Journal of Economics and Public Finance
ISSN 2377-1038 (Print) ISSN 2377-1046 (Online)
Vol. 12, No. 3, 2026
www.scholink.org/ojs/index.php/jepf

Original Paper

A Study on the Impact of New Quality Productive Forces on Silver-Haired Consumption

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Received: July 6, 2026 Accepted: July 27, 2026 Online Published: August 12, 2026

doi:10.22158/jepf.v12n3p61 URL: http://dx.doi.org/10.22158/jepf.v12n3p61

Abstract

Silver-haired consumption has become an important growth driver for expanding and upgrading China's consumer market. It plays a key role in unlocking domestic demand potential and optimizing consumption structure. This paper employs five-wave panel data from the China Health and Retirement Longitudinal Study (CHARLS), covering the survey years 2011, 2013, 2015, 2018 and 2020, to systematically investigate the effect of new-quality productivity on silver-haired consumption, alongside its underlying mechanisms. Empirical findings indicate that new-quality productive forces exert a significantly positive influence on silver-haired consumption. This conclusion still holds after implementing multiple robustness checks and mitigating potential endogeneity issues. Mechanism estimations suggest that the favorable effect is transmitted via three primary pathways: broadening digital application scenarios, advancing inclusive finance, and elevating the development quality of the silver economy. Furthermore, heterogeneity tests demonstrate that such promotional influence is stronger in central China and features inclusivity, functioning effectively in areas with disparate economic development levels. This research offers empirical support and policy implications for uncovering the inherent correlation between new-quality productive forces and silver-haired consumption, stimulating the silver consumer market, and facilitating the development of elderly-oriented finance.

Keywords

Silver-haired Consumption, New-quality Productivity, Inclusive Finance, Pension Finance

1. Introduction

1.1 Research Background

Silver-haired consumption has grown into a crucial driving force for domestic demand expansion and high-quality economic progress in China. The Report to the 20th National Congress of the Communist Party of China explicitly puts forward the national strategy of actively responding to population aging.

The 2024 Central Economic Work Conference further stressed that technological innovation should guide the development of new-quality productive forces and cultivate emerging consumption formats to expand consumption potential. In addition, the 15th Five-Year Plan clearly mandates that the concepts of positive and healthy aging should be fully integrated into the entire process of economic and social development. It calls for vigorously developing the silver economy, increasing the supply of age-appropriate products and elderly services, fostering leading enterprises and well-known brands in the silver economy sector, exploring the establishment of a certification system for elderly-oriented products, and improving statistical systems covering the silver economy. It also aims to continuously scale up the supply of inclusive elderly care services, and refine supportive policies for elderly consumer goods, pension finance, senior tourism and related sectors. New quality productive forces are profoundly transforming consumption patterns and structures, injecting new momentum into energizing the silver-haired consumer market and unlocking the consumption potential of the elderly population.

In practice, China is experiencing sweeping changes to its demographic structure. Official statistics released by the National Bureau of Statistics suggest that the population aged 60 and above hit 323 million by the end of 2025, making up 23.0% of the national population. This figure signals that China has stepped into a moderately aging society. At the same time, the elderly are also witnessing remarkable changes in their consumption willingness and purchasing capacity. Their consumption demands are evolving from traditional subsistence-oriented consumption toward development-oriented and leisure-oriented consumption, implying enormous potential within the silver-haired consumption market. Nevertheless, the expansion and quality upgrading of silver-haired consumption are constrained by challenges including the digital divide, insufficient accessibility of financial services, and inadequate supply of age-adapted products. How to leverage the advancement of new quality productive forces to tackle the structural bottlenecks hindering silver-haired consumption has become an urgent and important research issue.

Theoretically, the impact mechanism of new quality productive forces on silver-haired consumption is multi-dimensional and complex. Represented by digital technologies, artificial intelligence, green technologies and other innovations, new quality productive forces reshape consumption environments and behaviors of the elderly directly via technological innovation, industrial upgrading and factor restructuring. Indirectly, they boost silver-haired consumption through channels such as the development of pension finance, construction of digital infrastructure and cultivation of smart elderly care industries. Existing literature, however, mostly focuses on the impacts of the digital economy on aggregate consumption or independently examines the nexus between pension finance and consumption. Systematic research incorporating new quality productive forces, pension finance and silver-haired consumption into an integrated analytical framework remains scarce, making it difficult to deliver comprehensive and targeted theoretical support for policy formulation.

1.2 Research Significance

1.2.1 Theoretical Significance

First, this study expands the application dimensions of the theory of new quality productive forces. Existing research on new quality productive forces mainly centers on macro areas such as industrial upgrading and institutional innovation, while discussions on how they affect the consumption sector, especially consumption among specific groups, remain insufficient. By integrating new quality productive forces with silver-haired consumption, a segmented consumption scenario, this paper thoroughly analyzes the internal mechanism through which new quality productive forces influence silver-haired consumption via optimizing financial services and digitally empowering the elderly.

Second, it fills the research gap by offering a new perspective on silver-haired consumption. Current studies on silver-haired consumption mostly revolve around traditional dimensions including characteristics of consumption demand and supply of elderly care services, yet they rarely take into account the boosting effect of new quality productive forces, an emerging economic variable. Against the backdrop of the new development stage, this study explores the influencing mechanism of new-quality productive forces on silver-haired consumption from an innovative perspective. It further supplements the theoretical framework of elderly consumption research and enriches the connotation of consumption economic theory in the context of population aging.

Finally, as a profound transformation in the production sector, new quality productive forces inevitably exert far-reaching impacts on consumption. Meanwhile, silver-haired consumption, as a fast-growing consumption force, guides the development orientation of new quality productive forces. By investigating the interactive relationship between the two, this research deepens the understanding of the dialectical relationship between production and consumption under population aging in the new era, and provides empirical support for relevant theoretical studies.

1.2.2 Practical Significance

On the first dimension, this mechanism releases the sizable potential of the silver-haired consumption market and promotes the upgrading of consumption structure. Driven by deepening population aging and the growing elderly group in China, the silver economy turns into a promising impetus for economic growth. Nevertheless, the market is plagued by supply-demand mismatch and severe homogenization of products and services. This research identifies the empowerment channels of new quality productive forces for silver-haired consumption. It offers guidance for enterprises to optimize supply for elderly consumers relying on new quality productive forces, thereby stimulating growth momentum within the silver-haired consumption market.

This study also provides feasible solutions to address population aging issues and enhance elderly residents' overall welfare. Proactively coping with demographic aging represents a core national strategy for China, in which improving older adults' living standards serves as a central policy goal. The technological progress and service optimization enabled by new-quality productive forces can empower the elderly with high-standard care services, more accessible consumption scenarios, and diversified cultural and spiritual supplies.

1.3 Innovations

The innovations of this study are mainly reflected in three aspects. First, this study develops a customized evaluation system for new quality productive forces tailored to elderly consumer research scenarios in accordance with the core research positioning of the topic. On the basis of the classic three-dimensional theoretical paradigm for analyzing new quality productive forces adopted in mainstream research, this paper innovatively introduces a unique dimension applicable to silver economy development, along with a series of matched secondary evaluation indicators. This optimized index system effectively improves scenario adaptability, enabling it to better fit the practical research needs of elderly consumption-related studies. Second, there is an innovation in data selection. Previous relevant studies using the CHARLS database mostly adopted data covering fewer years. In contrast, this paper systematically integrates five waves of panel data from the database (2011, 2013, 2015, 2018 and 2020). The richer time-series data help improve the reliability and persuasiveness of empirical results. Third, this paper constructs a fresh analytical connection between new quality productive forces and elderly consumption. Existing scholarship is largely constrained by narrow research perspectives: relevant literature tends to examine either how new quality productive forces drive economic expansion or separate determinants shaping silver-haired consumption. This paper is the first to systematically investigate the causal relationship and internal transmission mechanism between new-quality productive forces and silver-haired consumption, broadening the interdisciplinary research boundary between new-quality productive forces and consumption economics.

