerning entrepreneurship were sourced from the China Macro Economy Database and the China Labor Economy Database. Original data for human capital and other control variables were sourced from the China Statistical Yearbook, the EPS data platform, and the wind database. All indicators were measured in currency units modified using the GDP deflator from 2003.

3.2. Variables

Table 1 shows the definitions and descriptive statistics for each variable. Following the convention in the literature and official statistical yearbooks, ages are usually divided into three groups, namely child dependents aged 0–14, the working population aged 15–64, and old-age dependents aged 65 and above. The OADR, which is the ratio of the population aged 65 and above to the people aged between 15 and 64, is the measure most frequently used and most widely accepted as the main explanatory variable to represent an aging population [24].

Concerning entrepreneurship, we utilize the two most commonly used dimensions to indicate it. Innovation in entrepreneurship, measured by patents [25], is the earliest proxy for entrepreneurship, since innovation is argued to be of central importance to entrepreneurship by Schumpeter [19]. Business for entrepreneurs, measured by self-employment and employment in private enterprises, is another proxy used in a considerable amount of research on entrepreneurship, as such businesses are regarded as a key means for entrepreneurship to leverage a healthy economy and educated workforce [9]. To avoid the narrow focus and empirical caveats arising from the use of a single variable to measure multi-dimensional entrepreneurship [1], both IE and BE are taken as proxies for entrepreneurship and dependent variables, aligning with some recent research [12]. Controlled variables include Human Capital (HC), Financial Development, Financial Openness, Marketization, Science and Technology Expenditures, and Government Intervention. In addition, in Section 4.2, Robustness Check, the Older Population Rate (OPR) is utilized.

Table 1. Descriptive statistics for the variables (Sample size: 450).

Variables	Definition	Mean	SD	Min	Max
OADR	Old Age Dependency Ratio, population ages 65 ⁺ to working age	12.78	2.630	7.440	21.88
OADR ²	OADR squared	170.3	72.04	55.35	478.7
IE	Innovation in Entrepreneurship, log of patent license number	8.980	1.650	4.250	12.51
BE	Business for Entrepreneurs, self-employed/employed in private enterprises of total employment	41.88	10.36	16.53	69.41
HC	Human Capital, log of average years of education	2.170	0.110	1.830	2.550
FD	Financial Development, year-end loan balance to GDP	1.170	0.410	0.540	2.580
FO	Financial Openness, Foreign Direct Investment in CNY to GDP, inverse indicator	0.020	0.020	0.000	0.080
MKT	Marketization, added value of state-owned enterprises to that of the second industry, inverse indicator	0.400	0.190	0.070	0.840
ST	Science and Technology, Government Science and Technology of total government expenditure	1.570	1.320	0.220	7.200
GI	Government Intervention, government spending to GDP	0.210	0.090	0.080	0.630
OPR	Older Population Rate, population ages 65 ⁺ of total population	9.360	1.920	5.430	16.38
OPR ²	OPR squared	91.34	38.31	29.48	268.3

3.3. Empirical Model

This study deploys panel regression models, which hold advantages in maintaining accuracy with limited sample sizes and simplifying computation and statistical inference [26]. By using panel data, changes in the variables over time in a country can be presented, and a time series dimension can be freely added [3]. For the core assumption that an aging population can have a significant impact on entrepreneurship through human capital, the regression equations for the linear effect of an aging population are as follows:

$$IE_{it} = \beta_0 + \mu_i + \beta_1 OADR_{it} + \beta_2 FD_{it} + \beta_3 FO_{it} + \beta_4 MKT_{it} + \beta_5 ST_{it} + \varepsilon_{it} \quad (1)$$

and

$$BE_{it} = \beta_0 + \mu_i + \beta_1 OADR_{it} + \beta_2 FD_{it} + \beta_3 FO_{it} + \beta_4 MKT_{it} + \beta_5 GI_{it} + \varepsilon_{it} \quad (2)$$

