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Old age support in kind

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Abstract

It has been argued whether a transfer policy for elderly people should be in kind or in cash. This paper presents a rationale to answer the question in an endogenous growth model with a two-way intrafamily transfer in middle age, education for the child as an inter-vivos transfer, and informal parental care in exchange for a bequest. We have two analytical results. First, a transfer in cash, such as a public pension, prevents economic growth because a strategic behavior concerning caregiving generates a disincentive effect on education. Second, a transfer in kind, such as public formal care, promotes economic growth because the valuation of the service generates an additional benefit of education, which dominates the disincentive effect. Our results show that old age support should be in kind rather than in cash in the context of economic growth and also welfare if bequests are strategic.

1 Introduction

While we usually observe public transfers in kind, such as public education, medical services, and public formal care for elderly people, it has been a controversial issue whether these public transfers should be in cash or in kind. People in favor of transfer in cash assert that no individual would prefer an in-kind transfer to its cash equivalent simply because he is able to spend it in any way he chooses, or that the second theorem of welfare economics ensures that the transfer of numeraire is sufficient to achieve a targeted optimum. Thurow (1974) says: 'While it is not axiomatically true that cash transfers always dominate restricted transfers, the general economic case for cash transfers is strong enough that the burden of proof should always lie with those who advocate restricted transfers. It is their duty to show that the aid is motivated by specific good externalities, that it is part of our individual-societal social welfare function, that it is directed at groups with limited consumer sovereignty, or that it is necessary to the furtherance of some essential value' (p. 195).

One strand of research emphasizes normative roles of in-kind transfer related to individual-societal social welfare functions, such as paternalistic preferences

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(Pollak, 1988), targeting a minimum requirement of merit goods (Ireland, 1990; Besley and Coate, 1991), and pecuniary redistribution (Coate, 1989; Coate *et al.*, 1994).

The other strand of research emphasizes the positive roles of in-kind transfer, such as internalizing externalities (Buchanan, 1968; Garfinkel, 1973), the effectiveness of quantity controls in a suboptimal economy (Guesnerie and Roberts, 1984), enhancing work incentives (Leonesio, 1988), alleviating the self-selection constraint (Nichols and Zeckhauser, 1982; Blackorby and Donaldson, 1988; Munro, 1992; Cremer and Gahvari, 1997; Blömquist and Christiansen, 1998), and resolving the Samaritan's dilemma (Lindbeck and Weibull, 1988; Bruce and Waldman, 1990, 1991; Coate, 1995).

The purpose of this paper is to demonstrate the other type of rationale of superiority of transfer in kind over in cash related to old age support programs. To make the model as simple and clear as possible, we extend Drazen's (1978) model of human capital investment in the following three ways. First, we add informal parental care in the retirement period. Second, the parental care is provided by an adult child in exchange for a bequest (Bernheim *et al.*, 1985).[1] Third, the original model is extended to an endogenous growth model (Lucas, 1988).

A critical assumption is that informal care is provided within the family. There are two reasons. One is related to the supply side. If informal care is more cost-effective than formal care, which could be provided publicly or privately, then the use of informal care would be more efficient. The other reason is related to the demand side. Elderly people would like to live in their own home, live together with or at least near to their children, or meet them as frequently as possible. Fragile people would be restricted from moving freely outside of their home. In such circumstances, a possible candidate for primary carer would be the spouse or one of the adult children.[2] In an actual situation, some strategic behavior may occur. For example, a primary carer could make a credible threat not to provide his parent with informal care. This is the only source of inefficiency in our model.

A main difference between the original model of Drazen (1978) and ours is the cost of education. In retirement, an old parent leaves a bequest for his child not to refrain from providing informal care, the price of which is equal to the child's real wage rate, i.e. human capital. Thus, this strategic behavior generates a disincentive effect on human capital formation. In middle age, a young parent may choose less child education because he takes into account the future cost of education. In this economy, we introduce two types of public transfer program: one is a transfer in cash, such as an unfunded public pension, and the other is a transfer in kind, such as public formal care.

[1] Motives for private transfers in the form of an inter-vivos and a bequest, and the related magnitude of transfer derivatives are controversial. See, for example, Becker (1974, 1976), Tomes (1981), Cox (1987, 1990), Bergstrom (1989), Cox and Rank (1992), Altonji *et al.* (1992, 1996, 1997), Cox and Jakubson (1995), Wilhelm (1996), Pezzin and Schone (1997), Schoeni (1997, 2002), McGarry (1999), and Cox *et al.* (2004).

[2] In Australia, New Zealand, and the United States, about three-quarters of primary carers is a family member living in the same household. The percentage is over 80 in Japan (OECD, 1996).

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It seems that the transfer in cash scheme would be effective if it is financed by a labor income tax. By reducing the child's real wage rate, we would be able to alleviate the individual rationality constraint related to caregiving. However, it is not the case. The reduced real wage rate decreases the benefit of human capital proportionally, making bad things worse because of the excess burden of labor income taxation. The transfer in cash scheme decreases education and also economic growth.

The transfer in kind scheme also suffers the disincentive effect on human capital formation. However, if the transfer is made in kind, a positive education effect is added to the valuation of the service provided.[3] An old parent values the formal care in terms of the substitute, i.e. informal care. Thus, he would behave as if he received income associated with the child's human capital. This valuation effect enhances the benefit of education. It turns out that the net effect is positive. The transfer in kind scheme increases education and also economic growth.

It has been widely recognized that a higher rate of growth need not increase welfare. As Drazen (1978) points out, however, we usually observe that the rate of return from human capital is higher than that from non-human capital, which implies that the level of education in the laissez-faire economy is smaller than the optimal one. If it is the case, the transfer in kind is superior to the transfer in cash in the context of welfare.

This paper is related to three strands of research. First, some researchers point out that in-kind transfer alleviates the self-selection constraint. In our model, the individual rationality constraint can be alleviated by a transfer policy. However, the mechanism is different in two aspects. First, it is not the in-kind transfer itself but the tax policy that alleviates the individual rationality constraint. Second, an important role of in-kind transfer in the self-selection economy is to decrease the welfare of low-skilled persons to make mimicking less attractive. There is neither mimicker nor loser in our model.

Second, some researchers emphasize that in-kind transfer resolves the Samaritan's dilemma. Bruce and Waldman (1991) and Coate (1995) point out that the central issue in the Samaritan's dilemma is the problem of timing and commitment. The timing matters in our model because the earlier decision on human capital investment is affected by the later decision on bequests. However, the problem of commitment does not matter because the same person chooses both investment and bequests in our model.

Finally, some researchers analyze policy effects in extended models of Drazen (1978), such as a bequest-constrained economy (Becker and Murphy, 1988; Nerlove *et al*., 1988; Caballé, 1995; Rangazas, 1996) and, more generally, a borrowing constraints economy (Altig and Davis, 1989, 1992, 1993). A critical difference between the literature and this paper is the motive for bequest. While the literature assumes conventional altruism, this paper assumes the strategic motive.[4] To the best of our

[3] Leonesio (1988) sorts out how to assign a value to the in-kind transfer into four categories: (1) donor resource cost, (2) market value, (3) funds released for alternative purchases, and (4) cash-equivalent value. We use (4) cash-equivalent value because the market for parental care is absent in our model.

[4] One may conclude that bequests are strategic because such bequests allow understanding of the negative relationship between education and informal caregiving that is observed.

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knowledge, there is no literature to compare transfer in cash and in kind in this line of research.

This paper is relevant in three aspects. First, it presents some insights into policy debates concerning population aging. Our results give an alert against alleged Liberalists who believe monetary transfer is superior to conventional in-kind transfer. Second, the analytical solution is useful for testing for robustness. Clear-cut results in the comparative statics will serve the purpose, although some assumptions may be restrictive. Finally, our results are consistent with empirical evidence. It will be shown that (1) informal care is negatively correlated with education, (2) informal care is negatively correlated with formal care, and (3) the effect of education on labor supply is ambiguous. Some empirical findings support these relationships.[5]

The construction of the paper is as follows. In Section 2 we analyze the transfer in cash scheme and the transfer in kind scheme alternatively. We know the transfer in cash scheme prevents economic growth, and that the transfer in kind scheme promotes economic growth. In Section 3, we first derive the social optimum to discuss the optimal scheme in a sense of the second best. Next, we illustrate changes in time allocation when the schemes expand in order to compare the results with empirical evidence. Finally, we discuss a possible use of the individual accounts. The final section concludes the paper.

