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Abstract

Informal family care presents important difficulties for the entire economy. Because of short supplies of formal elderly care, some family members are compelled to leave work to provide care for elderly relatives. Therefore, the overall loss of added value caused by informal family care is not negligible. After developing a model to assess how households determine allocation of formal and informal elderly care, we analyze subsidy effects for elderly care in the economy. Results show that subsidies for formal care that is bought by people of the younger generation are more effective for decreasing losses attributable to informal elderly care.

Keywords: Formal Care, Informal Care, Subsidy for Elderly Care, Unemployed Family Caregiver

JEL classifications: J14 O17

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1 Introduction

In some economically developed countries, an aging society with fewer children is progressing. Elderly care has come to be an important difficulty. Because of elderly care, some working people are compelled to quit their jobs. If elderly care provided by the market is obtainable, then working people need not stop working. The aim of the analyses described herein is development of a model in which family members determine how to provide formal and informal elderly care and analysis of elderly care subsidy. Furthermore, some policy implications might be derived to mitigate the difficulties.

Although it is true to varying degrees, trends of increase in the elderly population, defined as people aged 65 years and older, have been observed. Ratios of the elderly population to the working age (15–64 years) population have also increased in some OECD countries. The difficulty of determining who is responsible for elderly care is an important issue confronted by many countries today.

Elderly care is usually provided in two ways: formal elderly care is supplied by market services; informal elderly care is supplied by family members. However, dependence on elderly care by family members raises an important concern. If the family breadwinner must care for elderly parents, then that worker might be unable to earn wage income and might therefore fall into poverty. By virtue of elderly care services provided in the market, the poverty of working generations can be solved because the working generation can continue working even if the parents need elderly care.

The United States has experienced a sharp increase in the elderly population as baby boomers, people born during 1946–1964, have become older. If the supply of elderly care does not keep up with demand, then elderly care can be expected to depend greatly on contributions by family members. Chari et al. (2015) estimate that the opportunity costs of informal elderly care in the US are about 522 billion dollars annually. Not only the US, but also Japan, faces difficulties related to aging. The Ministry of Internal Affairs and Communications in Japan reports that about a hundred thousand people are compelled to stop working to provide informal elderly care every year. The total loss of value added from work stoppage for elderly care is estimated as about 650 billion yen (6 billion dollars). Traditionally in Japan, it is women who must quit their jobs and become homemakers after marrying. Recently, however, many female workers continue working even after

getting married. Therefore, the loss of future value from informal care is expected to be greater than the value estimated by the ministry. These severe difficulties must be resolved to mitigate their economic effects.

Several papers have described relevant studies for this topic. Lundholm and Ohlsson (1998) consider the relation between female labor and quantity of formal care services. They show that an increase in formal care raises the female labor supply but reduces their wages. Tabata (2005) analyzes aging effects on economic growth in a model including only formal care services. The model includes assumptions that formal care is bought by elder people for their own use and that formal care is bought by children for their parents. He concludes that aging negatively affects economic growth because of high elderly care costs. In contrast to Tabata (2005), Mizushima (2009) sets a model with informal elderly care. The aging society engenders a longer informal care time. Pestieau and Sato (2008) and Miyazawa (2010) consider the effects of elderly care on the economy in which formal and informal elderly cares are perfect substitutes. They find that elderly care should be provided by formal care rather than by informal care. This setting is consistent with those used for empirical studies, as described by Horioka et al. (2018). In addition, Canta et al. (2016) consider the effects of elderly care on capital accumulation and economic growth, reporting that public elderly care insurance can foster capital accumulation and can therefore positively affect economic growth. Kydland and Pretnar (2019) set an overlapping generations model with two types of care and estimate future welfare costs. Yakita (2020) provides a model that accounts for a situation in which informal family care is replaced by formal care as the economy develops. All the related papers described above rely on the assumption that elderly care is produced by, at most, two inputs.

In the real economy, elderly care comprises three components: formal care bought by elderly people for their own use, by adult children for their parents, and informal care provided by adult children. Fig. 1 presents shares of informal elderly care and formal elderly care.

[Insert Fig. 1 around here.]

As shown in Fig. 1, care of these two types might not be substitutes. Different from the early studies, we develop a model with these three types of inputs. We analyze formal care subsidy effects on the economy, and find that, to maintain the labor supply, the

government should provide subsidies for formal care purchased by adult children rather than by elderly parents for their own use. Our model with three inputs for elderly care obtains these interesting results.

