

POPULATION AGEING, INDUSTRIAL RESTRUCTURING, AND THE SILVER ECONOMY: A THEORETICAL AND REGIONAL ANALYSIS OF SHAOXING, CHINA

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Abstract: Population ageing and persistent low fertility are reshaping the development logic of Chinese city-regions, yet their regional implications remain insufficiently explored. This paper examines Shaoxing, a manufacturing-oriented city in Zhejiang Province, to analyze how demographic transition affects regional development through labour supply, dependency burdens, spatial differentiation, and industrial restructuring. The evidence shows that Shaoxing has entered a new stage marked by slowing population growth, negative natural increase, deep ageing, and growing internal divergence. In 2024, the share of the population aged 60 and above reached 31.6%, while population maintenance increasingly depended on migration rather than natural reproduction. To interpret these changes, the paper develops a stylized two-sector model composed of a traditional manufacturing sector and a silver-economy sector. The analysis shows that ageing has a dual effect: it weakens labour-intensive growth by reducing effective labour supply and increasing welfare burdens, while also creating new demand for healthcare, elderly care, rehabilitation, and age-friendly products. The paper argues that ageing in Shaoxing is best understood as a process of regional restructuring rather than merely demographic decline.

Keywords: Population ageing; Low fertility; Regional development; Industrial restructuring; Silver economy

1 INTRODUCTION

Population ageing and persistent low fertility have become defining features of contemporary demographic transition, with profound implications for economic growth, labour markets, public finance, and social welfare systems. Existing research shows that ageing may reduce labour-force participation, weaken savings, and slow long-run growth, while also intensifying pressure on pension and healthcare systems [1-3]. At the same time, another strand of literature argues that the consequences of ageing are not uniformly negative, because labour scarcity may induce automation, technological substitution, and institutional adaptation [4-5]. In China, where low fertility, negative natural growth, and rapid ageing have emerged within a relatively compressed historical period, the challenge is especially acute and increasingly structural rather than transitional [6-7].

Yet the economic consequences of ageing are not spatially uniform. They are mediated by regional industrial structure, migration patterns, fiscal capacity, and the territorial organization of public services. This is especially true for manufacturing-oriented regions, whose development has historically depended on abundant working-age labour, industrial agglomeration, and sustained inflows of mobile workers. Shaoxing provides a particularly revealing case in this respect. The city has entered a new stage characterized by negative natural population growth, shrinking and ageing labour supply, and increasing dependence on migrant inflows for maintaining population size. In 2024, the proportion of the population aged 60 and above reached 31.6%, while demographic pressure became increasingly differentiated across central districts, counties, and rural areas.

This paper argues that population ageing in Shaoxing should be understood not only as a demographic burden, but also as a process of regional restructuring. On the one hand, ageing weakens the traditional labour-intensive growth model by compressing effective labour supply, increasing dependency burdens, and intensifying fiscal and public-service pressures. On the other hand, it generates new demand for elderly-oriented services, healthcare, rehabilitation, smart-care technologies, and age-friendly products, thereby creating the conditions for the emergence of a silver economy. Although the opportunity dimension of ageing has received growing scholarly attention, most existing studies either focus on national-level macroeconomic consequences or discuss the silver economy in relatively general terms. Comparatively less attention has been given to how deep ageing reshapes the development logic of a manufacturing-oriented city-region that simultaneously faces labour contraction, internal spatial divergence, and sectoral adjustment.

Against this background, the paper makes three contributions. First, it situates the Shaoxing case within the broader literature on ageing, growth, regional development, and the silver economy. Second, it develops a stylized two-sector analytical framework to show how ageing may simultaneously constrain traditional manufacturing and expand elderly-oriented sectors. Third, drawing on the Shaoxing evidence, it argues that the city's demographic transition is best interpreted as a shift from labour-intensive accumulation toward a more productivity-dependent and service-restructured development path. The broader implication is that ageing in manufacturing-oriented Chinese cities

should be analysed not simply as a welfare challenge, but as a structural turning point in regional development.

2 LITERATURE REVIEW

Population ageing has long been recognized as a major structural force affecting economic growth. A large body of research argues that ageing tends to weaken labour-force participation, reduce savings, raise old-age dependency, and thereby constrain long-run growth potential (Bloom et al., 2010; Maestas et al., 2016; Kotschy & Bloom, 2023). In this view, the economic consequences of ageing arise not only from the declining size of the working-age population, but also from broader changes in productivity, investment, and public expenditure structures. For countries undergoing rapid demographic transition, these effects are often intensified by the speed with which ageing outpaces institutional adjustment.

