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Aging Population Spatial Distribution Discrepancy and Impacting Factor

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Abstract: The phenomenon of population aging is gradually spreading around the world. Consequently, it is leading to unsustainable economic development due to the decline of the labor force. Therefore, many people identify the aging population from national and intercontinental levels, as it would not be possible to recognize specific population spatial distribution characteristics and impacting factors in a province or state because of the spatial and temporal differences. In this paper, Jiangsu Province was selected as the study area to represent its aging population’s spatial characteristics and to identify the spatial heterogeneity with impacting factor by Geographically Weighted Regression (GWR), as well as to determine the impacting situation by marginal effect. The results show the following: (1) The impact factor’s spatial heterogeneity from the cities in Jiangsu Province is small but occurs in the city groups, while the impacting situation is the same in the north, central and south city groups, showing a disparity among them. (2) There is a significant change in the impact factor’s influence from 2010 to 2020. (3) The social–economic factor negatively relates to the aging population in 2020, with an interval value of \([-1.0585, -1.0632]\). This finding indicates that the spatial heterogeneity of the aging population at the province level is not the same as that at the national level. Therefore, we need to consider the local situation more. These findings further provide an empirical basis for the province-level study of the aging population, which differs from the national level.

Keywords: aging population; spatial heterogeneity; GWR; Jiangsu province

1. Introduction

The population is vital for sustainable development to guarantee labor productivity and promote social development. Declining fertility and increasing life expectancy consequent of urbanization will lead to an aging population [1]. The demographic dividend is gradually reflected in developing countries. United Nations has stated that the ratio of people aged over 65 in less-developed regions reached 8.2% in 2000 and is expected to exceed 22.3% in the middle of this century [2]. Due to the social welfare system not being well-established in developing countries, older people will suffer more stress than in developed countries.

If the proportion of people aged over 60 and 65 exceed 10% and 7%, respectively, a region is deemed to have an aging population; if the ratio of people older than 60 is more than 20% or if those older than 65 reaches 14%, it is considered to be a profoundly aging society [3,4]. In China, the proportion of people over the age of 65 has exceeded 7% since 2000, signifying that China is entering an aging society. The 2020 census reported that the ratio aged 65 is 13.5%, reflecting that China will join the global community of profoundly aging countries. China is the largest developing country and has experienced rapid urbanization and dramatically improved infrastructure, public services, and living environment in various regions [5]. However, the one-child policy has created the characteristics of China’s late-aged but rapidly developing society.
An aging and declining population directly impacts economic growth by reducing the labor force [6], and the imbalance that develops between urban and rural areas also will be strengthened. Elders' demands such as healthy living will enhance social welfare investment, aggravating social inequality. Therefore, recognizing the aging population's spatial distribution characteristics and correlation factors is significant and will tangibly provide a practical reference for formulating economic development policies and welfare security systems.

The aging population phenomenon is a research hot-spot that people study from different aspects. In terms of economic development, increasing the aged population share will indirectly reduce output through a direct impact on the employment rate in Japan [7]. Population aging positively relates to firm innovation in China, especially in state-owned enterprises [8]. This means that employees with more working experience will obtain a better innovation ability. Moreover, the rapidly aging population may harm sustainable social welfare construction development. For instance, the large transfer deficit will ultimately be unsustainable because, for example, transfers to the elderly have increased substantially in Korea in a short time [4].

Indeed, the aging spatial distribution study is usually considered because aging processes will profoundly affect public health policies and care [9]. Spatial auto-correlation means reviewing the distribution feature of the elderly population, i.e., an area with a high density of aging people, is perhaps adjacent to another high-density area, and vice versa. Additionally, random distribution is also possible. One study in China recognized older people's spatial distribution characteristics by the Bayesian spatial–temporal model from 1992 to 2015 [10].

Furthermore, this spatial characteristic is not only between nations but also within the nation. Life expectancy in rural areas was smaller than in urban areas that studied the trend of urban–rural differences in life expectancy at birth in the United States, between 1969 and 2009 [11]. The specific demographic, socioeconomic, and environmental factors that formed spatial heterogeneity in population aging were evident in China [12]. Acknowledging the spatial characteristic of the aging population distribution and regional development situation will contribute to us recognizing whether supply and demand are balanced. Then, local authorities or departments could adopt some measures to balance it by providing a friendly living environment for the elderly.

Spatial characteristics pay attention to three-dimensional space, whereas two-dimensional space does not. Hence, we should consider the location attribute to present local features. Meanwhile, we could calculate and determine the spatial value by utilizing some software regarding geographic information technology development. Geographically Weighted Regression (GWR) is a spatial regression model that combines the location attribute under the regression model. In [5], the authors identify the supply of public services as an impacting factor in the progress of urbanization by GWR. They found that the eastern region of China had a high level of urbanization; however, the speed was relatively slow between 2000 and 2015 compared with the rest of the country.

As Tobler’s first law of geography said, “everything is related to everything else, but near things are more related than distant things”. Spatial dependence is necessary for the spatial analysis of geographical information data of a given region and its neighboring regions [10]. Different spatial analysis scales will have disparate results, as [11] found. Current research on population aging focuses on the spatial–temporal discrepancy at the national or continental level [12]. The state (province) scale seems not to be mentioned very much. In addition, most of the literature recognizes the impact of aging and how to solve it. Few studies identify the attributes of an aging society, especially at the state (province) level. Indeed, it is difficult to describe or reflect the tangible features of an aging population on the microscopic scale, if we transfer the findings to a tiny scale from a macroscopic scale. That will not contribute to the local authority creating a livable and sustainable city.

Therefore, this paper attempts to identify the aging population transition process via an evaluation framework, mainly involving social–economic/demographic/healthcare
facilities attributes. Then, this paper will measure the aging spatial characteristic by Geographically Weighted Regression (GWR) and apply marginal effects to determine the impacting factor for aging populations in different cities to accurately reflect local aging society features. In this study, we will recognize the cause of aging population from impacting factors, which further understand the aging society. Spatial heterogeneity of an aging population distribution will be assessed to identify the spatial distribution of older people, whether they have any common characteristics or if there is a potential correlation from geographic space. That could be comparatively analyzed with the current study, which provides more details to the local authority to benefit policy development. In addition, human geography is devoted to identifying the relationship between social space organization, humans and the environment. An aging society has also gradually become a common issue in many countries or cities, which should consider the issue from different spatial scales. This study fulfils the regional trim space level gap based on spatial measurements, which contributes to recognizing the discrepancy or coherence in the national- and province-level aging population phenomenon.