The remainder of this paper consists of the following. Section 2 establishes the elderly care model. Section 3 presents an examination of the dynamics and steady states of the economy. Section 4 explains an analysis of subsidy effects on the economy. The final section concludes the paper.

2 Model

In this model, individuals in the household live in young and old periods. The number of households is assumed to be unity. There is no population growth. Younger individuals care for consumption of their own and the level of elderly care for their parents during the young period and the level of elderly care in their old period. The problem each household must solve is

$$\max_{c_t, l_t, e_t^y, e_{t+1}^o} \quad u_t = \alpha \ln c_t + \beta \ln E_t + (1-\alpha-\beta) \ln E_{t+1}, \tag{1}$$

$$s.t.\ E_t = B_t (e_t^o + e_t^y)^\eta l_t^{1-\eta}, \tag{2}$$

$$(1-l_t) w_t = c_t + e_t^y + \frac{e_{t+1}^o}{1+r_{t+1}}. \tag{3}$$

Eq. (1) is the utility function, where c_t stands for consumption and E_t represents the level of elderly care. It is assumed that elderly care service is not durable and that it consists of three inputs: final goods bought by the older individual e_t^o, those bought by their children e_t^y, and the elderly care time provided by their children l_t, as in eq. (2). Here, B_t is the productivity parameter of elderly care; η is a constant.[1] Thereafter, for the discussion presented in this paper, we define the final goods purchased by individuals as formal care and define elderly care time as informal care. Equation (3) is the lifetime budget constraint. Each young individual has a unit time, but divides the time into two activities: working for the final goods sector and informal family care. Therefore, the young individual earns $(1-l_t)w_t$ and allocates income among consumption, care goods for his parents, and savings for the older period, where w_t denotes the wage rate and r_t expresses the interest rate.

[1] Kydland and Pretnar (2019) set the home production function with goods and the informal elderly care time. The function form is defined as Cobb–Douglas type, which is similar with our setting.

From the maximization problem presented above, we can obtain the following optimal allocations:

$$c_t = \frac{\alpha}{\alpha+\beta+(1-\alpha-\beta)\eta}\left(w_t + e_t^o + \frac{e_{t+1}^y}{1+r_{t+1}}\right), \tag{4}$$

$$l_t = \frac{\beta(1-\eta)}{\alpha+\beta+(1-\alpha-\beta)\eta}\frac{w_t + e_t^o + \frac{e_{t+1}^y}{1+r_{t+1}}}{w_t}, \tag{5}$$

$$e_t^y = \frac{\beta\eta}{\alpha+\beta+(1-\alpha-\beta)\eta}\left(w_t + \frac{e_{t+1}^y}{1+r_{t+1}}\right) - \frac{\alpha+\beta+(1-\alpha-2\beta)\eta}{\alpha+\beta+(1-\alpha-\beta)\eta}e_t^o, \tag{6}$$

$$e_{t+1}^o = \frac{(1-\alpha-\beta)\eta(1+r_{t+1})}{\alpha+\beta+(1-\alpha-\beta)\eta}(w_t + e_t^o) - \frac{\alpha+\beta}{\alpha+\beta+(1-\alpha-\beta)\eta}e_{t+1}^y. \tag{7}$$

The final goods sector has Cobb–Douglas technology as

$$Y_t = K_t^\theta (A_t L_t)^{1-\theta},$$

where Y_t represents the production of final goods, which are used for both consumption and elderly care, K_t denotes the capital stock, and $L_t \equiv (1-l_t)$ signifies the labor supply. Under the competitive economy, we obtain each factor price as

$$1 + r_t = \theta K_t^{\theta-1}(A_t L_t)^{1-\theta},$$
$$w_t = (1-\theta)K_t^\theta A_t (A_t L_t)^{-\theta}.$$

