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by families, markets and the state**

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# Economic development and long-term care provision by families, markets and the state

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## Abstract

In earlier stages of economic development, women mainly provide family elderly care. With economic development, progress by women in the work force has lowered the care level. If it falls below the minimum care level for elderly parents, then children might enter into insurance contracts and even demand provision of long-term elderly care by the state. Such a change in elderly care providers is consistent with predictions that have been made in the literature. However, this paper presents the conjecture that, as wage rates rise further, children will provide sufficient elderly care to parents by purchasing market care services.

Keywords: altruistic children, economic development, informal elderly care, long-term care policy, market elderly care

JEL Classification: D13, D91, H55, O17

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## 1. Introduction

Population aging and recent social trends reflecting a declining role of family solidarity are expected to generate mounting demands on the market for elderly long-term care and on the state to provide alternatives to families. The gap separating life expectancy and healthy life expectancy tends to increase as life expectancy increases.<sup>1</sup> The proportion of people aged 80 and over, most of whom need long-term (elderly) care, has increased in economically developed countries from about 2 percent in the 1970s to about 4 percent and higher in the 2010s.<sup>2</sup> In addition, recent declines in family solidarity are exacerbated by children's mobility and a particular increase in childless families. Moreover, increases in the female labor force participation rates put more pressure on families to care for their dependent parents. Especially, female labor force participation rates are important if daughters and daughters-in-law typically play an important role in providing informal care. Female participation rates in OECD countries have increased in past decades from about 50 percent in the 1970s to about 70 percent and over in the 2010s.<sup>3</sup> In designing long-term care policy in Japan, the female labor force participation rate was considered because the policy approach took public long-term care as a substitute for family elderly care (Kadoya, 2016).<sup>4</sup> Consequently, increasing needs for elderly long-term care and advances by women in the market labor force have compelled families and society to share burdens of providing elderly long-term care. This paper presents an analysis of changes in elderly care providers, families, markets, and the state, emphasizing time allocation of families between elderly care at home and market labor supply along with economic development processes. The model also includes consideration of the market elderly care production industry explicitly. This is another contribution of this paper.

Reports of the literature show that women, mostly adult daughters and daughters-in-law, bear a disproportionate share of the parental care burden (Stone and Kemper, 1990;

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<sup>1</sup> For instance, Mayhew (2011) reports that the gap in England has increased in past decades and that it will continue to do so.

<sup>2</sup> For 'more developed regions' in the World Population Prospects 2017 (UN). The ratio of elderly people aged 80 and older was about 7.5% in Japan in 2015; the lowest among G7 countries in that year was about 4% in the USA.

<sup>3</sup> The female labor force participation (LFP) rate in Italy was about 55% in 2017: lower than that of any G7 country. The rate ranged from 75 % in Canada to 68% in France and of the US (OECD, OECD Stats 2017). Both elderly ratios and female labor force participation rates have shown upward trends in past decades.

<sup>4</sup> Therefore, the process of public long-term care provision is important in evaluating its duties although the evaluation in the USA is based on the condition of persons in nursing homes. Kadoya (2016) calls these evaluations process-based and outcome-based approaches, respectively.

Pezzin and Schone, 1999; Cremer et al., 2012). They also show that rising wage rates have changed the relative shares of time and financial support for elderly parents, i.e., from time to financial transfers (Couch et al., 1999; Zissimopoulos, 2001). These observations suggest that changes in female labor force participation rates and wage rates involve changes in the provision of elderly support: both informal (family) and formal (market and public). The purposes of this paper are to relate the issue of elderly care provision to economic development processes in a dynamic model and to infer patterns of elderly long-term care provision along with economic development.

From comparative static analysis with respect to the level of altruistic children's income, Pestieau and Sato (2008), among others, report that the form of parental support varies from *time-intensive care* at lower income levels to *finance-intensive care* at higher income levels.<sup>5</sup> Leroux and Pestieau (2014) also described their analysis of how the respective roles of families, markets, and governments in supporting elderly people have evolved from changes in various factors such as the reliability and effectiveness of family support. These works are fundamentally static, particularly addressing only one generation of agents who live for two periods, young and old, and who differ only with respect to their productivity. By contrast to these works, this paper presents extension of the analysis in a dynamic setting, i.e., a neoclassical growth model à la Galor and Weil (1996).<sup>6</sup>

The model incorporates consideration of altruism of grown-up children toward their elderly parents, although, for analytical convenience, parental altruism toward children is assumed away.<sup>7</sup> The model specifically assesses the behavior of each generation of adult children over their life cycle along with a time path of the economy. Children's time

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<sup>5</sup> Alternative models are based on exchange between generations. Bernheim et al. (1985), Sloan et al. (2002), and Yakita (2018), among others, consider an exchange model. Chang and Weisman (2005) and Chang and Luo (2015) model parental altruism and sibling competition in a two-stage Nash game. Horioka et al. (2018) construct a theoretical model of a dynamic game between altruistic parents and transfer-seeking children for empirical analysis of children's care-giving behavior in Japan.

<sup>6</sup> These analyses address the dynamics of elderly care provision and not optimality of the policy, although the public provision of long-term care is considered. Cremer and Roeder (2013), Cremer et al. (2013, 2017), and Canta and Cremer (2018) analyze the optimal long-term care policy.

<sup>7</sup> Ioannides and Kant (2000) report an empirical result: parents and their adult children are mutually altruistic. However, they also show that adult children's transfers to parents are based mainly on their parents' needs because of heterogeneity among parents and less among adult children. Cigno (1991) explains children's care of elderly parents without rewards by self-enforcing family rules rather than by altruism. Even if children are not altruistic toward parents, they benefit from maintaining the rules in earlier stages of economic development. Here children's unilateral altruism is assumed.

and financial transfers to their parents are evaluated mainly based on parents' needs when they become dependent. Otherwise, assistance from the children is provided only as a merit good to the parents, irrespective of the extent to which the parents evaluate them. Public long-term care is expected to be effective only when recipients are unlikely to have any other support (Ioannides and Kant, 2000). Consequently, in the analytical model examined in this study, parents make no decision for elderly care on their own.<sup>8</sup> Following the studies of the relevant literature, only women, mostly daughters and daughters-in-law, are assumed to bear family parental care burdens; also, female labor only is used in the elderly long-term care industry.<sup>9</sup> The goods production sector employs capital as well as labor of both women and men. Male labor involves physical and mental (non-physical) factors. Female labor involves only mental factors. Long-term care services outside the home are provided by the private long-term care production sector or by the state, both employing female labor. Mutual benefit societies (or corporations) or insurance companies might also exist, insuring the children's risk of supporting dependent parents. Such organizations and companies are assumed to be risk neutral; the consumption goods and long-term care markets are assumed to be competitive. It is noteworthy that, throughout the paper, private insurance markets for the children's risk of caring for dependent parents are distinguished from private care markets for external long-term care services. Children can purchase market long-term care directly for their parents.

The main results are the following. First, when the female wage rate is low in earlier stages of economic development, grown-up daughters and daughters-in-law devote their full time efforts to provision of a merit good, i.e., family elderly care, to the parents. Because of the gender wage gap, family elderly care is assumed to be provided by women. As the female wage rate rises, women start to supply labor to the market, simultaneously reducing family care time at home. When the female wage rate becomes sufficiently high, women work full time to supply their labor to the market. The family then purchases long-term care services from the market.<sup>10</sup> Second, if the level of family elderly care becomes lower than the minimum elderly care level for the parents because of high female labor force participation rates, then grown-up children might purchase mutual

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<sup>8</sup> By contrast, Cremer et al. (2013, 2017) consider a single generation of parents to study the role and design of public long-term care provision when children's assistance is uncertain.

<sup>9</sup> Actually, the ratio of male workers in the long-term-care production sector is low. In Japan, for example, only 24% of workers employed in long-term industry were male in 2017 (Ministry of Internal Affairs and Communications in Japan, 2017).

<sup>10</sup> Spouse care is not considered explicitly in this paper. The same probability of becoming dependent is assumed for a couple.

care insurance and market long-term care insurance. Third, if the amount of elderly care provided by the family becomes too small, then public long-term care programs might be necessary to provide a minimum level of care for elderly people. Fourth, as the female wage rate rises further along with capital accumulation, working children might instead prefer to purchase market long-term-care services and prefer to provide a sufficient level of elderly care to their respective parents.