2 Model

We use a three-period (education, working, and retirement) overlapping generations model with a two-way intrafamily transfer in middle age. Workers in middle age educate their children as an inter vivos transfer and provide informal parental care in exchange for a bequest. Population newborn is constant and normalized to unity. It is the intergenerational spillover effect of human capital that generates economic growth.

In Section 2.1 we examine an economy with public transfer in cash, such as a public pension. In Section 2.2 we incorporate transfer in kind, such as public formal care instead.

2.1 Transfer in cash

Consider a life cycle of an individual born at period $t-1$. In the first period of life, he receives education from his parent. The education improves his human capital h_t in the second, working period. In the second period, he has one child and allocates his time among labor l_t, child education e_t, and parental care z_t. He receives a bequest b_t from the parent in exchange for parental care, consumes c_{1t} and saves s_t. In the third, retirement period, he consumes c_{2t+1} and leaves a bequest b_{t+1} in exchange for informal care z_{t+1} from the child.

[5] Engers and Stern (2002) show that people with more education are less likely to be cared for by children, although the impact is small. Hoerger *et al.* (1996) show that making Medicaid-subsidized home health services more available to the disabled elderly in the community increases the probability that they live independently of their children rather than affecting the probability of institutionalization. Focusing on adult daughters, Pezzin and Schone (1999) show that formal care appears to be an important substitute to informal care in the case of joint living, and that the impact of education on labor supply is ambiguous.

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To make clear the intrafamily relationship, we first explain the maximization problem in the retirement period, then return to the working period.

The maximization problem in the retirement period is formulated as

$$\max \quad u_{2t+1} = c_{2t+1}^{1-\gamma} z_{t+1}^{\gamma}$$

subject to

$$I_{t+1} = c_{2t+1} + b_{t+1} \tag{1}$$

$$b_{t+1} \geqslant (1-\tau_w) w_{t+1} h_{t+1} z_{t+1} \tag{2}$$

where I_{t+1}, c_{2t+1}, b_{t+1} stand for retirement income, old-age consumption, and a bequest, respectively. z_{t+1} stands for informal care (or attention) that the child provides within the family. h_{t+1} is the child's human capital and w_{t+1} is a wage rate per unit of effective labor. $\tau_w \in [0, 1)$ is a contribution rate for workers. Equation (1) is a budget constraint. Equation (2) is the individual rationality constraint, which implies that an old parent has to pay at least a reservation wage of the child for informal care.

According to a constant parameter attached to informal care $\gamma \in [0, 1)$, the optimal allocation is $c_{2t+1} = (1-\gamma) I_{t+1}$ and $b_{t+1} = \gamma I_{t+1}$. The indirect utility in the retirement period is given by

$$u_{2t+1}^{*} = (1-\gamma)^{1-\gamma} \gamma^{\gamma} I_{t+1} [(1-\tau_w) w_{t+1} h_{t+1}]^{-\gamma} \tag{3}$$

Equation (3) shows that the welfare in retirement decreases with the child's human capital h_{t+1}. The reason is that the human capital increases the child's reservation wage, which is the price of informal care the parent faces. It is the strategic behavior which generates additional cost of education.[6]

The maximization problem in the working period is formulated as

$$V(h_t) = \max \quad \ln c_{1t} + \beta \ln u_{2t+1}^{*} + \rho V(h_{t+1})$$

subject to budget constraints

$$b_t + (1-\tau_w) w_t h_t l_t = c_{1t} + s_t$$

$$(1 + r_{t+1}) s_t + P_{t+1} = I_{t+1}$$

a time constraint

$$e_t + l_t + z_t = 1$$

and a technology of human capital formation

$$h_{t+1} = h_t \varphi(e_t) \tag{4}$$

c_{1t}, b_t, s_t stand for middle-age consumption, a bequest from the parent, and a saving, respectively. l_t, e_t, z_t stand for labor, child education, and parental care. h_t is his own human capital and h_{t+1} is his child's human capital. r_{t+1} is an interest rate and P_{t+1} is a pension benefit. u_{2t+1}^{*} is given by equation (3), and $V(.)$ is a value function of human capital. $\beta \in (0, 1)$ is a discount factor and $\rho \in (0, 1)$ is a parameter attached to the child's welfare.

[6] See, for example, Miyazawa (2003).

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Equation (4) implies that the growth rate on a balanced growth path is given by $\varphi(e_t)-1$.

We assume the education function φ takes the form of constant elasticity

$$e_t\varphi'(e_t)/\varphi(e_t)=\eta\in(0,1] \tag{5}$$

Rearranging the constraints, the maximization problem is reformulated as

$$V(h_t)=\max \quad \ln c_{1t}+\beta\ln I_{t+1}-\beta\gamma\ln h_{t+1}+\rho V(h_{t+1})$$

subject to (4) and

$$(1-\tau_w)w_th_t(1-e_t)+\frac{P_{t+1}}{1+r_{t+1}}=c_{1t}+\frac{I_{t+1}}{1+r_{t+1}} \tag{6}$$

Assuming the interior solutions, the first-order conditions require

$$\frac{1}{c_{1t}}-\lambda_{1t}=0 \tag{7}$$

$$\frac{\beta}{I_{t+1}}-\frac{\lambda_{1t}}{1+r_{t+1}}=0 \tag{8}$$

$$-\lambda_{1t}(1-\tau_w)w_th_t+\lambda_{2t}h_t\varphi'(e_t)=0 \tag{9}$$

$$-\frac{\beta\gamma}{h_{t+1}}+\rho\frac{dV_{t+1}}{dh_{t+1}}-\lambda_{2t}=0 \tag{10}$$

where λ_{1t} and λ_{2t} stand for multipliers attached to the constraints (6) and (4), respectively.

Equation (10) stands for the cost and benefit of the child's human capital. The second term is a benefit from altruism and the third term is a cost in a usual way. The first term $\beta\gamma/h_{t+1}$ is an additional cost of human capital generated by the strategic behavior in retirement, which contrasts this model with the other altruistic models.

Solving equations (4), (6), (7), (8), (9), and (10), we have net demand functions of h_t. From the envelope theorem, and using (5), we have

$$\frac{dV_t}{dh_t}=\lambda_{1t}(1-\tau_w)w_t\left(1-e_t+\frac{e_t}{\eta}\right) \tag{11}$$

Substituting (9) and (11) into (10), and using (5), we have

$$-\beta\gamma+\rho\lambda_{1t+1}(1-\tau_w)w_{t+1}h_{t+1}\left(1-e_{t+1}+\frac{e_{t+1}}{\eta}\right)-\lambda_{1t}(1-\tau_w)w_th_t\frac{e_t}{\eta}=0 \tag{12}$$

which determines the motion of education.

On the other hand, equations (6), (7), and (8) give us

$$\frac{1}{\lambda_{1t}}=\frac{1}{1+\beta}\left[(1-\tau_w)w_th_t(1-e_t)+\frac{P_{t+1}}{1+r_{t+1}}\right]$$

$$s_t=\frac{1}{1+\beta}\left[\beta(1-\tau_w)w_th_t(1-e_t)-\frac{P_{t+1}}{1+r_{t+1}}\right]$$

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The production sector uses a constant returns to scale technology, which is specified by a Cobb–Douglas form

$$y_t = f(k_t, h_t l_t) = A k_t^{\alpha} (h_t l_t)^{1-\alpha}$$

where y_t, k_t, h_t stand for output, physical capital, and human capital, respectively. l_t is raw labor and $h_t l_t$ stands for effective labor. $A > 0$ is a scale parameter and $\alpha \in (0, 1)$ is the physical capital share.

Factor markets competition requires

$$1 + r_t = f_1(k_t, h_t l_t) = \alpha A k_t^{\alpha - 1} (h_t l_t)^{1-\alpha}$$

$$(1 + \tau_f) w_t = f_2(k_t, h_t l_t) = (1 - \alpha) A k_t^{\alpha} (h_t l_t)^{-\alpha}$$

where $\tau_f \in [0, 1)$ is a contribution rate for firms.

The budget of unfunded public pension is balanced when

$$(\tau_w + \tau_f) w_t h_t l_t = P_t$$

Physical capital market is clear when

$$k_{t+1} = s_t$$

Since the model is closed, the good market clearing condition

$$y_t = c_{1t} + c_{2t} + k_{t+1}$$

is derived from the Walras' law.

We put aside the procedure to derive the equilibrium to Appendix 1.