2. Literature Review

2.1 Research on New Quality Productive Forces

Within the theoretical system of traditional Marxist political economy, the core implication of productive forces lies in the organic coupling of three tangible elements: workers, means of labor and objects of labor. A body of literature continues to employ the classic analytical paradigm to delineate the implications of new-quality productive forces by focusing on the aggregation of conventional tangible production factors. Relative to the conceptual definition of traditional productive forces, new-quality productive forces still fall under the core analytical scope of the three components of production, yet they realize essential transcendence over the connotations of conventional productive forces. Such inherent characteristics manifest in the systematic upgrading of laborers, labor instruments and labor objects, as well as the optimized allocation among these production factors[1]. They share common ground with general productive forces in that both take meeting human needs as the value starting point, require the coordinated participation of diverse production factors, and maintain a dynamic adaptive relationship with production relations[2]. The core divergence between them stems from the systematic transformation of factor quality and the structural upgrading of combination modes driven by scientific and technological innovation. Meanwhile, the evolutionary value of new quality productive forces ultimately needs to be realized and unleashed through diversified digital scenarios. Digital technologies break industrial

boundaries and continuously expand application scenarios, promote the two-way reconstruction of production modes and consumption scenarios, and create space for fostering new business forms[3].

As the penetration and influence of scientific and technological innovation keep deepening, the three core elements of traditional productive forces have undergone all-round reshaping, thoroughly breaking the morphological boundaries and functional limitations of traditional tangible elements. They have evolved into high-quality workers, new-medium means of labor and new-type objects of labor. The in-depth integration of the three represents a collaborative creation process empowered by technology, which ultimately completes the paradigm shift toward new quality productive forces[4], gradually forming a new form of productive forces led by scientific and technological innovation and built upon breakthroughs in key disruptive technologies. Its transcendence over traditional productive forces manifests not merely in superficial changes in factor forms and combination patterns, but more importantly in a fundamental shift in development logic[5]. On this basis, digital technology, as the core carrier and key form of scientific and technological innovation, further deepens this logic of transcendence. Its profound integration with the three traditional elements of productive forces gives rise to digital new quality productive forces, driving comprehensive and in-depth transformation and upgrading across all sectors of the national economy[6],[7]. The large-scale development of new quality productive forces also relies on support from the financial system. Relying on digital channels, inclusive finance lowers the threshold for resource allocation, unblocks circulation channels for innovative factors, provides steady capital guarantee for technology commercialization and industrial digital transformation, and serves as a vital empowering mechanism for the implementation of new quality productive forces[8].

Against the deepening theoretical research on new quality productive forces, the evaluation indicator systems developed by academia for measuring its core connotation demonstrate an obvious evolutionary hierarchy in measurement. Initially, a basic framework centered on workers, objects of labor and means of labor became a widely recognized construction logic. Relevant studies conducted preliminary measurements of new quality productive forces at the provincial level in China based on this framework and established the fundamental paradigm for measurement research[9],[10]. On this basis, measurement logic has been refined to target specific sectors. By subdividing production factors into high-quality workers, new-medium means of labor and new-type objects of labor, scholars have constructed a dedicated evaluation system for digital new quality productive forces and calculated corresponding indices via the entropy weight method, shifting measurement from general models to sector-adapted ones[11]. As research advances, the hierarchical nature of measurement systems has become more prominent. Drawing on existing findings, some studies built a multi-tier framework consisting of primary sub-dimensions (scientific & technological, green and digital productive forces) and secondary sub-dimensions (the three core elements of new quality productive forces). This breaks the constraint of single-dimensional factor analysis and upgrades measurement from a flat framework to a hierarchical one[12][13]. More comprehensively, certain measurement frameworks further transcend the mere factor-oriented perspective. Innovatively incorporating the cultivation environment alongside the traditional

three production factors, they form a four-dimensional evaluation system for the new quality productive forces index, with measurements implemented using an improved entropy method. Such frameworks strengthen factor integrity, optimize measurement approaches, and guarantee consistency between data and research subjects[14]. Overall, measurement research evolves progressively: from focusing on core production factors to sectoral refinement, from hierarchical expansion to inclusion of external environments, continuously improving the comprehensiveness and systematicness of measurement schemes. Most existing measurement systems concentrate on supply-side production factors while paying insufficient attention to demand-side market carriers. Several studies further argue that upgrading the silver economy constitutes a key target through which new quality productive forces empower consumption structure upgrading. Leveraging smart elderly care and the supply of age-appropriate digital products to vitalize the elderly consumer market can foster a two-way cycle between supply innovation and senior citizens' demand, and expand the market application boundary of new quality productive forces[15].

2.2 Research on Silver-haired Consumption

With the continuous rise in average life expectancy and persistently low fertility rates, China is accelerating toward deep aging. The size of the elderly population and the old-age dependency ratio keep rising, while the traditional demographic dividend gradually diminishes. Economic issues related to population aging have long been a key research focus in academia. Domestic research on the elderly-related economy began in the 1980s. In the early stage, there was no unified academic term of "silver-haired consumption". Scholars carried out theoretical and empirical studies centering on the keywords "aging industry" and "elderly consumption". Relevant research established a complete analytical framework for the aging industry, defining it as an integrated industrial cluster covering primary, secondary and tertiary industries and ten segmented sectors including elderly care services, senior health and wellness, and real estate for the elderly. Estimations show that the share of elderly consumption in GDP would rise from 5.55% in 2011 to 17.25% in 2050. Meanwhile, studies pointed out that the aging industry at that time suffered from multiple drawbacks, such as unbalanced urban-rural and regional development, absence of policy standards, lagging product research and development, and overemphasis on welfare attributes[16]. Focusing on the supply-demand imbalance in the aging industry, subsequent studies further proposed that the income level of the elderly, traditional frugal consumption concepts, family-based elderly care models and market irregularities jointly restrict the effective demand of the aging population, and clarified the essential difference between "potential elderly demand" and "actual purchasing power"[17]. In addition, several studies adopted the optimal growth model and conducted quantitative tests based on the CHARLS micro database, verifying that income, education attainment and health status are core variables determining the consumption level of the elderly, laying data and methodological foundations for follow-up empirical research on elderly consumption[18]. Building upon the above research on the aging industry and elderly consumption, along with rising incomes among the elderly, shrinking household sizes and the popularization of the digital economy.

With population aging accelerating nationwide in China, the economy is gradually shifting its development impetus: the traditional demographic dividend is giving way to exploration of the time dividend. Sufficient leisure resources among retired residents provide essential prerequisites to stimulate silver consumption potential.[19]. As the core demand-side component of the silver economy and a crucial pivot for expanding domestic demand, silver-haired consumption bears dual attributes: improving people's well-being and fueling economic growth. The qualitative upgrading and scale expansion of this market are highly consistent with the strategic demands of advancing the dual-circulation development paradigm, which prioritizes domestic demand while enabling mutual reinforcement between domestic and international economic cycles. Alongside generational shifts among the elderly population, rising income levels and strengthened policy support, it also helps the aging economy evolve into a new growth driver of the national economy[20]. Academic consensus holds that silver-haired consumption acts as the core driving force for scale expansion and structural upgrading of the silver economy, as well as vital support for coordinated development between population and the economy[21]. In terms of developmental characteristics and evolution, silver-haired consumption is marked by prominent trends toward hedonic consumption, intelligence and social interaction dependence. Its development requires joint efforts from both supply and demand sides. The evolution has gone through three stages: meeting basic needs, satisfying diversified demands, and advancing all-round well-being. Core demands concentrate on four areas: integrated medical and elderly care services, senior enjoyment services, age-friendly housing renovation, and digital age-adapted services[22],[23]. From an integrated perspective combining the life cycle theory and consumption behavior theory, scholars have constructed a multi-dimensional collaborative analytical framework of "endogenous driving-exogenous empowerment" to systematically interpret the formation mechanism of elderly consumption capacity. At the micro individual level, the framework focuses on the endogenous characteristics of the elderly group. Higher education attainment and optimized income structure jointly facilitate the shift of consumption philosophy from "savings-oriented" to "senior enjoyment-oriented", and lift consumption patterns from subsistence-driven to quality-oriented. At the meso industrial and market level, it centers on industrial supply and market adaptation. Business model optimization, consumption scenario restructuring and industrial digital upgrading can provide multi-dimensional paths to precisely match and effectively meet the diverse consumption needs of elderly groups. From the perspective of macro institutional conditions, this study further emphasizes the important supporting role of institutional arrangements and policy incentives. By perfecting income security systems, improving the healthcare and elderly care system and rolling out consumption incentive policies, the institutional environment and market ecosystem for silver-haired consumption can be collaboratively optimized.

