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Abstract
We examine the optimality of public long-term care policy, incorporating a Nash game between elderly parents and adult children and transfer-seeking competition among siblings, instead of children's altruism. Results show that when children compete to obtain more bequests from parents in exchange for attention and care, public long-term care policy is socially optimal if long-term care taxation sufficiently benefits parents through the long-term care provision, thereby reducing parental bequests to children, possibly to zero. If taxation insufficiently benefits parents, then formal long-term care policy might not be necessary because parents receive adequate informal care in exchange for bequests to children.

Keywords: bequests, exchange model of intergenerational transfers, long-term care insurance, transfer-seeking children

JEL Classification: D15, H20, H50

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1. Introduction

Increases in longevity tend to increase demand for elderly long-term care because healthy lifetime might not increase at the same pace (Mayhew, 2011). Especially, elderly people who are 80 years old and older are more likely to fall into dependency. Recent declines in family solidarity such as children's mobility and increases in the female labor force participation rate put more pressure on families to care for their dependent parents. Mounting demand for elderly care requires that markets and the state share burdens of providing elderly long-term care with families.

Most reports of the literature related to optimal long-term policy are based on altruism models.[1] Cremer et al. (2013, 2017), among others, analyze optimal long-term care policy when both children's altruism toward the parents and the event of parents' falling into dependency are uncertain. They report that the optimum policy should be a topping-up or opting-out scheme depending on the extent to which children are altruistic toward the parents and whether the long-term care insurance is actuarially fair, or not.

As described in this paper, we examine the optimality of public long-term care policy using a Nash intergenerational-exchange game between elderly parents and adult children and a game between siblings' transfer-seeking competition (Bernheim et al., 1985; Chang and Weisman, 1995; Yakita, 2018), instead of children's altruism.[2] Although few parents plan to leave a larger share of their bequest to children who provide more care in Western Europe countries, more parents are willing to have children for their elderly support in economically developing countries of Asia (Leroux and Pestieau, 2014). The related literature also indicates that few parents make that choice in Japan, but more so than in the other Western countries (Horioka et al., 2018).

We consider a long-term care insurance policy that covers a generation of elderly parents without public intergenerational transfers.[3] Two schemes of elderly care policy have been analyzed in the literature, i.e., opting-out and topping-up schemes (Cremer et al., 2017). In the present setting, in which children provide elderly care to parents in exchange for receiving transfers, a strict opting-out scheme seems implausible. Therefore, we are concerned only with a topping-up scheme of public long-term care policy. Children might also provide attention and care, but only when the parents fall

[1] They include Cremer and Roeder (2013), and Canta and Cremer (2018). An exception is Canta and Cremer (2017).
[2] Sloan and Zhang (2002) describe that the analysis of intergenerational transfers has been based largely on altruism or exchange theories. Yakita (2018) presents an analysis of the effects of pay-as-you-go pensions on the outcome of a Nash game between parents and siblings in an exchange model.
[3] We assume away private long-term insurance. Cremer et al. (2017) report that only thin markets exist for private long-term insurance.

into dependency, in exchange for transfers from them. Results demonstrate that whether the long-term care policy is socially necessary or not depends on the extent to which long-term care taxation benefits elderly parents through long-term care provision. If the net marginal benefits are small because of adequate family elderly care for a given amount of bequest, then the long-term care policy might be undesirable although the taxation might not decrease parental bequests to the children. By contrast, if the net benefits are great, then the public long-term care provision policy is socially desirable.

The next section introduces a model of a two-stage game between parents and children. Section 3 presents an examination of the optimality of actuarially-fair public long-term-care insurance. The final section concludes this paper.

2. Model

The timing of the model is the following. Government moves first and announces its policy (stage 0). Then, parents and children play the following two-stage game. In the first stage, parents choose the amount of their bequest according to a contest success function (CSF). In the second stage their grown-up children simultaneously and non-cooperatively compete for transfers by choosing how much attention to provide to the parents. The CSF characterizes a non-cooperative Nash game among siblings for parental transfers. We assume that the parents credibly commit not to reverse their decision. Parents transfer bequests to the children with the promise that parents receive attention and care from the children if they become dependent and nothing if they are autonomous. We also assume that parents do not distribute bequests until after the state of nature is revealed. We use backward induction to solve for the sub-game perfect Nash equilibrium in this two-stage game.