It can been shown that equation (12), which is the core in the model, can be transformed to

$$\frac{\rho e_{t+1}}{1 - e_{t+1}} = \frac{e_t}{1 - e_t} - \eta \left[\rho - \frac{\beta \gamma (1 + \theta)}{1 + \beta + \theta} \right] \tag{13}$$

where θ stands for a parameter representing the scale of transfer scheme

$$\theta = \frac{1 - \alpha}{\alpha} \frac{\tau_w + \tau_f}{1 + \tau_f} \tag{14}$$

Given α, θ is increasing in τ_w and τ_f.

Figure 1 shows the equilibrium education e^* in the transfer in cash scheme. The interior condition for education requires

$$\rho > \frac{\beta \gamma (1 + \theta)}{1 + \beta + \theta}$$

Since $\rho \in (0, 1)$, the equilibrium is unstable, which implies no transition. We know the intercept $A(\theta)$ is decreasing in θ given that $\gamma > 0$. It implies that e^* is decreasing in θ. The transfer in cash prevents human capital investment and also economic growth.

It is useful to see equation (12) in order to interpret the education effect of the transfer in cash scheme. The second and third term stand for conventional benefit and

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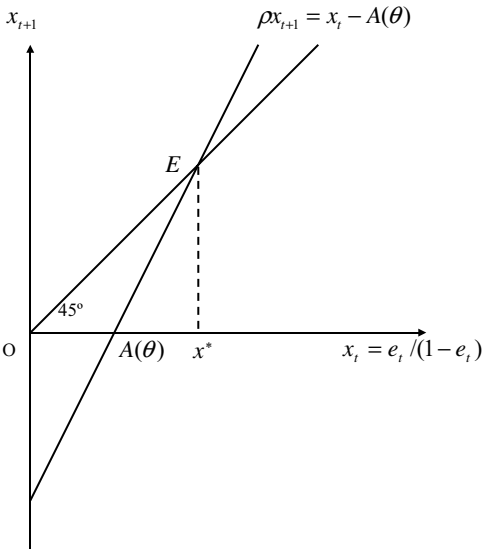


Fig. 1. Equilibrium

cost of education. In Appendix 1, we have

$$\lambda_{1t}(1-\tau_w)w_t h_t(1-e_t) = \frac{1+\beta+\theta}{1+\theta}$$

which is decreasing in θ. Since the transfer policy decreases the benefit and cost proportionally, it is irrelevant to education if the strategic behavior is absent, i.e. $\gamma = 0$. However, if $\gamma > 0$, the disincentive effect weighs on the cost side, decreasing education.

Comparative statics shows that e^* increases with ρ and η, and decreases with β and γ. Education is higher when altruism is stronger, human capital formation is more efficient, people are more patient and less interested in informal care. In sum, we have the following proposition.

Proposition 1. *The education in transfer in cash scheme is given by*

$$\frac{e^*}{1-e^*} = \frac{\eta\rho}{1-\rho}\left[1 - \frac{\beta\gamma(1+\theta)}{\rho(1+\beta+\theta)}\right] \tag{15}$$

The education is decreasing in θ *because of the disincentive effect of the strategic behaviour. The transfer in cash scheme prevents economic growth.*

2.2 Transfer in kind

This section introduces a transfer in kind, such as public formal care. It implies that a care service sector is newly added to the production side. Since care services are usually labor intensive, we assume formal care is produced by labor input only. A linear technology is assumed: one unit of labor is transformed to ε unit of formal

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care. Thus, the parameter ε stands for the cost effectiveness of formal care relative to informal care. If $\varepsilon < 1$, then the informal care is more cost-effective. Assuming perfect labor mobility, wages are equalized between the good production and the care sectors.

The optimization problem in the retirement period is formulated as

$$\max \quad u_{2t} = c_{2t+1}^{1-\gamma}(z_{t+1} + \varepsilon z_G)^{\gamma}$$

subject to

$$I_{t+1} = c_{2t+1} + b_{t+1}$$

$$b_{t+1} \geqslant (1-\tau_w) w_{t+1} h_{t+1} z_{t+1}$$

$z_G \geqslant 0$ stands for labor employed in the care sector. It is assumed that formal and informal care are perfect substitutes in order to have analytical solutions. Although it seems restrictive, the qualitative results would not be changed if the imperfect substitution is assumed.

The interior condition for informal care requires

$$\gamma I_{t+1} - (1-\gamma)(1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G \geqslant 0 \tag{16}$$

If equation (16) is satisfied, we have the demand for consumption and informal care

$$c_{2t+1}^{*} = (1-\gamma)[I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G]$$

$$(1-\tau_w) w_{t+1} h_{t+1} (z_{t+1}^{*} + \varepsilon z_G) = \gamma [I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G] \tag{17}$$

and the indirect utility

$$u_{2t+1}^{*} = (1-\gamma)^{1-\gamma} \gamma^{\gamma} [I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G] [(1-\tau_w) w_{t+1} h_{t+1}]^{-\gamma}$$

Comparing equations (3) and (17), we can recognize an additional benefit of the child's human capital. The parent values one unit of formal care exactly at the same price as informal care $(1-\tau_w) w_{t+1} h_{t+1}$. Even if they are imperfect substitutes, it can be shown that the valuation of formal care is positively related to the child's human capital. The higher the degree of substitution, the larger the valuation effect of the child's human capital.

The maximization problem in the working period is formulated as

$$V(h_t) = \max \quad \ln c_{1t} + \beta \ln u_{2t+1}^{*} + \rho V(h_{t+1})$$

subject to

$$b_t + (1-\tau_w) w_t h_t (l_t + z_G) = c_{1t} + s_t$$
$$(1 + r_{t+1}) s_t = I_{t+1}$$
$$e_t + l_t + z_G + z_t = 1$$
$$h_{t+1} = h_t \varphi(e_t)$$

One of the differences from the previous section is the opportunity of employment. He can choose to supply labor either in the production sector l_t or in the care sector z_G.

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Rearranging the constraints, the maximization problem is reformulated as

$$V(h_t) = \max \quad \ln c_{1t} + \beta \ln [I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G] - \beta\gamma \ln h_{t+1} + \rho V(h_{t+1})$$

subject to

$$(1-\tau_w) w_t h_t (1-e_t) = c_{1t} + \frac{I_{t+1}}{1+r_{t+1}} \tag{18}$$

Assuming the interior solutions, the first-order conditions require

$$\frac{1}{c_{1t}} - \lambda_{1t} = 0 \tag{19}$$

$$\frac{\beta}{I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G} - \frac{\lambda_{1t}}{1+r_{t+1}} = 0 \tag{20}$$

$$-\lambda_{1t} (1-\tau_w) w_t h_t + \lambda_{2t} h_t \varphi'(e_t) = 0 \tag{21}$$

$$\frac{\beta (1-\tau_w) w_{t+1} \varepsilon z_G}{I_{t+1} + (1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G} - \frac{\beta\gamma}{h_{t+1}} + \rho \frac{dV_{t+1}}{dh_{t+1}} - \lambda_{2t} = 0 \tag{22}$$

Equation (22) stands for the cost and benefit of the child's human capital. Comparing with equation (10), we can see the first term stands for the valuation effect. From the envelope theorem, we have

$$\frac{dV_t}{dh_t} = \lambda_{1t} (1-\tau_w) w_t \left(1 - e_t + \frac{e_t}{\eta}\right) \tag{23}$$

Substituting equations (20), (21), and (23) into equation (22), we have

$$\lambda_{1t} G_{t+1} - \beta\gamma + \rho \lambda_{1t+1} (1-\tau_w) w_{t+1} h_{t+1} \left(1 - e_{t+1} + \frac{e_{t+1}}{\eta}\right) - \lambda_{1t} (1-\tau_w) w_t h_t \frac{e_t}{\eta} = 0 \tag{24}$$

where G_{t+1} stands for the present value of formal care

$$G_{t+1} = \frac{(1-\tau_w) w_{t+1} h_{t+1} \varepsilon z_G}{1+r_{t+1}} \tag{25}$$

The first term in equation (24) stands for the valuation effect.