The organization of the paper is the following. The next section introduces the growth model. Section 3 examines the model dynamics. The relations among capital accumulation, wage rates, the female labor supply, and family elderly (long-term) care will be examined. In section 4, the possibility of an emergency in private long-term care insurance and state long-term care provision is discussed in relation to economic development. The final section concludes the paper.

## 2. Model

A family consists of a woman and a man: a couple.<sup>11</sup> Individuals of each sex are identical. They live for two periods: a working adult period and a retired elderly period. These analyses specifically examine dynamic changes in providers of elderly care along with economic progress rather than those in the elderly dependency ratio. Therefore, the lifetime is certain and the length of each period is normalized to one. To avoid the matching issue in marriage, women and men are assumed to be numerically equal. Each couple has a common unitary utility from consumption and from transferring elderly care to their parents. Men supply labor inelastically to the labor market, although women choose to allocate their time between elderly care at home and market labor.<sup>12</sup> Each couple has the same number of girls and boys. The number of child pairs grows at a positive rate:  $n - 1 > 0$ . For analytical purposes, the child-rearing time is not considered explicitly. It is therefore not included in the time endowment, although the burdens of child rearing should be shared within the couple. The production technology of consumption goods in the economy is represented by a constant-returns-to-scale (CRTS) production function incorporating physical capital and labor. Physical capital in goods production depreciates in one period. The production technology of the elderly care sector in the market uses female labor and goods inputs.

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<sup>11</sup> These analyses do not explicitly address the period of childhood. In these analyses, the issue of whether a couple co-resides with their elderly parents is not addressed.

<sup>12</sup> Pezzin and Schone (1999) describe that adult daughters are far more likely than sons to serve as primary caregivers, and that the female labor supply is more or less elastic.

## 2.1 Family decisions

The utility function of a couple in period  $t$  is

$$u_t = \ln c_t^1 + \rho \ln c_{t+1}^2 + \gamma \ln h_t, \quad (1)$$

where  $c_t^1$  and  $c_{t+1}^2$  respectively denote first-period and second-period family consumption, and where  $h_t$  represents the level of elderly care services provided to the parents.<sup>13</sup> In addition,  $\gamma > 0$  represents the degree of altruism of the couple toward their parents.  $\rho \in (0,1)$  stands for the time discount factor. Letting  $w_t^f$ ,  $w_t^m$ , and  $P_t$  respectively denote the female and male wage rates and the price of external long-term care services, the first-period budget constraint of the couple can be written as

$$w_t^m + (1 - \tilde{l}_t)w_t^f = c_t^1 + P_t q_t + s_t, \quad (2)$$

where  $\tilde{l}_t$  denotes the family (“informal”) elderly care time of a wife at home,  $q_t$  is the amount of external long-term care services purchased (measured in terms of care time), and  $s_t$  represents the savings for retirement. The second-period budget constraint is

$$(1 + r_{t+1})s_t = c_{t+1}^2, \quad (3)$$

where  $r_{t+1}$  stands for the interest rate in period  $t+1$ . The couple cares for their parents using the wife’s time and external long-term care time. Letting  $1/\phi$  be a required time input to care for the pair of parents, then the total time input necessary to provide elderly care  $h_t$  for the parents is given as  $h_t / \phi = \tilde{l}_t + q_t$ , where  $0 \leq \tilde{l}_t \leq 1$  and  $q_t \geq 0$ .<sup>14</sup> Family (informal) care and market (formal) care time are assumed to be

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<sup>13</sup> Elderly care time might not be valued by the parents when they are autonomous. Such goods provided by ‘paternalistic’ children are regarded as merit goods à la Currie and Gahvari (2008). Elderly long-term care provided to the parents in the case of dependency is included in the support.

<sup>14</sup> Under a logarithmic utility function, however, it is infeasible for utility maximization to have  $\tilde{l}_t = 0$  and  $q_t = 0$  simultaneously. Because of growth in the number of child pairs, the level of elderly care received by each couple of parents is  $nh_t$  in terms of per

perfect substitutes, as suggested by Pezzin and Schone (1999).<sup>15</sup>

The utility maximization problem of a couple is split into two steps: cost minimization of elderly care provision and utility maximization. The cost of providing elderly care  $h_t$  is given as  $C_t = w_t^f \tilde{l}_t + P_t q_t = (w_t^f - P_t) \tilde{l}_t + P_t (h_t / \phi)$ . By minimizing the cost for elderly parental care  $h_t$  subject to time constraint  $0 \leq \tilde{l}_t \leq 1$ , one can obtain the following cost function  $C_t = C(h_t)$ :

$$C(h_t) = \begin{cases} (i) & w_t^f + P_t[(h_t / \phi) - 1] & \text{when } w_t^f \leq P_t & \text{and } h_t / \phi \geq 1 \\ (ii) & (h_t / \phi) w_t^f & \text{when } w_t^f \leq P_t & \text{and } h_t / \phi < 1 \\ (iii) & (h_t / \phi) P_t & \text{when } w_t^f > P_t \end{cases} \quad (4)$$

In case (i), the wife does not supply labor to the market, i.e.,  $\tilde{l}_t = 1$ ; the couple might purchase external long-term care for high elderly care  $h_t$ . In case (ii), the wife allocates the time endowment between family care  $0 < \tilde{l}_t = h_t / \phi < 1$  and market labor  $0 < 1 - \tilde{l}_t < 1$ . In this case, the couple are unwilling to purchase external long-term care, i.e.,  $q_t = 0$ . In case (iii), the couple chooses  $\tilde{l}_t = 0$  and purchases  $q_t = h_t / \phi$  of external long-term-care time to provide elderly care  $h_t$ . The wife supplies full-time labor to the market.<sup>16</sup>

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couple of parents. Throughout the analyses presented in this paper, the care level is described in per-couple of adult children terms.

<sup>15</sup> Although Pezzin and Schone (1999) report that a well-defined market for formal care is a potentially perfect substitute for the child's informal caregiving efforts, parents generally use care of both types simultaneously if home and external long-term care are not perfect substitutes, for example, because of the so-called "home bias" (though, from the children's view in this paper), e.g.,  $h_t = H(\tilde{l}_t) + \varepsilon H(q_t)$ , where  $\varepsilon$  is a parameter reflecting the home bias ( $0 \leq \varepsilon < 1$ ). However, the ratio of population who want to be cared for, either totally or partly, by family members is only less than 30 percent in Japan in 2010 (Ministry of Health, Labour and Welfare in Japan, 2010). Therefore, the home bias might not be strong (even from the children's view).

<sup>16</sup> Here,  $q_t = 0$  is assumed when  $w_t^f = P_t$ , although the cost-minimizing combination of  $q_t$  and  $\tilde{l}_t$  cannot be determined uniquely.

As the second step, the couple chooses elderly care for the parents  $h_t$  and consumption during the two periods  $c_t^1$  and  $c_{t+1}^2$  to maximize family utility subject to the following intertemporal budget constraint as

$$w_t^m + w_t^f = c_t^1 + \frac{c_{t+1}^2}{1+r_{t+1}} + C(h_t). \quad (5)$$

The first-order conditions are

$$1/c_t^1 = \lambda_t, \quad (6a)$$

$$\gamma/h_t = \lambda_t C'(h_t), \quad \text{and} \quad (6b)$$

$$\rho/c_{t+1}^2 = \lambda_t / r_{t+1}, \quad (6c)$$

with budget constraint (5). Using cost function (4), and from (5) and (6), one obtains the following solutions.

