

## Original Paper

# Digital-Intelligent Pension Finance Empowering the Silver Economy: Theories, Practices, and Pathways

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### **Abstract**

*Despite the growing population, the silver economy market continues to increase, and the market still suffers from regional imbalance, supply-demand mismatches, and structural issues in the three-pillar pension system. Based on active aging, financial development, and synergy, this paper develops a "Technological Empowerment - Scenario Integration -- Policy Synergy" framework to analyze the fundamental mechanisms and pathways through which digital-intelligent pension finance can drive silver economy. The results show that Digital intelligence, by three-dimensional interaction of technology-enabled, scenario-enabled and policy-enabled cooperation, enables efficient resource allocation of pension finance and restores service ecosystem. Specifically, digital intelligence utilizes technologies such as big data and blockchain to improve the precision and efficiency of pension finance; scenario integration fosters a "finance+health-wellness" ecosystem; and policy synergy leverages regulatory sandboxes and data sharing to dismantle institutional barriers. Based on these insights, this paper proposes measures including strengthening age-friendly technological innovation, optimizing incentives for the third pension pillar, and establishing cross-sectoral ecosystem alliances. These initiatives aim to facilitate the transition of the silver economy from a "security-oriented" to a "development-oriented" model, providing pathways for aging governance.*

### **Keywords**

*Silver economy, Pension finance, Digital Intelligence*

### **1. Introduction**

Against the backdrop of accelerating global population aging, the silver economy is rapidly emerging as a core engine reshaping economic landscapes. In 2023, the silver economy in China reached a scale of 8.6 trillion RMB, accounting for over 7% of GDP, and is expected to exceed 45 trillion RMB by 2035, demonstrating huge market potential and room for growth.<sup>[13]</sup> But behind this vigorous

development are serious structural challenges such as regional mismatches, deep supply-demand mismatches and deficiencies of the three-pillar pension finance system. These challenges will not only hinder the healthy, sustainable growth of silver economy, but also hinder China's national policy for actively responding to population aging. To address such challenges, some studies have investigated multiple aspects: At the silver economy level, it has taken a generalisation from the European Union' (2015) definition of "economic activities of the 50+ population" to a preventive, life-cycle-wide approach;<sup>[1]</sup> In terms of ongoing domestic policy adjustments, the State Council's 2024 Document No. 1—Views on Developing the Silver Economy to Enhance the Well-being of the Elderly—has raised the silver economy to a national strategy. The core idea is to link "youth accumulation" with "elderly consumption." Research also shows that the silver economy has several key features: it evolves over time, brings together different sectors, and has both market and welfare characteristics.<sup>[14] [18]</sup> So, research on pension finance—most of it has been about two main things. One is how the whole ecosystem is being reshaped. The other is these deep structural contradictions that keep popping up. And if you look at how the theory has changed over time, it started with Bodie and Davis back in 2000—they were all about asset appreciation. Then later, around 2016, Dong Keyong came along and broke it down into three levels: pension fund finance, elderly service finance, and elderly industry finance.<sup>[2] [12]</sup> And then finally, you've got the official definition. Nine government departments—including the People's Bank of China—put out these Guidelines on Financial Support for Chinese-style Elderly Care and High-quality Development of the Silver Economy back in 2024. And in there, they basically define the silver economy as a whole comprehensive financial instrument ecosystem. Now, when you look at the existing research, people have dug deep into the core problems. Things like the three-pillar gap, maturity mismatch, risk mismatch, and regional differences. For example, there's this contradiction: you invest long-term in retirement communities, but credit is short-term. Or another one—older people tend to have a low risk appetite, but what's out there? A lot of high-risk products.<sup>[9] [11]</sup> So, on the digital-intelligent empowerment front, researchers have kind of come to a rough agreement. It's about how technology, scenarios, and policy all need to work together. Take the technology side—big data, blockchain, AI. They're showing some real promise in a few areas. Like, profiling demand, catching fraud, and optimizing how you allocate assets.<sup>[15] [17] [21]</sup> On the scenario side, studies by Wang Xiangnan (2024) and others show that digital tools such as the "dual-recording" policy can promote elderly people's financial participation;<sup>[26]</sup> And on the policy side? You've got things like regulatory sandboxes and domestic data integration platforms—Zhejiang's "Zheliyang" is a good example. They really show how institutional synergy can cut costs and boost efficiency. That's a big deal. Meanwhile, Huang Yiping and Huang Zhuo (2020), along with some others, have been looking more at the inclusive side of digital finance—making sure it actually helps people who need it. That said, the existing research does have some pretty clear gaps. For one thing, most studies tend to focus on just one piece of the puzzle. Some look at the macroeconomic features and contradictions of the silver economy. Others dive into pension finance's structural issues. And then there are those that explore what individual digital technologies could do. But very few try to bring all three together under

