AGE- AND HEALTH-RELATED NON-LINEAR INHERITANCE TAXATION

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Age- and health-related non-linear inheritance taxation

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Abstract. This paper studies the design of optimal non linear bequest taxation when individuals differ in wage, survival and probability to become dependent at the old age. Following the recent health and economic literature, we assume that agents with higher wage have higher survival chances and lower risks to become dependent. Agents make precautionary savings for their old age taking into account the uncertainty on their health. They exhibit joy of giving utility, so that they also set aside money for their heirs. In the absence of annuity and long-term care (LTC) insurance markets, heirs obtain different levels of bequests, depending on whether the donor died early or late in life and whether he was healthy at time of death. We assume that the government does not observe the decomposition of bequests between voluntary and involuntary ones. Instead, it observes the timing of death and the health condition at death of the donor. We show that, under asymmetric information, on top of marginal income taxation, the bequests left by low-income individuals in case of early death should be taxed at the margin. To the opposite, bequests obtained later in life need not be taxed or subsidized at the margin.

Résumé. Imposition sur les successions non linéaire liée à l'âge et à la santé. Cet article étudie la taxation non linéaire optimale de legs lorsque les individus diffèrent en terme de salaire, de survie et de probabilité de devenir dépendant en vieillissant. Conformément aux récentes études sur la santé et l'économie, nous supposons que les agents ayant un salaire supérieur ont de meilleures chances de survie et un risque inférieur de devenir dépendants. Les agents procèdent à de l'épargne de précaution pour leurs vieux jours en tenant compte de l'incertitude liée à leur état de santé. Ils retirent aussi de l'utilité à donner, de sorte qu'ils placent également de l'argent de côté pour leurs héritiers. En l'absence de marchés d'annuités et d'assurance de soins de longue durée, les héritiers obtiennent des valeurs différentes de legs, selon l'âge auquel est mort le donateur et son état de santé au moment du décès. Nous supposons que le gouvernement n'observe pas la décomposition des legs entre les legs volontaires et involontaires. Il observe plutôt le moment du décès et l'état de santé au décès du donateur. Nous démontrons que, lorsque l'information est asymétrique, en plus de l'impôt marginal sur le revenu, les legs laissés par des particuliers à faible revenu en cas de décès précoce devraient être taxés à la marge. À l'opposé, les legs obtenus plus tard au cours de la vie n'ont pas besoin d'être taxés ou subventionnés à la marge.

JEL classification: H21, H23, I14

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1. Introduction

"I SEE NOTHING OBJECTIONABLE in fixing a limit what anyone may acquire by mere favour of others, without any exercise of his faculties, and in requiring that if he desires any further accession of fortune, he shall work for it." John Stuart Mill's (1848) argument in favour of inheritance taxation has convinced a lot of thinkers over the years and yet, this form of taxation has never been as unpopular as today. Half of OECD member countries have abolished inheritance taxation. Among them, one finds social democratic Sweden and Norway, Canada and Austria. In OECD countries, the proportion of total government revenues raised by such taxes has fallen since the 1960s, from over 1% to less than 0.5% (half of Europe's billionaires have inherited their wealth).[1] There is a puzzle over why inheritance taxes are so unpopular relative to other taxes. Indeed, they are progressive and, assuming they are spent wisely on welfare goods, a majority of people should gain from such taxation. One of the main reasons why inheritance tax may be unpopular is its design.[2] This tax is plagued by many loopholes and cases of horizontal inequity. The purpose of this paper is to address an important issue concerning the design of inheritance taxes, namely whether these taxes should vary with the age of the deceased. This question has first been dealt with by Vickrey (1945), who was concerned by the fact that the tax burden was decreasing with the time lag between the occurrences of inheritance. He thus proposed to make bequests taxation depend on the number of years during which donors hold their wealth and to make it increase with the age gap between the donor and the receiver. This was supposed to prevent fiscal arbitrages across generations inside a given family.

Related to Vickrey's (1945) idea, our paper studies whether inheritance taxation should depend on the age of the deceased as well as on his health state at death, i.e., whether he lived long healthy or became dependent during old age. The amount of bequests most often results from two motivations. First, a precautionary motive induces the agent to save for his old age and to take into account that he will eventually have to finance extra expenses related to a loss of autonomy. Second, he may wish to set aside money for his heirs, out of a pure joy of giving motive. As a result, in case of early death, inheritance comprises both a planned and an unplanned (i.e., accidental) component, whereas in case of late death, it comprises only the planned component. Also, when the deceased had to go through LTC expenditures, his estate is likely to be lower than that of someone who remained autonomous till the end. Quite realistically, fiscal authorities will observe the age at death and the health status of the deceased, but they will not observe the decomposition of bequests between their planned and unplanned components. In this paper, we assume the same so that the government can distinguish only between the three types of bequests, depending or whether they are left early, late under autonomy or late under dependency.