At the same time, a second strand of literature suggests that the impact of ageing is not purely negative. Rather than treating demographic ageing as a one-directional drag on development, this literature highlights endogenous adjustment mechanisms. Acemoglu and Restrepo argue that labour scarcity associated with ageing may accelerate automation and other forms of labour-saving technological change [4-5]. Under this perspective, ageing can induce firms to substitute capital and technology for labour, thereby partly offsetting the negative consequences of workforce contraction. Related studies in the Chinese context further suggest that ageing may interact with digital transformation, innovation incentives, and organizational change in more complex ways than a simple decline narrative would imply [8]. The key implication is that the economic consequences of ageing depend not only on demographic structure itself, but also on the adaptive capacity of firms, sectors, and institutions.

A third strand of research emphasizes the territorial unevenness of demographic transition. Ageing does not unfold uniformly across regions, because it is mediated by migration patterns, industrial specialization, urbanization, and fiscal capacity. OECD research shows that ageing can have significantly different implications across regions depending on local productivity levels, labour-market adaptability, and service-provision capacity [9-10]. In city-regional contexts, ageing also reshapes the geography of development by altering demand for healthcare, elderly care, mobility, housing, and community infrastructure. This means that demographic ageing is not simply a national social-policy issue; it is also a regional development issue with strong spatial content. In China, this spatial dimension is particularly important because population mobility has become a central driver of regional demographic change. Some places continue to attract younger migrants and therefore age more slowly, whereas others experience the combined effects of low fertility, youth outmigration, and rapid population ageing [6].

A fourth strand of literature shifts attention from demographic burden to demographic opportunity through the concept of the silver economy. In broad terms, the silver economy refers to the range of economic activities associated with the needs and preferences of older people, including healthcare, elderly care, rehabilitation, age-friendly housing, mobility services, tourism, assistive technologies, and digitally enabled care systems [11-12]. More recent studies argue that ageing can create new development space at the local and regional levels, but only where demographic demand can be matched by institutional support, industrial capability, and service capacity [13]. This perspective is particularly relevant for manufacturing-oriented regions, because the opportunity dimension of ageing may extend beyond social care services to include age-friendly product manufacturing, smart-care equipment, and the recombination of manufacturing and service sectors.

Although these literatures provide valuable insights, an important gap remains. Existing studies tend to focus either on national-level macroeconomic consequences or on general discussions of elderly welfare and silver-economy expansion. Comparatively less attention has been paid to how deep ageing reshapes the development logic of a manufacturing-oriented city-region that simultaneously faces labour contraction, industrial adjustment, fiscal pressure, and internal spatial differentiation. This gap is especially significant in the Chinese context, where demographic transition is unfolding rapidly but unevenly across places. Shaoxing offers a useful case for addressing this issue because it sits precisely at the intersection of these processes.

3 DATA, CASE SELECTION, AND RESEARCH DESIGN

This paper is based on synthesized data from the 2000, 2010, and 2020 population censuses, the *Zhejiang Statistical Yearbook*, the *Shaoxing Statistical Yearbook*, the 2019–2024 national economic and social development bulletins of Zhejiang, Shaoxing, and its districts and counties, as well as specialized statistics released by local departments in civil affairs, health, human resources, and education.

The paper adopts a descriptive-analytical research design. It first identifies the major features of demographic transition in Shaoxing through structured descriptive statistics. It then develops a stylized theoretical model to clarify the channels through which ageing may affect a manufacturing-oriented city-region. Finally, it applies the model to the Shaoxing case through mechanism-based interpretation rather than formal econometric estimation.

Two points about statistical treatment should be noted. First, the source report uses resident-population data for total population size and annual population change, while several age-structure indicators are reported using household-registration-based demographic structure. Second, some 2024 indicators are available only for relative shares rather than for fully harmonized absolute population counts by age group. These features are retained in the present paper because the purpose is to construct a coherent regional demographic profile and to support theoretically informed case interpretation, rather than to estimate a unified statistical model from a single harmonized panel.

Shaoxing is selected not because it is demographically average, but precisely because it is structurally revealing. It is a traditional manufacturing city in one of China's most developed provinces, yet it has already moved into a stage of deep ageing, negative natural growth, and increasing dependence on migration for demographic maintenance. This combination makes it a particularly useful case for examining how demographic transition reshapes the development logic of manufacturing-oriented city-regions.

4 DEMOGRAPHIC TRANSITION IN SHAOXING

4.1 Population Size and the Shift in Growth Dynamics

Shaoxing's population trajectory shows a clear transition from expansion to plateau. Long-term growth continued, but growth rates slowed markedly after 2010. More importantly, after 2022 the city entered a stage in which natural population growth remained negative for three consecutive years, while resident population still increased modestly through migration and mechanical growth. This means that the source of demographic stability has changed.