2. Materials and Methods

   The aging society is a new phenomenon unprecedented in human history. The demographic transition corresponds to the change from a demographic regime with high birth and death rates to a rule characterized by low birth and death rates [13]. In this process, modernity is at heart, represented by the urbanization attribute that includes but is not limited to social–economic, demographic factors and healthcare facilities. These three categories of features are popularly selected to study aging population characteristics.

2.1. Impact Factor Literature Review

1. Social economics

   Social economics will provide an asset for provincial authority or self to guarantee high-quality living quality, whereas inequitable income distribution harms population health [14]. Life expectancy in rural areas is shorter than in urban areas [11], representing the social–economic relationship with the aging process. The members of the most disadvantaged groups experience worse health and higher mortality from birth through adulthood [15]. As to this, the social–economic attribute is vital for the aging population study.

   Indeed, the social–economic factor involves many indicators. This paper selects the per capita GDP/per capita disposable income factor as a variable to measure their relationship with the aging population. Per capita GDP reflects the holistic social–economic status of per capita gross domestic product (GDP) [10], which is one of the most widely used measures to evaluate the welfare level [16], which is more effective at explaining the social economy from a personal aspect. Indeed, the macro-economic development status possibly could not represent social wealth equality accuracy due to per capita GDP increasing aggravates inequality (Gini) [17]. Hence, this paper also chooses per capita disposable income to indicate the personal economic status, which could explain the social–economic factor more objectively due to having two dimensions.

2. Demographic

   (1) Nature factor of the Demographic

   Demographic characteristics directly represent the aging population situation, while fertility and mortality are bilateral attributes that affect the demographic structure. In recent years, the total fertility rates in some industrialized countries have reached historic lows [18]. Low fertility rates increase the pace and scale of population aging, negatively affecting the sustainability of the economy and public services. Fertility beginning to reduce will also lead to a decline in the population growth rate (but it will remain positive). That will lead to a decline in the total dependency ratio, due to the working-age population growing faster than the population as a whole.
Age and socio-economic characteristics of the population are also more closely related to mortality than regional characteristics [19]. Mortality is associated with an aging population that will increase deaths in high-upper-middle- and lower-middle-income countries, except in low-income countries. The proportion of deaths attributed to the aging population is from −43.9% to 117.4% in 195 countries/territories [20]. This represents a significant correlation between mortality and the aging population. The population growth rate also directly reflects the chosen local demographic status and vitality development.

Social factor of the Demographic

Children remain vital to the aging population, providing care, social companionship, and housekeeping [21]. The household wealth directly relates to the aging population that increased the availability of pensions and the housing reform beginning in the 1990s, which increased housing availability and enabled elders to live alone [22]. The number of household members may be associated with an aging population. Consequently, this paper selects it as a social demographic factor to determine its impact on the aging population.

3. Healthcare facility

Healthcare establishment is crucial for an aging population. The world’s health systems are increasingly burdened by an aging population [20]. The government should build health facilities to keep up with the demand as soon as possible. Meanwhile, 65 years of age or older is the most important of the various age groups that impact health care demand [23]. This group is 7.5 times larger than the population under 25 in terms of health care demand. The number of medical beds will be a direct reflection of local healthcare supply. Hence, this paper applies it to measure the correlation as an observed variable.

2.2. Method

Digital governance developments in China have been robust in recent years in the context of moving forward towards smart cities [24], such that most cities established open data platforms where people could search and download data without individual information. We downloaded and organized data from the website of the statistical department of Jiangsu province or cities. Indeed, these data belong to different statistical categories that we combined under the same period to guarantee consistency.

1. Study area

Jiangsu Province is located in the eastern coastal region of China, in the economically developed region on the Yangtze River Economic Belt (Figure 1). With an area of approximately 107,200 square kilometers, Jiangsu province represents about 1.12% of China’s total area. It is also densely populated, with a population of 80.70 million people [25], and there are 13 cities (Figure 1).

The aging population further aggravates the fact that the average senior population ratio (across all cities) was 10.98% in 2010, which increased to almost 16.20% in 2020 (Figure 2). In 2010, there were three cities in the phase of severe aging: Yangzhou, Taizhou, and Nantong, for which the average proportion was approximately 23.07%. However, in 2020, all cities were facing severe aging, and the city with the highest ratio city is Taizhou (22.01%) (Figure 2). Meanwhile, the largest change was seen in Yangzhou, where the aging population reached 19.99%, and the magnitude of the increase was around 120% (from 9.18%, 2010) (Figure 2).
From 2010 to 2020, Jiangsu Province’s economy expanded significantly. The average per capita GDP grew from CNY 20 thousand in 2010 to around CNY 40 thousand in 2020. The fastest growing city was Huai’an, which grew almost two-fold from CNY 29 thousand to CNY 87 thousand (Figure 3). However, the city with the largest increase in per capita disposable income is Xuzhou, going from around CNY 16 thousand to CNY 43.4 thousand. Meanwhile, the per capita disposable income in Huai’an had doubled by 2020, and nine cities’ growth ratio was more than a factor of one (around 69.23%), while the remaining cities obtained more than 60% growth.
The majority of cities recorded a lower population growth ratio from 2010 to 2020 (around 46.15%), and the most important is Huai’an, whose value dropped to −5.08% (2020) from −1.03% (2010) (Figure 4). In contrast, Lianyungang had the largest population growth, rising from 1.01% to 4.69%. During the same period, the fertility ratio showed a generally similar trend in 2010 and in 2020, as the fertility ratio increased. The mortality ratio is not stable over the same period, but there are a number of reasons for this. Half of the cities had a higher mortality rate in 2020 than in 2010, at 53.84% (seven cities), and the rest had a lower rate.

The population and the average number of households increased, but the average number of households decreased from 2010 to 2020 (Figure 5). This indirectly indicates that elderly people perhaps separated from their children, thus becoming more reliant on social resources to support their daily lives. Meanwhile, the number of medical beds increased.
over the same period (Figure 6), which represents the improvement in health facilities over the past decade. For additional information on the variables, please see Appendix A.