In the equations above, IE_{it} and BE_{it} refer to innovations in entrepreneurship and businesses for entrepreneurs, respectively, for the t th province in the i th year. β_1 is the target variable, indicating the direct effect of an aging population on entrepreneurship. $OADR_{it}$ is the old-age dependency ratio, indicating an aging population. FD_{it} , FO_{it} , MKT_{it} , and ST_{it} are control variables for Equation (1). FD_{it} , FO_{it} , MKT_{it} , and GI_{it} are control variables for Equation (2). μ_i represents the time fixed effect, and ε_{it} represents a disturbance term. Since this article considers the impact in each province, there is no random effect in this model.

Furthermore, to investigate the potential nonlinear relationship between an aging population and entrepreneurship, Equations (3) and (4), including both the linear and quadratic forms of OADR and an added control variable HC, are used.

$$IE_{it} = \beta_0 + \mu_i + \beta_1 OADR_{it} + \beta_2 OADR_{it}^2 + \beta_3 HC_{it} + \beta_4 FD_{it} + \beta_5 FO_{it} + \beta_6 MKT_{it} + \beta_7 ST_{it} + \varepsilon_{it} \quad (3)$$

and

$$BE_{it} = \beta_0 + \mu_i + \beta_1 OADR_{it} + \beta_2 OADR^2_{it} + \beta_3 HC_{it} + \beta_4 FD_{it} + \beta_5 FO_{it} + \beta_6 MKT_{it} + \beta_7 GI_{it} + \varepsilon_{it}. \quad (4)$$

4. Results

4.1. Linear and Nonlinear Effects Analysis

Both the linear and nonlinear effects of an aging population are shown in Table 2. For the linear effects, the direct and positive impacts of OADR on IE, BE, and HR are tested in two steps. The first step uses the OLS method, where the coefficients for OADR at the 1% statistical level with IE and BE are 0.188 and 0.702, respectively. The second step uses the FE method, where the coefficients for OADR at the 1% statistical level with IE and BE are 0.0701 and 0.852, respectively.

Table 2. Linear effects and nonlinear effects of OADR on IE/BE in China.

Variables	Linear Effects				Nonlinear Effects	
	OLS-IE	OLS-BE	FE-IE	FE-BE	FE-IE	FE-BE
OADR	0.188 *** (10.63)	0.702 *** (4.58)	0.0701 *** (4.74)	0.852 *** (4.74)	0.162 ** (2.44)	3.195 *** (3.26)
OADR ²					−0.00388 * (−1.68)	−0.0837 ** (−2.46)
HC					7.457 *** (17.82)	65.87 *** (11.26)
FD	−0.236 * (−1.89)	0.847 (0.83)	1.414 *** (11.52)	6.745 *** (3.82)	0.615 *** (5.99)	2.874 * (1.81)
FO	−14.64 *** (−5.69)	−0.232 (−0.01)	−4.213 * (−1.83)	11.05 (0.39)	−0.842 (−0.48)	44.56 * (1.78)
MKT	−3.529 *** (−13.01)	−32.96 *** (−14.80)	−4.230 *** (−15.88)	−39.26 *** (−9.80)	−2.109 *** (−8.91)	−24.81 *** (−6.63)
ST	0.661 *** (15.95)		0.397 *** (15.33)		0.238 *** (11.08)	
GI		52.62 *** (10.78)		23.74 ** (2.49)		−13.72 (−1.50)
Cons	7.572 *** (25.68)	34.16 *** (13.04)	7.612 *** (24.34)	33.68 *** (8.18)	−8.835 *** (−8.20)	−119.2 *** (−7.74)
Obs	450	450	450	450	450	450
N			30	30	30	30
R ²	0.720	0.471	0.790	0.570	0.881	0.670
F	232.2	80.94	345.5	125.9	480.6	135.1
F-Statistic			50.41 (p = 0)	17.75 (p = 0)	86.45 (p = 0)	25.49 (p = 0)