Table 1 Population Size and Slowing Growth in Shaoxing, 2000–2024

Year	Resident population (million)	Increase from previous benchmark/year (million)	Growth rate
2000	4.3269	—	—
2010	4.9120	0.5851	13.52%
2020	5.2910	0.3590	7.30%
2021	5.3370	0.0460	8.70‰
2022	5.3530	0.0160	2.30‰
2023	5.3940	0.0410	7.66‰
2024	5.4290	0.0350	6.49‰

Table 1 shows two important facts. First, resident population growth did not stop, but it slowed substantially after 2010. Second, recent population maintenance is no longer underpinned by natural increase. In demographic terms, Shaoxing has moved from a “dual-support” pattern of natural growth plus migration to a “single-support” pattern primarily dependent on migration inflows.

4.2 Ageing, Low Fertility, and Labour-force Shrinkage

Age structure is the most direct expression of Shaoxing's demographic transition. The city has experienced simultaneous low fertility, rapid ageing, and working-age population decline. The elderly share has risen sharply, while the labour-force base has weakened both relatively and structurally.

Table 2 Ageing and Labour-force Indicators in Shaoxing

Indicator	2010	2020	2024
Child population share (%)	12.78	11.89	13.2
Working-age population, 15–59 (million)	3.5300	3.4533	3.00
Working-age population share (%)	71.86	65.52	55.2
Population aged 60+ (%)	15.36	22.59	31.60
Population aged 65+ (%)	9.94	16.21	18.00
Total dependency ratio (%)	29.4	39.1	45.4
Old-age dependency ratio (%)	12.9	22.5	28.9
Birth rate (‰)	7.47	6.63	4.96

Table 2 indicates that Shaoxing has entered a deep demographic stage. The share of the population aged 60 and above more than doubled between 2010 and 2024, rising from 15.36% to 31.60%. At the same time, the working-age population share declined substantially, and the birth rate dropped to only 4.96‰ in 2024. The total dependency ratio and the old-age dependency ratio both worsened sharply, indicating that the city's labour-force base is supporting a much larger dependent population than before.

4.3 Internal Spatial Differentiation

Shaoxing's demographic transition is not spatially uniform. Population continues to concentrate in core urban districts, while peripheral counties and mountainous areas experience more severe ageing and stronger natural decrease. This territorial unevenness is central to understanding the developmental implications of demographic change.

Table 3 Intra-city Demographic Differentiation across Shaoxing Districts/Counties, 2024

District/County	Resident population (million)	Population aged 0–17 (%)	Population aged 60+ (%)	Natural growth rate (%)
Yuecheng	1.1363	13.9	31.6	-0.54
Keqiao	1.1329	15.9	28.8	-0.10
Shangyu	0.8090	11.7	33.0	-3.00
Zhuji	1.2382	13.3	31.7	-1.89
Shengzhou	0.6981	11.3	33.6	-4.88
Xinchang	0.4145	13.2	30.8	-3.12
City average	5.4290	13.2	31.6	-2.12

Table 3 shows a clear centre–periphery pattern. Keqiao remains relatively younger, while Shengzhou, Shangyu, and Xinchang face heavier ageing burdens and more negative natural growth. The report further notes that Yuecheng, Keqiao, and Shangyu together accounted for 84.1% of the city’s net migrant inflow, reinforcing the concentration of younger labour and population dynamism in the more industrially advantaged urban core.

Taken together, the evidence in this section suggests that Shaoxing’s demographic transition is characterized by five interrelated features: slowing population growth, negative natural increase, rapid ageing, labour-force contraction, and intensified internal spatial divergence. These facts provide the empirical basis for the theoretical and mechanism-based analysis that follows.

5 ANALYTICAL FRAMEWORK AND THEORETICAL MODEL

To formalize the development implications of ageing in Shaoxing, consider a stylized regional economy with two sectors: a traditional manufacturing sector M and a silver-economy sector S . The manufacturing sector captures the labour-intensive industrial base of the region, while the silver-economy sector includes elderly care, health services, rehabilitation, smart-care technologies, and age-friendly products.

Let the degree of population ageing be denoted by a , where a higher a implies a larger elderly share. Total effective labour supply is written as:

$$L(a) = L_0(1 - \mu a), \mu > 0 \quad (1)$$

where L_0 is the baseline labour endowment and μ captures the extent to which ageing reduces effective labour supply. Manufacturing output is given by:

$$Y_M = A_M(T) K_M^\alpha L_M^{1-\alpha}, 0 < \alpha < 1 \quad (2)$$

where $A_M(T)$ is productivity, increasing in technological upgrading T , K_M is capital, and L_M is labour allocated to manufacturing.