We first solve for the children's choices of time allocation given the CSF and parental bequests for the contest. We then solve for the optimal consumption and transfer decisions of the parents in the first stage of the game. For simplicity, we assume that each parent couple has two children.[4] Finally, government chooses the tax rate for long-term care provision to maximize the parents' welfare.

Each child couple is risk neutral. Each has one unit of time endowment available for working outside the home and for transfer-seeking activities. We assume that there are only two types of children and that children of two types make up a couple. We also assume away the issue of matching in marriage as given exogenously. The market wage

[4] Although we can consider children of more than two types, we assume away the fertility decisions of parents in this paper.

rates for the children of two types are given by constant $w_i > 0$ $(i = 1, 2)$.[5]

The transfer share of child i is denoted by the CSF as $p_i = a_i / (a_1 + a_2)$, where $a_i \geq 0$ stands for a fraction of child i's time endowment, which is devoted to attention and care toward parents as transfer-seeking activities $(i = 1, 2)$. Given that parents determine the total amount of bequest, the child simultaneously and non-cooperatively chooses the time allocation between attention toward elderly parents and market labor to maximize their respective incomes as

$$y_i = \pi(1 - a_i)w_i + (1 - \pi)w_i + p_i B, \tag{1}$$

where π represents the probability that the parents become dependent. The probability is assumed to be given exogenously, as reported in the related literature. The child provides attention and care to the parents only when they need elderly care.

The first-order condition is given as

$$\pi w_i = \frac{a_j}{(a_1 + a_2)^2} B \quad (i, j = 1, 2; i \neq j). \tag{2}$$

By way of a similar argument, we can obtain the optimal plan for the other type of children. Therefore, we obtain the Nash equilibrium between children as

$$a_i = \frac{w_j}{\pi(w_1 + w_2)^2} B \quad (i, j = 1, 2; i \neq j). \tag{3}$$

Using (1) and (3), we can readily demonstrate that an increase in bequests from the parents increases the after-transfer income of the children, i.e., $\partial y_i / \partial B > 0$. Therefore, children have an incentive to participate in transfer-seeking activities. The total transfer-seeking investment is measured in terms of the total amount of time contributed by all children as

$$a_1 + a_2 = \frac{B}{\pi(w_1 + w_2)}. \tag{4}$$

The higher the probability of parents' dependency, the less children's attention and care are for given bequests. To receive a given level of attention and care from the children, parents must bequeath more if the probability of dependency becomes higher. Eq. (4) also demonstrates that given the probability of dependency, the smaller attention and care those parents can receive in exchange for a given bequest are, the higher the wage rates of children are.

Next, we turn to the optimization of parents in stage 1. Following Chang and Weisman

[5] They might be equal. One of important ingredients of the present model is sibling competition for bequests.

(2005), we assume that transfers are compensated when time spent by children is valuable. Parents take a public long-term policy as given. The budget constraint of the policy scheme is given as

$$T = \tau(Y - B)/\pi\,, \tag{5}$$

where Y represents the parents' pre-transfer income, $\tau \in [0,1)$ denotes the tax rate for elderly long-term care insurance, and T stands for the long-term insurance benefits.[6] We assume that the pre-transfer income of parents is sufficiently great.[7] Elderly people of the parental generation pay taxes, but only those who become dependent receive benefits. Budget constraint (5) demonstrates that the long-term insurance is actuarially fair. For expositional simplicity, we assume that parents know how much they receive when they fall into dependency.

Parents as a couple are assumed to have the following unitary utility function.

$$U = (1-\tau)(Y - B) + \pi H(T + (a_1 + a_2))\,, \tag{6}$$

where H represents the utility from the long-term elderly care, which is the sum of the public long-term insurance benefits and family care provided by the children. For simplicity, we assume that a unit of public insurance benefits can be transformed to a unit of care services.[8] We assume that function H is concave, i.e., $H' > 0$ and $H'' < 0$. We also assume that $H(0) = 0$ and $H'(0) = \infty$.