In case (i), for which  $w_t^f \leq P_t$  and  $h_t/\phi \geq 1$ , if the optimal plans are interior solutions to the problem, then

$$h_t = \frac{\gamma\phi}{1+\gamma+\rho} \frac{P_t + w_t^m}{P_t} \quad \text{and} \quad s_t = \frac{\rho}{1+\rho} w_t^m. \quad (7)$$

However, for  $h_t$  in (7) to be consistent with condition  $h_t/\phi \geq 1$ , one must have

$P_t/w_t^m \leq \gamma/(1+\rho)$ . Because  $w_t^f \leq P_t$ , it must be true that  $w_t^f/w_t^m \leq \gamma/(1+\rho)$ . In this case, because couples are unwilling to purchase external elderly care, one obtains a corner solution if men are employed full time.<sup>17</sup> Therefore, when  $w_t^f/w_t^m \leq \gamma/(1+\rho)$ ,

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<sup>17</sup> When  $w_t^f < P_t$ , if  $h_t/\phi > 1$ , then the couple has two choices: (a) a corner solution of  $h_t = \phi$  or (b) purchase of  $q_t$ . In case (b), producing  $q_t$  requires female labor input, as will be explained in Section 2.3. Although one unit of female labor brings about  $w_t^f$ , the increased income can buy only  $w_t^f/P_t (< 1)$  units of  $q_t$ . Consequently, elderly care becomes smaller in case (b). Therefore, the couple will choose (a) a corner solution.

one obtains

$$h_t = \phi. \quad (8)$$

In case (ii), for which  $w_t^f \leq P_t$  and  $h_t / \phi < 1$ , we have

$$h_t = \frac{\gamma\phi}{1+\gamma+\rho} \frac{w_t^f + w_t^m}{w_t^f} \quad \text{and} \quad s_t = \frac{\rho}{1+\gamma+\rho} (w_t^f + w_t^m). \quad (9)$$

In this case, for optimal plan (9) to be consistent with condition  $h_t / \phi < 1$ , one must have

$$w_t^f / w_t^m > \gamma / (1 + \rho).$$

In case (iii), for which  $w_t^f > P_t$ , we have

$$h_t = \frac{\gamma\phi}{1+\gamma+\rho} \frac{w_t^f + w_t^m}{P_t} \quad \text{and} \quad s_t = \frac{\rho}{1+\gamma+\rho} (w_t^f + w_t^m). \quad (10)$$

## 2.2 Goods production sector

The production technology of consumption goods is assumed to be given by the following constant-returns-to-scale production function as

$$Y_t = F(K_t, L_t) + bL_t^m, \quad (11)$$

where  $Y_t$  represents aggregate output,  $K_t$  denotes aggregate physical capital,  $L_t$

expresses aggregate labor, and  $L_t^m$  stands for aggregate male labor in period  $t$ . In

addition,  $F(K, L)$  is a homogeneous function in physical capital  $K$  and labor  $L$ . Also,  $b > 0$  is the constant marginal productivity of male physical labor. Here, it is assumed that capital accumulation increases labor productivity: i.e.,  $F_{LK} > 0$ . Aggregate labor

$L_t$  represents the sum of non-physical labor of female and male workers,  $L_t = L_t^m + L_t^{fY}$ ,

where  $L_t^{fY}$  denotes female non-physical labor employed in the goods production sector.

Letting  $N_t$  stand for the number of couples in period  $t$ , the production function can be

rewritten in per-couple terms as

$$Y_t / N_t = F(k_t, 1 + l_t^{fY}) + b, \quad (11')$$

where  $k_t = K_t / N_t$ ,  $L_t^m / N_t = 1$ , and  $l_t^{fY} = L_t^{fY} / N_t$ . The zero-profit conditions are

$$F_K(k_t, 1 + l_t^{fY}) = 1 + r_{t+1}, \quad (12a)$$

$$F_L(k_t, 1 + l_t^{fY}) = w_t^f, \text{ and} \quad (12b)$$

$$F_L(k_t, 1 + l_t^{fY}) + b = w_t^m. \quad (12c)$$

The gender wage gap is given as  $(w_t^m - w_t^f) / w_t^f = b / F_L(k_t, 1 + l_t^{fY})$ . It is noteworthy that even if women do not supply market labor, as in case (i), the *implicit* female wage rate can be given by the marginal product.

### 2.3 Long-term care service production sector

The production of long-term care is assumed to require goods input  $A > 0$  per unit of long-term-care output in addition to female labor.<sup>18</sup> The goods input includes equipment and facilities for elderly care such as elderly care centers and nursing homes. Therefore, it can be assumed to depend on the level of long-term-care service output. For elderly people who are cared for in the sector, the greater their number becomes, the more goods must be input to care for them. The long-term care production technology can be expressed as  $Q_t = \mu L_t^{fQ}$ , where  $Q_t$  represents the aggregate product of long-term care (measured in care time),  $L_t^{fQ}$  signifies the labor employed, and  $\mu$  stands for the labor productivity in the sector. External elderly care can be regarded as a club good. More elderly people are allowed to share in the enjoyment of the long-term care and facility of a size because they are non-rivalrous unless congestion occurs. Therefore,  $\mu > 1$  is assumed. Each long-term-care worker is expected to care for more than one

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<sup>18</sup> Home nursing provided in the market or by the state is assumed away for these analyses, although the formal long-term care system in Japan, for example, might be characterized by a high weight of home care and home nursing, especially for slight dependence. Facilities equipped with robots and artificial intelligence (AI) might increase the labor productivity in the industry, although their mutual technical relationship are assumed away.

couple of elderly persons at a time. In addition to labor inputs, equipment and facilities must be produced in response to the level of long-term-care production to maintain the level of long-term-care services as appropriate for each person without congestion.<sup>19</sup> The profit of the long-term-care production sector is therefore given as

$$\pi_t^Q = P_t Q_t - w_t^f L_t^{fQ} - A Q_t, \quad (13)$$

where  $AQ_t$  stands for the total goods cost. The zero-profit condition in this sector can be written as

$$P_t \mu - w_t^f - A \mu = 0. \quad (14)$$

Therefore,  $P_t \stackrel{>}{<} w_t^f$  as  $\frac{\mu A}{\mu - 1} \stackrel{>}{<} w_t^f$ . When the female wage rate is sufficiently low relative to the per-unit goods cost, the price of external long-term care is higher than the female wage rate, and *vice versa*. If external long-term-care services are not demanded, then the services will not be produced.

### 3. Dynamics

#### 3.1 Market equilibrium

The system dynamics are specifically examined for each of three cases, as determined by the equilibrium in the capital market as

$$K_{t+1} = s_t N_t, \quad (15)$$

where  $s_t$  is given as (7), (9), and (10) for the respective cases.

The other important market is the labor market. Assuming that men are employed full time, the equilibrium condition is explainable by female labor. Couples do not purchase external long-term care in cases (i) and (ii). Therefore,  $L_t^{fQ} = 0$  in these cases. Wives supply part-time labor to the market in case (ii), although they do not supply market labor in case (i). In case (iii), because both spouses of each couple supply full-time labor to the market and purchase external long-term care, one has  $L_t^f = L_t^m = N_t$  and  $\tilde{l}_t = 0$ , where  $L_t^f$  denotes the female market labor. Therefore,

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<sup>19</sup> For example, the Ministry of Health, Labour and Welfare in Japan regulates the staff, facilities, and management of elderly nursing homes by ministerial ordinance.

$$l_t^f = 0 \text{ in case (i),} \quad (16a)$$

$$l_t^f = 1 - \tilde{l}_t = l_t^{fY} < 1; \quad l_t^{fY} > 0 \text{ and } l_t^{fQ} = 0 \text{ in case (ii), and} \quad (16b)$$

$$l_t^f = l_t^{fY} + l_t^{fQ} = 1; \text{ and } l_t^{fY}, l_t^{fQ} > 0 \text{ in case (iii),} \quad (16c)$$

where  $l_t^{fQ} = L_t^{fQ} / N_t$  represents female labor employed for external long-term-care production.

Finally, the equilibrium condition in the long-term-care market is  $Q_t = h_t N_t$  in case (iii).<sup>20</sup> The production of long-term-care services is linear in female labor. Therefore, the supply of long-term care is determined as equal to the demand described by the right-hand side of the equilibrium condition.

Next the dynamics for each case are examined in turn.