Our paper studies a non-linear taxation problem which accounts for these different types of bequests. To do so, we use a two-period model, where the first period is lived with certainty while the second is uncertain. If individuals survive, they may become dependent and make extra LTC expenses. Agents differ in productivity, in their survival probability as well as in their probability to become dependent. Following the recent empirical economic and health literature (Cambois et al. 2011, Cristia 2009, Kalwij et al. 2013, Lefebvre et al. 2018, Liu and Wang 2022), we assume that wealthier agents exhibit higher survival probability and lower probability to be in bad health at the old age. Combining these two findings,

1 OECD (2018).

2 For a survey of the literature, see Cremer and Pestieau (2006).

it can therefore be difficult to infer whether wealthier agents live longer in good health (the so-called "disability-free life expectancy") than poorer individuals. Nonetheless some papers, like Lefebvre et al. (2018), Cambois et al. (2011) and Zaninotto et al. (2020), have shown that the health dimension usually dominates the longevity dimension such that older individuals with high-income live longer under good health than low-income ones. In our setting, this will be equivalent to assuming that higher income agents face a higher survival probability, but smaller conditional and unconditional probabilities to become dependent.

In the first-period of their life, agents work and make precautionary savings for their old age taking also into account the uncertainty on their health status. They exhibit joy of giving utility, so that they also set aside money for their heirs. In the second period, if alive, they are retired and consume their savings. If they don't survive the first period, their heirs inherit the precautionary saving and the intended bequest, which both yield joy of giving utility. Key to our model is the absence of annuity and LTC insurance markets, so that in case of premature death or late death in good health, bequests are made of two components, a voluntary and an involuntary one (the part of savings which have not been consumed).[3] Heirs will then obtain different levels of bequests depending on whether the donor died early in life or late in life and, in the latter case, whether he was healthy at time of death. As explained above, the government does not observe the composition of bequests (between planned and unplanned ones) but, it observes the time of death and the health condition at death of the donor.

We obtain the following results. Under asymmetric information on socio-demographic characteristics, agents with high-productivity, high-survival chances and low probability to become dependent may be tempted to mimic low-productivity, low-survival chances and high probability to become dependent agents. Thus, in order to relax incentive constraints and given the correlation between demographic risks and earnings, we find that, above marginal income taxation of the low-type individual, it is also optimal to tax at the margin his bequests in case of early death. The main mechanism goes as follows. Recall first, that direct taxation of savings is not possible here because they are not observable. Because high-type agents face higher survival, they wish to make more precautionary savings than low-type agents, knowing that in case they die early, it will be donated to their heirs. On the other hand, they face lower probability to become dependent than low-type individuals, so that they may be willing to save less for their old days. Yet, relying on the specific results of Lefebvre et al. (2018) who show that the magnitude of the correlation between income and survival is greater than that of the correlation between income and dependency, the first effect will dominate the second. In such a case, high-type agents would like to save more than low-type ones and it is optimal at the second best, to tax at the margin the early bequests (which are observable and comprise savings) of the low-type individuals in order to prevent mimicking from the high types. We also find that bequests made late in life, independently from whether the agent died in good health or in bad health, do not need to be taxed or subsidized. The reason is quite obvious. Because in the second period uncertainty regarding survival and health has already realized, there is no need for additional marginal taxation.

These results are in contrast with those of an earlier paper by Leroux and Pestieau (2022), in which the tax instruments are restricted to be linear. In this earlier paper, there is a good case for distorting the three types of bequests and the outcome depends on whether the redistributive effect dominates the insurance effect that aims at equalizing the levels of

3 We come back on the implications of assuming no annuity and no LTC insurance market in section 2.1.

bequests across the three states of nature. Early bequests are more heavily taxed than the other bequests if the insurance effect dominates the equity effect. In the opposite case, they should be less taxed. Note that it is not unusual to obtain different results when dealing with linear or non-linear taxation problems. The main reason why we obtain results that may look contradictory is that linear taxation provides *average* taxation rates, which are all *identical* across individuals with different characteristics, while under non linear taxation, we obtain *marginal* taxation rates, which, as we show below, are *different* across agents with different characteristics.[4]

This paper can be related to three strands of the literature. First, our paper can be related to the optimal taxation literature which extends the well-known Atkinson–Stiglitz (1976) result. The Atkinson–Stiglitz (1976) result states that if preferences are separable between consumption and labour, and if preferences for consumption and labour are identical across agents, there is no need to tax savings besides optimal income taxation. Our paper builds upon that finding and shows that when individuals differ in more than one unobservable characteristic (income, but also survival and probability to become dependent), taxation of capital (in the form of bequests in our model) is required in addition to labour taxation.[5] As such, it complements the literature on the optimal taxation of both labour and capital / savings (see among others Blomquist and Christiansen 2008, Saez 2002, Diamond and Spinnewijn 2011, Gordon 2004, Gordon and Kopczuk 2014) by justifying the taxation of capital (in the form of bequests left) when individuals differ not only in income but also in longevity and in their health condition at the old age. It also extends Nishimura and Pestieau (2016), who assume the same relationship between socio-demographic characteristics as we do but assume away bequest motives and accidental bequests and show that it is desirable to tax both earnings and savings and to subsidize LTC spending. Second, as opposed to the literature cited before, we include joy of giving motives. Lockwood (2018) indeed shows that bequest motives play a crucial role in explaining the LTC insurance and annuity puzzles, by reducing the opportunity cost of precautionary savings. Because people do leave bequests, our paper can, thus, also be related to the specific literature on wealth transfer taxation.[6] As explained in the survey paper of Cremer and Pestieau (2006) and emphasized at the beginning of this paper, the distinction between the different bequest motives as well as the (non-)observability of wealth and of bequest transfers are crucial to the design of optimal wealth transfer taxation.[7] Finally, our paper contributes to the literature on age-dependent taxation, which was first introduced by Vickrey (1945).[8] Recently, Fleurbaey et al. (2022) also study the optimal taxation of (voluntary and accidental) bequests when individuals have different survival chances, and they have a section where the taxation of bequests is made contingent on the age of the deceased. Contrary to us, in their paper, the