Following Brauninger (2005), A_t is assumed to be proportional to the capital–labor ratio, $k_t \equiv \frac{K_t}{L_t}$, which is $A_t = a^{\frac{1}{1-\theta}}k_t$. Then, the production function becomes

$$Y_t = aK_t. \tag{8}$$

Under the production function (8), one can obtain the following rate of interest and the wage rate as

$$1 + r_t = a\theta, \tag{9}$$

$$w_t = (1-\theta)ak_t. \tag{10}$$

3 Dynamics and Steady States

Having developed the model, we turn to consideration of the dynamics of the economy. From eqs. (5)–(7), we obtain the following relation:

$$\frac{l_{t+1}w_{t+1}}{1+r_{t+1}} = \frac{1-\alpha-\beta}{\beta}l_t w_t.$$

The equation above is the Euler equation of the opportunity cost of informal care. Substituting (9) and (10) into the equation above, one can obtain the following dynamic equation as

$$l_{t+1}k_{t+1} = \frac{a\theta(1-\alpha-\beta)}{\beta} l_t k_t. \tag{11}$$

The dynamics of the capital–labor ratio is

$$(1-l_{t+1})k_{t+1} = (1-l_t)w_t - c_t - e_t^y.$$

Substituting (4), (9), and (10) into the equation above and using (11) yields

$$k_{t+1} = (1-\theta)ak_t + \frac{(\theta-\beta)(1-\eta) - \alpha(1-\eta\theta)}{\beta(1-\eta)} a l_t k_t - e_t^y. \tag{12}$$

We obtain the dynamics of purchase of care goods by children from (5), (6), (9), and (10) as

$$e_{t+1}^y = a\theta e_t^y + \left[\frac{\alpha+\beta+(1-\alpha-2\beta)\eta}{\beta(1-\eta)} l_t - 1\right](1-\theta)\theta a^2 k_t. \tag{13}$$

The economy is characterized by equations (11), (12), and (13). For the following analyses, we express the economy with two variables, $(l_t,\ \frac{e_t^y}{k_t})$ as

$$\frac{e_{t+1}^y}{k_{t+1}} = \frac{\{[\alpha+\beta+(1-\alpha-2\beta)\eta]l_t - \beta(1-\eta)\}(1-\theta)\theta a^2 + \beta(1-\eta)a\theta\frac{e_t^y}{k_t}}{\beta(1-\eta)(1-\theta)a + [(\theta-\beta)(1-\eta) - \alpha(1-\eta\theta)]al_t - \beta(1-\eta)\frac{e_t^y}{k_t}},$$
$$l_{t+1} = \frac{(1-\eta)(1-\alpha-\beta)\theta a l_t}{\beta(1-\eta)(1-\theta)a + [(\theta-\beta)(1-\eta) - \alpha(1-\eta\theta)]al_t - \beta(1-\eta)\frac{e_t^y}{k_t}}.$$

Next, we consider the steady state of this economy. We define $\Delta x_t \equiv \frac{e_{t+1}^y}{k_{t+1}} - \frac{e_t^y}{k_t}$ and $\Delta l_t \equiv l_{t+1} - l_t$. Then, we derive the following equations from $\Delta x_t = 0$ and $\Delta l_t = 0$ as

$$l_t = \frac{\beta(1-\eta)[(1-\theta)\theta a^2 + (1-2\theta)ax_t - x_t^2]}{a\{[\alpha+\beta+(1-\alpha-2\beta)\eta](1-\theta)\theta a - [(\theta-\beta)(1-\eta) - \alpha(1-\eta\theta)]x_t\}}, \tag{14}$$
$$l_t = \frac{\beta(1-\eta)}{[(\theta-\beta)(1-\eta) - \alpha(1-\eta\theta)]a}\left[\frac{a\theta(1-\alpha-\beta)}{\beta} - (1-\theta)a + x_t\right]. \tag{15}$$

From (14) and (15), we obtain the steady state equilibrium of this economy.

[Insert Fig. 2 around here.]

As shown in Fig. 2, we can obtain the unique stable steady state equilibrium. The steady state values of x_t and l_t are

$$x_t^* = \frac{(1-\theta)[(\beta-\theta)\eta - \alpha\theta(1-\eta)]a}{\alpha(1-\eta\theta) - (1-\eta)\theta + \beta(1+\theta-2\eta\theta)},$$
$$l_t^* = \frac{(1-\eta)[\beta - (1-\alpha-\beta)\theta]}{\alpha(1-\eta\theta) - (1-\eta)\theta + \beta(1+\theta-2\eta\theta)}.$$

In the case of Fig. 2, both formal elderly care and informal elderly care are actively provided. Depending on the parametric condition, a steady state exists such that both the levels of formal and informal elderly care are small.

Here, we consider the effects of population aging on the economy. As population aging progresses, the relative preference for the elderly care increases. This increase corresponds to lower α in our model. Lower α increases both formal and informal elderly care in a steady state. This result is very intuitive.