In view of the marginalized and special attributes of the elderly population, most academic studies on silver-haired consumption remain qualitative. Nevertheless, amid the rapid expansion of the digital economy, relevant quantitative research has gradually focused on the impacts of digital factors on silver-haired consumption. Based on survey data from databases including CHARLS and CFPS, some scholars

confirm that the digital economy can effectively boost elderly consumption and exert a prominent expansion effect on consumption among the young-old group[24][25]. Existing quantitative studies share a common feature: when conducting empirical analysis using mainstream micro-databases, most adopt household per capita consumption expenditure as the proxy variable for the level of silver-haired consumption. This practice rests on two rationales. First, consumption habits, lifestyles and consumption philosophies across generations within households tend to converge, so household-level consumption data can partially reflect the consumption characteristics of the elderly. Second, individual-level consumption data for senior citizens remain insufficiently accessible in existing databases, making it difficult to obtain such data directly for econometric analysis[26],[27],[28]. In terms of specific transmission channels, proficient adoption and application of digital technology tools by the elderly can raise their consumption levels and further drive the upgrading of silver-haired consumption[29]. Moreover, digital inclusive finance has also been verified to unlock the consumption potential of the elderly. By breaking barriers to financial services, improving the financial awareness of older adults, advancing personalized fintech solutions and stimulating latent consumption capacity, it enhances financial accessibility for the elderly and ultimately lifts silver-haired consumption levels[30],[31].

Notably, although systematic research outcomes have been formed separately for new quality productive forces and silver-haired consumption, obvious research gaps persist regarding their correlation. There is a lack of in-depth analysis on the interactive mechanism between the two. Empirical evidence concerning the specific channels through which new quality productive forces empower silver-haired consumption and how silver-haired consumption in turn supports new quality productive forces remains inadequate. Furthermore, few studies examine the heterogeneity of such impacts across regions and different subgroups of the elderly. Accordingly, systematic empirical research integrating the perspective of new quality productive forces and the analytical framework of silver-haired consumption is urgently required. Such research can not only uncover the specific empowerment mechanisms supporting their coordinated development, but also provide solid decision-making foundations for governments to implement differentiated and targeted policy guidance.

2.3 Development Status

In recent times, new-quality productive forces have exhibited a developmental trend centered on technological innovation as the primary driver, characterized by deep multi-technology integration and targeted penetration into sectors closely tied to people's livelihoods[33]. Digital technologies such as artificial intelligence, the Internet of Things and blockchain are accelerating their convergence with the real economy, constituting the core vehicle for cultivating new-quality productive forces. Large-scale application scenarios have emerged particularly in livelihood sectors such as elderly care services, and technological innovation has expanded from single-product research and development to thorough penetration across the entire industrial chain[34],[35]. Meanwhile, silver-haired consumption is transforming from traditional subsistence-oriented consumption toward quality-oriented consumption, marked by prominent trends of diversification, intellectualization and scenario-based development. The

elderly population constitutes a huge demand base. Supported by stable purchasing power, the new generation of senior consumers extends their demand to health management, cultural and entertainment activities, smart elderly care and other fields. Segmented sectors such as health monitoring equipment and senior tourism witness remarkable growth. Consumption patterns have shifted from simply purchasing individual products to full-scenario "product+service" experiences, and the penetration rate of digital consumption keeps rising, further compelling the supply side to accelerate the innovation and upgrading of age-appropriate products and services[36],[37]. Notably, these two trends are undergoing deep integration. Relying on technological achievements such as intelligent robots and advanced rehabilitation devices, new quality productive forces deliver solid technological support and impetus for supply upgrading for silver-haired consumption, and build a full-scenario elderly care service ecosystem connecting home-based, community-based and institutional care. In return, the demand for high-quality and intelligent silver-haired consumption guides the innovation direction of new quality productive forces, and drives the iterative upgrading of age-adapted technologies as well as the coordinated optimization of industrial chains.

3. Theoretical Analysis

3.1 Expansion of Digital Scenarios

Silver-haired consumption features both basic security and quality upgrading. It is typically characterized by physiological adaptability, continuous service provision, emotional attachment and scenario convenience, which impose higher requirements on the adaptability and service quality of consumption scenarios. Restricted by spatial boundaries and operation modes, traditional physical consumption scenarios suffer from structural deficiencies including limited business formats, insufficient age-friendly adaptation and poor timeliness of services. Such scenarios can only satisfy the basic physical consumption needs of the elderly and fail to accommodate the diversified and refined upgrading demands of silver-haired consumption, thereby curbing the release of the elderly's consumption potential. With the sustained advancement of the digital economy and the steady rise in its development index, the digital transformation of consumption scenarios has emerged as an essential path to address supply-demand mismatches within elderly consumption markets. From the demand-side logic, consumption upgrading among the elderly generates dual demands for scenario innovation. On the one hand, due to degenerative changes in physical functions, the elderly face relatively high costs for offline travel and consumption. Rigid consumption demands such as medical care and rehabilitation, home-based care and daily convenience services rely heavily on low-threshold, round-the-clock digital consumption carriers free from spatial restrictions. On the other hand, with generational shifts in population, the digital literacy and consumption awareness of the new cohort of elderly people keep improving. They gradually break away from the traditional offline consumption model, and the innovation of digital economic business forms fosters new quality-oriented consumption demands such as online medical consultation, smart elderly care and digital cultural entertainment. Slow iteration, limited coverage and inadequate personalized

supply of traditional consumption scenarios cannot adapt to the stratified and long-term development trend of silver-haired consumption empowered by the digital economy. It follows that the expansion of digital scenarios, as the concrete carrier of digital economic development, serves as a critical channel to accommodate the upgrading of silver-haired consumption. By establishing an integrated digital scenario system covering home, community and online spaces, it effectively lowers participation barriers for elderly consumers, smooths access to consumption services, precisely meets multi-level silver-haired consumption demands.

The expansion of silver-haired consumption scenarios and the upgrading of business formats empowered by the digital economy rely on fundamental support from cutting-edge technological innovation and industrial system reform. Centered upon technological innovation, new-quality productive forces make full use of emerging production factors including artificial intelligence, big data and the Internet of Things. These forces serve as a key driver to boost the operational efficiency of the digital economy, raise its development index, and facilitate the continuous expansion of digital consumption scenarios catering to the elderly. The two sides empower each other and develop in synergy to jointly boost the high-quality development of silver-haired consumption. From the technological perspective, digital technological innovation stemming from new quality productive forces consolidates the foundation for digital economic development. By optimizing age-adapted algorithms, building precise user profiles and upgrading intelligent terminal equipment, relevant innovation effectively eliminates barriers preventing the elderly from using digital products, matches differentiated consumption preferences, and enables the large-scale rollout of segmented digital scenarios including remote health care, smart communities and intelligent home monitoring. From the industrial perspective, new-quality productive forces accelerate the in-depth integration of the digital economy and the real elderly-oriented industries, restructure the supply system of the traditional elderly care industry, and generate new consumption supply such as age-adapted intelligent equipment, digital elderly care services, and online wellness and cultural entertainment. It further facilitates innovative expansion of online-offline integrated digital consumption scenarios targeting elderly groups. Within this chained transmission mechanism, relying on the expansion of digital scenarios as a key mediating channel, new quality productive forces break the scenario constraints and supply shortcomings of traditional silver-haired consumption, continuously enrich consumption formats for the elderly and optimize consumption experience, and ultimately realize the expansion of the silver-haired consumer market and the high-end upgrading of consumption structure.