4 Obviously, a zero marginal taxation rate does not mean that taxation is null.

5 Multidimensional screening problems have also been studied in Armstrong and Rochet (1999), for instance, and applied to the optimal direct/indirect tax mix in Cremer et al. (2001).

6 See among others, Boadway et al. (2000), Brunner and Pech (2012), Cremer et al. (2003), Cremer et al. (2012), Pestieau and Sato (2008).

7 See also for instance Blumkin and Sadka (2003) who study a dynastic model where bequests are both altruistic and accidental. Farhi and Werning (2013) also study an optimal estate taxation problem when parents exhibit different degrees of altruism.

8 For a review of the arguments in favour of making the taxation of bequests vary with the age of the deceased, see Pestieau and Ponthiere (2023).

social objective is ex post egalitarian, i.e., it wants to neutralize ex post welfare inequalities arising from different lifespans. Under that framework, the taxation of bequests is used as an instrument to achieve such welfare compensation. Instead, we assume a utilitarian social planner and allow for different probabilities to become dependent (in addition to differences in productivity and in survival). Apart from Leroux and Pestieau (2022), none of the above papers studying optimal bequest taxation account for the possibility that old-age agents become dependent, something that, given the current demographic trends, is most likely to happen in the future.

The rest of the paper is organized as follows. Section 2 explains the model and analyses the individuals' problem. Section 3 solves the first-best utilitarian problem and section 4 the second best problem. A final section concludes.

2. The model

2.1. The individuals' problem

This model features a society that comprises individuals with different types, indexed by $i = \{1, ..., N\}$, where each group is composed of n_i individuals. They all live at most two periods. The first period is certain but the second one is uncertain. In this second period of life, individuals can be healthy or not. Each type is characterized by a wage, equal to his productivity w_i, a survival probability $0 \leq \pi_i \leq 1$ and a dependency risk $0 \leq p_i \leq 1$. As commonly accepted in the literature, the relationship between π_i and w_i is assumed to be positive.[9] Also, relying on Lefebvre et al. (2018), Cambois et al. (2011) and Liu and Wang (2022), we assume that the relationship between productivity w_i and the probability to become dependent p_i, is negative. In addition, Lefebvre et al. (2018) and Cambois et al. (2011) show that poorer individuals live longer under dependency which, under our set-up, translates into a negative relationship between the unconditional probability to become dependent, $\pi_i p_i$ and w_i.[10]

Each individual i supplies an amount of labour l_i, which creates disutility $h(l_i)$. Disutility of labour is increasing and convex: $h'(l_i) > 0$ and $h''(l_i) \geq 0$. Out of his wage earnings, $y_i = w_i l_i$, each individual finances first-period consumption c_i, planned bequest b_i and saving $s_i$for second-period consumption. In case of autonomy, second-period consumption is denoted by d_i, while in case of dependency, it is denoted by m_i. When agents are in good health, consumption utility is denoted by $u(.)$ and, it is increasing and concave. When dependent, consumption utility is denoted by $H(.)$. This function is increasing and concave and such that $u(z) > H(z)\, \forall z$.[11] Finally, the joy of giving utility, or equivalently, the utility obtained

9 For instance, Cristia (2009), Delavande and Rohwedder (2011), Kalwij et al. (2013) and Lefebvre et al. (2018) find a positive relationship between wealth and survival.

10 To be precise, Lefebvre et al. (2018) show a positive relationship between *wealth* and survival and a negative one between *wealth* and the occurrence of dependency. Here, we instead model *income* at the old age. Cambois et al. (2011) show a relationship between the *occupational status*, the survival probability and the number of years with poor health and disabilities.

11 To obtain our optimal taxation results, we do not need to make any specific assumption on the relationship between $H'(z)$ and $u'(z)$. Some theoretical papers (Canta et al. 2016; Cremer and Pestieau 2014; De Donder and Leroux 2014, 2017; Klimaviciute and Pestieau 2018) assume that $H'(z) > u'(z) \forall z$. Some others (Leroux et al. 2021) assume to the contrary that $u'(z) > H'(z)$. De Donder and Leroux (2021) explain that it is very much an empirical question and that whether $u'(z) \gtrless H'(z)$ depends on the composition of the consumption bundle z and how it may change when dependency strikes.

from leaving bequests, is denoted by $v(b_i^j)$ where $j = \{E, L, D\}$ stand for the timing of death and the health status of the donor at death (early death, late death in good health and dependent). It is increasing and concave in its argument. Following Hurd (1989), we assume that consuming an amount z always provides more utility to the individual than if he was bequeathing it, i.e., $u(z) > v(z)\, \forall z \geq 0$, and that the marginal utility from consuming it is also higher, i.e., $u'(z) > v'(z)\, \forall z \geq 0$.