one roof—like a unified framework. And here's another issue. There's not enough theoretical explanation or solid empirical evidence on how digital intelligence, in a systematic way, can actually help pension finance solve those deep contradictions in the silver economy. You know, things like regional imbalances and supply-demand mismatches. Plus, the mechanisms and pathways involved—they're still pretty unclear. Most critically, the structural problems on the supply side of pension finance call for digital-intelligent solutions. The current product supply is overly homogeneous: savings-type products account for as much as 49.5% of all pension financial products (Note 3), making it hard to meet diversified, long-term retirement needs. Net-value products (such as target-date funds) are under-supplied and face low investor awareness and high redemption rates. Take some of those innovative products—commercial pension insurance, reverse mortgages, long-term care insurance. They've all hit some kind of bottleneck. None of them are really taking off. <sup>[16]</sup> And then there's the technology side—age-friendly tech is lagging behind. That just makes the "digital divide" among older people even worse. And it also holds back a lot of potential demand. So with all that in mind, this study tries to answer one core question. Basically: how can digital intelligence actually empower pension finance in a deep way? We're trying to build a three-dimensional framework—technology, scenarios, and policy all working together. And then use that framework to systematically allocate resources better, close regional gaps, clear those supply-demand blockages, and finally push the silver economy to shift from a "security-first" model to a "development-first" one. So here's how we approach it. We draw on three theories—financial deepening, active aging, and synergy theory. Then we try to figure out the inner mechanisms: how exactly does digital intelligence empower pension finance? We see it working through three channels: boosting financial efficiency, expanding participation scenarios, and improving the institutional environment. From there, we also look at concrete pathways—like how to bridge regional differences, optimize that three-pillar structure, and unlock new growth drivers for the silver economy. The goal is to offer a practical path reference. One that helps shift the silver economy from a security-oriented model to a development-oriented one—and also contributes to better aging governance overall.

## **2. Core Concepts**

### *2.1 The Silver Economy*

So the silver economy—basically, it's this whole economic model that comes out of population aging. And its meaning has changed over time, especially when you look at how different countries have defined it. Take the European Union back in 2015. They said it's "the sum of economic activities generated by public and consumption expenditure related to the population aged 50 and over." So they were really focused on market size and how different sectors connect to each other. <sup>[3]</sup> Then Klimczuk came along in 2016. He expanded the definition. To him, it's not just about older people—it's about economic activities that cover the whole life cycle of people who aren't old yet but are aging. So that brings in two key ideas: preventive accumulation, and making sure resources are balanced across

generations.<sup>[1]</sup> Japan's experience really shows how this staged evolution works. In the early days—1970 to 1994—they focused mainly on elderly care services. Then from 1995 to 2004, they moved to a two-pillar system: the silver industry plus services. And after 2005, they went all the way to what you could call a "full silvering of the economy and society." That means age-friendly products and services start using universal design—so the boundaries between "old" and "not old" get pretty blurry.<sup>[18]</sup>

In China's evolution, the definition of the silver economy has deepened with policy iteration. Yang Yansui (2015) focused on the livelihood orientation of "healthy longevity and consumption upgrading";<sup>[19]</sup> Hu Suyun (2020) emphasized government responsibility, noting that the silver economy also covers "public economic fields" related to it.<sup>[14]</sup> The State Council's 2024 Document No. 1, \*Views on Developing the Silver Economy to Enhance the Well-being of the Elderly\*, was the first special policy to establish a national strategic framework of "whole-life-cycle preparation," marking a shift from a deficit-filling elderly care model to an integrated economic ecology linking "youth accumulation" to "elderly consumption." Its extension features three unities: first, dynamic evolution — industrial forms progress with aging stages, as seen in China's current growth poles of smart elderly care and pension finance; second, industrial agglomeration — spanning three sectors (e.g., functional foods, intelligent assistive devices, pension finance) and relying on multi-department policy coordination; third, market-welfare duality — requiring institutional design, such as Japan's long-term care insurance, to balance corporate low-profit operations with universal supply.<sup>[18]</sup> In essence, the silver economy is a new paradigm that uses policy and technology as dual drivers to restructure resource allocation in an aging society.

## 2.2 Pension Finance

If you trace how pension finance theory has evolved, it's pretty clear—it went from a single dimension to a more systematic framework. It all started with Bodie and Davis back in 2000. They came up with this idea of "pension fund finance," which was really just about making sure institutional pension assets hold their value and grow.<sup>[1]</sup> Then, as China's population started aging faster, Dong Keyong and Yao Yudong came along in 2016. They built a three-level framework. Basically, they split pension finance into three parts: pension fund finance, elderly service finance, and elderly industry finance. That gave later research a much more systematic way to think about things.<sup>[12]</sup> Then in 2021, Dong Keyong added another layer. He brought in a whole-life-cycle perspective. The key idea? You need to "prepare before getting old"—and that means focusing on things like how individual pension accounts are set up institutionally.