Notes: * Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

For the nonlinear effects, the FE method is utilized, indicating that OADR has a positive impact, while OADR² has a negative impact on both IE and BE. The impacts are all significant, illustrating that an inverted HC relationship between OADR and IE/BE exists. The nonlinear effects of OADR on IE have a significance of 0.162 at the 5% statistical level, and those of OADR² on IE have a significance of −0.00388 at the 10% statistical level. The nonlinear effects of OADR on BE have a significance of 3.195 at the 1% statistical level, and those of OADR² on BE have a significance of −0.0837 at the 5% statistical level.

F-Statistic Tests for the linear effects of FE-IE and FE-BE, and the nonlinear effects of FE-IE and FE-BE are 50.41, 17.75, 86.45, and 25.49, respectively, and each is significant at the 1% statistical level, implying that the FE method is more suitable for running the models than the OLS method. Hausman Tests for the nonlinear effects of FE-IE and FE-BE are 116.83 and 59.81, respectively, but neither passes significance at the 1% statistical level, implying that the FE method is more suitable for running the models than the RE method.

4.2. Robustness Check

The positive correlation between an aging population and entrepreneurship could have chain effects on policy makers. Therefore, it is essential that the robustness of the “evidence” behind relevant recommendations be well founded [27].

This paper uses two steps in the robustness check. The first is to check the robustness of the empirical models, by introducing a new variable, OPR, to replace the main explanatory variable, OADR. Both OADR and OPR indicate aging population, and the numerator for both is the population aged 65 and above. The difference is that the denominator of OADR is the working-age population, while the denominator of OPR is the total population. As shown in Figure 2, although the overall trends are similar, the average level of the aging population with respect to OADR is higher than that with respect to OPR, and the difference gap is obvious when both variables are squared in comparisons.

Figure 2. Data comparisons between OADR and OPR and between OADR² and OPR² in China, Note: The author’s calculations are based on the World Bank’s Health Indicators.

Table 3 shows that both the linear and nonlinear effects of OPR and IE/BE have been proved. Moreover, the coefficients for OPR are nearly double those for OADR, for both linear and nonlinear effects, with better statistical significance. For the linear effects of OADR on IE/BE, the coefficients for OLS-IE, OLS-BE, FE-IE, and FE-BE models are 0.188, 0.702, 0.0701, and 0.852, respectively, at the 1% statistical level. Meanwhile, for the linear effects of OPR on IE/BE, the coefficients for the OLS-IE, OLS-BE, FE-IE, and FE-BE models are 0.303, 1.163, 0.125, and 1.486, respectively, at the 1% statistical level.

For the nonlinear effects of OADR, the coefficients of OADR and OADR² in the FE-IE model are 0.162 at the 5% statistical level and −0.00388 at the 10% statistical level, respectively, and the coefficients of OADR and OADR² in the FE-BE model are 3.195 at the 1% statistical level and −0.0837 at the 5% statistical level, respectively. Meanwhile, for the nonlinear effects of OPR, the coefficients of OPR and OPR² in the FE-IE model are 0.360 and −0.0134, respectively, at the 1% statistical level, and the coefficients of OPR and OPR² in the FE-BE model are 6.106 and −0.228, respectively, at the 1% statistical level.

Table 3. Linear effects and nonlinear effects of OPR on IE/BE in China.