Assuming that individuals have no pure time preference, the lifetime utility of an individual i takes the following form:

$$EU_i = u(c_i) - h(l_i) + \pi_i p_i \left[H(m_i) + v(b_i^D)\right] + \pi_i(1-p_i)\left[u(d_i) + v\left(b_i^L\right)\right] + (1-\pi_i)v(b_i^E).$$

In the following, we assume away any market for annuities and LTC insurance. This implies that the amount of bequests depends on the timing of death as well as on the health status of the donor at death, in the following way: $b_i^E = (b_i + s_i)$, $b_i^L = (b_i + x_i)$ and $b_i^D = b_i$. If the donor dies late under bad health, bequests comprise only the planned component, b_i. To the opposite, in case of early death or late death in good health, bequests include also an unplanned component, s_i or x_i respectively, where x_i is the (additional) amount of saving that an individual who was healthy in the second period of his life, bequeathes to his heir (we come back on this point below).

Assuming a zero rate of interest, the utility function of an individual i can then be rewritten as

$$EU_i = u(w_i l_i - s_i - b_i) - h(l_i) + \pi_i p_i \left[H(s_i) + v(b_i)\right] + (1-\pi_i)v(b_i + s_i) + \pi_i(1-p_i)\left[u(s_i - x_i) + v\left(x_i + b_i\right)\right], \tag{1}$$

where we replaced for the individual's per-period budget constraints.

Two words of clarification on this specification are in order. First, we purposely assume that there is no LTC insurance, nor annuity market. As a consequence, in case of early death, parents leave an amount s_i of unplanned bequests besides the planned bequest b_i and, individuals choose a saving level higher than what would be needed if $\pi_i = 0$ or if $p_i = 0$. Furthermore, if parents happen to be in good health in the second period, they optimally choose to leave an additional transfer x_i to their children. Note that, under our modelling, both the planned and the unplanned component of the bequests yield joy of giving utility. If annuities and LTC insurance were available at actuarially fair prices, individuals would choose to fully insure against the LTC risk and would fully annuitize their wealth so that there would be no accidental bequest s_i, nor any additional transfer x_i. In other words, within such a hypothetical setting, the only type of bequests would be intentional (equal to b_i) and the issue of differential inheritance taxes would vanish. In the real world, we witness only an incomplete annuitization of retirement saving through defined benefits, public or private, schemes and the extent of LTC insurance, both public and private, is limited.[12] This implies that there do exist involuntary bequests. We could introduce those partial schemes in our analysis but, the results would be qualitatively unchanged. As long as LTC insurance and annuitization are incomplete, there will still be three different levels of bequests depending on whether the agent lived long or died early and whether he remained

12 This is the so-called LTC insurance puzzle. See Brown and Finkelstein (2009) and Pestieau and Ponthiere (2011).

autonomous or became dependent in old age. The optimal fiscal policy we derive below will still be applicable.[13]

Second, we deliberately opted for a particular type of intended bequests, which arises from a joy of giving motivation. The modelling of the joy of giving utility is similar, for instance, to Ameriks et al. (2011), Fleurbaey et al. (2022), Glomm and Ravikumar (1992), Kopczuk and Lupton (2007), Lockwood (2018) and Piketty and Saez (2013) who also study bequest taxation. Like in these papers, we assume that the parent cares about the amount of bequests received by his heirs after his death, *net* of taxation. There exist alternative motivations for intended bequest, such as perfect and imperfect altruism and exchange (including strategic bequests). Empirically, it is not clear to assess which motivation is the most relevant.[14] For the problem at hand, the exchange motivation does not apply and the altruistic one would imply a dynamic setting that we prefer to avoid in order to keep the analysis tractable.

We assume that the only variables that can be observed are the three different types of bequests, b_i^E, b_i^D and b_i^L, gross earnings $y_i = w_i l_i$ and first-period consumption c_i.[15] Note that the observability of the *total* amounts of bequests $b_i^j\ \forall j = \{E, D, L\}$ does not mean that the decomposition of these bequests between the planned component (b_i) and the unplanned components (s_i and x_i) is observable. Actually, we assume in this paper that this decomposition is *not* observable. This is a crucial point of our analysis in two respects. First, it implies that the taxation of savings and of voluntary bequests separately is *not* possible. Second, it justifies a taxation of bequests depending exclusively on the age at death and, on the health condition of the deceased, both of which being, quite realistically, observable. Note that not observing this decomposition also implies that second-period consumptions, $m_i = s_i$ and $d_i = s_i - x_i$, are not observable.

For sections 3 and 4, we, therefore, express the individual's utility in terms of the observable variables:

$$
\begin{aligned}
EU_i = u(c_i) - h\left(\frac{y_i}{w_i}\right) + \pi_i p_i \left[H(b_i^E - b_i^D) + v(b_i^D)\right] \\
+ \pi_i(1-p_i)\left[u(b_i^E - b_i^L) + v(b_i^L)\right] + (1-\pi_i)v(b_i^E),
\end{aligned}
$$

where first-period consumption can also be written as $c_i = y_i - b_i^E$.