On the other hand, equations (18), (19), and (20) give us

$$c_{1t} = \frac{1}{1+\beta} [(1-\tau_w) w_t h_t (1-e_t) + G_{t+1}]$$

$$s_t = \frac{1}{1+\beta} [\beta (1-\tau_w) w_t h_t (1-e_t) - G_{t+1}]$$

The technology in the good production sector is the same as the previous section. The production cost of formal care $w_t h_t z_G$ is financed by worker's contribution $\tau_w w_t h_t (l_t + z_G)$ and firm's contribution $\tau_f w_t h_t l_t$. The balanced budget requires

$$(\tau_w + \tau_f) w_t h_t l_t = (1-\tau_w) w_t h_t z_G$$

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Market clearing conditions are the same as the previous section. The derivation in detail is put aside to Appendix 2.

It can be shown that the core equation in the transfer in kind scheme (24) is transformed to

$$\frac{\rho e_{t+1}}{1-e_{t+1}} = \frac{e_t}{1-e_t} - \eta\left\{\rho - \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{1+\beta+\varepsilon\theta}\right\} \tag{26}$$

The only difference between equations (13) and (26) is the constant term, namely the intercept $A(\theta)$ in Figure 1.

The interior condition for informal care (16) requires

$$\gamma-(1-\gamma)\varepsilon\theta \geqslant 0 \tag{27}$$

and the interior condition for education requires

$$\rho > \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{1+\beta+\varepsilon\theta}$$

In the same way in the previous section, the equilibrium e^{**} is unstable since $\rho \in (0,1)$. Contrasted with the previous section, e^{**} is increasing in θ because the intercept $A(\theta)$ is increasing in θ. The transfer in kind promotes human capital investment and also economic growth. Equation (24) explains the reason. In Appendix 2, we have

$$\lambda_{1t}(1-\tau_w)w_t h_t(1-e_t) = \frac{1+\beta+\varepsilon\theta}{1+\varepsilon\theta}$$

$$\lambda_{1t}G_{t+1} = \frac{\beta\varepsilon\theta}{1+\varepsilon\theta}$$

Conventional benefit and cost of human capital, which are represented respectively by the third and fourth term in equation (24), decrease proportionally in response to the transfer policy. The disincentive effect of the strategic behavior, the second term, is negative and constant as shown in the previous section. The first term $\lambda_{1t}G_{t+1}$ stands for the positive valuation effect, which increases with transfer policy. Therefore, the net effect on education is positive. When γ tends to zero, the interior condition (27) implies the policy is irrelevant to education. It is because the strategic behavior concerning caregiving is the only source of inefficiency.

Comparative statics results are similar to the previous section. e^{**} increases with ρ, η, ε, and decreases with β and γ. Education is higher when altruism is stronger, human capital formation is more efficient, people are more patient and less interested in informal care, and the formal care sector is more cost effective than informal care. In sum, we have the following proposition.

Proposition 2. *The education in transfer in kind scheme is given by*

$$\frac{e^{**}}{1-e^{**}} = \frac{\eta\rho}{1-\rho}\left\{1 - \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{\rho(1+\beta+\varepsilon\theta)}\right\} \tag{28}$$

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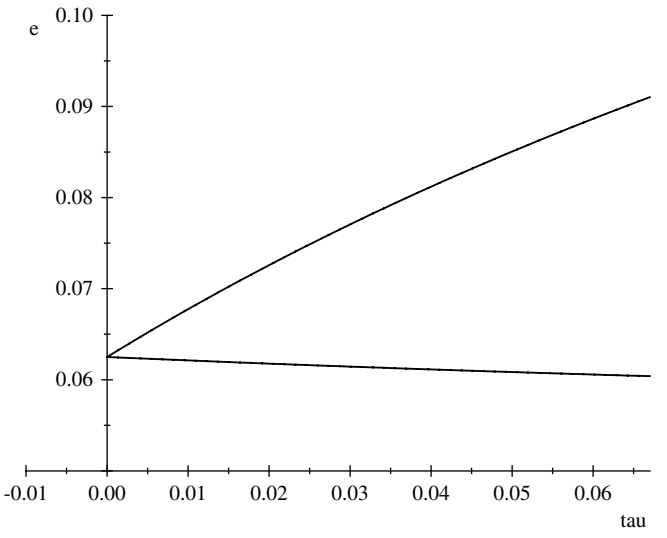


Fig. 2. Education, cash versus in-kind

where $\gamma-(1-\gamma)\varepsilon\theta \geqslant 0$. *The education is increasing in* θ *because the positive valuation effect dominates the disincentive effect in the strategic behavior. The transfer in kind scheme promotes economic growth.*

Figure 2 compares the education effect of transfer policies. The lower curve is e^* in equation (15) and the upper curve is e^{**} in equation (28). The horizontal axis is a contribution rate, instead of θ, based on the fifty–fifty rule ($\tau_w=\tau_f=\tau$) which several countries have adopted. Assumed parameters are: $\eta=0.4$, $\beta=0.5$, $\rho=0.2$, $\gamma=0.2$, $\alpha=1/3$, and $\varepsilon=1$. From equation (14), $\theta=4\tau/(1+\tau)$ and equation (27) requires $\tau \leqslant 6.67\%$.

The time share of child education in the laissez-faire is 6.25%. Under the transfer in cash scheme, the share decreases slowly. When the contribution rate is 6.67%, the share dips to 6.04%. The impact is fairly modest. Under the transfer in kind scheme, the time share increases sharply. One of the reasons is of course the assumption of perfect substitution. When the contribution rate is 6.67%, the share ups to 9.10%. We know the impact of the valuation effect on education is much larger than the disincentive effect.

3 Discussions

3.1 Welfare

The previous section demonstrates that transfer for elderly people should be in kind rather than in cash in the context of economic growth. This section shows it is also true in the context of welfare in some circumstances.

It is a strategic behavior about informal care within the family that causes inefficiency. If parents can access to the market of care services, the inefficiency would vanish. From the fact that the rate of return from human capital is higher than that

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from non-human capital, however, education in the laissez-faire is likely to be insufficient. If it is the case, a transfer policy to promote education would be welfare-improving. The transfer should be in kind rather than in cash in the context of welfare.

The procedure of the exercise is as follows. First, we characterize the social optimum. Second, we derive a sufficient condition for the optimal contribution rate to be positive in the transfer in kind scheme. Finally, we confirm that the equilibrium is the second-best optimal because of the excess burden of labor income taxation.

Iterating to substitute the utility functions toward the future, we can formulate a social planner's problem as of period zero as

$$V_0 = \max \sum_{t=0}^{\infty} \rho^t [\ln c_{1t} + \beta(1-\gamma) \ln c_{2t+1} + \beta\gamma \ln (z_{t+1} + \varepsilon z_{Gt+1})]$$

subject to

$$f(k_t, h_t l_t) = c_{1t} + c_{2t} + k_{t+1}$$

$$h_{t+1} = h_t \varphi(e_t)$$

$$e_t + l_t + z_t + z_{Gt} = 1$$

Obviously the product efficiency requires $z_{Gt} = 0$ ($z_t = 0$) when $\varepsilon < 1$ ($\varepsilon > 1$). Thus we assume $\varepsilon = 1$. The derivation of the solution is set aside to Appendix 3. It can be shown that the law of motion is determined by the following simultaneous difference equations of e_t and x_t.

$$\eta\rho x_t = \frac{e_t}{1-e_t} \left\{ \beta\gamma + \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{1 - \rho\alpha \frac{\varphi(e_t)}{\varphi(e_{t-1})}} \right\} \tag{29}$$

$$\rho x_{t+1} = x_t - \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{1 - \rho\alpha \frac{\varphi(e_{t+1})}{\varphi(e_t)}} \tag{30}$$

where $x_t = \lambda_{2t} h_{t+1}$ stands for current value of human capital. Equation (29) regulates $x_t = x(e_{t-1}, e_t)$ and also $x_{t+1} = x(e_t, e_{t+1})$. Substituting them into equation (30), we have a second-order difference equation of e_t.

Figure 3 illustrates the equilibrium and the comparative dynamics. The equilibrium is unique and unstable. Suppose that the economy stays at the equilibrium E until period $T-1$ ($e_{t-1} = e^*$ for $\forall t \leqslant T$) and that education in period T increases ($e_T > e^*$). First, the current value of human capital increases ($x_T > x^*$) from equation (29). Second, to adjust the cost and benefit of human capital, which is represented by equation (30), the line has to shift rightward. It implies $e_{T+1} > e_T$. The procedure continues forever. In the same way, if $e_T < e^*$, then $e_{T+1} < e_T$. Therefore, the equilibrium is unstable.