In case (i), from eq. (7),

$$k_{t+1} = \frac{\rho}{n(1+\rho)} [F_L(k_t, 1) + b], \quad (17)$$

from which one obtains

$$\frac{dk_{t+1}}{dk_t} = \frac{\rho}{n(1+\rho)} F_{LK} > 0 \text{ and } \frac{dw_t^f}{dk_t} = F_{LK} > 0. \quad (18)$$

Considering case (ii), from (12b) and (12c), (9) can be rewritten as

$$h_t = \frac{\gamma\phi}{1+\rho+\gamma} \left[ 2 + \frac{b}{F_L(k_t, 2 - h_t / \phi)} \right], \quad (19)$$

from which one obtains  $h_t = h(k_t)$ . One can readily demonstrate that

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<sup>20</sup> In case (i), from (10), (12b), and (12c), one has  $h_t = h(l_t^{fY}; k_t)$ . The equilibrium condition in external long-term-care market can be expressed as  $h_t = \mu(1 - l_t^{fY})$  in per-capita terms using the labor market equilibrium condition (16c). Eliminating  $h_t$  from the two equations above yields  $l_t^{fY} = l^{fY}(k_t)$ . Therefore, the variables in period  $t$  are determined for given  $k_t$ :  $w_t^f$ ,  $w_t^m$ ,  $r_{t+1}$ ,  $P_t$ ,  $l_t^{fY}$ ,  $l_t^{fQ}$ ,  $Y_t$ ,  $Q_t$ ,  $h_t$ , and  $s_t$ .

<sup>21</sup> Although no women work in the market, the potential female wage rate is given as the marginal product of labor in the goods production sector.

$$\frac{dh_t}{dk_t} = \frac{-\phi F_{LK}}{\frac{1+\rho+\gamma}{\gamma} \frac{(F_L)^2}{b} - F_{LL}} < 0. \quad (20)$$

In this case, wives allocate their time between family elderly care ( $\tilde{l}_t = h_t / \phi < 1$ ) and market (part-time) labor ( $1 - \tilde{l}_t$ ). Couples do not demand external long-term care.

Therefore,  $l_t^{fY} = 1 - \tilde{l}_t = 1 - h(k_t) / \phi \equiv l^{fY}(k_t)$  is obtained, where  $dl_t^{fY} / dk_t > 0$ .

Capital accumulation demands more female labor input for goods production. The equilibrium condition in the capital market is given as

$$nk_{t+1} = \frac{\rho}{1+\rho+\gamma} [2F_L(k_t, 2 - h_t / \phi) + b], \quad (21)$$

from which one can obtain

$$\frac{dk_{t+1}}{dk_t} = \frac{2\rho F_{LK}}{n(1+\rho+\gamma)} \left(1 - \frac{F_{LL}}{\phi F_{LK}} \frac{dh_t}{dk_t}\right) = \frac{2\rho F_{LK}}{n(1+\rho+\gamma)} \left[1 - \frac{bF_{LL}}{(F_L)^2} \frac{\gamma}{1+\rho+\gamma}\right]^{-1} > 0, \quad (22a)$$

and

$$\frac{dw_t^f}{dk_t} = F_{LK} \left(1 - \frac{F_{LL}}{\phi F_{LK}} \frac{dh_t}{dk_t}\right) > 0. \quad (22b)$$

Regarding case (iii), from (10), (12b), (12c), and (14), one obtains

$$h_t = \frac{\gamma\phi}{1+\rho+\gamma} \frac{2F_L(k_t, 2 - h_t / \mu\phi) + b}{F_L(k_t, 2 - h_t / \mu\phi) / \mu + A}, \quad (23)$$

from which one has  $h_t = h(k_t)$ . Differentiating (23) with respect to  $k_t$  yields

$$\frac{dh_t}{dk_t} = \frac{\left(2 - \frac{1+\rho+\gamma}{\gamma\phi\mu} h_t\right) F_{LK}}{\frac{1+\rho+\gamma}{\gamma\phi} \left(\frac{F_L}{\mu} + A\right) + \frac{F_{LL}}{\phi\mu} \left(2 - \frac{1+\rho+\gamma}{\gamma\phi\mu} h_t\right)}. \quad (24)$$

The sign of  $dh_t / dk_t$  depends on the signs of  $F_L + F_{LL} \left(2 - \frac{h_t}{\phi\mu}\right)$  and  $2 - \frac{(1+\rho+\gamma)h_t}{\gamma\phi\mu}$ .

One can demonstrate that  $F_L + F_{LL} \left(2 - \frac{h_t}{\phi\mu}\right) > 0$  holds if  $F(K, L)$  is the CES function.

Using eq. (14) and  $w_t^m = w_t^f + b$ , one can obtain  $dh_t / dw_t^f = P_t \left[2 - \frac{(1+\rho+\gamma)h_t}{\gamma\phi\mu}\right] > 0$

because elderly care is a normal good.<sup>22</sup> It seems plausible in the case in which parents incorporate consideration of price changes when purchasing external long-term-care services. Therefore, one can plausibly obtain  $dh_t / dk_t > 0$ .

The equilibrium condition in the capital market can be written as

$$nk_{t+1} = \frac{\rho}{1+\rho+\gamma} [2F_L(k_t, 2 - \frac{h_t}{\phi}) + b], \quad (25)$$

from which one obtains

$$\frac{dk_{t+1}}{dk_t} = \frac{2\rho}{n(1+\rho+\gamma)} (F_{LK} - \frac{F_{LL}}{\phi\mu} \frac{dh_t}{dk_t}) > 0, \quad (26a)$$

and

$$\frac{dw_t^f}{dk_t} = (F_{LK} - \frac{F_{LL}}{\phi\mu} \frac{dh_t}{dk_t}) > 0. \quad (26b)$$

### 3.2 Dynamics of the development path

Assuming that the initial per-couple capital stock is sufficiently small, an examination can be made of the time paths of the female wage rate and the elderly care level. For expositional purposes, the economy is assumed not to fall into a trap of lower long-term equilibrium in cases ( *i* ) and ( *ii* ). Also, it is assumed that  $[b\gamma(\mu-1)]/[\mu(1+\rho-\gamma)] < A$ .<sup>23</sup> The latter assumption indicates that long-term-care production requires sufficient goods inputs in addition to female labor. For that reason, some range of the female wage rate exists within which women wish to care for parents at home rather than spend a high price for external long-term care.

For the analyses in this section, the first assumption is that the level of family elderly

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<sup>22</sup> Assuming  $\rho = 0.3$ , as de la Croix and Michel (2002) did, and assuming  $\gamma = 0.271$ , as de la Croix and Doepke (2003) did, one obtains  $2 - (1 + \gamma + \rho)h_t / (\gamma\phi\mu) > 0$  if  $(h_t / \phi) / \mu = l_t^{fQ} \leq 0.345$ . Actually, the number of female employees in the long-term care service sector was 1.36 million in 2017 in Japan, whereas the number of female employees in all industries was 26.67 million in Japan in 2017 (2017 Employment Status Survey in Japan, <https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&tstat=000001107875&cycle=0&tclass1=000001107876&tclass2=000001107877&second2=1>). The ratio was 0.051. Therefore, one can infer that  $l_t^{fQ}$  is sufficiently small. The condition is plausibly satisfied.

<sup>23</sup> If this assumption is not satisfied, then family elderly care might not decrease with the female wage rate. However, in actuality, economically developed countries have experienced rapid rises in the female labor force participation rate. Therefore, this assumption is apparently plausible.

care provided by the member(s) of the family is sufficiently high and therefore, above the minimum level that is necessary to care for dependent parents. The case in which family elderly care might be less than the minimum level is examined in the next section.

Presuming first that the initial female wage rate is sufficiently low to satisfy  $w_t^f / w_t^m \leq \gamma / (1 + \rho)$  or, equivalently,  $w_t^f \leq \gamma b / (1 + \rho - \gamma)$ , then the economy is in case (i), for which the family elderly care level is constant as  $h_t = \phi$ . The female wage rate is too low for women to supply labor to the market. If the marginal utility of caring for parents is still high at  $\tilde{l}_t = 1$ , i.e., if women are in a corner solution, then the couple gives up the utility obtained from providing more elderly care.

From (18), capital accumulates and the female wage rate rises as time passes. After the female wage rate becomes sufficiently high to satisfy  $w_t^f / w_t^m > \gamma / (1 + \rho)$  or, equivalently,  $w_t^f > \gamma b / (1 + \rho - \gamma)$ , then the economy goes into the phase of case (ii).<sup>24</sup> At  $w_t^f(k_t) = \gamma b / (1 + \rho - \gamma)$ , one obtains  $h_t = \phi$  and  $F(k_t, 1) = \rho b / (1 + \rho - \gamma)$ .