<sup>[11]</sup> Recent research (Ba Shusong, 2024) focuses on the structural imbalance of the three pillars: although the basic pension insurance covers 1.07 billion people, enterprise annuity coverage is only 6.68%, and the third pillar faces the dilemma of "hot account opening but cold contributions."<sup>[9]</sup> Then in 2024, nine government departments—including the People's Bank of China, the National Financial Regulatory Administration, and the China Securities Regulatory Commission—jointly issued a set of guidelines. The full title is Guidelines on Financial Support for Chinese-style Elderly Care and High-quality

Development of the Silver Economy. And for the first time, they gave an official definition of "pension finance." So what is it? Basically, pension finance refers to all those financial activities that use a mix of instruments—credit, insurance, bonds, equity, wealth management products, you name it—to meet people's diverse retirement needs and to serve the development of the silver economy. Specifically, it covers several areas: managing pension funds, providing financing and risk management for the silver economy, offering pension financial products and services, and protecting the financial rights and interests of the elderly. Then Lin Xi and Cheng Huan, in 2025, took things down to the micro level. They used data from the China Household Finance Survey, or CHFS, and found some interesting behavioral patterns. Basically, the makeup of a household really affects how willing people are to save for retirement and how they allocate pension assets. Here's what they found. If you have a larger household size, people are less willing to save for retirement. But if you have more kids to support—a higher child dependency ratio—that actually increases the willingness to save. Then there's the old-age dependency ratio. That one pushes down people's willingness to buy commercial pension insurance. But at the same time, it encourages them to hold other kinds of pension assets. So what does that tell us? There's this complicated trade-off going on between family intergenerational support and financial savings. They kind of substitute for each other.<sup>[16]</sup> The above research and the official definition confirm the shift of pension finance theory from a single economic security function to a comprehensive service ecology.

So where is pension finance headed? Most people agree that digital-intelligent pension finance is the core trend right now. It's also a key way to actually make things happen—both in theory and in practice. What does that mean exactly? It's when you take new-generation digital intelligence technologies—big data, AI, blockchain, cloud computing, all of that—and you weave them into every part of the pension finance process. From start to finish, across the whole chain. The goal? Four things. You want resource allocation to be more precise. You want service processes to get smarter. You want risk management to be more penetrating—meaning you can actually see through things. And finally, you want the whole ecosystem to work together more efficiently.<sup>[27]</sup> Digital intelligence does more than just give traditional pension finance some new tools—though it does that too. You know, things like robo-advisors, blockchain-based certification, big-data actuarial science. But it goes further. It actually drives process reengineering and model restructuring. For example, creating closed loops between health and payments, or integrating different scenarios across the board.

The core goal? Use technology to systematically tackle those long-standing structural contradictions in pension finance—the three-pillar gap, maturity mismatches, regional imbalances, all of that. Improve service efficiency and user experience along the way. And ultimately, build a pension finance service ecosystem that's more efficient, more inclusive, and more resilient. That becomes the core financial engine for high-quality development of the silver economy.<sup>[28]</sup>

### 3. Current Status of the Silver Economy and Pension Finance and Their Digital-Intelligent Features

#### 3.1 Current Status and Digital-Intelligent Process of the Silver Economy

##### 3.1.1 Policy Evolution (2015–2024)

The past decade has been a critical period for accelerating improvement of China’s silver economy policy system, showing clear trends toward systematization and deepening, mainly reflected in two interrelated threads: the expansion of policy coverage from single services to the whole chain, and the shift of government role from direct provider to institutional designer and market guide. Specifically, policy focus has moved from early concentration on elderly care service supply to gradually covering age-friendly product R&D and manufacturing, cultivation of elderly consumer markets, and finally establishing pension finance as the core engine supporting the silver economy. The policy evolution clearly shows a tilt toward digital-intelligent solutions — from early market access concerns to building a “product + service + finance” ecological chain supported by digital technology. Meanwhile, the government’s role has also changed profoundly: from initially encouraging social capital participation, to elevating the silver economy to a national strategy and clarifying its meaning, and finally to top-level design — the 2024 State Council Document No. 1 and the systematic financial support policy (the 2024 guidelines by nine departments) — establishing the core empowering position of digital technology and focusing on technology-driven approaches, standard-setting, market environment cultivation, and cross-departmental coordination mechanisms, guiding market forces to become the main drivers of the silver economy.

**Table 1. Policy Evolution**

Year	Policy Name	Core Breakthrough
2015	Opinions on Promoting the Development of Elderly Care Services	First, it gave the first official definition of what the "elderly care industry" actually means. Second, it laid out clear pathways for social capital to get involved. And third, it ended up stimulating market vitality.
2021	Opinions on Strengthening Work on Aging in the New Era	Incorporated “actively cultivating the silver economy” into national strategy; proposed developing age-friendly products and expanding elderly consumer markets.
2022	14th Five-Year Plan for National Aging Career Development and Elderly Care Service System	Required financial institutions to innovate pension financial products; promoted deep integration of pensions, insurance, and elderly care services.
2024	Views on Developing the Silver Economy to Enhance the Well-being of the Elderly	First special policy on silver economy; defined “whole-life-cycle economic activities”; emphasized core position of digital technology empowerment.

