



# Analysis of the Co-operation Mechanism of ‘Property + Elderly Care’ in the Community Home in Heilongjiang Province Under the Background of New Quality Productivity

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**Abstract.** This study constructs a coupling model of government-property-elderly care organisations based on the theory of collaborative governance and the theory of resource dependence in the context of new quality productivity. The results of the study show that property enterprises rely on the integration of community resources to complement the professional services of senior care institutions, and government policy guidance can significantly improve the efficiency of synergy, in which reasonable resource elasticity coefficients, policy incentive strengths, and resource depreciation rates and other parameters have an important impact on the effectiveness of cooperation and system stability. From the perspective of mathematical model, this paper provides a model basis for the policy formulation of ‘property + elderly care’ cooperation mechanism, which is of great reference value for promoting the innovation of elderly care service and the modernisation of community governance.

**Keywords:** new quality productivity, property, elderly care, co-operation mechanisms

## 1 Introduction

In the context of the new quality of productivity, the importance of the community home ‘property + old age’ cooperation model has become increasingly prominent[1]. The ‘14th Five-Year Plan for the Development of the National Aging Career and Pension Service System’ proposes a new model of ‘property + pension’, which not only meets the real needs of China's aging society, but is also an important way to promote the innovation of pension services and enhance the effectiveness of community governance[2]. In recent years, China has accelerated into a deeply aging society, especially in Heilongjiang Province, where the proportion of people aged 65 and above in the total population is 18.8%, far exceeding the national average, and the traditional family model of elderly care is unsustainable due to the trend of paedophilia, and institutional elderly care is faced with a large shortage of beds and high cost challenges. At

this time, the community home ‘property + elderly’ cooperation model has become an innovative path to crack the aging dilemma.

In recent years, many scholars have carried out in-depth research on this topic, providing a rich theoretical basis and practical guidance for the construction and optimisation of this cooperative mechanism. As a region with more prominent aging problems, Heilongjiang Province, the traditional family pension and institutional pension model has been difficult to meet the growing demand for pension[3]. In this context, the community home care with its unique advantages gradually emerged, and the ‘property + old age’ mode of cooperation is the property services and old age services are closely integrated to provide more convenient and comprehensive services for the elderly[4]. At the same time, the successful construction of the ‘Property + Elderly’ cooperation mechanism requires the participation and co-operation of the government, the community, the property sector and the elderly[5]. The government should play a leading role in formulating relevant policies and plans to provide legal and policy protection for the co-operation mechanism; the community should make full use of its own resources to build a service platform to promote the in-depth integration of property and elderly services; and property enterprises should actively transform and upgrade to expand the field of elderly services and improve the quality of services[6]. It can be seen that scholars mainly focus on the theoretical study of ‘property + pension’ cooperation mode, and this paper mainly reveals the ‘property + pension’ synergy mechanism from the perspective of mathematical model construction, which provides a model basis for policy formulation.

## 2 Theoretical Foundation

### 2.1 Collaborative Governance Theory

Collaborative governance theory is an emerging theoretical framework highly respected in the field of social sciences in recent years, which integrates the core ideas of collaborative learning and governance theory, and emphasises that the collaborative role of multiple subjects is crucial in the handling of complex social and public affairs[7]. After scholars continue to deepen their research, it is pointed out that when dealing with social issues such as urban elderly services, the government, property companies and elderly care organisations should form a close cooperation network. This governance model transcends the limitations of the traditional government's single subject governance and advocates the joint participation of multiple subjects such as the government, the market and the society, so as to achieve the maximisation of public interests through resource sharing, information sharing and concerted action[8]. In the process of building a tripartite synergistic equation of government-property-elderly organisations, all parties need to clarify their respective roles and responsibilities, and give full play to their respective strengths to form a complementary effect.

## 2.2 Resource Dependence Theory

Resource dependence theory emphasises that in order to survive and develop, organisations must obtain the required resources from the surrounding environment[9]. In quantifying the resource complementarity between property and elderly care organisations, resource dependency theory provides an important analytical perspective. According to this theory, property companies and elderly care organisations each possess unique resources, such as property companies holding hardware resources such as sites and facilities in the community, while elderly care organisations possess software resources such as professional elderly care staff and management experience[10]. Through the analysis of resource dependence theory, it can be clearly seen that there exists the possibility of resource complementarity between property and elderly care institutions. In order to achieve optimal allocation of resources, both parties can share resources, reduce costs and improve service quality through cooperation or alliance.