3.2 Empowerment via Inclusive Finance

Silver-haired consumption is mainly characterized by rigid demand, stability and low risk appetite. Quality-oriented consumption such as long-term care, health and medical services, and age-friendly smart products entails sustained and periodic capital expenditure, generating rigid demands for accessible, secure and convenient supporting financial services, which differ from the short-term and flexible consumer financial needs of the general population. Relying on offline operation models and rigid credit granting rules, the traditional financial system faces prominent service barriers and age exclusion.

Insufficient offline service coverage, high credit thresholds and inadequate supply of age-adapted financial products make it difficult to match the consumer financial characteristics of the elderly, resulting in substantial financial constraints that hinder the unleashing of silver-haired consumption potential. Against the rapid development of digital finance, the regional digital inclusive finance index has risen steadily, and digital inclusive finance business forms have become a core measure to address the supply-demand mismatch in traditional finance. In terms of the consumption pain points of the elderly, their asset structure tends to be rigid with limited liquid funds, and relying solely on personal income cannot support the quality upgrading of elderly care consumption. Meanwhile, the elderly have strong risk aversion. The cumbersome procedures and complicated product systems of traditional finance fail to accommodate their consumption decision-making and operational habits. Supported by digital service carriers, digital inclusive finance streamlines financial transaction procedures, lowers access thresholds for services and extends services to daily-life scenarios. It can precisely satisfy the small-sum, frequent and stable consumer financial demands of the elderly, effectively ease liquidity constraints and reduce consumption decision-making costs.

As the core driving force behind the digital and inclusive transformation of the financial system, new quality productive forces can continuously empower the development of inclusive finance through technological iteration and industrial restructuring, significantly lift the regional digital inclusive finance index, and form a progressive mediating transmission path: new quality productive forces→development of digital inclusive finance→upgrading of silver-haired consumption. Different from the traditional factor-driven model, new quality productive forces leverage emerging digital technologies including big data, artificial intelligence and blockchain to restructure the systems of credit evaluation, risk management and scenario implementation for financial services. On the one hand, advanced digital technologies free traditional finance from reliance on offline assets and credit records. Multi-dimensional user data enable accurate evaluation of the credit status of the elderly, effectively resolving the dilemma of “weak credit standing and difficulty in obtaining credit” among senior citizens and expanding the coverage of age-adapted financial services. On the other hand, technological empowerment drives continuous iteration of financial products and services, fostering innovative financial formats such as age-friendly online payment, low-threshold consumption installment plans, inclusive elderly care insurance, and the digital revitalization of idle assets. This enables inclusive financial services to be deeply embedded in the full range of daily consumption, wellness and elderly care scenarios for the elderly. As new quality productive forces continuously empower digital inclusive finance to improve quality and efficiency, liquidity constraints and barriers to financial participation faced by the elderly keep diminishing, and previously suppressed potential consumption demand can be fully unlocked. Therefore, digital inclusive finance captures the innovation dividends brought by new quality productive forces and serves as a vital transmission carrier to drive the upgrading of silver-haired consumption, effectively boosting the expansion of silver-haired consumption scale and facilitating the shift of consumption structure toward higher quality and greater diversification.

3.3 Quality Improvement of the Silver Economy

Driven by generational population replacement and deepening population aging, alongside continuous improvement of the livelihood security system, China's silver economy has broken through the single development paradigm centered on basic elderly care services. It has gradually evolved into a comprehensive macroeconomic system encompassing the cultivation of market entities, provision of elderly employment opportunities, construction of elderly care facilities, social security for the aging population, and structural changes brought by population aging. Its overall development level and market ecosystem constitute core macro conditions restricting the expansion and quality upgrading of silver-haired consumption. The hierarchical upgrading and potential release of silver-haired consumption are not spontaneous expansion solely on the demand side. They rely heavily on a mature, complete, coordinated and orderly industrial ecosystem and market environment of the silver economy. Multiple macro factors, including the agglomeration scale of elderly-oriented enterprises, capacity to absorb elderly workers, layout of infrastructure for elderly care institutions and coverage of senior welfare security, jointly form the fundamental support system for the high-quality development of silver-haired consumption. Under the traditional development model, the silver economy has long suffered structural drawbacks such as fragmented development, lagging market cultivation and unbalanced resource allocation. Typical manifestations include insufficient elderly-oriented market participants, limited employment channels for the elderly, uneven distribution of supporting elderly care resources, and room for improvement in the effectiveness of aging-related security policies. Insufficient vitality of the overall market makes it hard to satisfy the diversified and large-scale upgrading demands of silver-haired consumption, forming structural constraints that curb the unleashing of the consumption potential of the elderly. Relying on digital technological innovation and innovative industrial development paradigms, new quality productive forces systematically reshape the development landscape of the silver economy from a macro perspective. They optimize the business environment for elderly-oriented industries.

The iterative upgrading and comprehensive expansion of macro business forms within the silver economy stem from fundamental technological changes and systematic restructuring of industrial development models. Supported by emerging production factors such as intelligent manufacturing, big data and the Internet of Things, new quality productive forces empower the high-quality development of the silver economy from both supply and demand sides, forming a complete chained mediating transmission path: new quality productive forces→development of the silver economy→upgrading of silver-haired consumption. From the supply side, the technological innovation dividends of new quality productive forces break industry boundaries and resource fragmentation plaguing the traditional elderly care industry. They promote cross-industry integration and transformation and upgrading of elderly-oriented industries, enrich the supply system of products and services in the silver market, make up for shortages of high-end and personalized supply in traditional markets, and achieve systematic improvement in the supply quality for silver-haired consumption. From the demand side, industrial innovation driven by new quality productive forces fosters flexible and intelligent employment scenarios

suitable for the elderly. This effectively raises the employment participation rate and income level of senior citizens and consolidates the income foundation for elderly consumption. Meanwhile, it continuously expands the number of market entities serving the elderly, optimizes the infrastructure layout of elderly care institutions, improves the overall consumption ecosystem of the silver market, and precisely matches the differentiated and multi-level consumption demands of various elderly groups. Within this progressive transmission mechanism, new quality productive forces activate the growth momentum of the silver economy through technological empowerment and industrial restructuring, eliminate supply constraints and demand barriers existing in the traditional silver market, fully unleash suppressed potential consumption demand among the elderly, and ultimately realize the coordinated upgrading of the silver-haired consumption market in terms of scale expansion and the shift toward a high-end and diversified consumption structure.

Accordingly, this paper puts forward the hypothesis: New quality productive forces can significantly boost the level of silver-haired consumption.

4. Model Construction and Data Description

4.1 Model Construction

This paper employs a two-way fixed effects model to investigate the impact of new quality productive forces on silver-haired consumption. The specific model specification is set as follows:

$$\boldsymbol{consumption_{ijt} = \beta_0 + \beta_1 new\_quality_{jt} + X_{it} + Z_{jt} + \rho_i + \tau_t + \varepsilon_{ijt}} \quad \text{..... (1)}$$

where i, j and t denote the individual (aged over 45), city and year, respectively. The explained variable represents the consumption level of individual i in year t; the core explanatory variable denotes the level of new quality productive forces of city j in year t; X_{it} stands for a set of individual-level control variables that may affect silver-haired consumption. Drawing on prior studies, nine indicators are selected from the dimensions of individual characteristics and social support: self-rated health of middle-aged and elderly people, education attainment, household size, stock market participation, life satisfaction of middle-aged and elderly people, number of surviving children, retirement status, marital status and household registration type; Z_{jt} represents city-level control variables that may affect silver-haired consumption. Two indicators are adopted in this paper: urbanization rate and the proportion of tertiary industry output value; ρ_i denotes individual fixed effects, capturing time-invariant inherent characteristics of each individual; $\tau_t$represents time fixed effects, accounting for aggregate external shocks or macroeconomic trends common to all individuals at a given time; ε_{ijt} is the random disturbance term. Standard errors are clustered at the individual level during model estimation. β_1 is the core coefficient of interest in this paper, which reflects the average treatment effect of new quality productive forces on silver-haired consumption.