2.2. Introducing taxation

Before solving the first- and second-best problems, let us introduce a system of non linear taxes $\theta(.)$ on income and bequests so that the individual's lifetime utility can

13 In unreported computations (available upon request), we show that the *levels* of bequests left will be different whether we allow for partial annuitization and LTC insurance or not. Nonetheless, the second-best trade-offs between bequests and consumptions as well as our results regarding marginal taxation or subsidization of bequests remain identical.

14 For instance, Kopczuk and Lupton (2007) mention that "the evidence suggests motives other than the maximization of a dynastic utility function" (p. 210).

15 We could have assumed that first-period consumption is not observable either. This would have complicated the model by requiring additional incentive constraints. In order to concentrate on bequest taxation, we decided to stay close to a modelling *à la* Atkinson–Stiglitz (1976).

be rewritten as[16]

$$\begin{aligned}EU_i &= u(y_i - \theta(y_i) - s_i - b_i) - h\left(\frac{y_i}{w_i}\right)\\&\quad + \pi_i p_i \left[H(s_i) + v(b_i - \theta(b_i)\right] + (1-\pi_i)v(b_i + s_i - \theta(b_i + s_i))\\&\quad + \pi_i(1-p_i)\left[u(s_i - x_i) + v\left(x_i + b_i - \theta(x_i + b_i)\right)\right].\end{aligned}$$

Deriving the FOCs with respect to $\{y_i, s_i, x_i, b_i\}$, we obtain the relevant trade-offs between the marginal rates of substitution and the marginal tax rates:

$$1 - \theta'(y_i) = \frac{\frac{1}{w_i} h'\left(\frac{y_i}{w_i}\right)}{u'(c_i)} \tag{2}$$

$$\begin{aligned}1 - \theta'(s_i + b_i) &= \frac{u'(c_i) - \pi_i p_i H'(m_i) - \pi_i(1-p_i)u'(d_i)}{(1-\pi_i)v'(b_i^E)}\\1 - \theta'(x_i + b_i) &= \frac{u'(d_i)}{v'(b_i^L)}\\1 - \theta'(b_i) &= \frac{H'(m_i)}{v'(b_i^D)},\end{aligned} \tag{3}$$

where $\theta'(s_i + b_i),\ \theta'(x_i + b_i)$ and $\theta'(b_i)$ correspond to the marginal tax on early bequests, late bequests under good health and late bequests under bad health, respectively. The expressions of b_i^D, b_i^L and b_i^E in the above trade-offs now include the taxes:

$$\begin{aligned}b_i^D &= b_i - \theta(b_i)\\b_i^L &= x_i + b_i - \theta(x_i + b_i)\\b_i^E &= b_i + s_i - \theta(b_i + s_i).\end{aligned}$$

Note that, in equation (3), the numerator is positive (as a result of s_i being interior). These trade-offs will be used in order to find the optimal levels of marginal taxation decentralizing the second-best optimum (section 4).

3. First-best optimum

Under full information on individuals' types, the utilitarian government seeks to maximize the sum of individuals' utility subject to the resource constraint of the economy. This is thus equivalent to solving the following problem:

$$\begin{aligned}\max_{c_i, y_i, b_i^E, b_i^D, b_i^L} \sum_i n_i &\left\{u(c_i) - h\left(\frac{y_i}{w\,_i}\right) + \pi_i p_i \left[H(b_i^E - b_i^D) + v(b_i^D)\right]\right.\\&\left. + \pi_i(1-p_i)\left[u(b_i^E - b_i^L) + v(b_i^L)\right] + (1-\pi_i)v(b_i^E)\right\}\\\text{s. to } &\sum_i n_i y_i \geq \sum_i n_i\left(c_i + b_i^E\right).\end{aligned}$$

16 Here, we assume that the non linear tax schedule is separable in y_i and b_i^j. Assuming instead a general (non separable) tax schedule $T(y_i, b_i^E, b_i^L, b_i^D)$ would yield the same qualitative results.

The last line is the resource constraint of the economy, which amounts to equalizing aggregate earnings y_i to first-period consumption c_i and early bequests $b_i^E = (b_i + s_i)$.

The FOCs of this problem are

$$u'(c_i) = \mu, \tag{4}$$

$$h'(l_i) = \mu w_i, \tag{5}$$

$$\pi_i p_i H'(b_i^E - b_i^D) + \pi_i(1 - p_i)u'(b_i^E - b_i^L) + (1 - \pi_i)v'(b_i^E) = \mu, \tag{6}$$

$$-H'(b_i^E - b_i^D) + v'(b_i^D) = 0, \tag{7}$$

$$-u'(b_i^E - b_i^L) + v'(b_i^L) = 0, \tag{8}$$

where μ is the multiplier associated with the resource constraint.