Therefore, the path of  $h_t$  is continuous in  $k_t$  at  $w_t^f(k_t) = \gamma b / (1 + \rho - \gamma)$ .

In phase (ii), family elderly care decreases, although the female wage rate increases (see (20)). Providing too much family elderly care raises the opportunity cost of women's care time at home. Therefore, couples reduce the level of elderly care until the marginal utility of providing elderly care equals the opportunity cost. Correspondingly, women reduce their care time at home and increase their labor supply to the market. The increased female wage income increases per-couple capital, which in turn increases the wage rates, as might be readily apparent from (22). As the wage rate becomes higher, couples reallocate wives' time from providing family care to supplying labor to the market. However, unless the female wage rate becomes higher than the price of market long-term care, couples are not willing to purchase externally provided long-term care.

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<sup>24</sup> *A priori*, one cannot rule out the possibility that the economy is trapped in a lower equilibrium in case (i). In this case, the long-term per-couple capital is given as  $k_{(i)} = [\rho / \phi(1 + \rho)][F_L(k_{(i)}, 1) + b]$ , where  $F_L(k_{(i)}, 1) < \gamma b / (1 + \rho - \gamma)$ , the elderly care level is  $h_{(i)} = \phi$ , and subscript  $(i)$  denotes the value in case (i).

After the female wage rate becomes sufficiently high to satisfy  $w_t^f \geq \mu A / (\mu - 1)$ , the economy moves into the phase of case (iii), in which  $w_t^f \geq P_t$ .<sup>25</sup> Substituting  $w_t^f(k_t) = \mu A / (\mu - 1)$  into (19), (21), (23), and (25), one can demonstrate that the time paths of  $h_t$  are continuous in  $k_t$  at  $w_t^f(k_t) = \mu A / (\mu - 1)$ , at which per-couple capital level the values of the elderly care level are  $h_t = \gamma \phi [2 + b(\mu - 1) / (\mu A)] / (1 + \rho + \gamma)$ . However, because one must have  $F_L(\mu A / (\mu - 1), 1 - h_t / \phi) = F_L(\mu A / (\mu - 1), 1 - h_t / \phi \mu)$  at  $w_t^f(k_t) = \mu A / (\mu - 1)$  for both cases (ii) and (iii), the female labor supply can be expected to change discontinuously from  $1 - h_t / \phi$  to  $1 - h_t / \phi \mu$ . At this point, women start to supply full time labor to the market, purchasing external long-term care. The female market labor is allocated between goods production and external long-term-care production sector to equilibrate the female wage rate in both sectors, although wives care for their parents at home immediately before the wage rate satisfies  $w_t^f = P_t$ . It is noteworthy that the marginal product of female labor in goods production is decreasing, although that in long-term-care production is constant.

From (24), the elderly care level increases with per-couple capital, i.e.,  $dh_t / dk_t > 0$ .

The female wage rate increases with per-couple capital (see (26b)). Therefore, the elderly care level rises as the female wage rate increases through the income effect. As might be apparent from (14), the price of external long-term care becomes lower relative to the female wage rate as the female wage rate increases. Consequently, couples can afford to have more elderly care by purchasing more external long-term care as the female wage rate rises.

However, because per-couple capital and therefore the female wage rate remain

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<sup>25</sup> The possibility cannot be ruled out, *a priori*, that the economy is trapped in a lower long-term equilibrium in case (ii), in which the per-couple capital is given as  $k_{(ii)} = (\rho / \gamma \phi) F_L[k_{(ii)}, 1 + l^{fY}(k_{(ii)})]$ , where  $F_L[k_{(ii)}, 1 + l^{fY}(k_{(ii)})] < \mu A / (\mu - 1)$ . In this case, the economy does not experience an elderly care rebound.

constant in the long-term equilibrium, the elderly care level also becomes constant in the long term, as might be readily apparent from (25). If the stability condition is satisfied, then one obtains long-term per-couple capital satisfying<sup>26</sup>

$$k = \frac{\rho}{n(1 + \rho + \gamma)} [F_L(k, 2 - h / \phi \mu) + b], \quad (27)$$

and the elderly long-term care level satisfying

$$h = \frac{\gamma \phi}{1 + \rho + \gamma} \frac{2F_L(k, 2 - h / \mu \phi) + b}{F_L(k, 2 - h / \mu \phi) / \mu + A}. \quad (28)$$

The elderly long-term care level might be higher than, equal to, or lower than  $\phi$ , depending upon the prevailing parameters of the economy. The gender wage gap persists even in the long term, but it is smaller when long-term per-couple capital is greater.

The time path of the elderly care level is presented in Figure 1, where the horizontal line measures the level of per-couple capital stock. The path of the elderly care level shows a reverse-J-shape or V-shape in the female wage rate (and in per-couple capital stock).<sup>27</sup> At earlier stages in economic development, elderly care is provided at home by daughters or daughters-in-law. As the female wage rate rises along with capital accumulation, women start to supply their labor to the labor market and start to reduce family elderly care time. When the female wage rate becomes sufficiently high, women spend their time doing full-time work. The couples purchase externally supplied long-term care services.<sup>28</sup>

### 3.3 Effects of altruism

At this stage of discussion, the effects of the degree of altruism are assessed. The effect on the elderly care at female wage rate  $w^f \Big|_{(i)/(ii)} = b\gamma / (1 + \rho - \gamma)$ , at which women start to work in the market, and the elderly care at the wage rate are

$$\frac{dw^f}{d\gamma} \Big|_{(i)/(ii)} = \frac{1 + \rho}{(1 + \rho - \gamma)^2} > 0 \quad \text{and} \quad \frac{dh}{d\gamma} \Big|_{(i)/(ii)} = 0. \quad (29)$$

The wage rate at which women start to work outside the home increases, although the elderly care level is unchanged. With stronger altruism, women still allocate all of their time to parental care, even at a higher wage rate. Next, the effects of a stronger altruism

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<sup>26</sup> The stability condition is given as  $dk_{t+1} / dk_t < 1$ .

<sup>27</sup> With utility function (1), one must have  $0 < \tilde{l}_t$  in case (ii).

<sup>28</sup> Yakita (2018) uses a similar growth model to derive fertility dynamics.

at  $w^f|_{(ii)/(iii)} = \mu A / (\mu - 1)$  are given as

$$\frac{dw^f}{d\gamma}|_{(ii)/(iii)} = 0 \quad \text{and} \quad \frac{dh}{d\gamma}|_{(ii)/(iii)} = \frac{\phi(1+\rho)}{(1+\rho+\gamma)^2} \frac{2\mu A + b(\mu-1)}{\mu A} > 0. \quad (30)$$

The wage rate at which women start to work full time does not change, although the elderly care level rises as couples become more altruistic toward their parents.

Finally, altruism effects on the long-term equilibrium are obtainable from (27) and (28) as

$$\frac{dk}{d\gamma}|_{t=\infty} = H^{-1} \left[ -\frac{k}{1+\rho+\gamma} (H_1) - \frac{2\rho h(1+\rho)}{n\gamma(1+\rho+\gamma)^2} \frac{F_{LL}}{\phi\mu} \right] \begin{matrix} > \\ < \end{matrix} 0 \quad \text{and} \quad (31)$$

$$\frac{dh}{d\gamma}|_{t=\infty} = H^{-1} \left[ \left(1 - \frac{2\rho F_{LK}}{n(1+\rho+\mu)}\right) \frac{(1+\rho)h}{(1+\rho+\gamma)\gamma} - (H_2) \frac{k}{1+\rho+\gamma} \right] \begin{matrix} > \\ < \end{matrix} 0, \quad (32)$$

where<sup>29</sup>

$$H = \left[1 - \frac{2\rho F_{LK}}{n(1+\rho+\gamma)}\right] (H_1) + \frac{2\rho F_{LL}}{n(1+\rho+\gamma)} (H_2), \quad (33)$$

$$H_1 = 1 + \frac{\phi\gamma}{\mu\phi(1+\rho+\gamma)} \frac{F_{LL}}{F_L / \mu + A} \left(2 - \frac{1+\rho+\gamma}{\mu\phi\gamma} h\right) > 0, \quad (34a)$$

$$H_2 = \frac{\phi\gamma}{1+\rho+\gamma} \frac{F_{LK}}{F_L / \mu + A} \left(2 - \frac{1+\rho+\gamma}{\mu\phi\gamma}\right) > 0. \quad (34b)$$

One can obtain  $H > 0$  from the stability condition of the long-term equilibrium. The signs of  $dk/d\gamma|_{t=\infty}$  and  $dh/d\gamma|_{t=\infty}$  cannot be determined *a priori*. When a couple is more altruistic, they lower per-couple capital and raise elderly care directly. The decreased capital consequently lowers the wage rates and thereby works to lower the level of elderly care. However, the increased elderly care requires more employment of women in long-term-care production, which decreases employment in goods production. In turn, it raises wage rates, which works to increase per-couple capital. The signs depend on the relative magnitudes of these two opposite effects.