2024

Guidelines on Financial Support for Chinese-style Elderly Care and High-quality Development of the Silver Economy

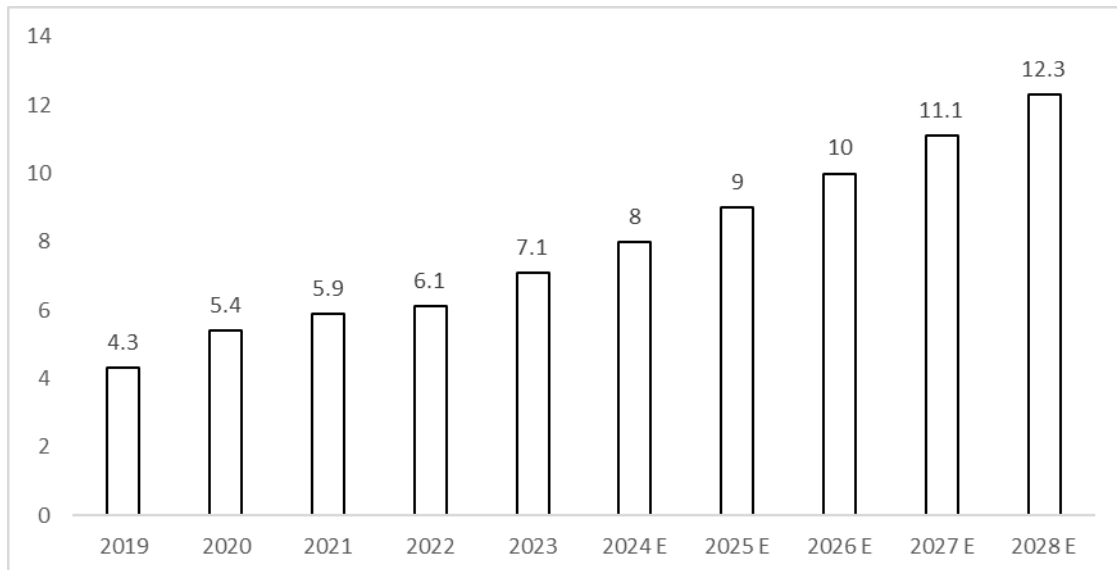
Set phased goals for 2028 and 2035; proposed 16 key measures across five areas: supporting various groups' retirement financial needs, expanding financing channels for the silver economy, improving financial security systems, strengthening the foundation of financial services, and building long-term mechanisms.

*Source:* Compiled from government documents.

### 3.1.2 Market Size, Trends, and Digital-Intelligent Drivers

The silver economy is becoming a core engine for China to address population aging. In 2023, China's silver economy reached 7 trillion RMB. From 2015 to 2023, the average annual compound growth rate (CAGR) of China's elderly care industry was as high as 12.7%, significantly outpacing GDP growth during the same period (Note 1). Over the long term, the silver economy's share of GDP will continue to rise. Under a medium-growth scenario for per capita consumption, forecasts indicate that by 2035 China's silver economy will reach 45.35 trillion RMB, accounting for 22.67% of GDP; by 2050, it will reach 98.22 trillion RMB, accounting for 24.55% of GDP.<sup>[13]</sup>

Industrial growth shows clear structural features. Three areas constitute core growth poles: manufacturing of elderly products (e.g., smart assistive devices, functional foods), health and wellness services (integrated medical and elderly care, retirement travel), and smart elderly care (remote monitoring, smart homes). Among these, smart elderly care is a typical area of digital-intelligent application. According to the \*14th Five-Year Plan for National Aging Career Development and Elderly Care Service System\* and related industry reports, these areas have been key targets of policy support and market investment in recent years, leading the growth momentum of the silver economy. Meanwhile, the continued increase in life expectancy (China's average life expectancy reached 77.93 years in 2022) (Note 11) and the upgrading of elderly consumption structure together form important basic drivers of market expansion, and the application of digital-intelligent technology is a key catalyst accelerating this process. Growth in emerging areas such as smart elderly care is particularly prominent. According to the \*China Aging Industry Development Report 2021-2022\* by the China National Committee on Aging, some smart elderly care products (e.g., health monitoring devices, smart home retrofitting for the elderly) have seen sales growth significantly higher than traditional elderly products in recent years.<sup>[20]</sup>



**Figure 1. China's Silver Economy Market Size (trillion RMB)**

*Source:* Compiled from Frost & Sullivan, \*2024 China Silver Economy Development Report\*.

### 3.1.3 Regional Differences and Industrial Features: The Digital Divide

Regional development is pretty unbalanced. You see a clear pattern: the east leads, while the central and western regions lag behind.

Take the eastern coastal developed areas—the Yangtze River Delta, Beijing-Tianjin-Hebei, the Pearl River Delta. They have higher economic development, better infrastructure, and they started aging earlier. So they're ahead in terms of market size, industry agglomeration, and service innovation. They're also way ahead in digital-intelligent infrastructure, smart elderly care platforms, and where all those silver economy tech firms are concentrated.

Now look at the central, western, and rural areas. They're not just struggling with affordability and service access. There's also a deeper digital divide—things like network coverage, how many people have smart devices, and whether digital services are actually age-friendly. That further holds back service efficiency and keeps demand from being released.

Some numbers to show the gap. By the end of 2020, the aging rate in the Yangtze River Delta was already over 20%. Per capita elderly consumption was 38,000 RMB per year. And that region's silver economy market made up 35% of the national total. In contrast, the western region only had 18%. And rural elderly people? Their spending power is about one-third of urban levels. Plus, rural areas have a much harder time getting convenient services. <sup>[5]</sup> This regional differentiation reflects the concrete manifestation of China's unbalanced economic and social development in addressing aging challenges.