4 Effects of an Elderly Care Subsidy

This section presents examination of how subsidies for elderly care affect the demand for market elderly care services and family care. First, our explanation describes derivation of the effects of a subsidy for elderly care with comparative statics. After applying comparative statics, the subsidy effect is simulated.

4.1 Qualitative analysis

In the subsidy model, the household budget constraint can be changed as shown below

$$(1-l_t)w_t - T_t = c_t + (1-\delta)e_t^y + \frac{(1-\epsilon)e_{t+1}^o}{1+r_{t+1}},$$

where δ, and ϵ denote the subsidy rates for elderly care. It is assumed that the subsidies are financed by the lump-sum taxation T_t.

Then, based on this budget constraint, one can obtain the following equations as the

optimal allocations,

$$
\begin{aligned}
c_t &= \frac{\alpha}{\alpha+\beta+(1-\alpha-\beta)\eta}\left(w_t - T_t + e_t^o + \frac{e_{t+1}^y}{1+r_{t+1}}\right),\\
l_t &= \frac{\beta(1-\eta)}{\alpha+\beta+(1-\alpha-\beta)\eta}\frac{w_t - T_t + e_t^o + \frac{e_{t+1}^y}{1+r_{t+1}}}{w_t},\\
e_t^y &= \frac{\beta\eta}{\alpha+\beta+(1-\alpha-\beta)\eta}\left[w_t - T_t + \frac{(1-\epsilon)e_{t+1}^y}{1+r_{t+1}}\right]\\
&\quad -\frac{\alpha+\beta+(1-\alpha-2\beta)\eta}{\alpha+\beta+(1-\alpha-\beta)\eta}e_t^o,\\
e_{t+1}^o &= \frac{(1-\alpha-\beta)\eta(1+r_{t+1})}{\alpha+\beta+(1-\alpha-\beta)\eta}[w_t - T_t + (1-\delta)e_t^o]\\
&\quad -\frac{\alpha+\beta}{\alpha+\beta+(1-\alpha-\beta)\eta}e_{t+1}^y.
\end{aligned}
$$

Then, the dynamics of k_t change into the following form in the case of a subsidy.

$$l_{t+1}k_{t+1} = \frac{1-\delta}{1-\epsilon}\frac{a\theta(1-\alpha-\beta)}{\beta}l_t k_t,$$

or

$$k_{t+1} = (1-\theta)ak_t + \frac{(\theta-\beta)(1-\eta)-\alpha(1-\eta\theta)}{\beta(1-\eta)}al_t k_t - T_t - (1-\delta)e_t^y.$$

The dynamics of market elderly care service e_t^y become

$$e_{t+1}^y = \frac{1}{1-\epsilon}\left\{(1-\delta)a\theta e_t^y + \left[\frac{\alpha+\beta+(1-\alpha-2\beta)\eta}{\beta(1-\eta)}l_t - 1\right](1-\theta)\theta a^2 k_t + a\theta T_t\right\}.$$

It is assumed that $T_t = \tau w_t = \tau a(1-\theta)k_t$, where $0 < \tau < 1$ denotes the tax rate. Then, the government budget constraint is shown as presented below.

$$\tau a(1-\theta)k_t = \delta e_t^y + \epsilon e_t^o.$$

Moreover, $\Delta x_t = 0$ and $\Delta l_t = 0$ become

$$l_t = \frac{L_1}{L_2}, \tag{16}$$

$$l_t = \frac{\beta(1-\eta)\left[\frac{a\theta(1-\alpha-\beta)(1-\delta)}{\beta(1-\epsilon)} - (1-\theta)a + \tau a(1-\theta) + \frac{1-\delta}{1-\epsilon}x_t\right]}{[(\theta-\beta)(1-\eta)-\alpha(1-\eta\theta)]a}, \tag{17}$$

where

$$
\begin{aligned}
L_1 &= \beta(1-\eta)\{(1-\theta)\theta a^2 - \tau a(1-\theta)[a\theta + (1-\epsilon)x_t] + [(1-\epsilon)(1-\theta) - (1-\delta)\theta]ax_t\\
&\quad -(1-\epsilon)(1-\delta)x_t^2\},\\
L_2 &= a\{[\alpha+\beta+(1-\alpha-2\beta)\eta](1-\theta)\theta a - (1-\epsilon)[(\theta-\beta)(1-\eta)-\alpha(1-\eta\theta)]x_t\}.
\end{aligned}
$$

From (16) and (17), we obtain the steady state equilibrium of the economy with a subsidy for elderly care.