![Figure 5](image-url). Social factor of demographic comparison between 2010 and 2020.

![Figure 6](image-url). Healthcare facilities comparison between 2010 and 2020.

2. Study process

This paper adopts the data in 2010 and 2020 data to analyze the population. Meanwhile, China’s rapid economic development and social livelihood issues gained more attention during this period. However, due to the COVID-19 pandemic, which affected normal living status in early 2020 in China, the government adopted an effective method to control and recover citizens’ living status in a short time. The most severe city (Wuhan) was confined for 76 days, from 23 January to 8 April. However, In the case study area, the city had been on lockdown for only 38 days, from 19 February to 27 March (data from the Jiangsu provincial government website), which means all social activities could subsequently be progressed without limitations. Therefore, it is useful to investigate the relationship between population aging and factors affecting it. The following process in Figure 7 is used to meet the study objective.
Figure 7. Study process.

Figure 7 illustrates the process by which this paper is considered. First, this paper will measure the correlation between independent variables by the Kendall correlation coefficient, which helps us to understand the relationship between variables. Analysis of the aging population by related factors is performed, which should ensure that the observation variable has an inner relationship. Hence, using the Kendall correlation coefficient to measure it will support the rest of the analysis. Then, the spatial auto-correlation and geographic weighting regression will be adopted to identify the aging population spatial characteristics in the study area, which could tangibly interpret the aging population spatial heterogeneity in Jiangsu province and the impacting situation of the explained variance. While the spatial distribution simply represents the spatial relationship between the aging population and impact factor, there is a lack of determination of the degree of impact. Therefore, this paper applies marginal effects to identify correlation factors that influence the aging population.

3. Evaluating framework establishment and correlation test

This paper selects several factors from social–economic, demographic and healthcare facilities attributes to measure how these observation variables affect the aging population and whether there is a spatial discrepancy in different cities under the same factor. The assessment framework can be found in Figure 8. This framework is drawn from this study on population aging. To ensure the effectiveness of this framework, the application of the Kendall correlation coefficient to measure the relationship between the explained variables avoids the selected variable that could not explain the population aging. The Kendall correlation coefficient is a classification test that differs from the Pearson coefficient, the latter being for normal distribution data, and it checks for similarities between variables.

Figure 8. Evaluating framework of aging population.
4. Spatial heterogeneity analysis

(1) Spatial auto-correlation analysis

The aging population ratio may reflect the absolute aging of the population and is the most famous indicator [12]. As mentioned above, all cities fall within the severe aging phase. Therefore, this paper will examine the aging society from the spatial factor to recognize the relationship between cities as a function of the elderly population ratio. Spatial auto-correlation is a method of evaluating the spatial distribution feature of the aging population, which divides the data into homogeneous groups and considers the geographic location of the feature [26]. This paper uses the spatial auto-correlation model to assess the geographical location attribute of the aging population to determine its distribution characteristic. This will recognize the distribution of the elderly in the study area, directly indicating the spatial heterogeneity of population aging.

Moran’s I identifies the potential interdependence between observation data of some variables in the same distribution area. It has a finite range and a definite reference value distinguishing between negative and positive spatial auto-correlation. Meanwhile, its interval value is \([-1, 1]\), where \([-1, 0]\) represents the default negative auto-correlation vice and \([0, 1]\) means positive [27]. The null hypothesis is “the attribute being analyzed is randomly distributed among the characteristics of your field of study”. Hence, if the \(p\)-value is not statistically significant, you cannot reject the null hypothesis.

(2) Spatial heterogeneity for impact factor

Population aging is linked to social-economic/demographic characteristics and healthcare facilities, and it is a complex societal problem. Moreover, many people identify its impact factor in various ways. Ref. [10] have adopted spatial spillovers to recognize the socio-economic influences of an aging population. They found that GNI per capita/rate of urbanization and life expectancy correlate positively with an aging population in a country and neighboring counties. Ref. [12] found that China’s aging population is determined by the demographic, socio-economic, and natural environment, but that there are different key factors in other regions.

The spatial analysis method could also be used to assess the aging population in various cities with non-space attributes, such as by using Geographically Weighted Regression (GWR). It enables the effect of population aging and other variables to vary over a geographical area [28]. GWR could identify the impact of the specific situation in different regions with explained variables, providing an actual scenario to describe how it affects the aging population. GWR is a spatial statistical method that shifts from the global regression models to local models [29].

In fact, in measuring the correlation between independent and dependent variables, different regression methods could be adopted. For instance, ordinary least square (OLS) has been widely used to identify the relationship, but this does not consider spatial variation [30]. In addition, machine learning methods such as random forest have also been applied to classify or determine the correlation [31]. GWR estimates and produces various parameters within the study area by weighting the distance [32]. That will recognize the spatial characteristics of the aging population and its correlation factor, which contributes to understanding the aging population feature of space distribution and defines variables that specifically impact the aging population in the study area. This paper adopts GWR to determine the correlation between population aging and the impact factor. Meanwhile, the GWR is merely quantifying the impact value in the specific area, and if we want to obtain holistic research, we could consider combining other methods.
5. Marginal effect evaluation

The qualifying of the relationship between the aging population ratio and the explanation of the variables from the global aspect will be conducive to more specific recognizing of their relationship. The marginal impact estimates the likelihood that a response level will change as the predicted changes occur. The estimated observation variable on the intention to use shared motorcycles, which claims to improve the variable with a higher average marginal effect value, will achieve a great benefit [33].

3. Finding and Analysis

3.1. Explain Variable Correlation Measuring

According to the explained variance and its data, this paper tests the Kendall correlation coefficient test via the R programming language and obtains the result shown in Figure 9. All the variables explained have an interior correlation, but there is a disparity in the degree of association. The degree of association value is more than 0.5 in GDP per capita, disposable income per capita, and the number of medical beds, and they have a positive correlation. Conversely, in terms of the average household, there is a negative correlation between per capita GDP, per capita disposable income, the number of medical beds, and aging population ratio, such that the value is more extensive than $-0.5$. The chosen variable is the correlation which could further explain the phenomenon of population aging.

Figure 9. Correlation among explain variables. Where V1 is population, V2 is average household, V3 is per capita GDP, V4 is per capita disposable income, V5 is the number of medical beds, V6 is aging population ratio, V7 is population growth ratio, V8 is fertility ratio, and V9 is mortality ratio.