Industrial features show three contradictory unities. The silver economy currently exhibits the three features of dynamic evolution, industrial agglomeration, and market-welfare duality. Its development contains opportunities for shifting from a passive “deficit-filling elderly care” to an active “preventive economy” linking youth accumulation and elderly consumption, giving rise to growth poles such as

smart elderly care and pension finance, but it is also deeply constrained by multiple structural contradictions. Dynamic evolution is hindered by lagging age-friendly standardization (e.g., standards for smart assistive devices and health equipment), which impedes large-scale promotion and effectiveness evaluation of digital-intelligent solutions. Industrial agglomeration spans primary, secondary, and tertiary sectors (e.g., functional food ingredients, smart assistive device manufacturing, pension finance), but the lack of cross-sectoral policy coordination and data-sharing mechanisms, especially barriers to integrating cross-domain digital-intelligent platforms and fully releasing data value, leads to inefficient resource integration and industrial chain disconnection. The market–welfare duality requires balancing long-term low-margin operations with universal needs, but social capital participation is weak due to insufficient institutional design (e.g., risk sharing, data privacy concerns, unclear return mechanisms), restricting effective supply. These features — opportunities coexisting with contradictions — constitute the core tensions of current industrial development.

**Table 2. Industrial Development Features**

<b>Feature Dimension</b>	<b>Concrete Manifestations</b>	<b>Existing Challenges</b>
Dynamic Evolution	Shift from deficit-filling elderly care (care services) to preventive economy (youth accumulation–elderly consumption)	Low standardization of age-friendly products; lagging digital-intelligent standards system
Industrial Agglomeration	Spans three sectors: primary (functional food ingredients), secondary (smart assistive device manufacturing), tertiary (pension finance, cultural tourism and wellness)	Lack of cross-sectoral policy coordination mechanisms; cross-domain data barriers hindering digital-intelligent platform integration
Market–Welfare Duality	Need to balance low-margin corporate operations (e.g., retirement communities take >10 years to return investment) with universal supply (drawing on Japan’s long-term care insurance model)	Weak willingness of social capital to participate

*Source:* Compiled from Xu Jianzhong et al., *China Silver Economy Development Report (2024)*.

### 3.2 Current Status of Pension Finance: Three-Pillar Gaps and Exploration of Digital-Intelligent Applications

#### 3.2.1 Supply Side: Structural Gaps in the Three-Pillar System and Lagging Digital-Intelligent Innovation in Products

##### (1) Structural gaps in the three-pillar pension system

China's three-pillar pension finance system shows significant gaps: as of the end of 2023, the first pillar (basic pension insurance) covered 1.07 billion people, but the replacement rate continued to decline, reaching 42% in 2023; the second pillar covered about 90 million people, only 7.94% of the working-age population; the third pillar (individual pension) faces the dilemma of “hot account opening but cold contributions” — from November 2022 to June 2024, about 50 million accounts were opened, but the coverage is even more limited.<sup>[9]</sup> This imbalance partly stems from the loss of convenience due to poor institutional transfer mechanisms — labor mobility and informal employment increase institutional barriers to transferring across pillars, putting the pension rights of flexible workers at risk.<sup>[10]</sup>

## (2) Lagging digital-intelligent innovation in pension financial products

Right now, China's pension financial products have some pretty serious problems—both in structure and in innovation. The result? They can't really meet people's diverse retirement needs.

Specifically, the product structure is way too homogeneous. Most of it is low-risk asset allocation. Pension assets are heavily concentrated in savings deposits. That shows we haven't really used digital-intelligent technologies enough to develop net-value products or scenario-embedded products that could actually meet diversified, long-term needs.

Here's a telling number. Looking at product supply, savings-type products make up 49.5% of all pension financial products. And within those savings products, bank savings deposits alone account for 91%. So there's a clear mismatch between what's being supplied and what people actually need (Note 3). Net-value products are under-supplied; the market lacks net-value products that meet long-term asset appreciation needs. Robo-advisory products that use AI for personalized asset allocation and dynamic risk management have low penetration in the pension field and lack age-friendly design. Regarding the supply of pension financial products, China's banking system has accumulated a large amount of short-term savings but lacks ways to convert short-term savings into long-term pension assets.<sup>[22]</sup> The development of various innovative pension financial products faces different constraints, as shown in the table below:

**Table 3. Obstacles to the Development of Innovative Pension Financial Products**

Product Type	Representative Product	Main Development Constraints
Target-Date Funds	ChinaAMC Target Date 2045 Three-Year Holding Period FOF	Insufficient investor awareness leads to limited acceptance; annualized redemption rate as high as 35%, indicating unstable long-term holding behavior; lack of effective, easy-to-use digital-intelligent investor education tools.
Commercial Pension	Ping An “Yuxiang Jinsheng” Annuity	Long product duration (usually >20 years) inhibits purchase intention and affects market penetration; insufficient

<b>Insurance</b>	Insurance		exploration of using big data for more precise life-cycle pricing and risk profiling to lower barriers and increase attractiveness.
<b>Reverse Mortgages</b>	Happy Life House Come” Mortgage Pilot	“Happy Reverse	Narrow pilot scope (only 8 cities); no effective solution to core risks such as property disposal; limited integration of blockchain and other trust technologies in property rights verification, valuation, and risk monitoring.
<b>Long-Term Care Insurance</b>	Taikang Covenant” Care Insurance Plan	“Care Long-Term	Very low national coverage (<5%); weak actuarial foundation, lacking long-term, reliable data on risk incidence and care costs.