Parents choose the amount of bequests to maximize their utility. The first-order condition is given as

$$\frac{dU}{dB} = -(1-\tau) + H'[\frac{\tau}{\pi}(Y - B) + \frac{B}{\pi(w_1 + w_2)}]\cdot(\frac{1}{w_1 + w_2} - \tau) = 0\,. \tag{7}$$

Assuming an interior solution of the parents' utility maximization problem, one can rewrite the condition as

$$H'[\frac{\tau}{\pi}(Y - B) + \frac{B}{\pi(w_1 + w_2)}] = \frac{1-\tau}{1/(w_1 + w_2) - \tau}\,, \tag{8}$$

where it must hold that $1/(w_1 + w_2) - \tau > 0$ for $H' > 0$.[9] From (8), we obtain the

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[6] We assume here that transfers are exempted for long-term care taxation. Some countries such as New Zealand have no gift taxes and a certain amount of gift to children is exempted in some countries such as the U.S.A. and Japan.

[7] Pre-transfer income of parents is assumed to satisfy $Y - B > 0$ for any chosen $B \geq 0$.

[8] For analytical simplicity, we assume that both types of care are perfect substitutes as assumed in Cremer et al. (2017). Stabile et al. (2006) report the possibility of perfect substitutability in Canada. We can instead assume that informal and formal long-term care are only partially substitutable. For example, Barigozzi et al. (2017) consider a case in which informal and formal care are imperfectly substitutable.

[9] Because of a linear utility from consumption, H' represents the marginal rate of substitution between consumption and elderly care. A concave utility function complicates the results, but it does not fundamentally alter the conclusion.

optimal amount of transfers as

$$B = \frac{\pi H'^{-1}[(1-\tau)/(1/(w_1+w_2)-\tau)] - \tau Y}{1/(w_1+w_2)-\tau} \equiv B(\tau), \tag{9}$$

where H'^{-1} is the inverse function of H' in condition (8). Differentiating B with respect to tax rate τ and using condition (8), it follows that

$$\frac{dB}{d\tau} = \frac{\frac{\pi(H'-1)}{[1/(w_1+w_2)-\tau]} - H''(Y-B)}{H''[1/(w_1+w_2)-\tau]}. \tag{10}$$

Whether or not a tax hike increases parental bequests to the children is ambiguous *a priori*, depending on the sign of $H'-1$, i.e., the difference between the increase in the expected utility obtained from the increased public long-term care provision and the decrease in consumption brought about by an additional unit of tax payment. If an increase in the expected utility of the additional public long-term care is sufficiently great, i.e., if the net expected marginal utility of formal long-term care is non-negative ($H'-1 \geq 0$), then parents reduce bequests to children when the tax rate increases, i.e., $dB/d\tau < 0$. By contrast, if the increased expected utility is insufficiently great i.e., if $H'-1 < 0$, then it is ambiguous whether parents increase bequests or not. In the latter case, formal long-term care does not necessarily crowd out informal (family) elderly care.

It should be noted that because term $H'-1$ can be rewritten as $[1-1/(w_1+w_2)]/[1/(w_1+w_2)-\tau]$ using condition (8), the sign of the net expected marginal utility of formal long-term care is unchangeable with respect to the tax policy in this paper. Although this assumption seems restrictive, it might make the optimality of long-term care policy more prominent in the presence of sibling transfer-seeking competition.

3. Optimality of long-term care policy

Now we can analyze an optimal long-term care insurance policy, i.e., a decision of government at stage 0. Differentiating the parents' utility (6) with respect to tax rate τ and using the envelop theorem, we obtain

$$\frac{dU}{d\tau} = (Y-B)(H'-1). \tag{11}$$

From condition (8), it is apparent that the optimal tax rate is obtainable as an interior solution only when $1/(w_1+w_2)=1$. However, as described in the preceding section, it is not always the case in this model. Although parents choose bequests to satisfy condition (8), we might have a corner solution for optimizing the long-term care policy. Defining the right-hand side of condition (8) as $S(\tau)$ and differentiating it, one has

$$S'(\tau) = \frac{1-1/(w_1+w_2)}{[1/(w_1+w_2)-\tau]^2}. \tag{12}$$

Therefore, we can proceed through the analysis by considering the following three cases; (i) $1-1/(w_1+w_2)<0$, (ii) $1-1/(w_1+w_2)=0$, and (iii) $1-1/(w_1+w_2)>0$.