Next, we examine the subsidy effects on raising δ on l_t and x_t. An increase in δ represents a subsidy for the market elderly care purchased by younger people. With a small tax burden, we can present the following figure as an example.

[Insert Fig. 3 around here.]

As presented in the figure above, the subsidy for market elderly care purchased by younger people shifts $\Delta l_t = 0$ downward. On the one hand, this shift reduces family care time l_t. On the other hand, $\Delta x_t = 0$ shifts upward. Therefore, to the degree that the shift of $\Delta x_t = 0$ is small, the care time by children, l_t, decreases.

[Insert Fig. 4 around here.]

Fig. 4 presents the case of a subsidy for market elderly care purchased by older people. Given a certain parameter condition, one can obtain the figure shown above. In this case, both $\Delta l_t = 0$ and $\Delta x_t = 0$ shift upward. Then, both formal care x_t and informal care l_t increase. Results of these analyses suggest that the government should probably subsidize the formal care bought by the younger generation.

Proposition With a small tax burden, the subsidy for younger generation is preferable to one for older generation in order to decrease informal care.

4.2 Numerical analysis

This subsection presents a numerical analysis of the subsidy effects. We set the parameter such that the annual income growth rate is 2%. As shown by the simulation of real business cycle theory (RBC), we set $1 - \alpha - \beta = 0.7$. Subsequently, we examine the two cases to obtain the constraints above.

Case 1 The parameters are set as $a = 6.2, \alpha = 0.5, \beta = 0.2, \eta = 0.659, \theta = 0.3, \phi = 0.1$. The policy function is defined as $\delta_t = \phi\delta_{t-1} + f$, which f denotes the policy shocks. Also, ϕ denotes the continuation of the policy. η is given by Kydland and Pretnar (2019). This parameter set derives that the annual income growth rate is 2%. Considering the period

of the overlapping generations model as 30 years, the income growth rate g was given as 0.8 at this parameter set.

The impulse of the policy shock of the subsidy for the formal elderly care purchased by younger people is shown by the following.

[Insert Fig. 5(a) around here.]

Moreover, we examine the case of a subsidy for formal care to be purchased by older people.

[Insert Fig. 5(b) around here.]

These results are straightforward. The subsidy raises demand for formal elderly care. The younger people reduce the purchase for formal elderly care if the subsidy for formal elderly care purchased by the older people is provided. This is the substitution effect. However, the informal elderly care increases. This result is attributed to the complementary between formal and informal care. Then, the labor supply can decline over time.

Even if the parameter values are changed as Case 2, $a = 3.1, \alpha = 0.6, \beta = 0.1, \eta = 0.659, \theta = 0.3, \phi = 0.1$, the results do not change appreciably. This case shows a decrease in the preference for elderly care for parents.[2]

[Insert Fig. 6(a, b) around here]

5 Conclusions

For this study, we develop an overlapping generations model in which people of the young generation care not only for themselves, but also for their parents. Elderly care consists of care goods or services bought by people of both old and young generations plus informal care time supplied by the young generation. Our analyses can derive the equilibrium in the model with both formal and informal elderly care. Based on our model, we examine population aging effects on both formal and informal elderly care. Population aging pulls up not only formal elderly care but also informal elderly care. Then, because of an increase in informal elderly care, the labor supply decreases. In many economically developed countries, population aging is progressing quickly. Demand for both formal

[2]However, we set $a = 3.1$ to avoid changing the income growth rate.

and informal elderly care is increasing. The results presented herein are consistent with those found for actual economies all over the world.

In addition to the analysis of population aging, we examine the effects of subsidies for formal elderly care on both formal and informal elderly care. By virtue of a subsidy for formal elderly care purchased by older people, both formal elderly care and informal elderly care increase. In contrast, when commencing a subsidy for elderly care purchased by younger people, the subsidy raises the amount of formal elderly care provided but reduces informal elderly care. As demonstrated by this result, the subsidy for formal elderly care purchased by people of the younger generation is more effective than that for people of the older generation for mitigating the effects of a decrease in the labor supply. Therefore, the government should provide a subsidy for formal elderly care purchased by younger people to reduce the loss of value added resulting from informal care. Subsidies of this type can resolve severe difficulties confronting many economically advanced countries.