## 3 Model Construction

### 3.1 Synergy Benefit Function Model Derivation

The standard Cobb-Douglas production function takes the form as:

$$Y = A \cdot L^\alpha \cdot K^\beta \quad (1)$$

Where  $L$  and  $K$  represent labour and capital inputs respectively, and  $\alpha$  and  $\beta$  are output elasticity coefficients. In this model, the property resource  $R_m$  and old-age demand resources  $R_e$  are considered as two key input factors, and a similar product form is used  $R_m^\rho R_e^{1-\rho}$  to describe the synergistic relationship between them. Here,  $\rho$  is the resource elasticity coefficient, which takes a value between 0 and 1, reflecting the relative contribution weight of the property resources in the synergistic benefits. At the same time, in the actual process of cooperation, a certain amount of management, coordination, communication and other costs are bound to arise, using  $C_c$  expressed. This part of the cost increases with the expansion of the scale of cooperation and the increase of resource inputs, so it needs to be deducted from the benefits generated by resource synergies when calculating synergistic benefits in order to reflect the real economic benefits.

Therefore, a refinement based on the Cobb-Douglas production function is used to measure the combined benefits arising from the synergy between property resources and pension demand resources, defining the synergy benefit function as:

$$\Pi(t) = \alpha(R_m^\rho R_e^{1-\rho}) - C_c + \beta \frac{d(R_m R_e)}{dt} \quad (2)$$

Where the last term  $\beta \frac{d(R_m R_e)}{dt}$  reflects the dynamic nature of resource synergies.

Here  $\beta$  is a constant coefficient representing the intensity of resource synergies, while  $\frac{d(R_m R_e)}{dt}$  then represents the rate of change of the resource product over time. This term was introduced to capture the additional benefit growth from the rational allocation and synergistic use of resources, highlighting the importance of dynamically adjusting and optimising the allocation of resources to enhance synergistic benefits. The variables are defined as follows Table 1 :

**Table 1.** Variable Definition

Variable	Meaning
$R_m(t)$	Inventory of Property Resources at Time t
$R_e(t)$	Resource Needs for Elderly at Time t
$\alpha$	Resource Complementarity Factor
$\beta$	Benefit-sharing Factor
$C_c$	Cost of Collaboration

### 3.2 Resource Dynamics Evolution Equations

#### 3.2.1 Property Resource Growth

According to Equation (2), the dynamics of property resources over time is shown in Equation (3) after considering the effects of endogenous growth, policy incentives and resource depletion:

$$\frac{dR_m}{dt} = \underbrace{k_m R_m \left( 1 - \frac{R_m}{K_m} \right)}_{\text{endogenous growth}} + \underbrace{\gamma \theta R_e}_{\text{policy incentives}} - \underbrace{\eta R_m R_e}_{\text{resource depletion}} \tag{3}$$

Where  $k_m$  is the endogenous growth rate of property resources, reflecting the natural growth capacity of property firms in the absence of external disturbances and resource constraints. The growth rate of property resources first rises and then falls with the increase in the amount of resources, when the resources approach the environmental carrying capacity  $k_m$  when the resource approaches the environmental carrying capacity  $k_m$ , the growth rate tends to zero. Where  $\gamma$  reflects the strength of the policy incentives and  $\theta$  denotes the extent to which pension demand resources respond to the policy incentives. As the old-age demand resource  $R_e$  increases, the promotion effect of policy incentives on the growth of property resources will also increase accordingly, reflecting the interactive relationship between policy and market demand. Where  $\eta$  is the rate of

depreciation of resources after they have been invested in aged care services, this depletion is unavoidable and needs to be deducted from the resource growth equation to accurately reflect the net change in property resources.

**3.2.2 Evolution of the Demand for Old Age**

The process of the evolution of the demand for old age over time, taking into account the effects of saturation growth and satisfaction, consists of the following two main components, as described in equation (4):

$$\frac{dR_e}{dt} = \underbrace{\frac{k_e R_e^2}{K_e + R_e}}_{\text{saturation growth}} + \underbrace{\delta \lambda R_m}_{\text{satisfaction}} \tag{4}$$

Where  $k_e$  and  $K_e$  are parameters related to the growth of old-age demand. There is a certain upper limit to the growth of old-age demand, when the old-age demand resource  $R_e$  is large, the growth rate will gradually slow down, and eventually tend to saturation. Where  $\delta$  reflects the sensitivity of residents' satisfaction with property services, and  $\lambda$  indicates the driving strength of property resources on the growth of senior care demand. When the property enterprise increases the resources such as facility investment and staffing for senior care services and the quality of service is high, residents' satisfaction with the existing senior care services increases.