In case (i), we have $S'(\tau)<0$. From the definition of $S(\tau)$, we can also show that $S<1$ at $\tau=0$ and $S\to 0$ as $\tau\to 1$. Because parents adjust bequests to satisfy condition (8), $H'<1$ for $\tau\in[0,1/(w_1+w_2))$. Therefore, we have $dU/d\tau<0$ for all $\tau\in[0,1/(w_1+w_2))$.[10] In this case, the optimum tax rate and therefore insurance benefits are zero. Public long-term care insurance should be unimplemented. Increases in bequests bring about more attention and care toward parents from the children, net of reduced public long-term care benefits, more than the reduced parental consumption. Therefore, parents are willing to bequeath more to the children. Sibling transfer-seeking competition engenders sufficient family attention and care to the parents.

In case (ii), any tax rate, i.e., $\forall\tau\in[0,1/(w_1+w_2))$, can achieve optimality because $H'=1$. Parents choose bequests to satisfy condition (8), taking the public long-term care insurance benefits as given. Because formal and informal long-term care are perfect substitutes, the public long-term care policy can be a topping-up type.[11]

In case (iii), from (12), we have $S'(\tau)>0$. Using the definition of $S(\tau)$, we can demonstrate that $S>1$ at $\tau=0$, $S\to\infty$ as $\tau\to 1/(w_1+w_2)-0$, $S\to-\infty$ as $\tau\to 1/(w_1+w_2)+0$, and $S\to 0$ as $\tau\to 1$. Therefore, we have $S>1$ for $\tau\in[0,1/(w_1+w_2))$, therefore $H'>1$, and $S<0$ for $\tau\in(1/(w_1+w_2),1]$, therefore $H'<1$. The optimum which satisfies condition $dU/d\tau=0$ might not obtain in this case. Because $S<0$ cannot give the optimum, the optimum tax rate is positive but less than $1/(w_1+w_2)$ $[<1]$, i.e., $0<\tau^*<1/(w_1+w_2)$, if it exists. The optimal tax rate is expected to be given by an intersection point of the left-hand side of condition (8), $H'[\{\tau(Y-B(\tau))+B(\tau)/(w_1+w_2)\}/\pi]\equiv H'(\tau)$, and the right-hand side, $S(\tau)$, satisfying condition (8). The optimal tax rate is expected to be given by an intersection point of the left-hand side of condition (8), $H'[\{\tau(Y-B(\tau))+B(\tau)/(w_1+w_2)\}/\pi]\equiv H'(\tau)$, and the right-hand side, $S(\tau)$, satisfying condition (8). We can demonstrate that condition (8) is always satisfied for any

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[10] Recall that we assume here sufficiently high pre-transfer income of parents.

[11] The level of bequests must be non-negative. We assume that this constraint is satisfied.

$\tau \in [0, 1/(w_1 + w_2))$, if the optimum exists.[12] Because $H' - 1 > 0$ in this case, the optimal tax rate approaches $1/(w_1 + w_2)$. Therefore, it might be impossible to define the optimal tax rate in this case. By contrast to the possibility of an interior solution, the possibility exists of having an optimal tax rate as a 'corner' solution. The optimal tax rate can be given by condition $B(\tau^*) = 0$ because $B'(\tau) < 0$ from (10). Parents adjust bequests to satisfy condition (8). Therefore, the optimal tax rate satisfies $H'(\tau^* Y / \pi) = (1 - \tau^*) / [1/(w_1 + w_2) - \tau^*] > 1$.[13] At this optimum tax rate, parents give no bequests to children. Therefore, the children do not provide family elderly care. Long-term care is provided solely by a public long-term care insurance program. This situation seems that the public long-term policy *opts out* of informal care.[14]

The relation between the tax rate and the right-hand side of condition (8), $S(\tau)$, is depicted respectively for the three cases in Figure 1.

4. Conclusion

We have demonstrated that public long-term care insurance policy might not be necessary if parents can expect sufficient attention and care from children by giving bequests when children compete to obtain more transfer in exchange for attention and care. In contrast, if parents cannot expect adequate attention and care through bequests to children, then public long-term care insurance policy is socially optimal even if the insurance is actuarially fair. The latter case might be important. For example, when children's wage income becomes too high, parents cannot expect their children to provide much attention and care for them. These results are similar to those reported by Cremer et al. (2017), although our model is based on intergenerational exchanges rather than children's altruism.