4.2 Data Description

4.2.1 New Quality Productive Forces

To construct the core explanatory variable, this paper collects and sorts relevant data from *China*

Statistical Yearbook, *China Industrial Statistical Yearbook* and provincial statistical yearbooks. To match the data of the dependent variable, five time points (2011, 2013, 2015, 2018 and 2020) are selected as observation windows. The sample covers 31 provinces, autonomous regions and municipalities directly under the Central Government across China (excluding Hong Kong, Macao and Taiwan). Following the practices of Lu et al[38], Zhu & Zeng[39]and other scholars, the evaluation system for new quality productive forces is built upon four primary indicators: scientific and technological productive forces, green productive forces, digital productive forces and silver-oriented productive forces (see the tables and figures below for detailed indicators).

Table 1. Indicator Construction

Primary indicator	Secondary indicator	Tertiary indicator	Unit	Attribute
Scientific and technological productive forces	Input	Full-time equivalent of R&D personnel in industrial enterprises above designated size	person-year	+
		Expenditure on science and technology	10,000 yuan	+
		Number of industrial enterprises above designated size	unit	+
	Output	Proportion of secondary industry output value	%	+
Digital productive forces	Input	Number of employees in information transmission, computer services and software industry	person	+
		Length of optical cable routes / regional land area	m	+
		Number of internet broadband access subscribers	10,000 households	+
	Output	Total telecommunications business volume	100 million yuan	+
		E-commerce sales volume	10,000 yuan	+
Green productive forces	Input	Number of employees in water conservancy, environment and public facilities management industry	person	+
		Green total factor productivity	%	+
		Total electricity consumption of the	100 million kWh	-

		whole society		
	Output	Comprehensive utilization rate of industrial solid waste	%	+
	Input	Employees engaged in medical and elderly care services	person	+
Silver-oriented productive forces		Total number of elderly care institutions and medical institutions	unit	+
	Output	Output value of pharmaceutical manufacturing industry	100 million yuan	+

4.2.2 Silver-haired Consumption

The data adopted in this paper come from the China Health and Retirement Longitudinal Study (CHARLS), a project led by the National School of Development at Peking University and implemented by the Institute of Social Science Survey, Peking University. Based on the Health and Retirement Study (HRS), CHARLS conducts surveys on families and individuals aged 45 and above. This paper adopts five waves of panel data from the survey for 2011, 2013, 2015, 2018 and 2020 (a total of five waves of data have been released by the database to date). The reason for selecting this database is as follows. In accordance with the definition of the silver economy stipulated in *Opinions of the General Office of the State Council on Developing the Silver Economy and Enhancing the Well-being of the Elderly* (Document No. Guo Ban Fa〔2024〕1), the silver economy encompasses both the aging economy targeting the elderly population and the pre-retirement economy for groups who have not yet reached old age and engage in consumption for advance pension planning. Hence, the research scope is not restricted to the legally defined elderly population aged 60 and above. The group aged over 45 includes some elderly individuals as well as a large number of pre-retirement residents with silver-haired consumption demands such as health management savings and pension planning. Their consumption behavior can also be affected by the development of new quality productive forces. If only samples aged over 60 are used, the consumption responses of the pre-retirement population will be omitted, leading to sample truncation bias. Furthermore, this paper takes household per capita consumption expenditure as the proxy variable for consumption among the silver-haired population. This choice arises from difficulties in obtaining individual consumption data for the silver-haired group. Meanwhile, consumption habits and behaviors across generations within households are highly homogeneous. Hence, household per capita consumption expenditure can indirectly reflect the consumption level of the elderly and pre-retirement members within a household.

To guarantee data integrity and continuity, winsorization at the 1st and 99th percentiles is applied to all continuous variables, and uniform dimensional standardization is implemented for all data. In the data processing stage of this study, to ensure the integrity, continuity and reliability of research data from the outset and avoid interference of extreme outliers on subsequent analytical results, all continuous variables

are corrected for outliers via winsorization at the 1% and 99% quantiles. Meanwhile, standardized dimension treatment is carried out on all research data to eliminate analytical bias caused by differences in dimension and magnitude among variables. This ensures that all indicators participate in subsequent statistical analysis and model construction on a comparable basis, laying a solid data foundation for scientific and accurate research conclusions.

5. Empirical Analysis

5.1 Descriptive Statistics

Table 2 presents the descriptive statistics for the main variables. As for the core variables, the consumption level of the elderly is processed by adding one and taking the natural logarithm for dimension adjustment. The resulting silver-haired consumption level (consumption) has a mean value of 9.094 and a standard deviation of 1.002, with a wide range between the minimum value (0) and the maximum value (14.22). This indicates significant individual heterogeneity in consumption levels among the elderly in the sample. New quality productive forces (new_quality) have a mean of 0.0885 and a standard deviation of 0.0479. Its maximum value (0.432) is approximately 23 times the minimum value (0.0184), reflecting substantial unevenness in the development of new quality productive forces across regions, which provides valid variation to identify its heterogeneous impacts on silver-haired consumption. In terms of control variables, the mean value of self-rated health of the elderly in the sample is 3.039 (full score of 5), and the mean life satisfaction stands at 3.226, both reaching an upper-middle level on the whole. The average education attainment is 2.020, suggesting that the educational level of the elderly in the sample is generally low. The mean urbanization rate is 0.537, and the mean value of the household registration type variable (rural) is 0.765, which reveals that the sample is dominated by residents with rural household registration and possesses representativeness for rural groups. In addition, the mean value of stock market participation (stock) is merely 0.007, implying that only a tiny share of the elderly participate in stock trading, consistent with the conservative risk preference generally observed among the elderly population.

Table 2. Descriptive Statistics

Variable Name	Definition	Mean	Std. Dev.	Min	Max
consumption	Silver-haired consumption level	9.094	1.002	0	14.22
new_quality	New quality productive forces	0.0885	0.0479	0.0184	0.432
health	Self-rated health of middle-aged and elderly people	3.039	0.984	1	5
family_size	Household size	3.177	1.632	1	16
edu	Education attainment	2.020	1.060	1	4

Variable Name	Definition	Mean	Std. Dev.	Min	Max
urban	Urbanization rate	0.537	0.144	0.226	1
gdp3	Proportion of tertiary industry output value	0.427	0.0973	0.207	0.839
marry	Marital status	0.858	0.349	0	1
rural	Household registration type	0.765	0.424	0	1
stock	Stock market participation	0.00676	0.0819	0	1
retire	Retirement status	0.148	0.355	0	1
child	Number of surviving children	2.594	1.398	0	15
life	Life satisfaction of middle-aged and elderly people	3.226	0.780	1	5

5.2 Baseline Regression

Table 3 reports the estimation results of the model examining the impact of new quality productive forces on silver-haired consumption. Column (1) presents the baseline regression results without any control variables; Column (2) only incorporates individual-level control variables; Column (3) further adds city-level control variables on this basis. It can be observed that the coefficients of new quality productive forces are significantly positive at the 1% significance level ($p<0.01$). This indicates that the improvement in new quality productive forces can significantly boost silver-haired consumption. According to the estimation results in Column (3), each one-unit increase in new quality productive forces leads to a significant rise of 1.498 in silver-haired consumption level, which verifies the reliability of the conclusion.