**3.3 Equilibrium Condition Solving**

In order to find the level of resource allocation of the system in the long-term steady state, it is necessary to solve for the equilibrium point, i.e., to make  $\frac{dR_m}{dt} = 0$ ,

$\frac{dR_e}{dt} = 0$ , the following system of equations is obtained by association as equation (5):

$$\begin{cases} k_m R_m^* \left( 1 - \frac{R_m^*}{K_m} \right) + \gamma \theta R_e^* - \eta R_m^* R_e^* = 0 \\ \frac{k_e (R_e^*)^2}{K_e + R_e^*} + \delta \lambda R_m^* = 0 \end{cases} \tag{5}$$

Solving this system of non-linear equations is more complicated, so the Taylor expansion is used to linearise the non-linear terms and approximate the equilibrium solution to obtain equation (6):

$$\begin{aligned}
 R_m^* &\approx \frac{\gamma\theta K_m}{k_m + \eta K_e} \\
 R_e^* &\approx \frac{\delta\lambda K_e}{k_e}
 \end{aligned}
 \tag{6}$$

### 3.4 Proof of Stability

In order to ensure that the constructed model converges to an equilibrium state during dynamic changes, the stability of the system needs to be analysed. Constructing the Jacobi matrix and calculating its eigenvalues is a common method for analysing the stability of the system. The Jacobi matrix  $J$  is of the form as equation (7):

$$J = \begin{bmatrix} k_m \left( 1 - \frac{2R_m^*}{K_m} \right) - \eta R_e^* & \gamma\theta - \eta R_m^* \\ \delta\lambda & \frac{k_e R_e^* (2K_e + R_e^*)}{(K_e + R_e^*)^2} \end{bmatrix}
 \tag{7}$$

Where the elements of the matrix are, respectively, the resource dynamic evolution equations for  $R_m$  and  $R_e$  of the partial derivatives at the equilibrium point. The trace

$tr(J) = J_{11} + J_{22}$  reflecting the overall trend of the system, the determinant  $det(J) = J_{11}J_{22} - J_{12}J_{21}$ , then it reflects the local stability of the system near the equilibrium point. When  $tr(J) < 0$  and  $det(J) > 0$  are satisfied, it means that the eigenvalue of the system has a negative real part, which ensures that the system can automatically return to the equilibrium state after small perturbations.

## 4 Conclusions

This paper analyses the dynamic evolution, equilibrium allocation and stability of resources by constructing a mathematical model of the cooperation mechanism of ‘property + elderly care’ in Heilongjiang Province. The results show that reasonable resource elasticity coefficients, policy incentive strengths, resource discount rates and other parameters have an important impact on the effectiveness of the cooperation and the stability of the system. In practical application, resource allocation should be optimised and policy support should be strengthened.

### 4.1 Optimising Resource Allocation

The resource elasticity coefficient  $\rho$  in the model shows the relative contribution of property resources and resources of elderly care demand in the synergistic benefits.

Communities in Heilongjiang Province should rationally allocate resources based on their own resource status and elderly care needs. Communities with abundant resources and high service level can moderately increase the input of property resources to improve service quality; communities with tight resources need to optimise the efficiency of resource utilisation to ensure that limited resources are used to maximum benefit.

#### **4.2 Strengthening Policy Support**

The intensity of policy incentives  $\gamma\theta$  has a significant role in promoting the growth of property resources. Government departments in Heilongjiang Province should improve incentive policies, such as providing financial subsidies, tax breaks, project support, etc., to reduce the operating costs and risks of property enterprises participating in the senior care service industry and enhance their motivation. At the same time, the policy should take into account the regional differences and the development of enterprises, for resource constraints or service level to be improved in the community to promote the balanced development of community care model.

#### **4.3 Improve the Enthusiasm and Efficiency of Property Enterprises' Participation**

Resource depreciation rate  $\eta$  Affects the efficiency of cooperation and system stability. Property enterprises should strengthen resource management, introduce advanced technology and equipment to improve resource utilisation efficiency and reduce wastage. At the same time, they should strengthen staff training and improve service quality and professionalism to meet the elderly needs of community residents and enhance their satisfaction and trust. In addition, co-operation and exchanges can be carried out among enterprises to share successful experiences and management models, and jointly promote the development of care services.

#### **4.4 Establishment of a Dynamic Monitoring and Evaluation Mechanism**

In order to ensure the effective operation of the cooperation mechanism, communities in Heilongjiang Province should establish a dynamic monitoring and evaluation system to regularly collect and analyse data on property resource inputs, changes in elderly care demand, and service satisfaction, compare the model's predicted effects, and identify deviations and adjust strategies in a timely manner. Through scientific assessment, continue to optimise the cooperation model, improve service quality and management level.

#### **4.5 Promoting Intelligent and Informative Construction**

In the context of new quality productivity, intelligence and information technology is an important means to enhance the level of community home care. Communities in Heilongjiang Province should actively introduce intelligent elderly care equipment and

technology, such as intelligent home systems, telemedicine equipment, health monitoring equipment, etc., to improve service efficiency and quality. A community elderly care information platform should be established to integrate information on property resources, elderly care needs, and service projects, so as to achieve accurate matching and efficient management.

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