#### 4. Private insurance and public long-term care

As explained in the preceding section, a rising women's labor participation rate

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<sup>29</sup>  $1 - 2\rho F_{LK} / [n(1+\rho+\gamma)] > 0$  from the stability condition.

reduces the family care time of daughters and daughters-in-law at home. If the family elderly care provided by women becomes less than the minimum level necessary for elderly dependents, then couples might join a mutual benefit association or take out nursing-care insurance for the parents. In this model with altruistic children, insurance covers the risk of caring for the dependent parents.<sup>30</sup>

Let  $\pi$  and  $\bar{h}$  respectively represent the probability that parents fall into dependency and the required minimum level of the elderly care for them (measured in per couple terms).<sup>31</sup> As in the literature (Cremer et al., 2017), these analyses are based on the assumption that the probability of becoming dependent is given exogenously and that parents cannot affect it through their behaviors. The arguments presented in preceding sections have assumed that elderly care provided by grown-up children is greater than the minimum level, i.e.,  $h_t \geq \bar{h}$ , where  $\bar{h} < \phi$ . In such a case, the parents enjoy the informal (family) elderly care provided as merit goods by the children more than the minimum level. However, if family care services provided by the children run short of the minimum level, i.e., if  $\bar{h} > h_t$ , then there must be elderly care demand on the market or on the state, other than families. From arguments presented in preceding sections, such circumstances might occur when the (female) wage rate becomes high or when children's altruism is low. Women prefer more to work in the labor market rather than provide family elderly care to parents at home.

When market long-term care insurance and public long-term care programs are introduced, children choose optimal plans of consumption and family care provision considering the probability of parents' becoming dependent and the minimum level of elderly care. In this section, however, for the sake of explanation, the effect of the probability on family care provision is not considered explicitly. Couples only provide elderly care if parents become dependent. The minimum level of elderly long-term care must be attained by long-term market insurance and the public long-term program.<sup>32</sup>

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<sup>30</sup> Insurance among elderly people covering the risk of being dependent is assumed away. Although the so-called long-term care (LTC) insurance is the one purchased by individuals against their own risk of becoming dependent in old age, the LTC private insurance market is observed to remain small (Cremer et al., 2012). This phenomenon is called the LTC insurance market puzzle.

<sup>31</sup> It must be recalled that the level of elderly care received by each couple of parents is  $n\bar{h}$ . For analytical purposes, both  $\pi$  and  $\bar{h}$  are assumed to be constant over time in this paper.

<sup>32</sup> Simple explanations of the situations with the presence of market insurance and public long-term care policy are given in the Appendix.

#### 4.1 Private insurance<sup>33</sup>

Presumably, as the female wage rate rises, family care time might decrease, so that  $\tilde{l}_t < \bar{h} / \phi$ , where  $\bar{h} / \phi$  is the minimum family care time to provide elderly care  $\bar{h}$  to the parents. The daughters' or daughters-in-laws' care time does not bring about sufficient family elderly care. In this situation, if  $\pi \bar{h} / \phi \leq \tilde{l}_t < \bar{h} / \phi$ , then the couple might be willing to be a member of a mutual benefit society. As a member, they can receive  $\bar{h} / \phi$  care time from the mutual benefit society if the parents need elderly care, and nothing otherwise, in exchange for the promise of providing  $\pi \bar{h} / \phi$  care time to the mutual benefit society as a *premium*. The mutual benefit society pays  $\pi N_t \cdot \bar{h}$ , in all, for elderly long-term care to elderly dependents because the proportion of elderly people who need care is  $\pi$ , whereas the total *premium revenue* from grown-up children is  $\pi \bar{h} \cdot N_t / \phi$ . Although the premium and benefits are paid in terms of care time, the mutual benefit society actually provides *actuarially fair insurance*. Therefore, as long as  $\pi \bar{h} / \phi \leq \tilde{l}_t < \bar{h} / \phi$ , grown-up children are willing to enter into such an insurance contract. In doing so, they can provide the minimum level of elderly care to the parents, although they are not willing to do so individually, i.e.,  $\bar{h} > \phi \tilde{l}_t = h_t$ .

After the wage rate becomes higher than  $w^f = \mu A / (\mu - 1)$ , i.e., in case (iii), grown-up children pay a premium of  $P_t(\pi \bar{q}) \equiv P_t(\pi \bar{h} / \phi)$  to an insurance company, or a mutual benefit society instead of *care time*. If the parents need elderly care with the probability of  $\pi$ , then the children receive the insurance benefit of  $P_t \bar{q}$ ; otherwise, they

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<sup>33</sup> Children are assumed for these analyses to be altruistic. Cremer et al. (2013) presents demographic (childless families) and societal (declines in family norms) factors as reasons for family solidarity default in addition to economic (increasing labor participation of women) factors. The first two factors for these analyses are assumed away.

receive nothing. By purchasing long-term care from the insurance market, they can provide minimum elderly care  $\bar{h} = \phi\bar{q}$  to the parents.<sup>34</sup>

#### 4.2 Public long-term care<sup>35</sup>

If the altruism of grown-up children toward the parents is insufficiently strong, then the provision of family care time from children to parents might be low such that  $\tilde{l}_t < \pi\bar{h} / \phi$ . In such a situation, grown-up children are not willing even to enter into insurance contracts irrespective of whether  $w_t^f \leq \mu A / (\mu - 1)$  or  $w_t^f > \mu A / (\mu - 1)$ .

Parents cannot receive the minimum level of elderly care (i.e.,  $\phi\tilde{l}_t < \pi\bar{h} < \bar{h}$ ). In this case, the state must provide the minimum level of elderly long-term care publicly. The elderly care provision involves the state in the employment of female workers. For expositional simplicity, a topping-up scheme is assumed. A topping up scheme is defined by Cremer et al. (2017) as the one under which an altruistic child chooses how much to supplement the government's provision, while under an opting out scheme she decides between her own assistance versus that of the government.

When  $w_t^f \leq \mu A / (\mu - 1)$ , the government will choose to provide minimum elderly care at the home of an elderly couple who become dependent. It will do so because public nursing-home care requires facility costs in addition to the cost of female labor employment. The state provides elderly care  $\bar{h} - \phi\tilde{l}_t$  to each dependent elderly person using female labor from the labor market. The parents completely receive the minimum level of elderly care  $\bar{h}$  because the children of the parents provide care time  $\tilde{l}_t$ . It is noteworthy that, in this section,  $\tilde{l}_t$  denotes family elderly care provided by children under the public long-term policy. Children with parents who are not dependent can

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<sup>34</sup> As discussed in the Appendix A1, children entering into insurance contracts might be willing to spend only a constant amount of  $\pi\bar{h} / \phi$ , irrespective of their wage rates.

<sup>35</sup> Pestieau and Sato (2008) compare four public policies: (i) a payroll tax, (ii) a subsidy for children, (iii) a subsidy on private insurance premium, and (iv) institutional nursing assistance. Different from the present analyses, they consider a parent's choice of private insurance and public nursing home. Recall that altruistic children are assumed.

devote care time to the parents at home, i.e., merit good  $\phi \tilde{l}_t$ . However, if the minimum level of long-term care is provided by the government, then couples might provide no family elderly care time (Appendix A2). Parents come to be dependent with probability  $\pi$ . Therefore, the total long-term care to be provided publicly is given as  $\pi(\bar{h} / \phi - \tilde{l}_t)$  in terms of the children's care time. In this sense, the public long-term care provision is effectively an opting-out scheme as described in Cremer et al. (2017).<sup>36</sup> To finance the policy, the government imposes the amount of tax  $w_t^f \pi(\bar{h} / \phi - \tilde{l}_t)$  on each couple.<sup>37</sup> To keep the argument simple, a lump-sum tax is assumed. Some of the female labor employed by the government in the long-term care services production derives from the goods production sector. The shift of employment from the market to the public sector tends to raise the wage rate.