The first equation above shows that at the first best, $u'(c_i) = \mu \; \forall i$, so that every agent should obtain the same amount of first-period consumption, $\bar{c}$. The second equation shows that higher productivity agents should provide more labour. This is the standard Mirrlees (1971) result. In interpreting the conditions on bequests (equations (6) to (8)), it is important to note that the first-best optimum is somehow constrained by the absence of insurance mechanisms that would cover the risk of longevity and that of dependency (as detailed in section 2.1). With such devices, both unplanned bequests, s_i and the additional gifts, x_i in case of a long healthy life would disappear and we would simply have: $b_i^E = b_i^L = b_i^D = b \; \forall i$. Without these insurance devices, we have condition (6) that establishes an equality between the marginal utility of first-period consumption $u'(\bar{c})$ and the weighted average of the marginal utilities of bequests.

Under our assumption that $u'(x) > v'(x) \; \forall x$, we obtain from equation (8) that $d_i > b_i^L$. Assuming that $H'(.) > u'(.)$ (see footnote 11), we then obtain that $H'(.) > v'(.)$ and, thus, that $m_i > b_i^D$. Finally, replacing for equations (7) and (8) in equation (6), we can also show that $\bar{c} > b_i^D$.[17]

As to the implementation of the first-best optimum, only interpersonal lump sum transfers would suffice so as to redistribute resources from the high-type individuals toward the low-type ones. No marginal taxation of labour and of bequests is needed: $\theta'(y_i) = \theta'(b_i) = \theta'(b_i + s_i) = \theta'(x_i + s_i) = 0 \; \forall i$.

4. Second-best optimum and non linear taxation

We now turn to the second-best problem in which we assume that the planner cannot observe the individuals' types but only their distribution in the society. It still observes $\{c_i, y_i, b_i^E, b_i^D, b_i^L\}$ for each individual with type i. In that situation, more productive individuals may be tempted to mimic the less productive ones.[18]

In the following, in order to keep the presentation simple, we restrict the analysis to a two-type model, $N = 2$, with $w_2 > w_1$. As mentioned in the beginning of section 2.1, following Lefebvre et al. (2018) and Cambois et al. (2011), it implies that individual 2 has a higher survival probability $\pi_2 > \pi_1$, lower conditional and unconditional probabilities

17 To see this, recognize that $u'(\bar{c})$ is a linear combination of $v'(b_i^E)$ and $p_i v'(b_i^D) + (1 - p_i)v'(b_i^L)$ with $v'(b_i^D) > v'(b_i^L)$. This implies that $v'(b_i^E) < u'(\bar{c}) < v'(b_i^D)$.

18 This will be the case in particular if differences in productivity dominate differences in the demographic characteristics.

to become dependent, $p_2 < p_1$ and $\pi_2 p_2 < \pi_1 p_1$. Below, we will also exploit the additional result of Lefebvre et al. (2018) that the magnitude of the relationship between income and the length of life under bad health is small, which, under our modelling, translates into assuming a *small* negative relationship between $\pi_i p_i$ and w_i. For simplicity, we may refer to type 2 agents as the high-type individuals and to type 1 agents as the low-type agents.

The second-best problem consists in solving the following problem:

$$\max_{c_i, y_i, b_i^E, b_i^D, b_i^L} \sum_i n_i \{u(c_i) - h\left(\frac{y_i}{w_i}\right) + \pi_i p_i \left[H(b_i^E - b_i^D) + v(b_i^D)\right]$$
$$+ \pi_i(1-p_i)\left[u(b_i^E - b_i^L) + v(b_i^L)\right] + (1-\pi_i)v(b_i^E)\}$$
$$\text{s. to } \sum_i n_i y_i \geq \sum_i n_i \left(c_i + b_i^E\right)$$
$$\text{s. to } u(c_2) - h\left(\frac{y_2}{w_2}\right) + \pi_2 p_2 \left[H(b_2^E - b_2^D) + v(b_2^D)\right]$$
$$+ \pi_2(1-p_2)\left[u(b_2^E - b_2^L) + v(b_2^L)\right] + (1-\pi_2)v(b_2^E)$$
$$\geq u(c_1) - h\left(\frac{y_1}{w_2}\right) + \pi_2 p_2 \left[H(b_1^E - b_1^D) + v(b_1^D)\right]$$
$$+ \pi_2(1-p_2)\left[u(b_1^E - b_1^L) + v(b_1^L)\right] + (1-\pi_2)v(b_1^E).$$

The last constraint is the incentive constraint, which ensures that at the second-best optimum, the high-type agents do not mimic the low-type ones.

One can easily check that the optimal trade-offs of type 2 individuals will not be distorted at the second best. In other words, the first-best conditions (4) to (8) apply, and no taxation (neither on income nor on bequests) is needed for high-type individuals. As to individual 1, some of his choices will be distorted, as we now see from the FOCs:

$$u'(c_1)(n_1 - \lambda) = \mu n_1 \tag{9}$$

$$-n_1 h'\left(\frac{y_1}{w_1}\right)\frac{1}{w_1} + \lambda h'\left(\frac{y_1}{w_2}\right)\frac{1}{w_2} = -\mu n_1 \tag{10}$$

$$n_1[\pi_1 p_1 H'(b_1^E - b_1^D) + \pi_1(1-p_1)u'(b_1^E - b_1^L) + (1-\pi_1)v'(b_1^E)]$$
$$-\lambda\left[\pi_2 p_2 H'(b_1^E - b_1^D) + \pi_2(1-p_2)u'(b_1^E - b_1^L) + (1-\pi_2)v'(b_1^E)\right] = \mu n_1 \tag{11}$$