From equations (29) and (30), the optimal education is given by

$$\frac{e}{1-e} = \frac{\eta\rho}{1-\rho} \left\{ 1 - \frac{\beta\gamma(1-\rho\alpha)}{\beta\gamma(1-\rho\alpha) + (1-\alpha)[\rho + \beta(1-\gamma)]} \right\} \tag{31}$$

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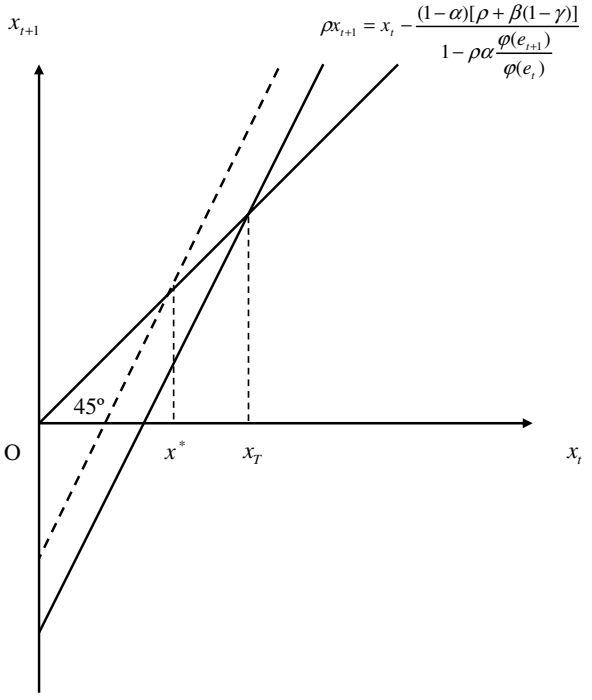


Fig. 3. Social Optimum

When $\gamma=0$, we have $e^*=e^{**}=e=\eta\rho/[1-(1-\eta)\rho]$.[7] It is because the only source of inefficiency arises from the strategic behavior about informal care in our model. Comparing equations (26) with $\varepsilon=1$ and (31), we have the following proposition.

Proposition 3. *The transfer in kind scheme achieves the optimal education if and only if*

$$\theta^*=\frac{\gamma(1-\rho)\{\beta(1-\rho\alpha)-\alpha[\rho+\beta(1-\gamma)]\}}{[\rho+\beta(1-\gamma)][1-\alpha+\gamma\alpha(1-\rho)]} \tag{32}$$

From equation (32), we know the contribution rate is positive if and only if

$$\beta(1-\rho\alpha)-\alpha[\rho+\beta(1-\gamma)]>0 \tag{33}$$

The condition (33) is more likely to be satisfied for larger γ and β and smaller ρ and α.[8] The scheme is effective when the distortion of strategic behavior is large, altruism is small, and people are more patient.

[7] Under the transfer in kind scheme, the interior condition (27) ensures $\lim_{\gamma\to 0} e^{**}=e$. The positive relationship between thriftiness and growth is well known. See Lucas (1988) and Caballé (1995).

[8] The condition (33) can be transformed to

$$1-\gamma<\frac{1}{\alpha}-\rho\left(1+\frac{1}{\beta}\right)$$

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To show that equation (32) is not the first best, we examine how the transfer in kind scheme improves resource allocations. From appendices 2 and 3, we know that the resource allocation under the transfer in kind scheme with $\varepsilon = 1$ is given by

$$\frac{k_{t+1}}{y_t} = \frac{\beta[1-\alpha(1-\gamma)(1+\theta)]}{1+\beta+\theta}$$

$$\frac{c_{1t}}{y_t} = \frac{(1+\theta)[1-\alpha(1-\gamma)(1+\theta)]}{1+\beta+\theta}$$

$$\frac{c_{2t}}{y_t} = \alpha(1-\gamma)(1+\theta)$$

and that the optimal allocation is given by

$$\frac{k_{t+1}}{y_t} = \frac{\rho(1-\rho\alpha)}{\rho+\beta(1-\gamma)}$$

$$\frac{c_{1t}}{y_t} = \frac{\beta(1-\gamma)(1-\rho\alpha)}{\rho+\beta(1-\gamma)}$$

$$\frac{c_{2t}}{y_t} = \rho\alpha$$

Comparing them, we have the following proposition.

Proposition 4. *The transfer in kind scheme achieves the optimal allocation if and only if*

$$\theta^{**} = \frac{\beta(1-\rho\alpha)-\alpha[\rho+\beta(1-\gamma)]}{\alpha[\rho+\beta(1-\gamma)]} \tag{34}$$

The scheme is also effective in the context of resource allocation if the condition (33) is satisfied.

Finally, comparing equations (32) and (34), we have the following proposition.

Proposition 5. *Suppose that the transfer in kind scheme is effective. The contribution rate to restore the optimal education is smaller than that to restore the optimal allocation. The scheme is not the first-best solution.*

Proof From (32) and (34), we have

$$\theta^{**} - \theta^{*} = \frac{(1-\alpha)\{\beta(1-\rho\alpha)-\alpha[\rho+\beta(1-\gamma)]\}}{\alpha[1-\alpha+\gamma\alpha(1-\rho)][\rho+\beta(1-\gamma)]}$$

which is positive when the condition (33) is satisfied. □

Using parameters in section 2.2 and assuming the fifty–fifty rule, equations (32) and (34) give $\tau = 2.53\,\%$ and $\tau = 50.0\,\%$, respectively. The optimal allocation cannot be

One of the sufficient conditions is that the right-hand side is greater than one, i.e.

$$\rho \leqslant \frac{\beta}{1+\beta}\frac{1-\alpha}{\alpha}$$

which is more likely to be satisfied for a larger β and smaller ρ and α.

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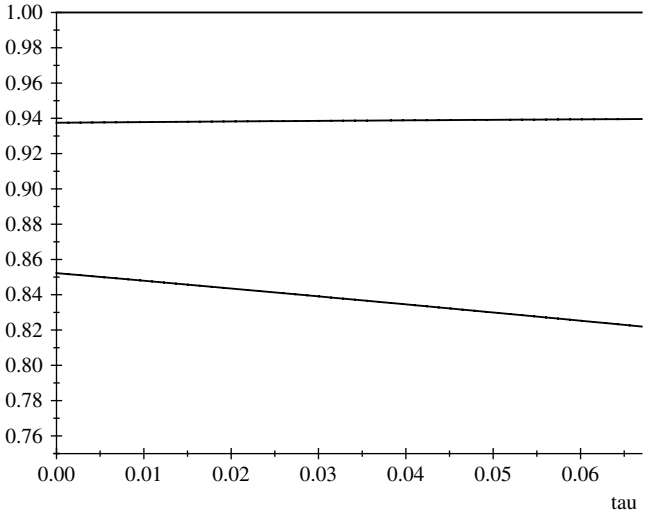


Fig. 4. Time allocation, cash

feasible because the latter value violates the interior condition (27). However, a modest transfer in kind scheme can restore the optimal education and improve welfare.

3.2 Time allocation

The previous section demonstrates that some kind of transfer policy for elderly people should be in kind rather than in cash in the context of economic growth and welfare. Another merit can be pointed out, namely employment. Since the public provision of formal care widens the opportunity of employment, it is likely to improve the rate of employment by releasing informal parental care from the family.

Appendix 1 shows that labor and informal care under transfer in cash scheme are given by

$$l = \frac{1-\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\theta)}(1-e^*)$$

$$z = \frac{\gamma\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\theta)}(1-e^*)$$

The education e^* is given by equation (15). Since e^* is decreasing in θ, the informal care z increases with θ. The negative relationship between education and informal care is consistent with an empirical finding in Engers and Stern (2002). The effect on an employment rate, which is measured by the working time l, is ambiguous because the share effect is negative and the education effect is positive.[9]

Figure 4 illustrates the changes in time allocation under transfer in cash scheme. It indicates education, informal care, and labor from top to bottom. In this case, the employment rate decreases with the transfer policy.

[9] Pezzin and Schone (1999) show that the effect of education on labor supply is ambiguous.