As described in this paper, we particularly examined subsidy effects on the quantity of formal elderly care and the time for informal elderly care. We do not consider the policy for social welfare. We expect to undertake social welfare analysis in future work.

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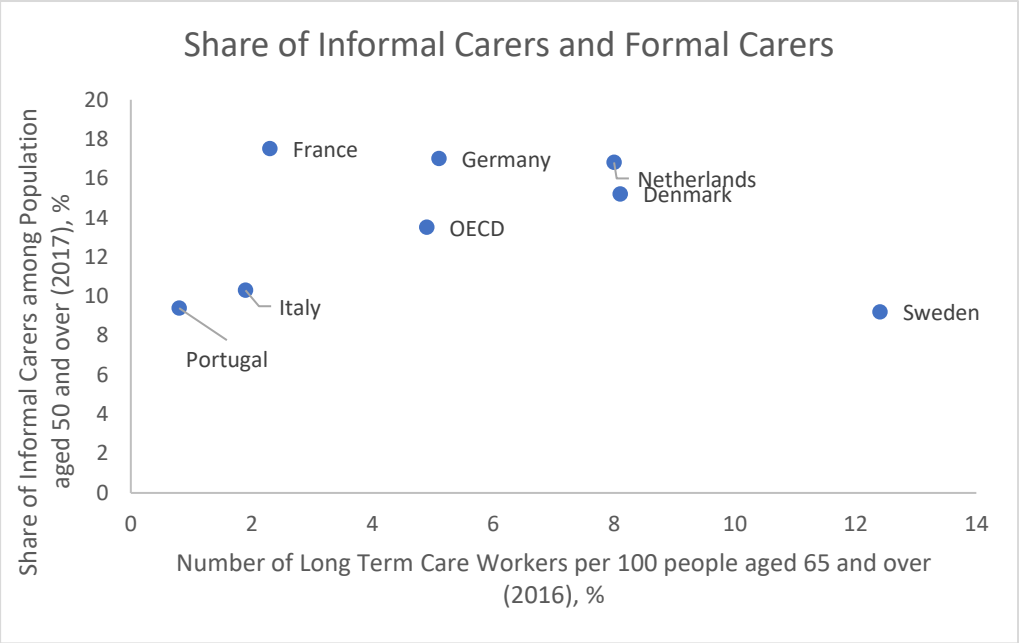

Fig. 1 Share of Informal Cares and Formal Carers.

(Data: OECD Data "Health as a Glance 2019: OECD Indicators" and "Long-term care workforce: caring for the aging population with dignity")