Variables	Linear Effects				Nonlinear Effects	
	OLS-IE	OLS-BE	FE-IE	FE-BE	FE-IE	FE-BE
OPR	0.303 *** (12.46)	1.163 *** (5.33)	0.125 *** (5.70)	1.486 *** (5.52)	0.360 *** (3.71)	6.106 *** (4.21)
OPR2					−0.0134 *** (−2.96)	−0.228 *** (−3.38)
HC					7.304 *** (17.55)	63.10 *** (11.01)
FD	−0.277 ** (−2.29)	0.216 (0.21)	1.394 *** (11.48)	6.792 *** (3.90)	0.621 *** (6.10)	3.418 ** (2.17)
FO	−17.39 *** (−6.92)	−9.450 (−0.40)	−4.392 * (−1.93)	9.117 (0.33)	−1.313 (−0.75)	37.84 (1.51)
MKT	−3.513 *** (−13.60)	−32.62 *** (−14.84)	−4.040 *** (−14.94)	−37.77 *** (−9.43)	−2.015 *** (−8.47)	−24.33 *** (−6.54)
ST	0.618 *** (15.49)		0.395 *** (15.48)		0.232 *** (10.81)	
GI		54.57 *** (11.18)		21.02 ** (2.22)		−18.91 ** (−2.05)
Cons	7.316 *** (26.21)	32.65 *** (12.57)	7.293 *** (22.43)	30.61 *** (7.25)	−9.268 *** (−8.80)	−122.6 *** (−8.20)
Obs	450	450	450	450	450	450
N			30	30	30	30
R2	0.740	0.479	0.795	0.578	0.882	0.674
F	256.5	83.64	355.3	129.8	486.7	137.9
F-Statistic			47.23 (p = 0)	17.83 (p = 0)	82.57 (p = 0)	26.35 (p = 0)

Notes: * Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

The second step is to check the robustness of the empirical results by utilizing a new SYSGMM model to double-check the nonlinear effects of the FE method. The regression results are reported in Table 4. The coefficients of OADR and OADR² on IE are 0.1165 at the 5% statistical level and −0.0043 at the 1% statistical level, respectively. The positive coefficient of OADR and the negative coefficient of OADR² suggest that the relationship between OADR and IE is nonlinear (inverted U-shaped). The coefficients of OADR and OADR² on BE are 0.1817 and −0.0049, respectively. Albeit with insufficient statistical significance, the positive coefficient of OADR and the negative coefficient of OADR² again suggest that the relationship between OADR and BE is nonlinear (inverted U-shaped), which aligns with the results of FE.

Table 4. Robustness check for the nonlinear effects of OADR on IE/BE in China.

	SYSGMM-IE		SYSGMM-BE	
	Coefficient	Standard Errors	Coefficient	Standard Errors
OADR	0.1165 **	0.0546	0.1817	0.7310
OADR2	−0.0043 ***	0.0016	−0.0049	0.0266
IEt-1	0.9454 ***	0.0710		
BEt-1			0.9597 ***	0.0880
OPR(1)-p		0.002		0.001
OPR(2)-p		0.749		0.586
Wald test		75,354.70 (p = 0)		4118.43 (p = 0)
Hansen-p		0.00		0.06

Notes: * Significance at the 10% level. ** Significance at the 5% level. *** Significance at the 1% level.

The results of the Arellano–Bond test for serial correlation support the validity of the specification of the nonlinear regression models (Equations (3) and (4)). Although the models fail to pass the Hansen test, this result cannot overturn the null hypothesis. Note that the Hansen test of the SYSGMM is

actually to see whether the variance-covariance matrix is small enough after minimizing the error variance-covariance matrix; there is a problem of circular argumentation in logic, so this test cannot be considered very reliable [28]. At the same time, the Wald test for the combined significance of coefficients rejects the null hypothesis that the explanatory variable is 0 at the 1% significance level. Consequently, the test results of the nonlinear effects of OADR on IE/BE are still reliable.

5. Discussion, Conclusion and Implications

5.1. Discussion and Conclusion

This paper makes a novel contribution to the literature on aging populations by proposing inverted U-shaped impacts of an aging population on entrepreneurship. The empirical investigation of the linear effects and nonlinear effects uses panel data regressions for 30 provinces in China from 2003 to 2017. The results reflect and complement the relationship between aging population and entrepreneurship with a series of interesting findings.