3.2. Aging Population Auto-Correlation

In general, the aging society has been broken down into several hierarchies among the 65-year-olds [31]. If the aged proportion is more than 7% and less than 9%, that is the beginning aging phase; a proportion between 9% and 12% represents the moderate aging phase; a proportion higher than 12% indicates the severe aging phase. All cities were in a
challenging aging phase due to the aging population ratio exceeding 12% in 2020, but only three cities (around 23%) were classified as a severe aging society in 2010 (Table 1 shows).

Table 1. Aging population proportion.

| City         | 2020   | 2010   |
|--------------|--------|--------|
| Nanjing      | 13.70% | 9.20%  |
| Wuxi         | 14.65% | 9.50%  |
| Xuzhou       | 14.72% | 10.43% |
| Changzhou    | 14.88% | 9.80%  |
| Suzhou       | 12.44% | 8.51%  |
| Nantong      | 16.20% | 16.50% |
| Lianyungang  | 14.63% | 9.18%  |
| Huai’an      | 16.42% | 10.40% |
| Yancheng     | 19.88% | 11.97% |
| Yangzhou     | 19.99% | 12.45% |
| Zhenjiang    | 17.51% | 10.36% |
| Taizhou      | 22.01% | 14.24% |
| Suqian       | 13.56% | 10.22% |

According to Moran’s I model, this paper found significant changes from 2010 to 2020 that strengthened the cluster phenomenon. As Figure 10a,b show, the spatial correlation coefficient is pressed in 2010 and 2020 but more concentrated in 2020. This directly means that the aging of the population in spatial clusters was a strength. However, Moran’s I could not determine any specific spatial relationship, and thus, it could not measure the correlation of the aging population distribution between cities. Hence, to recognize this phenomenon in a more tangible way, this paper adopts Getis-Ord General G to measure the inner relationship between the cities of the provincial city of Jiangsu, determining spatial belonging. As [34] identified the commercial facilities clustered situation under Getis-Ord General G* and found that hot pot restaurants and coffee shops with high customer evaluation are significantly clustered, there is thus random distribution in the road network space.
Figure 11a,b present the city’s auto-correlation of an aging population whose distribution gradually widens from 2010 to 2020 in general. This shows the aging society phenomenon enhancing. In 2020, three cities were high–high clusters, meaning those cities have a high aging proportion of seniors. The rest of the cities have no cluster situation. The average age ratio of the population is 20.63% in all three cities, the highest in 2020 (Figure 2). Moreover, the population growth ratio declined from 2010 to 2020, while that of Yangzhou increased slightly (2.24%), the lowest positive increase in 2020. These three cities have a higher aging population and a lower population growth ratio, further reinforcing the aging society that contributes to the high aging population cluster.

![Figure 11a](image1.png) ![Figure 11b](image2.png)

**Figure 11.** (a) Auto-correlation in city (2010); (b) auto-correlation in city (2020).

3.3. Spatial Heterogeneity for Impact Factor

After the development of the ArcGIS software, we can concretely recognize the spatial features and visualize the results. This paper measures factors that influence population aging impacting factors in 2010 and 2020, respectively. In 2010 and 2020, the $R^2$ is in the range of 0.505 and 0.685, respectively (see Table 2). This means that this model result could be looked at. In general, it does not show any significant disparity in the different cities of the same year with the same observation variable. However, there is a remarkable shift from 2010 to 2020.

| Items            | 2010    | 2020    |
|------------------|---------|---------|
| Bandwidth        | 43.22   | 43.22   |
| Residual Squares | 0.48    | 0.342   |
| Effective Number | 5.01    | 5.011   |
| Sigma            | 0.245   | 0.207   |
| AICc             | 20.051  | 15.636  |
| $R^2$            | 0.505   | 0.686   |

Table 2. GWR model coefficient.

Figure 12a,b show the negative socio-economic relationship with population aging in 2010 and 2020, with the range value being $[-1.0632, -1.0611]$ and $[-0.3921, -0.3908]$, respectively, and also shows that the impacting capability decreases. In 2010, socio-economic capacity had the largest impact located south of Jiangsu Province and gradually weakened in northern cities. Conversely, socio-economic capacity gradually increased from southern to northern cities in 2020. Meanwhile, the holistic impact degree has been reduced compared to 2010. This means that aging is increasing unaffected by the socio-economic factors.
Indeed, the social–economic development in the south area of Jiangsu Province is more vital than in other regions, due to this area being close to Shanghai, which is the center of the economy in China. Many industries will spill from Shanghai to cities in southern Jiangsu because of the limited cost of land and labor. As a result, the economy in the south area is better than others. With social–economic development, most people obtain an excellent social welfare guarantee that will reduce the reliance on the economy for the aging population because the marginal effect will gradually decline after reaching the threshold. In this regard, the socio-economic impact status becomes opposite from 2010 to 2020.

In terms of the nature factor of the demographic (Figure 13a,b), the relationship is opposite in 2010 and 2020. The range between the influence factors is $[0.0715, 0.0709]$ and $[-0.1425, -0.1400]$, respectively. It gradually weakened from north to south in cities, but it remained positive in 2010. However, it grew from north to south in cities and has negative impacts on 2020.

Due to the “Universal One Child Policy” in China, which expired in 2016, most families have had only one child since 1980. Since 2016, families have been allowed to have two or three children. Thus, the nature factor of the demographic (fertility, motility, and population growth rates) was opposite between 2010 and 2020. In 2010, due to the “Universal One Child Policy”, the higher population growth rate meant more family numbers representing more elderly people because young couples have to care for four elderly people at least.
This is a positive correlation for 2020, when a family could have more children and lower the average rate of the aging population.

The ability to have an impact with the social factor of the demographic is significantly different to that of the nature factor of the demographic. It is negative relative to the population aging in 2010 and 2020, whose coefficient of influence interval is \([-0.6212, -0.6193]\) and \([-0.8024, -0.7997]\), respectively. However, the impact trend has changed, gradually enhancing from north to south cities in 2010, whereas the opposite is true in 2020 (see Figure 14a,b). The social factor of the demographic is the average household size and population that reflects the total population, where the average impacting degree in 2020 is stronger than in 2010, which means increasing the population will relieve the aging population. As to this, Nanjing had launched several plans to attract more young people to live and work there, such as “Nanjing 321 Talent Program” or “Nanjing 345 Overseas High-level Talent Introduction Program” (data from the government website).