When  $w_t^f > \mu A / (\mu - 1)$ , government will provide public nursing-home-care services to elderly people who need care, instead of home care services, financing it by a lump-sum tax. The total cost is  $(w_t^f / \mu + A)\pi(\bar{h} / \phi - q_t)$ .<sup>38</sup> Because all women and men work full time in the market in this situation, i.e., in case (iii) of the previous section, the policy must shift female labor from the goods production sector to the long-term care service production sector. This labor shift will also raise the wage rate.

Two remarks are noteworthy at this point: First, as capital accumulates, it is noteworthy that the wage rate rises even when  $w_t^f > \mu A / (\mu - 1)$ . The rising wage rates induce couples to prefer market insurance to public policy in due time. As the wage rate rises further, each couple might come to purchase long-term-care services from the market and to provide sufficient elderly long-term care to the respective parents. Such a possibility depends on the laissez-faire dynamics of the economy and the long-term equilibrium. If the long-term equilibrium level of elderly long-term care is high relative to the minimum care level, then market insurance is expected to be purchased by

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<sup>36</sup> Cremer et al. (2017) compare a topping up and an opting out scheme.

<sup>37</sup> The lump-sum taxation does not affect the marginal conditions of family utility maximization. Presumably, government imposes a tax on children because parents' dependence is an event for altruistic children.

<sup>38</sup> Private purchase of market long-term care services might be crowded out, as explained in the Appendix.

children. With higher wage rates, adult children will purchase market elderly care services for parents privately. Even in these stages, public long-term-care services can be provided under a topping up scheme. However, if the public provision involves, for example, X-inefficiency, then the market mechanism might be socially preferred to the public sector for providing elderly long-term care. Figure 2 presents that possibility.

Second, this paper reports that the need for government intervention might not derive from the altruism default, as suggested by Cremer et al. (2017), but might instead derive from the low wage rates under insufficient economic development, i.e., an economic reason. The degree of children's altruism toward the parents is assumed to be unchanged through all stages of economic development. Therefore, after the wage rate becomes sufficiently high, each couple will provide sufficient elderly long-term care to the parents by purchasing market elderly care services.<sup>39</sup> In this sense, the economic reason for family solidarity default posed in Cremer et al. (2013) might be resolved through economic development, although the analyses in this paper do not incorporate consideration of the psychic factors of the parents, i.e., whether they evaluate market elderly long-term care as a merit good or not.<sup>40</sup>

#### 4.3 Increased number of elderly dependent people

At this stage of argument, the effects of increases in the probability of falling into dependency are considered briefly.<sup>41</sup> When family members provide adequate merit goods to the elderly parents, increases in the probability of becoming dependent do not affect the behaviors of family members. A greater proportion of merit goods provided is devoted to family long-term care for parents as parents need it. In contrast, when family care runs short of the minimum level of elderly long-term care for dependent parents, i.e., when  $\tilde{l}_t < \bar{h} / \phi$ , the increased probability that parents become dependent affects

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<sup>39</sup> By contrast, Cox and Stark (2005) emphasize parents' inculcation of values in children through their own behaviors can influence the children's behaviors against altruism default. Rapoport and Vidal (2007) develop a model of endogenous altruism. It is also well recognized in the empirical literature such as a report by Pezzin et al. (2005) that co-residence of generations can affect children's transfers to parents. Cigno et al. (2017) show that policies such as wage redistribution might reduce the share of the adult population governed by such family rules. If the degree of children's altruism becomes lower with economic development, long-term elderly care must be still provided by government.

<sup>40</sup> One should recall that daughters' or daughters-in-laws' care time and market-provided care services are assumed to be perfect substitutes in producing elderly care. Parents can have their respective home biases.

<sup>41</sup> Because our main concern is amounting demand for long-term care, we do not consider expansion of longevity explicitly in this paper.

the behaviors of family members. If the increase in the probability is sufficiently small to satisfy  $\pi\bar{h}/\phi \leq \tilde{l}_t < \bar{h}/\phi$ , then children are still willing to be members of a mutual benefit society or to enter into an insurance contract. However, if the increased probability violates the first inequality, i.e., if it makes  $\tilde{l}_t < \pi\bar{h}/\phi$  hold, then they are no longer willing to have insurance contracts. In this case, public long-term care should be provided to a minimum level by the state. Therefore, the amount to be financed through taxes increases as the probability becomes higher. The employment of female labor in long-term care production also becomes greater. Consequently, female labor is reallocated from goods production, thereby reducing goods production, to long-term care production and increasing long-term care production. Therefore, the increased demand for long-term care by a higher probability of dependence might increase wage rates more and total income in the society as a whole.

## 5. Concluding remarks

An analysis is presented here, demonstrating how the level of elderly parent care changes along with economic development in light of grown-up children's altruism toward their parents. Advances by women in the work force, for example, are expected to lower the level of family elderly care. Sometimes this phenomenon is characterized as a "decline in family solidarity." If the family care time chosen by children becomes lower than the minimum level of care time necessary for the elderly parents, then the children might enter into an insurance contract, i.e., insurance provided by mutual benefit associations or insurance companies. If further advances by women in the work force lower their attention time devoted to the parents, then some provision of long-term care by the state is necessary to care for elderly dependent people in society. It is noteworthy that long-term market insurance is one means of preparing for risks of children's burden of providing elderly care to parents. After female wage rates become sufficiently high, market elderly care (part-time and full time nursing home care) is expected to be provided by the private long-term care production sector employing female labor. These changes in the form of elderly support are consistent with predictions in the literature, which describe that an increase in the wage rate decreases time transfers and increases financial transfers (e.g., Zissimopoulos, 2001).

The present model also predicts that, as wage rates rise further in the future, each couple can be expected to provide sufficient elderly care by purchasing long-term-care services from the market without policy intervention.

Our analysis is based on some restrictive and unrealistic assumptions. Actually, the lifetimes of people vary and vary with uncertainty. Whether a person becomes dependent or not and whether children are altruistic toward the parents are also not certain (Canta and Pestieau, 2013; Cremer et al., 2013). Parents might be able to purchase insurance by themselves (Pestieau and Sato, 2008). Moreover, an opting-out policy is assumed away here (Cremer et al., 2017). These issues have been analyzed mostly in a fundamentally static context in the literature. Finally, assuming the minimum level of elderly care *ad hoc*, the optimal level of elderly long-term care has not been examined. Relaxing these assumptions in a dynamic setting is expected to be an important subject for future research.

Appendix: Cases in which constraint  $h_t \leq \bar{h}$  is binding

To explain the effects of the constraint on behaviors of couples' behaviors, children presumably provide elderly care with time in case (ii) and with financial support in case (iii), respectively, to the parents only when the parents become dependent. If the elderly parents are autonomous, then they need no elderly care and might only receive merit goods provided by their children. Moreover, it is assumed that a minimum level of elderly long-term care  $\bar{h}$  must be provided by children or by government if parents are dependent.

In case (ii), if the degree of altruism  $\gamma$  is insufficiently high relative to  $(w_t^f, w_t^m)$ , then  $h_t < \bar{h}$  can hold (see (23)). In this case, the elderly care level is constrained at minimum level  $\bar{h}$ . Couples choose optimal plans subject to constraint  $h_t = \bar{h}$ , thereby minimizing the provision cost. A similar argument applies to case (iii). It is noteworthy that, because  $dh_t/dw_t^f > 0$  from the argument related to (23), constraint  $h_t = \bar{h}$  becomes unbinding as wage rate  $w_t^f$  rises in case (iii). By contrast, in case (ii), rising wage rates tighten the constraint, i.e.,  $dh_t/dw_t^f < 0$  from (28).