First, the linear effects determined from the scatterplot and the linear effects model show that OADR has positive impacts on IE/BE, so the positive relationship between an aging population and entrepreneurship is proved. The test results run counter to the stereotype of an aging population having only negative impacts on entrepreneurship [6,7,12,13] and, more importantly, give solid support for guiding the public to recognize the value of an aging population.

Second, the nonlinear relationship we empirically testified in this paper is different from the linear relationship between an aging population and entrepreneurship in the majority of the literature [7,12,13]. To guarantee the validity of the results, we use IE and BE to stand for the two dimensions of entrepreneurship in the model design, use OLS and FE to run provincial-level data, change the main explanatory variable of OADR to OPR, and use SYSGMM to repeatedly go through the results for nonlinear effects in the robustness check. The consistency of the empirical results through all tests for nonlinear effects proved our assumptions that a nonlinear relationship of OADR-IE/BE exists. This finding is consistent with an inverted U-shaped relationship between age and entrepreneurship at the micro level [22,23]. It also aligns with the nonlinear relationships between regional age distribution and entrepreneurial activity in Western Germany and in Australia [3,4].

Third, corresponding with the “golden age” as the threshold for the effects of age on entrepreneurship at the micro level [22], the threshold of the effect of OADR on IE and BE at the macro level, namely the “optimal OADR”, is generalized in this paper. The nonlinear results indicate that, as the population ages, innovations in entrepreneurship, as well as businesses for entrepreneurs, will continue to increase. Meanwhile, an aging population exceeding the “optimal OADR” turns out to have negative impacts on entrepreneurship. The corresponding test results of OADR and $OADR^2$ on IE and BE are

$$IE_t = -8.835 + 0.162 \times OADR_t - 0.00388 \times OADR_t^2 + 7.457 \times HC_t + 0.615 \times FD_t - 0.842 \times FO_t - 2.109 \times MKT_t + 0.238 \times ST_t \quad (5)$$

and

$$BE_t = -119.2 + 3.195 \times OADR_t - 0.0837 \times OADR_t^2 + 65.87 \times HC_t + 2.874 \times FD_t + 44.56 \times FO_t - 24.81 \times MKT_t - 13.72 \times GI_t \quad (6)$$

To compute the corresponding “optimal OADRs” maximizing IE and BE, this study takes the derivatives of IE and BE with respect to OADR from the model to test nonlinear impacts. The equations become

$$0 = 0.162 - 2 \times 0.00388 \times OADR \quad (7)$$

and

$$0 = 3.195 - 2 \times 0.0837 \times OADR \quad (8)$$

Accordingly, the “optimal OADR” maximizing IE is 20.88%, and the “optimal OADR” maximizing BE is 19.09% (Figure 3). These results also indicate that an aging population has more impact on BE than that on IE, which is in line with the findings from linear effects.

Figure 3. (a) The inverted U-shaped relationship between OADR and IE; (b) the inverted U-shaped relationship between OADR and BE.

5.2. Managerial Implications

Straightforward institutional implications can be refined from the empirical results. First, the positive correlation between an aging population and entrepreneurship, illustrated by both the positive linear effects and the inverted U-shaped relationship of OADR-IE/BE, indicates the advantages of an age-related factor in entrepreneurship; thus, efforts in this area have been insufficient in China and many developing countries. Studies conducted around themes such as older, late-career, mature-age, senior, and third-age entrepreneurs [4,14,17] have hardly been reviewed in the context of China or many developing countries. Policy frameworks to support the elderly [29] and inclusive initiatives for senior entrepreneurship [15] have also been generalized and conducted more in developed countries. As Kautonen stressed, the working age group unsurprisingly takes on the highest share of entrepreneurship, but the elderly group can make significant contributions to entrepreneurship as well [14]. The positive impacts of an aging population call for more research and policies in any countries tackling this demographic trend.