$$n_1 \pi_1 p_1 \left[-H'(b_1^E - b_1^D) + v'(b_1^D)\right] - \lambda \pi_2 p_2 \left[-H'(b_1^E - b_1^D) + v'(b_1^D)\right] = 0 \tag{12}$$

$$n_1 \pi_1 (1-p_1)\left[-u'(b_1^E - b_1^L) + v'(b_1^L)\right] - \lambda \pi_2 (1-p_2)\left[-u'(b_1^E - b_1^L) + v'(b_1^L)\right] = 0 \tag{13}$$

where λ is the multiplier associated with the self-selection constraint.

First, it is obvious that equations (9) and (10) can be combined to obtain that labour income of the low-income individuals should be distorted downward. Comparing it with equation (2) from the decentralization problem, we obtain that the labour earnings of type 1 individuals should be taxed at the margin, i.e., $\theta'(y_1) > 0$, as in Atkinson and Stiglitz (1976).

Second, we turn to the second-best optimal choice of b_1^E and see whether it should be distorted at the second-best optimum. In the appendix, we show that the marginal rate of substitution between s_i and b_i^E for individual 1 (as computed in expression (3)), is equal to

$$\frac{u'(c_1) - \pi_1 p_1 H'(b_1^E - b_1^D) - \pi_1(1-p_1)u'(b_1^E - b_1^L)}{v'(b_1^E)(1-\pi_1)} = \frac{1 - \frac{\lambda}{n_1}\frac{1-\pi_2}{1-\pi_1}}{1 - \frac{\lambda}{n_1}C} \tag{14}$$

with C equal to

$$C = \frac{1 - \pi_2 \left[\frac{p_2 H'(b_1^E - b_1^D) + (1-p_2) u'(b_1^E - b_1^L)}{u'(c_1)} \right]}{1 - \pi_1 \left[\frac{p_1 H'(b_1^E - b_1^D) + (1-p_1) u'(b_1^E - b_1^L)}{u'(c_1)} \right]}. \tag{15}$$

Equation (14) gives the second-best trade-off between savings and early bequests for type 1 individuals. If the RHS of (14) is greater than 1 (equivalently if $C > (1-\pi_2)/(1-\pi_1)$), this trade-off is distorted upward. Comparing the above expression with equation (3) from the decentralization problem, it implies that $\theta'(s_1 + b_1) < 0$ so that it is optimal to subsidize early bequests. Equivalently, if the RHS of (14) is smaller than 1 (equivalently if $C < (1-\pi_2)/(1-\pi_1)$), the trade-off is distorted downward and it is optimal to tax early bequests, i.e., $\theta'(s_1 + b_1) > 0$.

When the probabilities of survival and of dependency are the same for the two types of individuals, $C = 1$ and $\theta'(s_1 + b_1) = 0$. In that situation, we are back to the Atkinson–Stiglitz (1976) framework, and only labour supply of the low-productivity agent should be taxed in order to solve the incentive problem.

Yet, in our model, individuals have different π_i and p_i so that C likely to be different from 1. In order to understand our results, we proceed by steps. Assume first that $p_1 = p_2 = p$ so that individuals differ only with respect to their survival chances, and $\pi_2 > \pi_1$. In the appendix, we show that $(1-\pi_2)/(1-\pi_1) > C$, so that $\theta'(s_1 + b_1) > 0$. It is then optimal to set a marginal tax on early bequests for the low-type individual. The mechanism behind this result goes as follows. Recall first, that direct taxation of savings is not possible here because they are not observable. Hence, taxing bequests is an indirect way of doing so. In this simplified scenario where the probabilities to become dependent are identical across agents, type 2 individuals have higher survival probability and higher wages than type 1 individuals. Thus, they wish to make more precautionary savings (i.e., s_2), which results in higher early bequests if they die at the end of the first period. Hence, distorting downward the early bequests of type 1 agents is a way to make their allocation less desirable (by preventing them to make savings and to leave bequests in case of early death) to type 2 individuals and thus prevent them from mimicking type 1 agents.

Assume now instead, that survival probabilities are the same $\pi_2 = \pi_1 = \pi$. Under that second scenario, agents with higher-productivity face lower probability to become dependent at the old age: $p_2 < p_1$. In that case, we show in the appendix that $C > 1$, and a subsidy on early bequests (i.e., $\theta'(s_1 + b_1) < 0$) is then optimal. The mechanism behind this result is then a mirror image of the previous case. Because $p_1 > p_2$, type 2 individuals would like to make less precautionary savings than type 1 individuals. Distorting upward the early bequests (which include savings) of the latter makes their allocation less desirable to type 2 agents because they have lower probability to become dependent and thus a lower willingness to save.