Table 3. New Quality Productive Forces and Silver-haired Consumption: Baseline Results

	(1)	(2)	(3)
VARIABLES	consumption	consumption	consumption
new_quality	1.057*** (Note 1)	1.217***	1.498***
	(2.89)	(2.66)	(3.08)
srh		-0.022***	-0.021***
		(-3.58)	(-3.20)
family_size		-0.155***	-0.155***
		(-36.31)	(-34.24)
edu		0.026	0.042
		(0.45)	(0.59)
marry		-0.001	0.037
		(-0.02)	(0.91)

rural2		-0.085**	-0.075**
		(-2.36)	(-1.97)
social9		-0.039	-0.040
		(-0.57)	(-0.58)
retire		0.044*	0.061**
		(1.65)	(2.24)
hchild		-0.001	-0.005
		(-0.09)	(-0.36)
satlife		0.014*	0.013*
		(1.94)	(1.75)
urban			-0.174*
			(-1.72)
gdp_c3			-0.060
			(-0.35)
Constant	8.502***	9.090***	9.100***
	(365.66)	(66.10)	(49.41)
Observations	69,997	47,146	42,601
R-squared	0.174	0.209	0.203
Individual-level control variables	NO	NO	YES
City-level control variables	NO	YES	YES
Individual fixed effects	YES	YES	YES
Time fixed effects	YES	YES	YES
Cluster	Individual	Individual	Individual

5.3 Robustness Tests

To effectively mitigate the disturbances to the reliability of research conclusions caused by model specification bias, measurement bias of the core explanatory variable, omitted variables and other issues, and ensure the universality and stability of the core conclusion from the baseline regression that new quality productive forces exert a significant positive promoting effect on silver-haired consumption.

5.3.1 Alternative Measurement of the Explanatory Variable

The measurement accuracy of the core explanatory variable directly affects the credibility of regression results. To avoid measurement bias stemming from constructing the new quality productive forces indicator based on a single dimensional framework, this paper follows the research approach proposed by Cai & He[40] and optimizes and adjusts the sub-system dimensions for constructing the new quality productive forces indicator. Specifically, drawing on the three factors of labor theory in labor economics, this study takes the three dimensions of "quantitative accumulation, quality improvement and innovative expansion" as the target layer, and reconstructs the sub-indicator system of new quality productive forces

based on three core criterion layers: laborers (employment of workers, output created by workers, etc.), objects of labor (industrial development, scientific and technological innovation, etc.), and means of labor (production energy, infrastructure, etc.). Consistent with the synthesis method used in the baseline regression, a new proxy variable for new quality productive forces is generated. The paper conducts regression again with this new indicator and the silver-haired consumption variable. The test results are reported in Column (2) of Table 4. The regression coefficient of the newly constructed proxy variable for new quality productive forces is 1.683 and significantly positive at the 1% statistical significance level, which is highly consistent with the core conclusion of the baseline regression, preliminarily verifying the robustness of the baseline model.

5.3.2 Alternative Index Synthesis Methods

The entropy weight method is adopted to construct the composite indicator of new quality productive forces in the baseline regression. This method determines weights according to the information entropy of each sub-indicator. Its primary advantage lies in fully utilizing the dispersion of indicators, objectively reflecting the information contribution of each sub-indicator and reducing bias arising from subjective weighting. Nevertheless, this method is sensitive to the distribution characteristics of indicator data. To further verify the robustness of the conclusion, this paper reconstructs the composite indicator of new quality productive forces by using the coefficient of variation method and the entropy weight-TOPSIS method for robustness checks. The coefficient of variation method features simple calculation and stronger tolerance to extreme values, which can compensate for the drawback that the entropy weight method is sensitive to data distribution. On the basis of objective weighting via entropy weight, the entropy weight-TOPSIS method introduces distance measurement between positive and negative ideal solutions, enabling a more comprehensive characterization of the relative development level of new quality productive forces in each sample. Regressions are carried out with indicators synthesized by the two methods respectively, and the results are presented in Columns (3) and (4) of Table 4. The regression coefficients of the core explanatory variable are 1.521 and 1.230, both significantly positive at the 1% statistical significance level. It demonstrates that the positive promoting effect of new quality productive forces on silver-haired consumption remains stable after adopting different objective weighting and comprehensive evaluation methods to construct the explanatory variable, further confirming the robustness of the research conclusion.

5.3.3 Adding Additional Control Variables

The baseline regression incorporates core control variables including the middle-aged and elderly's self-rated health status, household size and education attainment. As a vital demographic characteristic of the elderly population, individual age may indirectly interfere with the relationship between new quality productive forces and silver-haired consumption by affecting consumption capacity and willingness. Omitting this variable may lead to omitted variable bias in the model. To alleviate this concern, the variable of age is further added as an extra control variable into the baseline regression model to control its potential influence on the consumption of the elderly population, and the regression test is repeated.

The results are shown in Column (5) of Table 4. After incorporating age as a control variable, the regression coefficient of new quality productive forces is 1.498 and still significantly positive at the 1% statistical significance level. It implies that the baseline model is reasonably specified, and omitted variables exert limited disturbance to the research conclusions.

Table 4. Robustness Tests

VARIABLES	(1) consumption	(2) consumption	(3) consumption	(4) consumption	(5) consumption
new_quality	1.498***				1.498***
	(3.08)				(3.08)
new_quality_1		1.683***			
		(3.29)			
v_quality			1.521***		
			(2.89)		
c_quality				1.230***	
				(3.06)	
age					0.081***
					(17.86)
Observations	42,601	30,317	42,601	42,601	42,601
R-squared	0.203	0.144	0.203	0.203	0.203
Control	YES	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES
Cluster	Individual	Individual	Individual	Individual	Individual

5.4 Endogeneity Test

To alleviate potential endogeneity issues between the core explanatory variable new quality productive forces (new_quality) and the explained variable silver-haired consumption level (consumption), mainly arising from reverse causality and omitted variable bias, this paper follows Bartik[41]and adopts the one-period lag of the core explanatory variable (l_new_quality) as the instrumental variable. The two-stage least squares (2SLS) method is employed for the endogeneity test. Selecting the one-period lagged variable as the instrumental variable complies with the fundamental principles for instrumental variable selection. The lagged new quality productive forces are strongly correlated with the contemporaneous core explanatory variable, yet cannot directly affect current consumption (consumption). It effectively avoids simultaneous endogenous correlation with the explained variable and satisfies the exogeneity

requirement of instrumental variables.

The validity test of the instrumental variable and the 2SLS regression results are reported in Table 5. In the first-stage regression, the estimated coefficient of the instrumental variable l_new_quality is 0.232 and statistically significant at the 1% level, confirming a significant positive correlation between the instrumental variable and the core explanatory variable. The Kleibergen-Paap rk LM statistic is 321.121 ($p<0.01$), rejecting the null hypothesis of underidentification, which implies the instrumental variable is identifiable. Both the Cragg-Donald Wald F statistic and the Kleibergen-Paap rk Wald F statistic are substantially larger than the corresponding critical value (critical value under 10% bias), which rules out the weak instrumental variable problem and guarantees reliable test results.

The second-stage regression results show that the estimated coefficient of the core explanatory variable new_quality is 7.812 and significantly positive at the 1% statistical level. This reveals that after addressing endogeneity, new quality productive forces still exert a significant positive impact on silver-haired consumption.

Table 5. Endogeneity Test: Instrumental Variable Approach

Variables	2SLS Estimation	
	First Stage	Second Stage
	new_quality	consumption
IV = l_new_quality	0.232***	
	(21.560)	
new_quality		7.812**
		(2.470)
Cragg-Donald Wald F statistic		1153.523
Kleibergen-Paap rk Wald F statistic		464.928
Kleibergen-Paap rk LM statistic		321.121***
Observations	22138	22138
Control	YES	YES
Individual fixed effects	YES	YES
Time fixed effects	YES	YES
Cluster	Individual	Individual

5.5 Mechanism Analysis

This paper adopts empirical methods to test three transmission mechanisms through which new quality productive forces affect silver-haired consumption.

5.5.1 Expansion of Digital Scenarios

As a core comprehensive indicator measuring the scale, quality and development potential of regional

digital economy, the digital economy index acts as a critical mediating channel linking new quality productive forces and silver-haired consumption. Its level directly reflects the penetration and application efficiency of regional digital technologies. Accordingly, this paper first examines the direct impact of new quality productive forces on the digital economy index, and then verifies its role as a mediator transmitting the influence between new quality productive forces and silver-haired consumption, laying a foundation for hypothesis testing. To scientifically measure the development level of the regional digital economy, this paper draws on the construction framework of the digital economy index proposed by Liu et al[42] and evaluates the comprehensive development of the digital economy centered on internet development. Four representative indicators are selected to measure internet development: internet penetration rate, employment in relevant sectors, relevant output, and mobile phone penetration rate. After selecting indicators, all variables are standardized to eliminate dimension differences, and the principal component analysis is used to calculate the composite digital economy index. This index can comprehensively and objectively reflect the overall development of the regional digital economy and serves as a reliable core measurement indicator for subsequent empirical tests.