Second, the nonlinear regression tests help clarify China’s current trend of aging population through the lens of entrepreneurship. OADR has an inverted U-shaped effect on IE and BE, implying that an aging population has positive impacts on both innovation in entrepreneurship and business for entrepreneurs up to the “optimal OADR”, and that beyond that critical threshold, OADR harms entrepreneurship. More importantly, the sample mean of OADR in provincial-level data from 2003 to 2017 (12.78%) is lower than the “optimal OADR” for both IE (20.88%) and BE (19.09%), implying that the aging population level has not yet damaged China’s entrepreneurship. Indeed, entrepreneurship continues to grow with the aging population, and this trend will go on for quite a long while. Additionally, comparing the two inverted U-shaped curves (Figure 3), it can be seen that the slope indicating OADR-IE in Figure 3a is slower than the slope indicating OADR-BE in Figure 3b. This aligns with the linear effects, implying that an aging population has a more obvious impact on businesses for entrepreneurship than that on innovations in entrepreneurship.

Third, the “optimal OADRs” allow policymakers to obtain a better picture of their regional aging population. Figure 4 shows the regional OADR in 2017, classified as the mean of OADR (12.78%),

the mean of OADR in 2017 (15.31%), the “optimal OADR” associated with BE (19.08%), and the “optimal OADR” associated with IE (20.88%). The regional aging population can be observed and compared easily. Seven provinces are far from aging, as their regional OADR in 2017 is lower than the mean of OADR from 2003 to 2017 in all China. Eight provinces are relatively young, as their regional OADR in 2017 is in between the mean of OADR from 2003 to 2017 in all China and the mean OADR in 2017 in all China. Eleven provinces are on their way to meeting the “optimal OADR” for BE, as their regional OADR in 2017 is in between the mean of OADR in 2017 in China and the “optimal OADR” for BE. For four provinces (municipalities), namely Anhui (19.14%), Jiangsu (19.19%), Sichuan (19.83%), and Chongqing (20.60%), their relatively high level of aging population has a negative impact on businesses for entrepreneurs but a positive impact on innovation in entrepreneurship, as their regional aging population is between the “optimal OADR” for BE and the “optimal OADR” for IE. None of the regional aging populations have negative impacts on both businesses for entrepreneurs and innovations in entrepreneurship, as none of the regional OADR values in 2017 exceed the “optimal OADR” for IE. This result is useful for regional policy makers tracking their regional aging population and adjusting entrepreneurship initiatives in a responsive manner.

Figure 4. Regional old age dependency rate in China, Notes: Classified by the mean of old-age dependency rate (OADR) from 2003 to 2017, 12.78%; the mean of OADR in 2017, 15.31%; the “optimal OADR” for BE, 19.08%; and the “optimal OADR” for IE, 20.88%. Tibet is excluded for incomplete data.

6. Limitations and Future Research

The first limitation of the present study naturally includes the data. It could be argued that entrepreneurship can be influenced by several factors at the macro level, such as social, economic, cultural factors [13,23], making the “optimal OADR” vary in countries. Some countries with a relatively high old-age dependency rate still see an increase in entrepreneurship, while others with a similar level of aging population suffer from a decline. Whether the findings are applicable to other developing

countries or regions may deserve further investigation. It would also be intriguing to check whether and why the OADR-IE/BE relationship might vary in developed countries or regions. Another limitation of the study is that we only illustrate the inverted U-shaped relationship between an aging population and entrepreneurship without digging up the reasons behind it. Future studies can try to expand the measures of an aging population or explore moderating factors to better understand the mechanisms by which aging population translates into entrepreneurship.

Population aging is an inevitable trend when the social economy develops to a certain stage, and preparing for it is essential to fulfill the pledge that “no one will be left behind” and achieve global sustainable development [5]. Exploring the value of an aging population and how to make the most of it have become important current issues in the realms of both academia and institutions, and such topics deserve continuous attention around the world.

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