Silver-economy output is represented as:

$$Y_S = A_S K_S^\beta L_S^{1-\beta}, 0 < \beta < 1 \quad (3)$$

but the effective demand and value of silver-economy output rises with ageing. Let the effective price of silver-economy output be:

$$p_S(a) = p_0 + p_1 a, p_1 > 0 \quad (4)$$

Here, p_0 is the baseline relative price when ageing is absent (reflecting basic demand for elderly-oriented products even without demographic pressure), and p_1 measures how much the relative price increases per unit increase in a (capturing the ageing-induced demand shift). Manufacturing output is taken as the numéraire, so its price is normalized to 1.

Total regional output is therefore:

$$Y = Y_M + p_S(a) Y_S \quad (5)$$

subject to the resource constraints:

$$L_M + L_S = L(a), \quad K_M + K_S = \bar{K} \quad (6)$$

This framework yields three implications. First, as a rises, effective labour supply contracts, placing direct pressure on labour-intensive manufacturing. Second, as a rises, the relative value of elderly-oriented services and products increases, shifting labour and capital toward silver-economy activities. Third, the net effect of ageing on regional development is indeterminate. It depends on whether the negative production effect caused by labour contraction is larger than the positive restructuring effect generated by silver-economy expansion and technological upgrading. Put differently, ageing becomes less economically destructive when the region can raise $A_M(T)$ through automation while simultaneously expanding sector S through service and product innovation.

The strength of this model lies not in formal complexity, but in its ability to capture the dual nature of demographic transition in a manufacturing city. Ageing is simultaneously a constraint on the old development regime and a potential stimulus for a new one.

6 DISCUSSION: APPLYING THE FRAMEWORK TO SHAOXING

6.1 Labour Contraction and the Erosion of the Traditional Growth Model

The first implication of the framework is that population ageing reduces the effective labour supply available to the traditional manufacturing sector. The evidence from Shaoxing strongly supports this mechanism. Beyond the broad decline in labour-force share already shown in Section 4, statistical data show that the internal composition of the labour force has also become older, with the share of the 45–59 age group rising to 47.3%. At the same time, the average wage of urban employees in manufacturing increased by 231.9% between 2010 and 2024. These trends suggest that Shaoxing is facing not simply fewer workers, but a more structurally aged and more expensive labour force.

For a city whose industrial base remains strongly associated with textiles, machinery, chemicals, and other labour-intensive sectors, this change weakens the logic of growth through factor expansion. In terms of the model, the decline in $L(a)$ raises production pressure in the manufacturing sector and lowers the viability of the traditional accumulation regime. The importance of this mechanism lies not only in labour shortage itself, but in the erosion of the demographic foundation on which Shaoxing's earlier industrial expansion depended.

6.2 Demographic Reproduction Decline and Dependence on Migration

The labour-supply constraint is reinforced by the weakening of endogenous demographic reproduction. Section 4 has already shown that resident population continued to increase modestly after 2020 even as natural growth turned negative. What explains this divergence is migration. Statistical data show that the number of people flowing in from outside the city increased from 1,018,525 in 2010 to 1,113,683 in 2020, accounting for 20.74% and 21.04% of the resident population, respectively. Once natural growth became persistently negative, net inflows became the only effective source of population increase, with a contribution rate exceeding 100%.

This matters analytically because it means that Shaoxing's labour supply is no longer reproduced primarily within the local population itself; it increasingly depends on the city's ability to attract and retain outside workers. In a manufacturing city, such a pattern is more fragile than one based on both natural growth and migration, because it ties labour availability more tightly to interregional competition for people and jobs.

6.3 Deep Ageing, Dependency Burdens, and Fiscal-social Restructuring

A second major implication of the framework is that ageing raises dependency burdens and shifts the expenditure structure of the regional economy. The broad demographic evidence is already clear in Section 4. The additional statistical data show how this demographic change is being translated into institutional pressure. The number of participants in the basic pension insurance system increased from 2.57 million in 2020 to 2.79 million in 2024, while social security and employment expenditure rose from RMB 6.672 billion to RMB 13.190 billion over the same period, an increase of 97.7%. Statistical data also note that cumulative investment in elderly-service provision reached RMB 1.15 billion between 2021 and 2024, with an average annual growth rate of 35.34%.