Table 6 reports the mediation effect regression results showing that new quality productive forces raise silver-haired consumption indirectly by boosting the digital economy index. The coefficients of new quality productive forces in Columns (1)–(3) are all significantly positive at the 1% significance level. It fully demonstrates that the advancement of new quality productive forces significantly promotes the regional digital economy index, and the rise of the digital economy index further lifts silver-haired consumption, forming a complete transmission chain: new quality productive forces → digital economy index → silver-haired consumption. This empirical result is highly consistent with the foregoing theoretical analysis, clearly verifying the mediating transmission role of the digital economy index between new quality productive forces and silver-haired consumption, and formally confirming the hypothesis proposed in this paper.

Table 6. Mechanism Analysis: Digital Scenario Expansion

	(1)	(2)	(3)
VARIABLES	consumption	digital	consumption
new_quality	1.498***	3.343***	1.355***
	(3.076)	(27.858)	(2.754)
digital			0.0504**
			(2.323)
Observations	42,601	55,887	42,601
R-squared	0.203	0.689	0.204
Control	YES	YES	YES
Individual fixed effects	YES	YES	YES

Time fixed effects	YES	YES	YES
Cluster	Individual	Individual	Individual

5.5.2 Inclusive Finance Empowerment

As a core comprehensive indicator reflecting the coverage breadth, usage depth and digitization level of regional digital inclusive finance, the digital inclusive finance index serves as a vital financial mediating channel through which new quality productive forces boost silver-haired consumption. Its development level directly determines the coverage, service quality and accessibility of financial services for the silver-haired group, and constitutes a key measure to ease the consumption financial constraints and unlock consumption potential among the elderly population. On this basis, this paper focuses on examining the direct impact of new quality productive forces on the digital inclusive finance index, and further identifies its mediating transmission role between new quality productive forces and silver-haired consumption. It provides important support for the comprehensive verification of mediation effects and echoes the transmission logic of digital inclusive finance elaborated in the foregoing theoretical analysis. Following Guo et al[43], this paper adopts the China Digital Inclusive Finance Index (difi) released by the Institute of Digital Finance, Peking University as the core measurement indicator for empirical tests. The index covers three core dimensions: coverage breadth, usage depth and digitization level, which precisely align with the core logic of how digital inclusive finance empowers silver-haired consumption in this research. Table 7 presents the mediation effect regression results that new quality productive forces raise silver-haired consumption via empowering inclusive finance. The coefficients of new quality productive forces in Columns (1)–(3) are significantly positive. It fully demonstrates that the development of new quality productive forces can significantly promote the regional digital inclusive finance index and thereby lift silver-haired consumption level. The findings are highly consistent with the previous theoretical analysis and offer solid empirical evidence for the comprehensive verification of the hypothesis.

Table 7. Mechanism Analysis: Inclusive Finance Empowerment

	(1)	(2)	(3)
VARIABLES	consumption	difi	consumption
new_quality	1.498***	140.0***	1.233**
	(3.076)	(50.360)	(2.427)
difi			0.00168*
			(1.746)
Observations	42,601	55,887	42,601
R-squared	0.203	0.998	0.203
Control	YES	YES	YES
Individual fixed effects	YES	YES	YES

Time fixed effects	YES	YES	YES
Cluster	Individual	Individual	Individual

5.5.3 Quality Improvement of the Silver Economy

As a core dimension measuring the development quality of the regional silver economy, supporting facilities of aging-related industries and the capacity to guarantee the livelihood of the elderly, quality improvement of the silver economy serves as a fundamental mediating channel through which new quality productive forces empower silver-haired consumption. Its development level and maturity directly determine the supply quality of regional aging services, construction of consumption scenarios for the elderly and vitality of the silver market. Furthermore, it acts as vital support for breaking the shackles restricting silver-haired consumption and unlocking the consumption potential of the aging population. Accordingly, this paper constructs a composite silver economy index(silver) as the core measurement indicator. Synthesized from multi-dimensional indicators including pension expenditure, pension coverage rate, poverty rate among the elderly, employment rate of the elderly, participation rate in elderly education, number of aging-oriented enterprises, this indicator can comprehensively and systematically reflect the effectiveness of quality improvement in the regional silver economy, matching the core logic of how new quality productive forces empower silver-haired consumption in this research. Table 8 shows the regression results of the mediating effect of new quality productivity in boosting the silver economy and thereby increasing silver-age consumption levels. The coefficients of new quality productive forces in Columns (1)–(3) are significantly positive at the 1% significance level. It reveals that by advancing regional industrial upgrading, optimizing the livelihood security system and fostering distinctive aging industries, new quality productive forces continuously elevate the quality and efficiency of the regional silver economy. This effectively improves livelihood guarantees for the elderly, expands the scale of aging-related industries and optimizes the development structure adapted to population aging. It significantly perfects supporting systems for silver-haired consumption, enriches consumption scenarios for the elderly, lowers consumption barriers for the silver-haired group, and addresses prominent bottlenecks including inadequate security guarantees, insufficient consumption scenarios and limited consumption experience among the elderly. It provides solid support for the elderly to engage in various consumption activities and access high-quality aging services, and effectively strengthens their sense of consumption security and willingness to consume. Highly consistent with the foregoing theoretical analysis, it supplies crucial empirical evidence for the comprehensive verification of the hypothesis.

Table 8. Mechanism Analysis: Quality Improvement of the Silver Economy

	(1)	(2)	(3)
VARIABLES	consumption	bank	consumption
new_quality	1.498***	0.682***	1.187**
	(3.076)	(46.712)	(2.332)
silver			0.438*
			(1.872)
Observations	42,601	55,887	42,601
R-squared	0.203	0.810	0.203
Control	YES	YES	YES
Individual fixed effects	YES	YES	YES
Time fixed effects	YES	YES	YES
Cluster	Individual	Individual	Individual

6. Heterogeneity Analysis

6.1 Regional Economic Development Level

To examine whether the impact of new quality productive forces on silver-haired consumption exhibits regional economic heterogeneity, this paper divides the full sample into two subsamples: using the median GDP of each region as the grouping threshold, and conducts grouped regressions. The corresponding estimation results are reported in Columns (1) and (2) of Table 9. Grouped regression results reveal that the positive promoting effect of new quality productive forces on silver-haired consumption holds significantly in both regional subsamples. The coefficient stands at 1.333 for low-economic-development regions and 1.886 for high-economic-development regions, both significant at the 5% level ($p<0.05$). To further verify the two groups, the Chow test is adopted to examine intergroup coefficient differences. The test confirms a significant disparity between the two coefficients, which demonstrates that the empowering effect of new quality productive forces on silver-haired consumption features notable regional economic heterogeneity.

In terms of heterogeneous transmission mechanisms, regions with higher economic development enjoy higher household disposable income, more sound infrastructure for elderly consumption, and a more mature silver consumption market system. Such regions can efficiently absorb high-quality supplies generated by new quality productive forces, including innovative elderly care products and smart healthcare services, thereby fully unlocking the consumption expansion dividends brought by new quality productive forces and generating a stronger marginal promoting effect. By contrast, in regions with relatively backward economic development, although new quality productive forces can still effectively stimulate local silver-haired consumption demand, fill supply gaps in the consumer market, and significantly advance the upgrading of silver-haired consumption, the boosting effect on

consumption is weaker than that in economically developed regions. This is constrained by fundamental conditions such as residents' income, public elderly care supporting resources and the construction of consumption scenarios, eventually leading to heterogeneous effects across regions.