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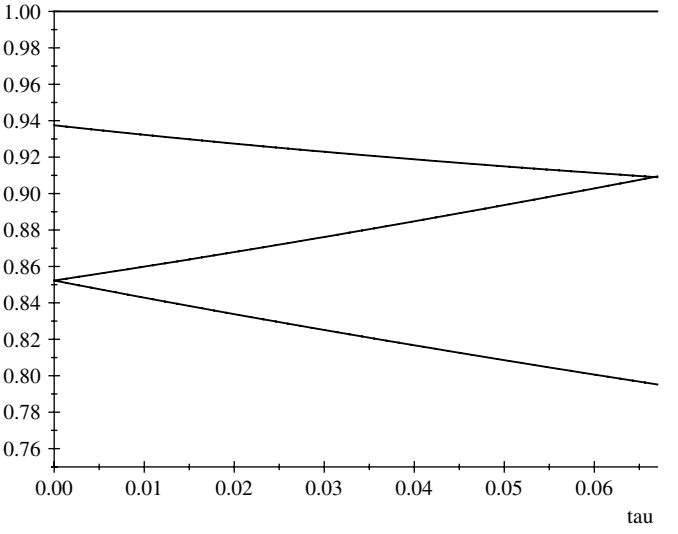


Fig. 5. Time allocation, in-kind

Appendix 2 shows that employment in the good sector l and the care sector z_G, and informal care z under transfer in kind scheme are given by

$$l = \frac{1-\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**})$$

$$z_G = \frac{\alpha\theta}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**})$$

$$z = \frac{\alpha[\gamma-(1-\gamma)\varepsilon\theta]}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**})$$

Since e^{**} is increasing in θ, both employment in the good sector l and informal care z decrease with θ. The negative relationship between education and informal care is observed again. The effect on employment in the care sector z_G is ambiguous because the share effect is positive and the education effect is negative. However, it is likely that z_G increases with θ and that total employment $l+z_G$ also increases.

Figure 5 illustrates the changes in time allocation under transfer in kind scheme. It indicates education, informal care, employment in the care sector, and the good production sector from top to bottom. The negative relationship between formal and informal care is consistent with Hoerger *et al.* (1996) and Pezzin and Schone (1999). Informal care is entirely crowded out at the upper bound of $\tau = 6.67\%$. In our specification, both total employment $l+z_G$ and the amount of care service parents receive $z+\varepsilon z_G$ increase when the scheme expands.

3.3 Individual accounts

Miyazawa (2004) demonstrates that a social security system financed by a labor income tax has a decent impact on economic growth under individual accounts, which

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means that a social security benefit received in retirement is tied with choices in middle age, such as labor, education, and savings. The same logic applies to this model. Under the transfer in cash scheme in Section 2.1, suppose that a parent in middle age expects to receive a social security benefit

$$P_{t+1}=(\tau_w+\tau_f)w_{t+1}h_{t+1}l_{t+1}$$

in retirement. Then, he has an incentive to invest in his child's human capital because the investment will be paid back as the social security benefit. It can be shown that the transfer in cash scheme under individual accounts rule is the same policy effect as the transfer in kind scheme in Section 2.2. Moreover, the effect can be larger if the valuation effect is smaller, which corresponds to a case in which formal care is less substitute for informal care. The superiority of transfer in kind over in cash vanishes. However, the individual accounts rule would face the problem of administration cost and real effectiveness. Diamond (2004) shows a rather negative point of view with respect to labor incentives related to the individual accounts.

Concluding remarks

This paper demonstrates that transfer in kind matters in old age support programs. The reason for this is that an old parent values publicly provided services in terms of his child's human capital, which promotes human capital investment in middle age. This valuation effect is intrinsic in transfer in kind, which should not be neglected when a market of care service is incomplete or absent.

There is scope for future analyses. First, perfect substitution between formal and informal care is restrictive. With a more general function, such as CES function and plausible parameters, we would have a relevant solution numerically. It would be expected that the positive valuation effect is weakened, while the qualitative characteristics would not be changed. Second, it would be useful to incorporate living arrangements into the model. Pezzin *et al.* (1996) show that the substitution between formal and informal care is relatively small, and that a generous public home care program significantly increases the probability that unmarried persons will live independently, and reduces the probability of living in shared households or in nursing or personal care homes. A proper transfer in kind would alleviate the inefficiency caused by a strategic behavior concerning living arrangements. Third, it is well known that an older daughter plays an important role as a primary carer except for the spouse of the cared-for. It could be an outcome of a strategic behavior concerning caregiving among siblings. To endogenize the selection of primary carer and examine the behavioral response to a policy change would be an important theoretical topic in the issue of whether transfer in kind matters in old age support programs. Finally, to incorporate uncertainty seems interesting. Diamond (2004) emphasizes annuitization as one of the most important roles of public pensions.

Diamond (2004) also mentions auxiliary benefits. We believe that our results meet his insight. It says: 'we are learning more about the way in which the allocation of resources within the family does not conform to a single maximization with a single budget constraint. Since the government cares about the different family members

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(and not just the worker), direct allocations to family members matter since they will change the allocation of resources within the family. Protecting family members is a role governments have recognized for centuries.'

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Appendix 1

[Transfer in cash scheme]
The equilibrium is characterized by the following ten equations

$$e_t + l_t + z_t = 1 \tag{A1.1}$$

$$\frac{1}{\lambda_t} = \frac{1}{1+\beta}\left[(1-\tau_w)w_t h_t(1-e_t) + \frac{P_{t+1}}{1+r_{t+1}}\right] \tag{A1.2}$$

$$s_t = \frac{1}{1+\beta}\left[\beta(1-\tau_w)w_t h_t(1-e_t) - \frac{P_{t+1}}{1+r_{t+1}}\right] \tag{A1.3}$$

$$\frac{I_{t+1}}{1+r_{t+1}} = \frac{\beta}{\lambda_t} \tag{A1.4}$$

$$(1-\tau_w)w_{t+1}h_{t+1}z_{t+1} = \gamma I_{t+1} \tag{A1.5}$$

$$\rho\lambda_{t+1}(1-\tau_w)w_{t+1}h_{t+1}[e_{t+1} - \eta(1-e_{t+1})] = \lambda_t(1-\tau_w)w_t h_t e_t + \eta\beta\gamma \tag{A1.6}$$

$$(1+r_t)k_t = \alpha y_t \tag{A1.7}$$

$$(1+\tau_f)w_t h_t l_t = (1-\alpha)y_t \tag{A1.8}$$

$$(\tau_w + \tau_f)w_t h_t l_t = P_t \tag{A1.9}$$

$$k_{t+1} = s_t \tag{A1.10}$$

From (A1.7), (A1.8), and (A1.9)

$$\frac{P_{t+1}}{1+r_{t+1}} = \frac{1-\alpha}{\alpha}\frac{\tau_w + \tau_f}{1+\tau_f}k_{t+1} = \theta k_{t+1} \tag{A1.11}$$

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Substituting (A1.11) into (A1.3) and using (A1.10)

$$k_{t+1}=\frac{\beta(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\theta} \tag{A1.12}$$

$$\frac{P_{t+1}}{1+r_{t+1}}=\frac{\beta\theta(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\theta} \tag{A1.13}$$

Substituting (A1.13) into (A1.2)

$$\frac{1}{\lambda_t}=\frac{(1+\theta)(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\theta} \tag{A1.14}$$

Substituting (A1.14) into (A1.6), and rearranging, we have

$$\frac{\rho e_{t+1}}{1-e_{t+1}}=\frac{e_t}{1-e_t}-\eta\left[\rho-\frac{\beta\gamma(1+\theta)}{1+\beta+\theta}\right] \tag{A1.15}$$

which is equation (13) in the main body. The condition $e^* \in (0, 1)$ requires

$$\rho>\frac{\beta\gamma(1+\theta)}{1+\beta+\theta}$$

Since $\rho \in (0, 1)$, the sequence $\{e_t/(1-e_t)\}$ diverges unless $e_{t+1}=e_t=e^*$. The steady state is unstable. There is no transition.

From (A1.15), we have

$$\frac{e^*}{1-e^*}=\frac{\eta\rho}{1-\rho}\left[1-\frac{\beta\gamma(1+\theta)}{\rho(1+\beta+\theta)}\right]$$

which is equation (15) in the main body.