#### A1. Private elderly care insurance

First, a case is considered in which family care time in the absence market insurance is below the minimum level, but not too low, i.e.,  $\pi\bar{h}/\phi \leq \tilde{l}_t < \bar{h}/\phi$ . In this case,  $\pi\bar{h} = \phi(\tilde{l}_t + \tilde{q}_t)$  must be satisfied, where  $\hat{l}_t = \tilde{l}_t/\pi$  and  $\hat{q}_t = \tilde{q}_t/\pi$  because the necessary elderly care in the economy is  $\pi\bar{h}$  in per-couple terms. Children are willing to enter into an insurance contract of mutual societies that provide care time  $\bar{h}$  when parents are dependent, and nothing otherwise, in exchange for provision of care time  $\tilde{l}_t$  in case (ii) and amount  $P_t q_t$  in case (iii), respectively, as a premium. In the presence of market elderly care insurance, the optimization problem of a couple is

$$\underset{c_t^1, c_{t+1}^2, \hat{l}_t}{Max} \ln c_t^1 + \rho \ln c_{t+1}^2 + \pi \ln \bar{h} \quad (A1)$$

$$\text{s.t. } w_t^m + w_t^f [(1-\pi) + \pi(1-\hat{l}_t)] = c_t^1 + \pi P_t \hat{q}_t + \frac{c_{t+1}^2}{1+r_{t+1}}. \quad (A2)$$

Defining the cost of providing family elderly care as

$$C_t = w_t^f \hat{l}_t + P_t \hat{q}_t = (w_t^f - P_t) \hat{l}_t + P_t (\bar{h} / \phi), \quad (A3)$$

the following cost function  $C(\bar{h})$  is obtained, as explained in the text. Situations are considered in which the constraint is binding for cases (ii) and (iii) as

$$C(\bar{h}) = \begin{cases} (ii) & \pi(\bar{h} / \phi) w_t^f & \text{when } w_t^f \leq P_t \text{ and } \bar{h} / \phi < 1 \\ (iii) & \pi(\bar{h} / \phi) P_t & \text{when } w_t^f > P_t \end{cases}. \quad (A4)$$

The family elderly care time and the market care purchases are therefore obtained as shown below.

$$\begin{cases} (ii) & 0 < \hat{l}_t = \tilde{l}_t / \pi (= \bar{h} / \phi) < 1 \\ (iii) & \hat{l}_t = \tilde{l}_t / \pi = 0, \quad \hat{q}_t = q_t / \pi = \bar{h} / \phi \end{cases}. \quad (A5)$$

Therefore, the couple's family care premium might be just sufficient to provide the minimum level of long-term care  $\bar{h}$  to dependent elderly people.

## A2. Public long-term care

Next, a case is considered in which family care time chosen personally by the children is below the minimum level and too low such that  $\tilde{l}_t < \pi \bar{h} / \phi$ . In this case, couples are not willing to enter into insurance contracts. Therefore, the public elderly care policy must be implemented. The benefits must be financed by taxes. Letting  $T_t$  be a lump-sum tax on each couple in period  $t$ , then the maximization problem of a couple is

$$\underset{c_t^1, c_{t+1}^2, \hat{l}_t}{Max} \ln c_t^1 + \rho \ln c_{t+1}^2 + \pi \ln \bar{h} \quad (A1)$$

$$\text{s.t. } w_t^m + w_t^f [(1-\pi) + \pi(1-\hat{l}_t)] - \pi T_t = c_t^1 + \pi P_t \hat{q}_t + \frac{c_{t+1}^2}{1+r_{t+1}}, \quad (\text{A6})$$

where  $\bar{h} = \phi(l_{gt}^f + q_{gt})$ ,  $l_{gt}^f$ , and  $q_{gt}$  respectively denote female labor employed (in case (ii)) and market long-term care purchased (in case (iii)) by the government in per-couple terms, i.e.,  $l_{gt}^f = \pi \bar{h} / \phi$  in case (ii) and  $q_{gt} = \pi \bar{h} / \phi$  in case (iii).

If the government provides the minimum level of long-term care,  $\bar{h}$ , to dependent elderly persons, then family elderly care time (in case (ii)) and the private purchase of market care services (in case (iii)) might be *zero* because couples do not gain from devoting time to family care or from privately purchasing market long-term-care services in addition to the tax payment, as might be apparent from the couples' maximization problem described by (A1) and (A6).

### A3. Public long-term-care policy to private care insurance and then to families

The per-couple 'cost' of providing the minimum level of long-term care to dependent elderly people is the same between cases (ii) and (iii), i.e.,  $\tilde{l}_t^{(ii)} (\equiv \pi \hat{l}_t) = l_{gt}$  or  $q_t^{(ii)} (\equiv \pi \hat{q}_t) = q_{gt}$  in case (ii) and  $q_t^{(iii)} = q_{gt}$  in case (iii). However, the discrepancies of the constrained levels of elderly care from those which are obtainable when the constraint is not binding,  $\bar{h} - h_t$ , are greater when insurance contracts are chosen than when public policy should be implemented. Therefore, couples have incentives to move from public policy to private insurance as wage rates rise. In case (iii), constraint  $h_t = \bar{h}$  must harm the welfare of children, so that couples might choose to purchase market long-term care services for their respective parents individually rather than insurance as the wage rates rise further. In this case, however, if the costs of providing long-term care are the same in the public sector and in the market, then private purchases might be topped up to the public provision.

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## Conflict of interest

The author has no conflict of interest, financial or otherwise, related to this study.

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Figure 1. Change in elderly care – a case of family elderly care above the minimum level.

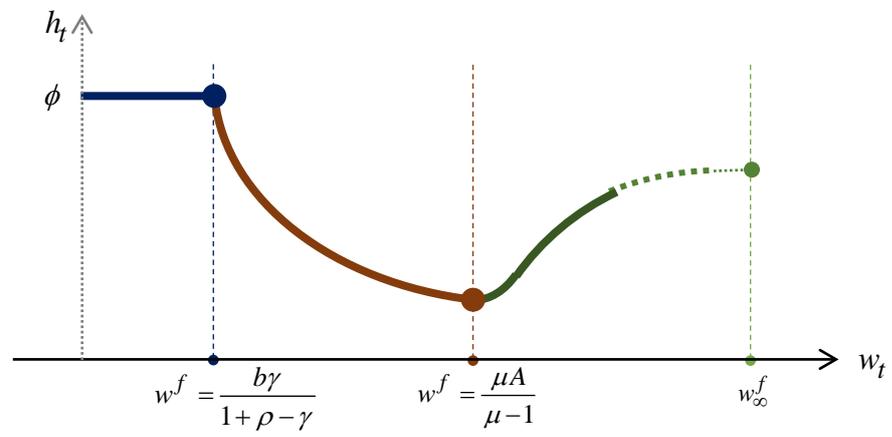
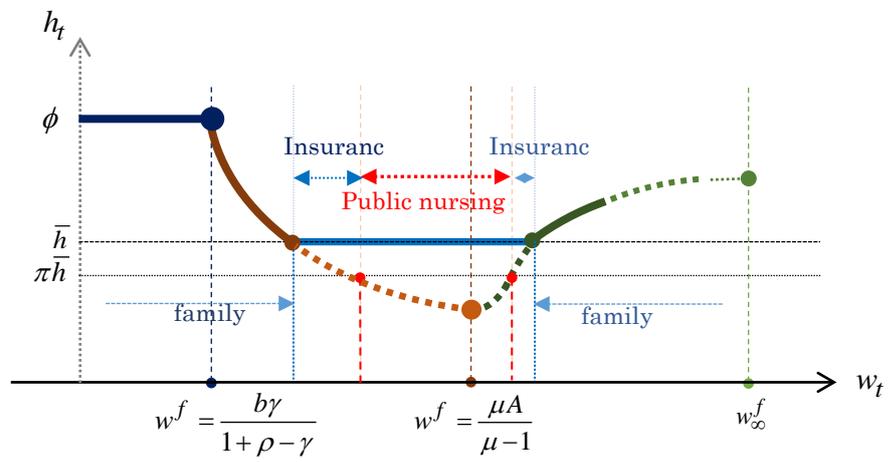


Figure 2. Insurance and public long-term care – a case of family elderly care below the minimum level.



<Supplementary figures: NOT TO BE PUBLISHED>

Figure A1. Effects of weakened altruism.