Figure 14. (a) Social factor of demographic impacting coefficient distribution in 2010; (b) social factor of demographic impacting coefficient distribution in 2020.

The healthcare facility is not the same as other factors. It has a one hundred percent positive correlation between 2010 and 2020, with an interval value of \([0.8532, 0.8587]\) and \([0.3460, 0.3476]\), respectively, but the impacting value is almost down to half in 2020 compared with 2010. Meanwhile, the distribution of impactful capacity is similar to other factors, except for the social demographic component (Figure 15a,b). As the number of medical beds rose from 2010 to 2020, the government provided more healthcare facilities to ensure that seniors were healthy. Therefore, they could have more opportunities to receive health care within a timeframe similar to the past. As a result, the impact of the number of medical beds has gradually decreased.

Figure 15. (a) Healthcare facility impacting coefficient distribution in 2010; (b) healthcare facility impacting coefficient distribution in 2020.
3.4. Marginal Effect Evaluating

Figure 16 depicts the marginal effect of each variable on the aging population. The value of the social–economic factor, nature factor of the demographic, social factor of the demographic, and healthcare facility is $-1.06$, $0.07$, $-0.62$, and $-0.85$, respectively. This means that the greatest correlation with the aging population is social economics, which has a negative relation with the aging population. The factor of per capita GDP and per disposable income negatively impacts the aging population and the average household population. Conversely, the number of medical beds, fertility, mortality, and population growth rates are optimistic in light of population aging.

![Figure 16. Average marginal effect (AME) confidence intervals.](image)

4. Discussion

4.1. Aging Population Sprawl Concentrated

In 2020, the aging population will be more severe than in 2010. Meanwhile, the aging population sprawl was focused around cities with a higher proportion of aging in 2010 and the sprawl around them. Three cities have a high–high cluster of aging population in 2020, comprising the group of cities with around the second-highest aging population rate in 2010 (Taizhou). In addition, the rate of population aging has doubled over this period. Figure 17 illustrates the rate of population aging in 2010 and 2020 (normalization value of the Z-score), which represents the high concentration cities (Yangzhou, Taizhou, Yancheng) in 2020 and thus represents a similar situation. The aging of the population in these cities is much greater than in other cities and exceeds the average rate at least once. The population aging rate in 2010 was lower than the average ratio. This means the aging population situation is gradually worsening, especially in these three cities.
4.2. Impacting Factor without Significant Spatial Heterogeneity

Although there is a significant spatial high–high cluster phenomenon of the aging population in 2020, there is no significant spatial heterogeneity at the province level based on impact factors, which differs from the national level in that the birth rate and death rate have the most significant impact on aging in the four areas with evident spatial heterogeneity, as well as remaining factors [12]. The small scale has a more similar economic development and social background that form the same social characteristics. The impact factor of the population aging varies somewhat over the same period. However, there is a wide range from 2010 to 2020 with respect to the incidence of the observation variable.

The social–economic factor, nature factor of the demographic, social factor of the demographic and healthcare facilities have different impacts on the aging population. In 2010, the capacity of impact gradually increased from the southern to northern cities in Jiangsu province, with the exception of the nature factor of the demographic (fertility/mortality/population growth rate). Meanwhile, the social–economic factor and social factor of the demographic has a negative relationship to population aging, and the interval value is $[-1.0585, -1.0632]$ and $[-0.6193, -0.6212]$, respectively. The healthcare facility is optimistic about the aging population, including the internal value $[0.8532, 0.8587]$. Moreover, the nature demographic factor is positive with the aging population with a value of $[0.0709, 0.0715]$, while the northern region has the highest impact and gradually weakens towards southern cities.

As of 2020, the situation has changed. First, the positive impact factor merely affects healthcare facilities, and the rest are negative. Second, the impact capacity of these factor has nearly halved from 2010. The social–economic factor, nature factor of the demographic and social factor of the demographic negatively relate to the population aging, and the incidence interval value is $[-0.3904, -0.3921]$, $[-0.14, -0.1425]$ and $[-0.7997, -0.8024]$, respectively. However, the healthcare facility remains positively correlated with the aging population at the coefficient interval value $[0.3460, 0.3476]$. Third, the impact trend is opposite to 2010, whereby merely the nature factor of the demographic is gradually weakened from south to north, while the remaining factors have a converse trend.

Indeed, in the past decade, from 2010 to 2020, owing to the obtained social and economic sufficiency developing in China, the gross domestic product (GDP) increased around 1.4 times compared with 2010, such that most people could gain essential social–economic living guarantees. Consequently, life expectancy increased gradually without external factors. As to this, the spatial discrepancy of the impacting factor is slight, but all of the impacting factors selected by this paper are significant for the aging population because they were still having an impact in 2020.
The positive factor means that this will contribute to allowing seniors to stay and live, even attracting seniors from outside come here. This will directly or indirectly aggravate the aging of society. In contrast, the negative factor means that it contributes to reducing the aging of the population due to the lack of a comfortable living environment for older people. For instance, death rates were found to have a positive effect on population aging in developing countries, due to a decline in the death rate first appearing in the lower age group and then gradually extending to the middle and old-age groups [12]. In this paper, we found the nature of the demographic is positive with the aging population in 2010 and negative in 2020, a finding which corresponds to a previous study [12] because the death rate belongs to the nature of the demographic factor in this paper. Additionally, we could reasonably infer that mortality became negative in 2020, meaning it no longer appeared in the lower age groups because these groups could obtain adequate healthcare.

Although the spatial heterogeneity of influencing factors is insignificant, there are still some discrepancies. The result shows that there is spatial heterogeneity in Jiangsu province. There is a significant boundary of the impacting factor situation in the northern cities (Xuzhou, Lianyungang, Suqian, Huai’an), central cities (Yancheng, Yangzhou, Taizhou, Nanjing, Zhenjiang, Changzhou) and southern cities (Wuxi, Nantong, Suzhou). Jiangsu province appears to have been divided into three groups of cities which affect the factor and have the same situation within the group but are different from the others. This indicates that spatial heterogeneity in the aging population may not occur at the city level but may occur at the regional level.