These figures show that ageing is no longer only changing the age composition of the population; it is also reconfiguring the fiscal priorities of the city. In model terms, the rise in a does not only affect labour input, but also alters the allocation of public and social resources across sectors. This is why ageing in Shaoxing should be understood as both a demographic and an institutional restructuring process.

6.4 Spatially Uneven Adjustment

The Shaoxing case also demonstrates that demographic ageing is territorially uneven rather than spatially neutral. Section 4 has shown the centre–periphery pattern in age structure and natural growth. The additional statistical data on migration deepen this interpretation. According to statistical data, Yuecheng, Keqiao, and Shangyu together accounted for 84.1% of the city's net migrant inflow. This means that the city does not experience one homogeneous ageing process; rather, it contains multiple demographic regimes. Core districts are partially buffered by continued inflows of working-age population, whereas peripheral areas face a cumulative cycle of outmigration, ageing, weaker economic vitality, and further outmigration.

In the language of the model, the effects of $L(a)$ and the capacity to reallocate resources across sectors are spatially differentiated. Core districts are better positioned to absorb demographic pressure because they continue to attract people, capital, and industrial opportunities, while county-level areas face a much more constrained adjustment environment. Demographic transition is therefore inseparable from internal regional inequality.

6.5 The Silver Economy As An Emerging Development Path

The final implication of the framework is that ageing may generate a new demand structure and thereby open the possibility of sectoral recomposition. In Shaoxing, this possibility is grounded in observable market change. Statistical data indicate that between 2021 and 2024, the number of elderly-service-related market entities increased by 68.2%, while household medical and healthcare consumption expenditure grew at an average annual rate of 8.7% between 2020 and 2024. These changes suggest that population ageing is already reshaping the structure of local demand, particularly in healthcare, elderly care, rehabilitation, and other age-related services.

The significance of this shift lies in its potential connection with Shaoxing's existing industrial and regional assets. The city possesses a strong manufacturing base as well as cultural, ecological, and tourism resources that could support the development of care-oriented services, smart-care applications, and age-friendly products. In model terms, this

corresponds to the rise in the relative value of silver-economy output as α increases. Yet the evidence also suggests that this opportunity is conditional rather than automatic. Demand expansion alone is insufficient. The silver economy can become a new development path only if elderly-oriented services, manufacturing capability, digital technologies, and institutional support are effectively linked. Thus, the opportunity dimension of ageing in Shaoxing is real, but it depends on the city's ability to translate demographic pressure into a coordinated process of service upgrading and industrial recombination.

7 CONCLUSION

This paper has examined how deep ageing and persistent low fertility are reshaping the development trajectory of Shaoxing, a manufacturing-oriented city in eastern China. The evidence shows that Shaoxing has entered a new demographic stage marked by slowing population growth, negative natural increase, a shrinking and ageing labour-force base, and increasingly uneven spatial distribution of demographic pressure. These changes indicate that demographic transition in Shaoxing is no longer a background condition. It has become a structural force that is redefining the city's development constraints, adjustment mechanisms, and future growth possibilities.

The analysis has shown that ageing affects Shaoxing through at least three closely related channels. First, it weakens the traditional labour-intensive growth model by reducing the effective supply of working-age labour and increasing labour costs, thereby undermining the demographic foundation on which earlier industrial expansion depended. Second, it intensifies fiscal, social-security, and public-service pressure by raising old-age dependency and shifting expenditure priorities toward pensions, healthcare, elderly care, and long-term support. Third, it reinforces internal spatial differentiation, as core urban districts continue to absorb migrants and economic opportunities while peripheral counties experience a more severe combination of ageing, outmigration, and demographic decline. In this sense, ageing is not only a demographic issue, but also an economic, institutional, and spatial restructuring process.

At the same time, the Shaoxing case suggests that ageing should not be interpreted exclusively through the language of burden and decline. The expansion of elderly-oriented demand in healthcare, rehabilitation, care services, smart ageing, and age-friendly products also opens space for new forms of development. The stylized two-sector model proposed in this paper captures this duality: ageing simultaneously constrains traditional manufacturing and increases the relative value of silver-economy activities. The key question, therefore, is not whether ageing matters, but under what conditions its negative effects can be offset by industrial upgrading, technological substitution, and institutional adaptation.

The broader implication is that manufacturing-oriented Chinese city-regions need to move beyond a development logic based primarily on abundant labour and factor expansion. For cities such as Shaoxing, successful adaptation will depend on whether demographic pressure can be transformed into a coordinated strategy of productivity enhancement, service restructuring, and silver-economy cultivation. In this sense, population ageing does not simply mark the exhaustion of an old growth model; it also signals the emergence of a new developmental logic in which demographic adaptation becomes central to regional transformation.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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