*Source:* Compiled from public information on Tian Tian Fund Network and insurance company websites as of December 2024.

### 3.2.2 Demand Side: Life-Cycle Behavioral Differentiation and Challenges of Digital-Intelligent Service Adaptation

#### (1) Age-stratified financial needs and digital-intelligent acceptance

The retirement financial needs of different age groups vary quite a bit. Let me break it down.

First, the 30 to 45 age group—the pre-old group. Their main concerns are retirement accumulation planning and balancing education costs with medical expenses. Behavior-wise, they tend to go for regular investments—like systematic investment plans—or buying annuities. And they really rely on digital tools for planning and managing their retirement. Data shows this group has the highest share of individual pension account holders.

Then you've got the 46 to 60 group—the near-old. Their focus shifts to preserving and growing their assets, and filling gaps in health protection. They're actively locking in retirement community rights and stepping up health risk management.

Finally, the 60 and above group—the old group. Their primary needs are cash flow management, paying for medical care, and bequests. In terms of behavior, they lean heavily on savings and family support. Rural elderly in this group spend less than 1,200 RMB a month on average. They also face a serious digital divide. Most online financial services aren't designed with them in mind, so they end up depending a lot on offline channels.

The bottom line? There are big differences across age groups in how willing and able they are to use digital-intelligent pension finance tools and services. So products and services need to be designed with strong layered adaptability—meaning different versions or interfaces for different age groups.

#### (2) Triple contradictions of supply-demand mismatch and the potential of digital-intelligent solutions

So there are three major structural contradictions in pension finance supply and demand. Let me walk you through the first two.

First, maturity mismatch. Take elderly care industries—retirement communities, for example. They

typically need eight to twelve years of long-term investment to see returns. But bank credit? Usually provides funding support for less than five years. That's a pretty big gap. Digital-intelligent platforms could potentially help—they might connect long-term assets like REITs with retirement needs, or create more flexible financing structures. But so far, there aren't any mature models available.

Second, risk mismatch. Chinese elderly people generally avoid risky assets. That's basically a structural mismatch: the financial supply out there is high-risk, but their risk appetite is low. Digital finance could help ease this contradiction by lowering barriers and maybe raising risk appetite a bit. But vulnerable groups are still held back because there just aren't suitable products for them.<sup>[21]</sup> And third, regional mismatch is pretty acute. It shows up as a kind of urban-rural divide—really a dualization. On the one hand, urban areas have relatively concentrated services, but there's this trend toward high-end offerings, which might leave some basic needs unmet. On the other hand, rural and remote areas face double—sometimes even triple—constraints. Service accessibility is low. Elderly people's purchasing power is insufficient. Just to give you a number: rural elderly spend about 6,734 RMB per year on daily living. That's per capita. And that's only about a third of urban levels. So you can see the gap,<sup>[25]</sup> and weak digital-intelligent infrastructure, further aggravating access difficulties.

#### **4. Core Mechanisms of Digital-Intelligent Empowerment in Pension Finance: Technology, Scenario, and Policy Synergy**

Digital-intelligent pension finance is the core pathway to solving the supply-demand contradictions of the silver economy. Its theoretical logic can be unfolded from three dimensions: technological empowerment, scenario integration, and policy synergy, corresponding respectively to financial deepening theory, active aging theory, and synergy theory. Together they form a closed-loop framework of “tools – scenarios – institutions.”

##### *4.1 Technological Empowerment: Financial Deepening Theory Driving Cost Reduction and Efficiency Gains*

Based on financial deepening theory (Shaw and McKinnon), digital technology reshapes the efficiency of pension finance markets by reducing transaction costs and alleviating information asymmetry.<sup>[7] [8]</sup>

The mechanisms are as follows:

##### **4.1.1 Big Data Drives Precision Services: Reconstructing Pension Finance Demand Identification and Response Mechanisms**

Big data is really changing how pension finance works. The core value? It makes services much more precise and adaptable. You can see this in two main ways.

First, demand profiling gets an upgrade. Traditionally, you'd just use static labels like age and income. That's pretty limited. Now, with big data, you can pull in all kinds of information from different sources—health data from wearable devices, spending habits from mobile payments, even social preferences from online interactions. You put all that together, and you get a dynamic, holistic picture of each elderly person. That lets you really understand their individual financial needs.