[Time allocation]

From (A1.7) and (A1.8)

$$\frac{(1+\tau_f)w_{t+1}h_{t+1}l_{t+1}}{1+r_{t+1}}=\frac{1-\alpha}{\alpha}k_{t+1}$$

Substituting (A1.4) and (A1.14) into (A1.5)

$$\frac{(1-\tau_w)w_{t+1}h_{t+1}z_{t+1}}{1+r_{t+1}}=\gamma(1+\theta)k_{t+1}$$

Dividing both sides and arranging

$$\frac{z}{l}=\frac{\gamma\alpha(1+\theta)}{1-\alpha(1+\theta)} \tag{A1.16}$$

Solving (A1.1) and (A1.16), we have

$$\begin{aligned} l&=\frac{1-\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\theta)}(1-e^*)\\ z&=\frac{\gamma\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\theta)}(1-e^*) \end{aligned} \tag{A1.17}$$

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[Resource allocation]

From (A1.8), (A1.12), and (A1.17)

$$\frac{k_{t+1}}{y_t} = \frac{\beta[1-\alpha(1+\theta)]}{1+\beta+\theta}\frac{1-e^*}{l} = \frac{\beta[1-\alpha(1-\gamma)(1+\theta)]}{1+\beta+\theta}$$

From (A1.12) and (A1.14)

$$c_{1t} = \frac{1}{\lambda_t} = \frac{1+\theta}{\beta}k_{t+1}$$

Therefore

$$\frac{c_{1t}}{y_t} = \frac{(1+\theta)[1-\alpha(1-\gamma)(1+\theta)]}{1+\beta+\theta}$$

From (A1.4) and (A1.7)

$$\begin{aligned} c_{2t+1} &= (1-\gamma)I_{t+1} \\ &= \frac{\beta(1-\gamma)}{\lambda_t}(1+r_{t+1}) \\ &= (1-\gamma)(1+\theta)(1+r_{t+1})k_{t+1} \\ &= \alpha(1-\gamma)(1+\theta)y_{t+1} \end{aligned}$$

which completes the proof.

Appendix 2

[Transfer in kind scheme]

The equilibrium is characterized by the following 11 equations

$$e_t + l_t + z_G + z_t = 1 \tag{A2.1}$$

$$\frac{1}{\lambda_t} = \frac{1}{1+\beta}[(1-\tau_w)w_t h_t(1-e_t) + G_{t+1}] \tag{A2.2}$$

$$I_{t+1} = (1+r_{t+1})s_t \tag{A2.3}$$

$$s_t = \frac{1}{1+\beta}[\beta(1-\tau_w)w_t h_t(1-e_t) - G_{t+1}] \tag{A2.4}$$

$$(1-\tau_w)w_{t+1}h_{t+1}(z_{t+1}+\varepsilon z_G) = \gamma[I_{t+1} + (1-\tau_w)w_{t+1}h_{t+1}\varepsilon z_G] \tag{A2.5}$$

$$G_{t+1} = \frac{(1-\tau_w)w_{t+1}h_{t+1}\varepsilon z_G}{1+r_{t+1}} \tag{A2.6}$$

$$\rho\lambda_{t+1}(1-\tau_w)w_{t+1}h_{t+1}[\eta(1-e_{t+1})+e_{t+1}] = \lambda_t(1-\tau_w)w_t h_t e_t + \eta(\beta\gamma - \lambda_t G_{t+1}) \tag{A2.7}$$

$$(1+r_t)k_t = \alpha y_t \tag{A2.8}$$

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$$(1+\tau_f)w_t h_t l_t = (1-\alpha)y_t \tag{A2.9}$$

$$(\tau_w+\tau_f)w_t h_t l_t = (1-\tau_w)w_{t+1}h_{t+1}z_G \tag{A2.10}$$

$$k_{t+1} = s_t \tag{A2.11}$$

Substituting (A2.10) into (A2.6), and using (A2.8) and (A2.9)

$$G_{t+1} = \varepsilon \frac{1-\alpha}{\alpha}\frac{\tau_w+\tau_f}{1+\tau_f}k_{t+1} = \varepsilon\theta k_{t+1} \tag{A2.12}$$

Substituting (A2.12) into (A2.4) and using (A2.11)

$$k_{t+1} = \frac{\beta(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\varepsilon\theta} \tag{A2.13}$$

$$G_{t+1} = \frac{\beta\varepsilon\theta(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\varepsilon\theta} \tag{A2.14}$$

Substituting (A2.14) into (A2.2)

$$\frac{1}{\lambda_t} = \frac{(1+\varepsilon\theta)(1-\tau_w)w_t h_t(1-e_t)}{1+\beta+\varepsilon\theta} \tag{A2.15}$$

Substituting (A2.14) and (A2.15) into (A2.7), and rearranging

$$\frac{\rho e_{t+1}}{1-e_{t+1}} = \frac{e_t}{1-e_t} - \eta\left\{\rho - \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{1+\beta+\varepsilon\theta}\right\} \tag{A2.16}$$

which is equation (26) in the main body.

From the assumption (16), we have

$$\gamma-(1-\gamma)\varepsilon\theta \geqslant 0$$

The condition $e^{**} \in (0, 1)$ requires

$$\rho > \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{1+\beta+\varepsilon\theta}$$

Since $\rho \in (0, 1)$, the sequence $\{e_t/(1-e_t)\}$ diverges unless $e_{t+1}=e_t=e^{**}$. The steady state is unstable. There is no transition.

From equation (A2.16), we have

$$\frac{e^{**}}{1-e^{**}} = \frac{\eta\rho}{1-\rho}\left\{1 - \frac{\beta[\gamma-(1-\gamma)\varepsilon\theta]}{\rho(1+\beta+\varepsilon\theta)}\right\}$$

which gives equation (27).

[Time allocation]

From (A2.10)

$$\alpha\theta l = [1-\alpha(1+\theta)]z_G \tag{A2.17}$$

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From (A2.3) and (A2.11), $I_{t+1}=(1+r_{t+1})k_{t+1}$.

Therefore (A2.5) gives

$$z+(1-\gamma)\varepsilon z_G=\frac{\gamma(1+r_{t+1})k_{t+1}}{(1-\tau_w)w_{t+1}h_{t+1}}$$

Substituting (A2.8) and (A2.9) into the right-hand side, and rearranging

$$\theta z=[\gamma-(1-\gamma)\varepsilon\theta]z_G \tag{A2.18}$$

Solving (A2.1), (A2.17), and (A2.18), we have

$$l=\frac{1-\alpha(1+\theta)}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**}) \tag{A2.19}$$

$$z_G=\frac{\alpha\theta}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**}) \tag{A2.20}$$

$$z=\frac{\alpha[\gamma-(1-\gamma)\varepsilon\theta]}{1-\alpha(1-\gamma)(1+\varepsilon\theta)}(1-e^{**}) \tag{A2.21}$$

[Resource allocation]

From (A2.9), (A2.13), and (A2.19)

$$\begin{aligned}\frac{k_{t+1}}{y_t}&=\frac{\beta[1-\alpha(1+\theta)]}{1+\beta+\varepsilon\theta}\frac{1-e^{**}}{l}\\&=\frac{\beta[1-\alpha(1-\gamma)(1+\varepsilon\theta)]}{1+\beta+\varepsilon\theta}\end{aligned}$$

From (A2.13) and (A2.15)

$$c_{1t}=\frac{1}{\lambda_t}=\frac{1+\varepsilon\theta}{\beta}k_{t+1}$$

Therefore

$$\frac{c_{1t}}{y_t}=\frac{(1+\varepsilon\theta)[1-\alpha(1-\gamma)(1+\varepsilon\theta)]}{1+\beta+\varepsilon\theta}$$

From (A2.5)

$$\begin{aligned}c_{2t+1}&=(1-\gamma)[I_{t+1}+(1-\tau_w)w_{t+1}h_{t+1}(z_{t+1}+\varepsilon z_G)]\\&=\frac{1-\gamma}{\gamma}(1-\tau_w)w_{t+1}h_{t+1}(z_{t+1}+\varepsilon z_G)\end{aligned}$$

Using (A2.8), (A2.19), (A2.20), and (A2.21), we have

$$\frac{c_{2t}}{y_t}=\alpha(1-\gamma)(1+\varepsilon\theta)$$

which completes the proof.

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Appendix 3

[Social optimum]
Let us set up the Lagrangian

$$\begin{aligned} L = \sum_{t=0}^{\infty} \rho^t \{ & \ln c_{1t} + \beta(1-\gamma) \ln c_{2t+1} + \beta\gamma \ln (z_{t+1} + z_{Gt+1}) \\ & + \lambda_{1t}[f(k_t, h_t l_t) - c_{1t} - c_{2t} - k_{t+1}] \\ & + \lambda_{2t}(h_t \varphi_t - h_{t+1}) \\ & + \lambda_{3t}(1 - e_t - l_t - z_t - z_{Gt})\} \end{aligned}$$

For convenience, we use a notation $\varphi_t = \varphi(e_t)$.