4.3. Impacting Factor Has Significant Temporal Heterogeneity

There is no significant disparity in different cities under the same impact factor in the same period. Nevertheless, the influence of the impacting aspects have changed significantly over time, particularly for the nature factor of the demographic (fertility, mortality and population growth rate). Its impact went from negative in 2010 to positive in 2020.

In general, the marginal effect of each variable on the aging population, the social–economic factor and social factor of the demographic is negative with an aging population, thus indicating that individual wealth will decline if they have to take care of aging people. In fact, it fits the logic of having more population and more people in the family representing more newborns or juveniles, which will directly reduce the rate of the aging population. Furthermore, since the personal income of the seniors is usually lower than that of young people, more seniors will diminish the average individual benefit. Meanwhile, the population and average number of households will increase with fewer seniors, but the incidence is low. In addition, the number of medical beds and fertility, mortality, and population growth rate positively correlate with the aging population, which means the local government could not hope to relieve the aging population by increasing fertility. However, the inverse phenomenon in 2010 represents temporal heterogeneity in the same area.

4.4. Provide More Facilities for Elderly Group

Due to a general weakening of the capacity of the factors affected between 2010 and 2020, the aging population gradually encounters fewer external factors. This suggests that basic life security is assured and that increased life expectancy is the main reason for an aging population.

The conclusion of this paper also indicates that the government of Jiangsu province devotes enough healthcare facilities to stratify the demand as much as possible (Figure 18). There was a rapid increase in medical beds between 2010 and 2020, reaching 62.3 in 2020 versus 30.59 in 2010; the most significant change is Xuzhou, where the number of beds grew eight times over the decade. The number of medical beds represents the necessary level of local healthcare facility for the elderly group [33]. The guide from China’s National Health Commission suggests that the number of medical beds should reach 74–75/10,000 people by 2025. In the meantime, Germany reached 80 in 2017 (data from the World Health
Organization). Therefore, the government of Jiangsu province should continue to improve healthcare facilities due to an aging population.

Figure 18. Average medical beds quantity in 2010 and 2020.

4.5. Provide More Policy for “Universal Three-Child Policy”

In recent years, the “Universal Three-Child Policy” was announced in China, and we should adhere to it and provide more policies to alleviate the anxiety of young couples. However, there are no appropriate policy safeguards that may not achieve the expected outcome. Encouraging more young couples to have children should help them solve problems associated with children and the aging population. From a child’s perspective, early childhood care is very important. Social development means that most young couples do not have the same educational concepts as their parents. Thus, some of them are reluctant to seek the help of their parents. However, they do not have enough time to take care of their baby due to being busy working, which will discourage young couples’ desire to have children. Therefore, a sound and well-implemented early childhood system will eliminate this concern.

5. Conclusions and Implications

5.1. Conclusions

This paper established the aging population evaluation framework by considering the aspects of social–economic factor, nature factor of the demographic, social factor of demographic and healthcare facility, and it selected Jiangsu Province as a case study area to identify its aging population situation in spatial–temporal and geographic terms. All cities in this province are entered a severe aging phase in 2020, and three cities in 2010. There is no spatial heterogeneity in the incidence factor over the same period, but there have been significant changes over the decade between 2010 and 2020 at different national levels [12]. There is a spatial heterogeneity in the group of cities, according to which there is a disparity in the impact of the situation between the group of cities in the north, the center, and the south. Meanwhile, the temporal heterogeneity is observed. Over the decade, the impact factor of population aging has changed dramatically, suggesting that we should adjust and revise previous policy and actions after several years of implementation.

The degree of impact of external factors such as social economics weakens progressively for the aging population, and deducting the current social well-being could guarantee the basic needs of older people. While there still is some disparity in impact factors, the per capita GDP and disposable income are negative with the aging population, average household size and population of the city, but the impact degree of the last one is small. Conversely, the number of medical beds and rate of fertility, mortality, and population growth are negatively related to the aging population, especially for the number of medical beds. Demographic factors are a direct cause of this. The indirect factor is the healthcare
facility, because a better healthcare system will improve the health of seniors and possibly attract more seniors.

5.2. Implications

The aging of the population will increase the pressure on the social welfare system and endanger sustainable economic development, especially for developing countries which are old but not yet rich because of decoupling between population aging and social and economic growth that will exacerbate social inequalities [2]. The low-income group will have fewer surpluses because they will have to deal with the same number of seniors as the high-income group.

The socioeconomic improvement will relieve the aging population, and the demographic dividend has been gradually eliminated. However, the local government could transfer the industrial structure from the production and manufacturing industry to a high-end technology industry that will attract and retain young talent. It will effectively improve social and economic conditions and reduce the tendency for an aging population trend. At the same time, the local authority could invest more in the social protection system for children and older people as a result of the increase in tax earnings. This would improve fertility and ensure the live of older people.

The limitations of this study can be addressed in future work. Firstly, as digital governance develops, the city is dedicated to building a smart urban brain. Hence, the mobility status of older people could be recognized, helping to identify the spatial heterogeneity characteristics of this group. Second, this paper selects one province as a case study to determine the aging population in a small region, which could be extended to more areas to conduct a comparative analysis, more objectively revealing the aging population spatial distribution discrepancy at the province level. Third, this paper selected several factors relating to the aging population to identify its spatial distribution characteristics in the same dimension that could further consider the urban–rural discrepancy to analyze the feature in more detail. Fourth, this paper recognizes the spatial characteristics of a province’s aging population that may extend to more than one region for comparative analysis.