6.2 Regional Heterogeneity

To further explore whether the impact of new quality productive forces on silver-haired consumption varies across regions, this paper divides Eastern, Central and Western regions, in accordance with China's standard geographical regional classification. Grouped regression analyses are carried out to compare the marginal effects of new quality productive forces on silver-haired consumption in different areas. The regression results for each group are presented in Columns (3)–(5) of Table 9. The coefficient of new quality productive forces is 1.312 and significantly positive at the 5% statistical level for the Central region. The coefficient is positive yet weakly significant in the Eastern region, while the positive driving effect in the Western region fails to pass the significance test. From all this, we can see that the empowering effect of new quality productivity on silver-haired consumption shows significant regional differences, with the central region showing the most noticeable effect.

The underlying mechanisms accounting for such regional disparities can be interpreted from three perspectives: regional economic foundation, industrial supply, and the adaptability of consumption scenarios. First, the Central region boasts a large elderly population, whose rigid demand for basic consumption such as elderly care, healthcare and daily life support remains concentrated. Benefiting from industrial transfer and digital transformation dividends, emerging industries including smart elderly care and digital healthcare experience rapid growth. New products and services spawned by new quality productive forces precisely match the core consumption demands of local silver-haired groups and effectively unlock regional silver consumption potential, generating significant consumption driving effects. Second, the Eastern region has a mature silver consumption market and sound supporting systems. Traditional elderly consumption resources have been fully integrated, leading to diminishing marginal improvement effects of new quality productive forces on silver-haired consumption and weaker statistical significance accordingly. Third, restricted by weak economic foundations, insufficient coverage of digital infrastructure and inadequate supporting facilities for smart elderly care industries in the Western region, the advantages of new quality productive forces in technological empowerment and industrial innovation cannot be fully leveraged to satisfy local silver-haired consumption demand, which explains why its positive impact lacks statistical significance.

Table 9. Heterogeneity Analysis

	(1) High Economic Development	(2) Low Economic Development	(3) Eastern	(4) Central	(5) Western
VARIABLES	consumption	consumption	consumption	consumption	consumption
new_quality	1.886**	1.333**	0.312	4.411***	-0.400
	(2.052)	(2.126)	(0.382)	(3.942)	(-0.443)
Chow Test	218.87***				
Observations	15,022	27,579	15,427	16,213	10,961
R-squared	0.184	0.212	0.216	0.223	0.168
Control	YES	YES	YES	YES	YES
Individual fixed effects	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES
Cluster	Individual	Individual	Individual	Individual	Individual

7. Conclusions and Recommendations

7.1 Research Conclusions

This paper employs five-wave panel data covering 2011, 2013, 2015, 2018 and 2020 to systematically investigate the impact and underlying mechanisms of new-quality productive forces on silver-haired consumption.

First, new-quality productive forces exert a significant positive effect on silver-haired consumption. Benchmark regression results indicate that an improvement in new-quality productive forces substantially boosts the growth of silver-haired consumption. This conclusion still holds even after various robustness checks, like changing the way we measure variables or the method of combining indicators. The estimates from the instrumental variable method further eased the endogeneity problem and confirmed that the research findings are reliable.

Second, new-quality productive forces promote silver-haired consumption through three transmission channels. Mechanism tests reveal that new-quality productive forces stimulate silver-haired consumption via three mediating paths: expansion of digital scenarios, inclusive financial empowerment, and high-quality development of the silver-hair economy. Specifically, the expansion of digital scenarios lowers the barriers for older adults to engage in digital consumption; inclusive financial empowerment eases the liquidity constraints faced by the elderly; and high-quality silver-hair economic development matches the diverse consumption demands of senior citizens and advances consumption-structure

upgrading. Mutually supportive and synergistically effective, these three paths jointly constitute the transmission mechanism through which new-quality productive forces foster silver-haired consumption. Third, the effect of new-quality productive forces on silver-haired consumption presents pronounced regional heterogeneity. Empirical outcomes suggest that the facilitating effect is more prominent in regions with higher economic development levels and in central China. It demonstrates that new-quality productive forces feature inclusiveness as well as spatial heterogeneity. They can effectively compensate for deficiencies in traditional infrastructure and public services, which creates opportunities to narrow regional disparities in silver-haired consumption.

7.2 Policy Recommendations

7.2.1 Deepen the Construction of Digital Scenarios and Continuously Narrow the Digital-consumption Divide among the Elderly

Local authorities shall take the opportunity brought by the development of new-quality productive forces to systematically promote large-scale expansion, optimization and upgrading of age-friendly digital consumption scenarios. On the one hand, it is necessary to accelerate the digital transformation of high-frequency consumption sectors for the elderly, including retail commerce, health care, home-based services, and cultural entertainment. Efforts should be made to simplify operation interfaces for elderly users and optimize the age-adaptive functions of smart devices, so as to build a convenient, safe and friendly digital consumption ecosystem for senior citizens. On the other hand, The government and communities should regularly carry out digital literacy training for older adults, so as to improve their capabilities in using smart devices, making online consumption decisions and identifying cyber risks, thereby effectively removing barriers to digital access. By comprehensively expanding digital consumption access channels for the elderly, the empowering effect of expanded digital scenarios on silver-haired consumption can be fully unleashed.

7.2.2 Improve the Inclusive Financial Support System and Enhance the Elderly's Capacity for Payment and Intertemporal Consumption

The age-friendly upgrading of the inclusive finance system should be further advanced to establish a financial service mechanism adapted to the income characteristics, risk preferences and consumption patterns of the elderly. Financial institutions shall continuously optimize the small-sum consumer credit, and conservative pension wealth management products. Procedures for elderly-related financial businesses need to be simplified to lower the threshold for the elderly to access consumer finance. Meanwhile, supervision over elderly-targeted financial risks and anti-fraud publicity shall be strengthened to standardize the order of the elderly-oriented financial market and ease the elderly's consumption concerns as well as capital constraints. By improving the empowering mechanism of inclusive finance, the liquidity constraints facing the elderly can be alleviated, their willingness for immediate and high-quality consumption can be enhanced, and the vitality of the silver-haired consumption market can be steadily stimulated.

7.2.3 Promote High-quality Upgrading of the Silver-hair Economy and Establish a Senior-oriented Consumption Development System with Matched Supply and Demand

Leveraging the advantages of new-quality productivity to empower industry upgrades, we should comprehensively work on improving the quality and efficiency of the silver economy industry system. Market players should focus on the elderly's multi-level, high-quality, and personalized consumption needs, increase R&D of senior-friendly products, supply of health and wellness services, and layout of elderly entertainment industries, enriching silver-aged product categories and optimizing the consumption supply structure. The government should strengthen top-level planning, improve support policies for the silver industry, industry standards, and supporting systems, guide resources to gather toward high-quality elderly-friendly industries, and phase out low-end, homogeneous supply. By continuously improving the quality of silver economy development, we can achieve a precise match between the supply system for elderly consumption and the consumption needs of seniors, creating new silver-age consumption through high-quality supply and driving the ongoing optimization and upgrade of the silver consumption structure.

7.3 Research Limitations and Prospects

There are still some limitations in this study that need further exploration. First, due to data availability constraints, the measurement of core variables like new-type productivity and digital scenario expansion is still relatively rough, and more refined indicators need to be developed. Second, this paper mainly looks at three mediation paths, but the way new-type productivity affects silver economy consumption could be more complex, with factors like human capital accumulation and improvements in the social security system worth including in future research. Third, the panel data used here only goes up to 2020, so it doesn’t capture the recent rapid developments in new-type productivity, which limits the timeliness of the conclusions.

For future research directions, several dimensions merit attention. First, cross-national comparative research. By investigating experiences from different countries and regions, referable policy implications can be summarized. Second, research on micro-mechanisms. Experimental or quasi-experimental methods can be adopted to further reveal the psychological and behavioral mechanisms underlying how new-quality productive forces shape elderly people’s consumption decisions. Third, dynamic prediction research. Based on existing empirical evidence, forward-looking judgments on future trends can be made to provide references for long-term policy-making.

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Note

Note 1. Values in parentheses are t-statistics. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively. The same notation applies to all subsequent tables.