The first-order conditions require

$$\frac{1}{c_{1t}} - \lambda_{1t} = 0 \tag{A3.1}$$

$$\frac{\beta(1-\gamma)}{c_{2t+1}} - \rho\lambda_{1t+1} = 0 \tag{A3.2}$$

$$\frac{\beta\gamma}{z_{t+1} + z_{Gt+1}} - \rho\lambda_{3t+1} = 0 \tag{A3.3}$$

$$\lambda_{1t} f_{2t} h_t - \lambda_{3t} = 0 \tag{A3.4}$$

$$\lambda_{2t} h_t \varphi_t' - \lambda_{3t} = 0 \tag{A3.5}$$

$$\rho\lambda_{1t+1} f_{2t+1} l_{t+1} + \rho\lambda_{2t+1}\varphi_t - \lambda_{2t} = 0 \tag{A3.6}$$

$$\rho\lambda_{1t+1} f_{1t+1} - \lambda_{1t} = 0 \tag{A3.7}$$

$$f(k_t, h_t l_t) - c_{1t} - c_{2t} - k_{t+1} = 0 \tag{A3.8}$$

$$h_t \varphi_t - h_{t+1} = 0 \tag{A3.9}$$

$$1 - e_t - l_t - z_t - z_{Gt} = 0 \tag{A3.10}$$

The transversality conditions are $\lim_{t\to\infty} \rho^t \lambda_{1t} k_{t+1} = 0$ and $\lim_{t\to\infty} \rho^t \lambda_{2t} h_{t+1} = 0$.

From (A3.9), the BGP condition requires

$$\frac{c_{1t+1}}{c_{1t}} = \frac{k_{t+1}}{k_t} = \frac{h_{t+1}}{h_t} = \varphi_t \tag{A3.11}$$

The constant income share implies

$$f_{1t} k_t = \alpha y_t \tag{A3.12}$$

$$f_{2t} h_t l_l = (1-\alpha) y_t \tag{A3.13}$$

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First, substituting (A3.1) into (A3.7), and using (A3.11)

$$f_{1t+1} = \frac{\varphi_t}{\rho} \tag{A3.14}$$

From (A3.12) and (A3.14)

$$\rho\alpha y_t = \varphi_{t-1} k_t \tag{A3.15}$$

[Resource allocation]

Substituting (A3.1), (A3.2), (A3.15), and $k_{t+1} = \varphi_t k_t$ into (A3.8), we have

$$\frac{1}{\lambda_{1t} k_t} = \frac{\varphi_{t-1} - \rho\alpha\varphi_t}{\alpha[\rho + \beta(1-\gamma)]} \tag{A3.16}$$

Therefore, the resource allocation is given by

$$\frac{c_{1t}}{y_t} = \frac{\rho}{\rho + \beta(1-\gamma)} \left(1 - \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}\right)$$

$$\frac{c_{1t}}{y_t} = \frac{\beta(1-\gamma)}{\rho + \beta(1-\gamma)} \left(1 - \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}\right)$$

$$\frac{k_{t+1}}{y_t} = \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}$$

[Education]

Multiplying both side of (A3.5) by e_t and using $\varphi_t' e_t = \eta\varphi_t$, we have

$$\lambda_{3t} e_t = \eta\lambda_{2t} h_{t+1} \tag{A3.17}$$

Multiplying both side of (A3.4) by l_t and using (A3.13), (A3.15) and (A3.16), we have

$$\lambda_{3t} l_t = \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{\rho\left(1 - \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}\right)} \tag{A3.18}$$

Substituting (A3.3), (A3.17), and (A3.18) into (A3.10), we have

$$\lambda_{3t} = \frac{\beta\gamma}{\rho} + \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{\rho\left(1 - \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}\right)} + \eta\lambda_{2t} h_{t+1} \tag{A3.19}$$

Substituting (A3.19) into (A3.17), and rearranging

$$\eta\rho\lambda_{2t} h_{t+1} = \frac{e_t}{1-e_t} \left\{ \beta\gamma + \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{1 - \rho\alpha \frac{\varphi_t}{\varphi_{t-1}}} \right\} \tag{A3.20}$$

which is equation (29) in the main body.

Finally, multiplying both side of (A3.6) by h_{t+1}, and using (A3.9), (A3.13), (A3.15), and (A3.16), we have

$$\rho\lambda_{2t+1} h_{t+2} = \lambda_{2t} h_{t+1} - \frac{(1-\alpha)[\rho + \beta(1-\gamma)]}{1 - \rho\alpha \frac{\varphi_{t+1}}{\varphi_t}} \tag{A3.21}$$

which is equation (30) in the main body.

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[Uniqueness]

At a steady state, equation (A3.21) gives

$$\lambda_{2t}h_{t+1}=\frac{(1-\alpha)[\rho+\beta(1-\gamma)]}{(1-\rho)(1-\rho\alpha)} \tag{A3.22}$$

Substituting this into (A3.20), we have a unique solution

$$\frac{e}{1-e}=\frac{\eta\rho}{1-\rho}\frac{(1-\alpha)[\rho+\beta(1-\gamma)]}{\beta\gamma(1-\rho\alpha)+(1-\alpha)[\rho+\beta(1-\gamma)]}$$

[Time allocation]

Substituting (A3.22) into (A3.19)

$$\lambda_{3t}=\frac{\beta\gamma(1-\rho\alpha)+(1-\alpha)[\rho+\beta(1-\gamma)]}{\rho(1-\rho\alpha)}\frac{1}{1-e}$$

Substituting this into (A3.3) and (A3.18), we have

$$z+z_G=\frac{\beta\gamma(1-\rho\alpha)}{\beta\gamma(1-\rho\alpha)+(1-\alpha)[\rho+\beta(1-\gamma)]}(1-e)$$

$$l=\frac{(1-\alpha)[\rho+\beta(1-\gamma)]}{\beta\gamma(1-\rho\alpha)+(1-\alpha)[\rho+\beta(1-\gamma)]}(1-e)$$

[Instability]

The law of motion is regulated by equations (A3.20) and (A3.21)

$$\phi(e_{t-1},e_t)=\frac{1}{\eta\rho}\frac{e_t}{1-e_t}\left[\beta\gamma+\frac{D}{1-\rho\alpha\frac{\varphi(e_t)}{\varphi(e_{t-1})}}\right] \tag{A3.23}$$

$$\rho\phi(e_t,e_{t+1})=\phi(e_{t-1},e_t)-\frac{D}{1-\rho\alpha\frac{\varphi(e_{t+1})}{\varphi(e_t)}} \tag{A3.24}$$

where $\lambda_{2t}h_{t+1}=\phi(e_{t-1},e_t)$ and $D=(1-\alpha)[\rho+\beta(1-\gamma)]$.

Differentiating (A3.23), and evaluating at e^*, we have

$$\phi_1(e^*,e^*)=-\frac{\alpha}{\eta}\frac{e^*}{1-e^*}\frac{D}{(1-\rho\alpha)^2}\frac{\varphi'(e^*)}{\varphi(e^*)}<0 \tag{A3.25}$$

$$\phi_2(e^*,e^*)=\frac{1}{\eta\rho}\frac{1}{(1-e^*)^2}\left(\beta\gamma+\frac{D}{1-\rho\alpha}\right)+\frac{\alpha}{\eta}\frac{e^*}{1-e^*}\frac{D}{(1-\rho\alpha)^2}\frac{\varphi'(e^*)}{\varphi(e^*)}>0 \tag{A3.26}$$

Let $e_{t-1}=e^*$. Total differentiating (A3.24), and evaluating $e_t=e_{t+1}=e^*$, we have

$$\rho(\phi_1{}^*de_t+\phi_2{}^*de_{t+1})=\phi_2{}^*de_t-\frac{D\rho\alpha}{(1-\rho\alpha)^2}\frac{\varphi'(e^*)}{\varphi(e^*)}(de_{t+1}-de_t)$$

Therefore

$$\left[\rho\phi_2{}^*+\frac{D\rho\alpha}{(1-\rho\alpha)^2}\frac{\varphi'(e^*)}{\varphi(e^*)}\right]de_{t+1}=\left[\phi_2{}^*+\frac{D\rho\alpha}{(1-\rho\alpha)^2}\frac{\varphi'(e^*)}{\varphi(e^*)}-\rho\phi_1{}^*\right]de_t$$

From (A3.25) and (A3.26), $de_{t+1}/de_t>1$. The equilibrium is unstable. There is no transition.

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