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## Appendix A. The Data-Based of Impact Factor in 2010 and 2020

| City       | Population (Unit:10,000) | Average Household (Unit: Person) | Per Capita GDP (Unit: 100 Million Yuan) | Per Capita Disposable Income (Unit: Yuan) | Number of Medical Beds (Unit: Each) | Aging Population Ratio | Population Growth Ratio | Fertility Ratio | Mortality Ratio |
|------------|--------------------------|---------------------------------|------------------------------------------|--------------------------------------------|-------------------------------------|-----------------------|------------------------|-----------------|-----------------|
| Nanjing    | 800.76                   | 2.77                            | 79,427                                   | 28,312                                     | 25,894                              | 9.20%                 | 28.31%                | 7.87%           |                 |
| Wuxi       | 637.26                   | 2.78                            | 92,166                                   | 25,947                                     | 26,012                              | 9.50%                 | 23.03%                | 7.83%           | 8.13%           |
| Xuzhou     | 858.05                   | 3.16                            | 33,233                                   | 16,762                                     | 6200                                | 10.43%                | 22.52%                | 8.22%           |                 |
| Changzhou  | 459.2                    | 2.7                             | 67,327                                   | 16,701                                     | 16,610                              | 9.80%                 | 19.40%                | 7.80%           | 8.50%           |
| Suzhou     | 1046.6                   | 2.84                            | 145,229                                  | 39,200                                     | 26,300                              | 8.51%                 | 51.31%                | 9.19%           | 6.75%           |
| Nantong    | 728.36                   | 2.65                            | 47,419                                   | 21,825                                     | 26,300                              | 9.50%                 | 22.52%                | 7.83%           | 8.13%           |
| Lianyungang| 439.39                   | 3.27                            | 26,987                                   | 19,020                                     | 12,249                              | 9.18%                 | 13.87%                | 8.85%           |                 |
| Huai-an    | 479.99                   | 3.28                            | 29,000                                   | 15,983                                     | 13,761                              | 10.40%                | 10.60%                | 6.50%           |                 |
| Yancheng   | 726.02                   | 2.9                             | 31,400                                   | 16,935                                     | 20,128                              | 11.97%                | 13.20%                | 8.57%           |                 |
| Yangzhou   | 445.98                   | 3                              | 48,955                                   | 21,766                                     | 14,685                              | 12.45%                | 7.71%                 | 9.34%           |                 |
| Zhenjiang  | 311.34                   | 2.92                            | 64,281                                   | 23,075                                     | 9204                                | 10.36%                | 7.46%                 | 6.23%           |                 |
| Taizhou    | 461.86                   | 2.89                            | 44,118                                   | 14,928                                     | 14,24%                              | 14.24%                | 9.18%                 | 11.10%          |                 |
| Suqian     | 471.56                   | 3.56                            | 22,525                                   | 13,784                                     | 13,330                              | 10.22%                | 18.70%                | 10.10%          |                 |

### 2020

| City       | Population (Unit:10,000) | Average Household (Unit: Person) | Per Capita GDP (Unit: 100 Million Yuan) | Per Capita Disposable Income (Unit: Yuan) | Number of Medical Beds (Unit: Each) | Aging Population Ratio | Population Growth Ratio | Fertility Ratio | Mortality Ratio |
|------------|--------------------------|---------------------------------|------------------------------------------|--------------------------------------------|-------------------------------------|-----------------------|------------------------|-----------------|-----------------|
| Nanjing    | 931.97                   | 2.48                            | 159,322                                  | 60,606                                     | 57,455                              | 13.70%                | 16.38%                | 9.49%           | 6.00%           |
| Wuxi       | 746.4                    | 2.56                            | 165,851                                  | 57,589                                     | 51,600                              | 14.65%                | 17.06%                | 7.75%           | 7.91%           |
| Xuzhou     | 908.39                   | 2.79                            | 80,673                                   | 43,390                                     | 59,400                              | 14.72%                | 12.40%                | 7.20%           |                 |
| Changzhou  | 527.96                   | 2.51                            | 147,900                                  | 52,080                                     | 29,327                              | 14.88%                | 14.93%                | 7.60%           | 7.90%           |
| Suzhou     | 1274.96                  | 2.62                            | 158,466                                  | 62,582                                     | 74,700                              | 12.44%                | 21.88%                | 9.01%           | 7.36%           |
| Nantong    | 772.8                    | 2.43                            | 129,900                                  | 42,608                                     | 57,104                              | 16.20%                | 6.08%                 | 10.12%          |                 |
| Lianyungang| 460.1                    | 2.83                            | 71,303                                   | 29,501                                     | 28,400                              | 14.63%                | 4.69%                 | 0.1056          | 5.92%           |
| Huai-an    | 455.92                   | 2.67                            | 87,507                                   | 31,619                                     | 27,930                              | 16.42%                | -5.08%                | 12%             | 7.51%           |
| Yancheng   | 670.96                   | 2.47                            | 88,700                                   | 33,700                                     | 43,324                              | 19.88%                | -7.58%                | 7.20%           | 9.39%           |
| Yangzhou   | 455.98                   | 2.57                            | 132,784                                  | 38,843                                     | 26,316                              | 19.99%                | 2.24%                 | 6.52%           | 8.91%           |
| Zhenjiang  | 321.1                    | 2.51                            | 131,580                                  | 46,180                                     | 17,300                              | 17.51%                | 3.09%                 | 6.81%           | 8.78%           |
| Taizhou    | 451.28                   | 2.48                            | 114,596                                  | 39,701                                     | 28,962                              | 22.01%                | -2.03%                | 7.10%           | 9.66%           |
| Suqian     | 498.82                   | 2.92                            | 65,400                                   | 26,421                                     | 31,396                              | 13.56%                | 5.66%                 | 10.61%          | 6.97%           |
References

1. Anderson, G.F.; Hussey, P.S. Population aging: A comparison among industrialized countries. Aging Male 2009, 3, 158. [CrossRef] [PubMed]

2. Wu, F.; Yang, H.; Gao, B.; Gu, Y. Old, not yet rich? The impact of population aging on export upgrading in developing countries. China Econ. Rev. 2021, 70, 101707. [CrossRef]

3. Hwang, S.; Choe, C.; Choi, K. Population ageing and income inequality. J. Econ. Ageing 2021, 20, 100345. [CrossRef]

4. Kim, H.K.; Lee, S.-H. The effects of population aging on South Korea’s economy: The National Transfer Accounts approach. J. Econ. Ageing 2021, 20, 100340. [CrossRef]

5. Zhao, Z.; Pan, Y.; Zhu, J.; Wu, J.; Zhu, R. The impact of urbanization on the delivery of public service–related SDGs in China. Sustain. Cities Soc. 2022, 80, 103776. [CrossRef]

6. Watanabe, J.-i.; Kimura, T.; Nakamura, T.; Suzuki, D.; Takemoto, T.; Tamakoshi, A. Associations of social capital and health at a city with high aging rate and low population density. SSM-Popul. Health 2022, 17, 100981. [CrossRef]