Second, life-cycle pricing breaks new ground. Using big-data actuarial models, you can set up differentiated, forward-looking pricing and asset allocation strategies. For example, for young people aged 30 to 45, you might put a high percentage in stocks—say 80%—in their target-date funds. For the near-old group, 46 to 60, you design a gradual risk reduction, like cutting stock exposure by about 5% each year. And for those 60 and above, you customize solutions around cash flow management. That's the idea. <sup>[15]</sup>

#### 4.1.2 Artificial Intelligence Enhances Service Efficiency

AI significantly improves the efficiency of pension finance services, mainly through automation for cost reduction and intelligent asset allocation optimization. In **automated processes**, smart customer service and robotic process automation (RPA) effectively replace manual review steps, greatly reducing service costs — for example, Bank of China's practice shows that AI application has significantly reduced the per-transaction cost of its pension business (Note 6). In **asset allocation optimization**, AI-driven robo-advisors can dynamically adjust the equity/fixed-income ratio based on the user's life-cycle stage, as seen in the application of U.S. life-cycle funds in 401(k) plans. Relevant data show that such strategies have achieved stable annual returns over the past five years, with lower return volatility compared to traditional portfolios, effectively improving the risk-adjusted returns of long-term pension fund management (Note 8).

#### 4.1.3 Blockchain Builds Trust Mechanisms

Blockchain technology is also playing a role. With its distributed ledger, immutability, and transparent traceability, it builds a whole new trust mechanism for pension finance. You mainly see this in two areas: penetrating supervision and better risk prevention and control.

Take pension fund management first. Blockchain makes full-process penetrating supervision possible. All the data—contributions, investment operations, benefit payments—gets stored on the chain. That really improves transparency and security around how funds move.

Then look at long-term care insurance. Blockchain is being used effectively to fight fraud. How? Blockchain platforms cross-check care service data from different sources. That lets them accurately spot fake service work orders. This shows blockchain's key value: fixing institutional loopholes and strengthening risk control. <sup>[17]</sup>

### 4.2 Scenario Integration: Active Aging Theory Expanding Participation Dimensions

WHO's active aging theory emphasizes the trinity of "health, participation, and security." Digital-intelligent pension finance, through scenario integration, enables the elderly to shift from passive recipients to active participants:

#### 4.2.1 Health Management and Financial Payment Closed Loop

Digital-intelligent pension finance also builds a closed-loop system that ties health management and financial payments together. That loop really improves service efficiency, accuracy, and the incentives behind it. And it gives strong support to the "health" and "security" sides of active aging.

The value of this closed loop shows up first in cross-scenario service integration. A good example is China Construction Bank's "Anxin Elderly Care" platform. It seamlessly connects health service scenarios—like medical appointments, hospital deposit payments, and rehabilitation care settlement—with financial payment functions. So you get one integrated process: from identifying a health need, to getting the service, to paying the bill. That shortens the service response chain and makes things a lot more convenient for elderly users (Note 2). Second, this closed-loop system also brings something new to risk management and precise pricing. Because blockchain is immutable and traceable, you can cross-check care service data from different institutions. That does two things. One, it greatly improves settlement efficiency. But more importantly, it helps spot and cut down on fraud—things like fake service work orders. So it gives you technical support for more refined management and risk control, all based on real health service data.

What these practices show is that integrating health management with financial payment isn't just a nice idea. It's systematically improving how accessible and sustainable elderly health services are. It does that by optimizing service processes and strengthening risk control.

#### 4.2.2 Social Participation Empowers Economic Autonomy

Digital-intelligent pension finance also helps older people feel more economically independent and more involved in society. It does this by lowering barriers to entry and activating social mutual aid mechanisms.

On one side, you've got age-friendly digital financial tools. These really cut down on the operational hurdles elderly people face. Take ICBC's mobile banking "senior version." It has features like voice navigation. The result? Transaction volume among users over 70 went up significantly, and error rates dropped a lot (Note 7). On the other hand, there are these innovative "time bank" models. They use blockchain to build social participation and economic value exchange mechanisms based on intergenerational mutual aid.

Take Sichuan's blockchain-based "mutual aid elderly care platform" as an example. It quantifies and records volunteer service hours. And it has attracted over 400,000 young participants. So not only does it activate social mutual aid networks, but it also gives elderly people a non-monetary pathway to secure future care services (Note 9). This technology-empowered participation model fundamentally promotes a shift from passive acceptance of services to active participation and control over economic life for the elderly.

### 5. Policy Synergy: Haken's Synergetics Optimizing the Institutional Ecology

Haken's synergetics reveals that subsystems in a complex system can produce synergistic effects ( $1+1>2$ ) through orderly interaction.<sup>[6]</sup> Second, you push for cross-departmental data sharing and interoperability. That means breaking down information silos and removing barriers to data flow, which lays the groundwork for precision services.

Third, you design incentive-compatible rule systems—things like tax preferences and special subsidies. These clarify who gets what rights, who bears what responsibilities, and how benefits are distributed, which motivates market participants to get involved.