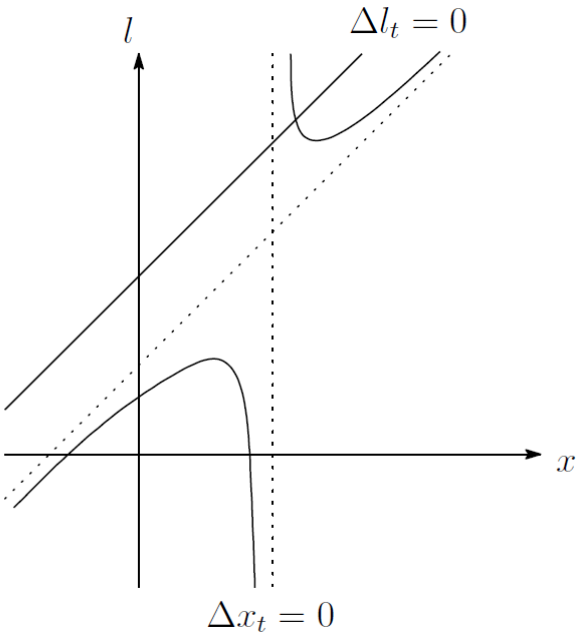

Fig. 2: Steady State Equilibrium

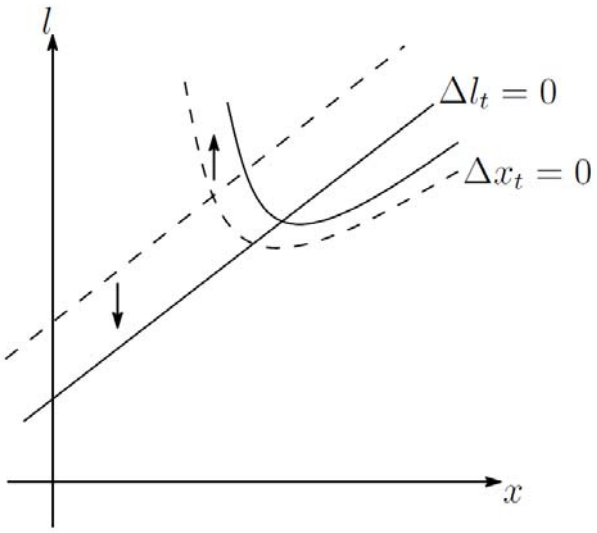

Fig. 3: Subsidy for market elderly care purchased by younger people.

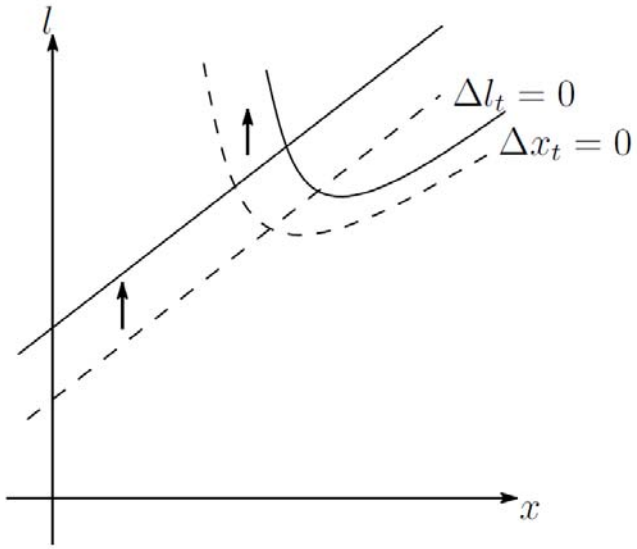

Fig. 4: Subsidy for market elderly care purchased by older people.

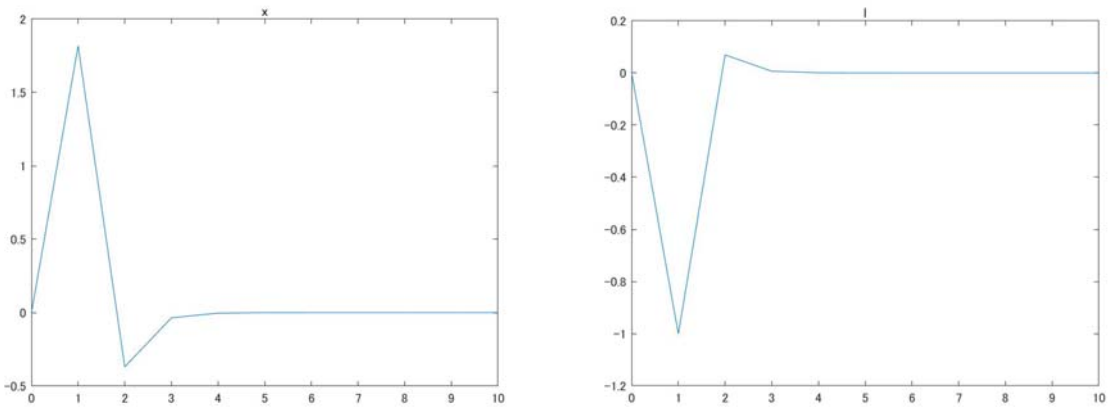

Fig. 5(a) Subsidy for formal elderly care purchased by younger people (Case 1).
The left panel shows the change of the level of formal elderly care purchased by younger people. The right panel shows the change of informal elderly care.