7. Otsu, K.; Shibayama, K. Population aging, government policy and the postwar Japanese economy. J. Jpn. Int. Econ. 2022, 64, 101191. [CrossRef]

8. Tan, Y.; Liu, X.; Sun, H.; Zeng, C. Population ageing, labour market rigidity and corporate innovation: Evidence from China. Res. Policy 2022, 51, 104428. [CrossRef]

9. Watanabe, J.-i.; Kimura, T.; Nakamura, T.; Suzuki, D.; Takemoto, T.; Tamakoshi, A. Associations of social capital and health at a city with high aging rate and low population density. SSM-Popul. Health 2022, 17, 100981. [CrossRef]

10. Wang, X.-Q.; Chen, P.-J. Population ageing challenges health care in China. Lancet 2014, 383, 870. [CrossRef]

11. Wang, S. Spatial patterns and social-economic influencing factors of population aging: A global assessment from 1990 to 2010. Soc. Sci. Med. 2020, 253, 112963. [CrossRef] [PubMed]

12. Singh, G.K.; Siahpush, M. Widening rural-urban disparities in life expectancy, U.S., 1969–2009. Am. J. Prev. Med. 2014, 46, e19–e29. [CrossRef] [PubMed]

13. Park, J.-k.; Ryu, D.; Lee, K. What determines the economic size of a nation in the world: Determinants of a nation’s share in world GDP vs. per capita GDP. Struct. Chang. Econ. Dyn. 2019, 51, 203–214. [CrossRef]

14. Costantini, M.; Paradiso, A. What do panel data say on inequality and GDP? New evidence at US state-level. Econ. Lett. 2018, 168, 115–117. [CrossRef]

15. Macia, E.; Cheve, D.; Montepare, J.M. Demographic aging and biopower. J. Aging. Stud. 2019, 51, 100820. [CrossRef] [PubMed]

16. Luo, W.; Xie, Y. Economic growth, income inequality and life expectancy in China. Soc. Sci. Med. 2020, 256, 113046. [CrossRef] [PubMed]

17. Acciai, F. The age pattern of social inequalities in health at older ages: Are common measures of socio-economic status interchangeable? Public Health 2018, 157, 135–141. [CrossRef] [PubMed]

18. Park, J.-k.; Ryu, D.; Lee, K. What determines the economic size of a nation in the world: Determinants of a nation’s share in world GDP vs. per capita GDP. Struct. Chang. Econ. Dyn. 2019, 51, 203–214. [CrossRef]

19. Costantini, M.; Paradiso, A. What do panel data say on inequality and GDP? New evidence at US state-level. Econ. Lett. 2018, 168, 115–117. [CrossRef]

20. Marois, G.; Gietel-Basten, S.; Lutz, W. China’s low fertility may not hinder future prosperity. Proc. Natl. Acad. Sci. USA 2021, 118, e2108900118. [CrossRef]

21. Suulamo, U.; Tarkiainen, L.; Remes, H.; Martikainen, P. Changes in regional variation in mortality over five decades—the contribution of age and socioeconomic population composition. SSM-Popul. Health 2021, 15, 100850. [CrossRef]

22. Cheng, X.; Yang, Y.; Schwebel, D.C.; Liu, Z.; Li, L.; Cheng, P.; Ning, P.; Hu, G. Population ageing and mortality during 1990-2017: A global decomposition analysis. PLoS Med. 2020, 17, e1003138. [CrossRef]

23. David, E.; Bloom, D.L. The global demography of aging: Facts, explanations, future. In Handbook of the Economics of Population Aging; North-Holland: Amsterdam, The Netherlands, 2016.

24. Xin, M.; Chuliang, L.; Gustafsson, B.A.; Shi, L.; Sicular, T. What Determines Living Arrangements of the Elderly in Urban China? Inequality and Public Policy in China; Cambridge University Press: Cambridge, UK, 2008; pp. 267–286.

25. Li, L.; Du, T.; Hu, Y. The effect of population aging on healthcare expenditure from a healthcare demand perspective among different age groups: Evidence from Beijing city in the people’s Republic of China. Risk Manag. Healthc. Policy 2020, 13, 1403–1412. [CrossRef] [PubMed]

26. Deng, T.; Zhang, K.; Chen, Z.-J. A systematic review of a digital twin city: A new pattern of urban governance toward smart cities. J. Manag. Sci. Eng. 2021, 6, 125–134. [CrossRef]

27. Yi, X.; Jue, W.; Huan, H. Does economic development bring more livability? Evidence from Jiangsu Province, China. J. Clean. Prod. 2021, 293, 126187. [CrossRef]

28. Peeters, A.; Zude, M.; Käthner, J.; Ünlü, M.; Kanber, R.; Hetzroni, A.; Gebbers, R.; Ben-Gal, A. Getis–Ord’s hot- and cold-spot statistics as a basis for multivariate spatial clustering of orchard tree data. Comput. Electron. Agric. 2015, 111, 140–150. [CrossRef]

29. Tillé, Y.; Dickson, M.M.; Espa, G.; Giuliani, D. Measuring the spatial balance of a sample: A new measure based on Moran’sIindex. Spat. Stat. 2018, 23, 182–192. [CrossRef]

30. Dziauddin, M.F. Estimating land value uplift around light rail transit stations in Greater Kuala Lumpur: An empirical study based on geographically weighted regression (GWR). Res. Transp. Econ. 2019, 74, 10–20. [CrossRef]
31. Cheng, L.; Chen, X.; De Vos, J.; Lai, X.; Witlox, F. Applying a random forest method approach to model travel mode choice behavior. *Travel Behav. Soc.* 2019, 14, 1–10. [CrossRef]

32. Gan, Z.; Yang, M.; Feng, T.; Timmermans, H. Understanding urban mobility patterns from a spatiotemporal perspective: Daily ridership profiles of metro stations. *Transportation* 2018, 47, 315–336. [CrossRef]

33. Li, R.; Krishna Sinniah, G.; Li, X. The factors influencing resident’s intentions on e-bike sharing usage in China. *Sustainability* 2022, 14, 5013. [CrossRef]

34. Wang, T.; Wang, Y.; Zhao, X.; Fu, X. Spatial distribution pattern of the customer count and satisfaction of commercial facilities based on social network review data in Beijing, China. *Comput. Environ. Urban Syst.* 2018, 71, 88–97. [CrossRef]