Put these three together, and you get a multi-dimensional collaborative network that works across technology, business, and different actors. That's what drives the system toward something more efficient, more inclusive, and more sustainable. International experience and domestic practice confirm the effectiveness of policy synergy. Internationally, the **\*\*institution–technology dual-drive model\*\*** has achieved remarkable results: the U.S. “401(k) plan” combined with robo-advisory technology has significantly increased the digitization rate of pension accounts and reduced mismatch losses (Note 10); the UK’s “regulatory sandbox” empowers pension technology by allowing firms to test innovative solutions (e.g., AI pension advisors, blockchain pension records) in a controlled environment, effectively shortening the time-to-market for innovative products.<sup>[4]</sup> Domestically, policy synergy has achieved key breakthroughs: Zhejiang Province, through provincial-level policy coordination, built the “Zheliyang” one-stop smart elderly care service platform, whose core synergy lies in cross-departmental data sharing and business integration (Note 5); Shanghai’s “Government Online-Offline Shanghai” platform integrates data from health, civil affairs, finance, and other departments, reducing the process for elderly allowance applications from “five visits” to “zero materials, instant approval,” (Note 4) greatly improving service efficiency and accuracy. These cases confirm the core effectiveness of policy as an “order parameter” in reducing institutional costs, breaking data barriers, and setting incentive rules, providing institutional guarantees for systemic synergy.

## **6. Pathways for Digital-Intelligent Pension Finance to Empower the Silver Economy**

### *6.1 Research Conclusions*

After going through the theory and the case analysis, this study shows pretty clearly how digital finance and pension finance can work together to empower the silver economy. Here are the main takeaways.

First, synergistic development is the key to solving the structural contradictions in the silver economy. Back in 2023, China's silver economy was already 8.6 trillion RMB. But it's facing three big imbalances: regional gaps, mismatches between supply and demand, and structural holes in the three-pillar system. What this study finds is that when digital finance and pension finance work together—through technology, scenario integration, and policy coordination—they can systematically improve how resources are allocated.

Second, there's a three-dimensional model that forms the core driving framework: technological empowerment, scenario integration, and policy synergy.

Let me break that down. Technological empowerment makes things more efficient and precise. For example, blockchain smooths out pension processes, and AI cuts service costs a lot while making things more adaptable.

Scenario integration expands how people can participate. Platforms that tie health management to financial payments create service closed loops, and that boosts how active elderly users are.

Policy synergy improves the whole institutional environment. Things like regulatory sandboxes help break down data and institutional barriers, giving synergistic development the safeguards it needs.

Put it all together, and you get a closed-loop empowerment system—tools, scenarios, and institutions all feeding into each other. Third, **practice still faces significant bottlenecks**. Although financial institutions have begun exploring digital transformation, problems such as lagging product innovation, insufficient ecosystem collaboration, and lack of age-friendly design constrain the effectiveness of synergy and urgently need to be addressed. The development of digital-intelligent pension finance is essentially about using technological innovation to restructure life-cycle resource allocation, using policy innovation to break down institutional barriers, and using ecosystem integration to unlock the potential of the silver economy. Only through a full-chain breakthrough of “technological innovation – institutional adaptation – ecosystem collaboration – international coordination” can we achieve the historic leap from a “survival-oriented” elderly care model to a “development-oriented” silver economy, providing a Chinese solution for global aging governance.

## *6.2 Pathways for Digital-Intelligent Pension Finance to Empower the Silver Economy*

### *6.2.1 Strengthen Age-Friendly Technological Innovation to Bridge the Digital Divide*

We need to accelerate the development of digital tools suitable for the elderly, focusing on voice-interactive wealth management applications and blockchain pension certification systems to reduce operational complexity. At the same time, build a multi-level digital literacy training system. It is recommended to set up a special “Silver Digital Education Fund” and cooperate with communities to conduct dialect-based smart device operation training, aiming to increase the mobile payment usage rate among rural elderly to 40% within three years, effectively breaking down digital access barriers.

### *6.2.2 Improve Institutional Incentives and Risk Control, and Optimize the Three-pillar Structure*

We need to make the third pillar more attractive. That means speeding up the rollout of EET tax preferences for individual pensions. Also, give some fiscal subsidy incentives to people under 30 who contribute.

At the same time, we should set up a digital standard framework. Issue policies that clarify the boundaries for data sharing and privacy protection—covering health data, civil affairs data, and financial data. Use institutional design to strike a balance between innovation efficiency and risk prevention.

### *6.2.3 Build Cross-sectoral Ecosystem Alliances to Promote Balanced Regional Development*

Push for a multi-dimensional collaborative pension finance ecosystem that brings together banks, insurers, and tech companies. Replicate mature models like “insurance + retirement community” and “payment + health management.”

To deal with regional imbalances, here's a suggestion: set up “Silver Economy Innovation Pilot Zones” in the Yangtze River Delta and the Pearl River Delta. Explore financing mechanisms like REITs to

revitalize existing assets. And use policy tilts to guide social capital toward the central and western regions, which would help ease resource shortages in less developed areas.

#### 6.2.4 Deepen the Localization of International Experience and Participate in Global Governance Cooperation

Systematically bring in mature international products, but adapt them to local conditions. Focus on improving how reverse mortgages handle property disposal. Pilot "housing-for-pension" insurance schemes that actually fit China's situation.

At the same time, get more involved in cross-border rule-making. Push for mutual recognition of pension cross-border settlement standards in the Guangdong-Hong Kong-Macao Greater Bay Area. And use multilateral platforms like the OECD to share China's experience with digital governance. That would help boost our international voice.

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## Notes

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