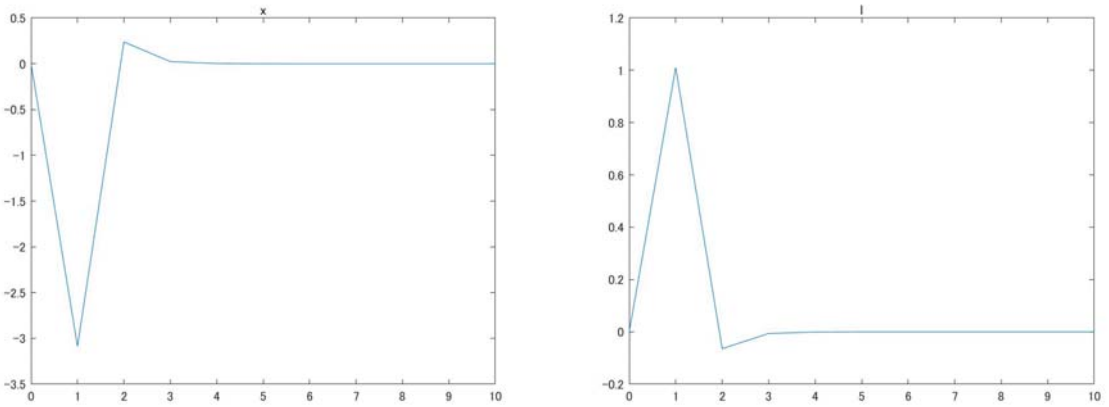

Fig. 5(b) Subsidy for formal elderly care purchased by older people (Case 1).
The left panel shows the change of the level of formal elderly care purchased by younger people. The right panel shows the change of informal elderly care.

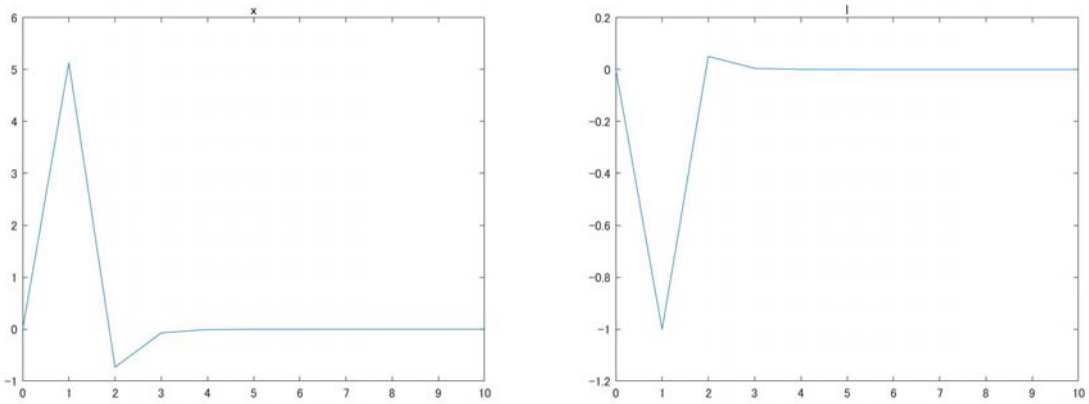

Fig. 6(a) Subsidy for formal elderly care purchased by younger people (Case 2).
The left panel shows the change of the level of formal elderly care purchased by younger people. The right panel shows the change of informal elderly care.

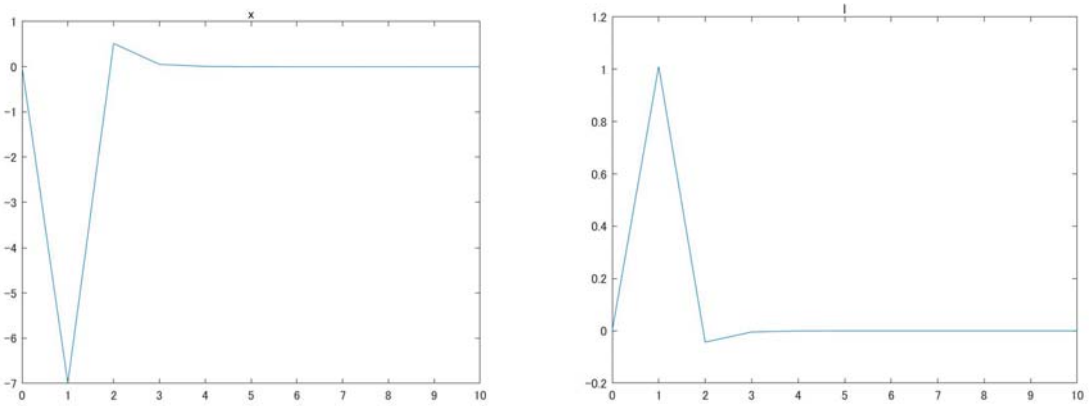

Fig. 6(b) Subsidy for formal elderly care purchased by older people (Case 2).
The left panel shows the change of the level of formal elderly care purchased by younger people. The right panel shows the change of informal elderly care.