When parents plan to leave a larger share of their bequest to children who provide more care, i.e., an intergenerational exchange model applies, public long-term care policy might not be socially desirable. If economic development raises children's wage income rapidly, children come to provide less attention and care in exchange for bequests. Cigno et al. (2017) report that policy interventions such as compulsory education reduce the share of elderly parents who enjoy children's attention. In this situation, the net benefits

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12 See the Appendix.

13 Locus $H'(\tau)$ is not continuously differentiable with respect to τ at a tax rate satisfying the boundary condition $B(\tau) = 0$. Condition (8) might not be satisfied for τ greater than the tax rate.

14 Assuming here certain lifetime in this paper, accidental bequests are ruled out.

of public long-term care taxation might become greater. The analyses in this paper might have important implications for policy design, particularly in economically developing Asian countries. These countries are expected to experience population aging in the near future.

Appendix

A1. Loci of $S(\tau)$ and $H'(\tau)$ in case (iii)

We have $H'_{\tau=0} = H'(\frac{B(0)}{\pi(w_1+w_2)})$ and $S_{\tau=0} = w_1 + w_2$, where subscript $_{\tau=0}$ represents the value at $\tau = 0$. Therefore, it is apparent that the two loci do not generally mutually coincide at $\tau = 0$.

Differentiating $H'[\{\tau(Y-B(\tau)) + B(\tau)/(w_1+w_2)\}/\pi]$ with respect to τ, one obtains

$$\frac{dH'}{d\tau} = \frac{H''}{\pi}[(Y-B) + (\frac{1}{w_1+w_2} - \tau)\frac{dB}{d\tau}]. \quad \text{(A1)}$$

Using (10), because $1-1/(w_1+w_2) > 0$ in case (iii), it follows that

$$(Y-B) + (\frac{1}{w_1+w_2} - \tau)\frac{dB}{d\tau} = \frac{\pi[1-1/(w_1+w_2)]}{H''[1/(w_1+w_2)-\tau]^2} < 0. \quad \text{(A2)}$$

Therefore, we have

$$\frac{dH'}{d\tau} = \frac{1-1/(w_1+w_2)}{[1/(w_1+w_2)-\tau]^2} > 0. \quad \text{(A3)}$$

Function H' can be represented as an upward-sloping curve in (τ, S) space.

From (12) and (A3) it is apparent that both loci S and H' have the same slop at each τ in (τ, S) space. Therefore, if the optimum exists, the two loci have the same vales at $\tau = 0$, i.e., the two loci overlap in (τ, S) space. Therefore, condition (8) is satisfied for any $\tau \in [0, 1/(w_1+w_2))$.[15]

A2. Imperfect substitution between formal and informal elderly care

Assuming that family (informal) and public (formal) long-term care are not perfect substitutable for parents as in Barigozzi et al. (2017), the utility function can be written as

$$U = (1-\tau)(Y-B) + \pi[H_r(a_1+a_2) + \beta H_u(T)], \quad \text{(A4)}$$

[15] The sign of B might be negative in the neighborhood of $\tau = 1/(w_1+w_2)$ for condition (8) to be satisfied although it is feasibly impossible.

where $\beta \in (0,1]$ stands for the degree of substitutability. The first-order condition of the parents is

$$dU / dB = -(1-\tau) + H_r '(w_1 + w_2)^{-1} + H_u ' \beta\tau = 0 . \tag{A5}$$

Differentiating (S2), we have

$$\frac{dB}{d\tau} = \frac{\pi(\beta H_u '-1) - H_u '' \tau\beta(Y-B)}{H_r ''(w_1+w_2)^{-2} + H_u '' \beta\tau^2} . \tag{A6}$$

If $\beta H_u '-1 \geq 0$, then we have $dB / d\tau < 0$; and if $\beta H_u '-1 < 0$, then the sign of (A6) is ambiguous. $\beta H_u '-1$ stands for the net marginal utility of public long-term care.

The marginal effect of a tax change on the parents' welfare is given as

$$dU / d\tau = (Y-B)(\beta H_u '-1) . \tag{A7}$$

From (S2) we obtain

$$\beta H_u ' = H_r '/[\tau(w_1+w_2)] - (1-\tau)/\tau \equiv S(\tau) , \tag{A8}$$

where $H_r ' = H_r '[B(\tau)/(\pi(w_1+w_2))]$. In this case function $S(\tau)$ might not monotonically change with tax rate τ . Therefore, the analysis of the optimal tax rate is much complicated in this case. We do not pursue the solution in this supplementary note.

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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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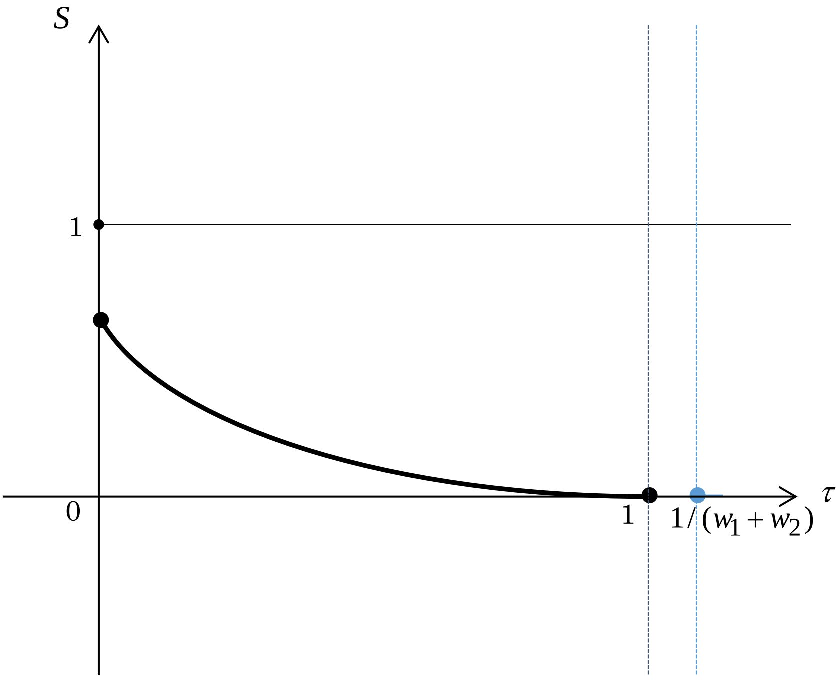
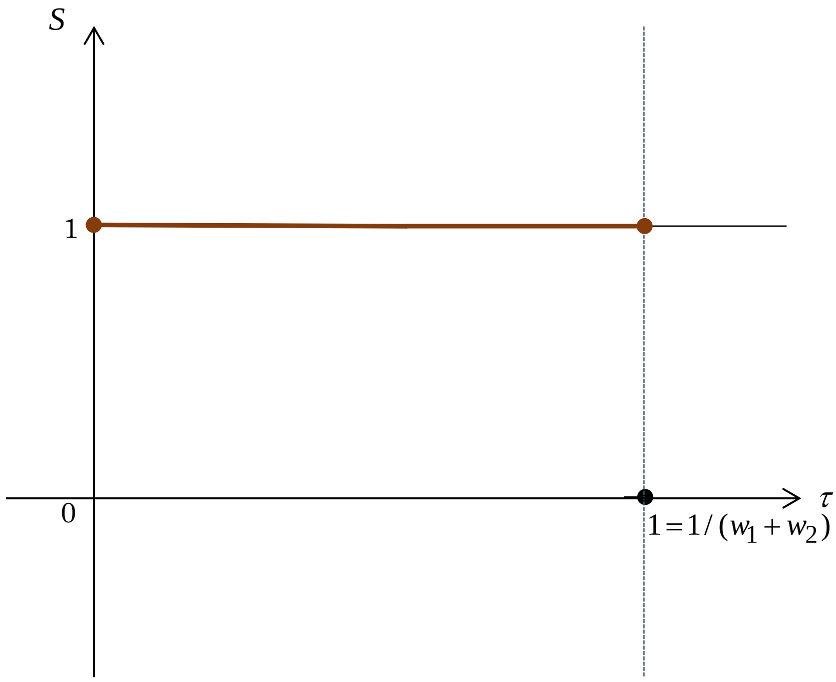
Figure 1. Tax rates and the right-hand side of condition (8).

(a) case (i)



(b) case (ii)



(c) case (*iii*)