In the general case where both π_i and p_i are different across individuals, in order to have unambiguous results, we follow Lefebvre et al. (2018) and further assume that differences in survival probabilities ($\pi_2 > \pi_1$) are larger than differences in the unconditional probabilities to become dependent ($\pi_2 p_2 < \pi_1 p_1$), which are found to be *small*. In expression (14), this implies that $C < (1-\pi_2)/(1-\pi_1)$ (see the appendix) and, thus, that a marginal tax on the early bequests of type 1 individuals, $\theta'(s_1 + b_1) > 0$, is optimal. Indeed, on the one hand, differences in survival probabilities push toward a downward distortion of early bequests. On the other hand, differences in the probabilities to become dependent push toward an upward distortion. Because differences in survival probabilities are larger than differences in the unconditional probability to become dependent, the first effect dominates the second one, and it is optimal to distort downward the early bequests of the low-type agents. As a result, because type 2 individuals would like to make higher precautionary savings (due to relatively higher survival chances), it is optimal to impose a marginal tax on the early bequests of low-type individuals, in order to prevent mimicking from type 2 individuals.

Finally, we study the optimal choices of b_1^D and b_1^L. Equations (12) and (13) imply that there should be no distortion in the choice of b_1^D and b_1^L. In other words, no marginal taxation of late bequests (either in good or in bad health) is required at the second-best optimum: $\theta'(x_1 + b_1) = \theta'(b_1) = 0$. The reason why the two types of late bequests are not taxed comes from the fact that in the second period of life, uncertainty regarding survival and the health status has already realized and demographic characteristics play no role anymore. In the second period, agents then make consumption reallocation, once they have learnt their health status. This implies that the second-best optimal trade-offs for late bequests are always identical to the laissez-faire and the first-best ones (i.e., equations (7) and (8) are identical to equations (12) and (13)).

Our results are summarized in the following proposition.

PROPOSITION 1. *At the second-best optimum, when individuals differ in terms of productivity and demographic characteristics,*

- *If survival probabilities and probabilities to become dependent are identical across individuals, the standard* Atkinson−Stiglitz (1976) *result holds: optimality can be attained by imposing a marginal tax only on the income of the low-productivity individuals.*
- *If individuals also differ in their demographic characteristics, in addition to income taxation, it is, in general, optimal to also tax the early bequests of the low-productivity individuals.*
- *Late bequests should never be taxed or subsidized.*

This proposition shows that in order to relax the incentive constraint (due to the unobservability of individuals' types by the government), it is optimal to tax early bequests of the low-type individuals. Importantly, this result relies on Lefebvre et al. (2018), who shows that the magnitude of the relationship between wealth and survival is higher than the magnitude of the relationship between wealth and the unconditional probability to become dependent. Contrary to Atkinson−Stiglitz (1976), and because of the multi-screening problem, labour income taxation alone is not sufficient to solve the incentive problem. Interestingly, early bequests need to be taxed. The mechanism goes through (unobservable) savings whose size depends on income and demographic characteristics and which are transferred as bequests as a consequence of the absence of annuity and of LTC insurance markets.

5. Conclusion

This paper has studied the design of an optimal non linear inheritance taxation in a setting where individuals differ in wage as well as in their risks of both mortality and old-age dependance. We assume, as shown by Lefebvre et al. (2018), Cambois et al. (2011) and Liu and Wang (2022), that higher-wage individuals have higher survival chances and lower conditional and unconditional probabilities to become dependent. In our model, agents exhibit a joy of giving motive and as observed in reality, we assume that there is no perfect annuity or LTC insurance market. This leads to having three types of bequests depending on the realization of nature: early bequests, late bequests under autonomy and late bequests under dependency. The government cannot distinguish between bequests motives, that is whether bequests result from voluntary or involuntary reasons. Instead, it observes only the timing of the donation, that is, whether bequests are made early in life or late in life and in the latter case, whether the donor was healthy or not. In that setting, we show that in a second-best framework where the government cannot observe productivity and demographic characteristics, in addition to labour income taxation, the early bequests of the low-productivity agent should be distorted downward, i.e., they should be taxed at the margin, so as to make the problem incentive compatible. To the opposite, late bequests (either under autonomy or under dependency) should not be taxed at the margin.

Our paper contributes to the literature on the optimal taxation of inheritance, by adding several dimensions to the standard Atkinson−Stiglitz (1976) model. These are the possibility that agents care about the bequests they leave, the fact that they may become dependent in old age but that they do not face the same mortality and dependency risks. These dimensions were largely absent from this literature. The advent of old-age dependency has become an increasing concern for policy makers in many developed countries. As such, our paper contributes to a better understanding of these issues and to how the taxation of bequests should be adapted to account for these new societal challenges.

Appendix: Second-best trade-off for the taxation of early bequests of type 1 individual

Replacing for (9) in equation (11), we obtain after some rearrangements:

$$\begin{aligned} &n_1[\pi_1 p_1 H'(b_1^E - b_1^D) + \pi_1(1-p_1)u'(b_1^E - b_1^L) - u'(c_1)] + n_1(1-\pi_1)v'(b_1^E) \\ &= \lambda\left[\pi_2 p_2 H'(b_1^E - b_1^D) + \pi_2(1-p_2)u'(b_1^E - b_1^L) - u'(c_1)\right] + \lambda(1-\pi_2)v'(b_1^E). \end{aligned}$$

Using the following notation $A = u'(c_1) - \pi_1 p_1 H'(b_1^E - b_1^D) - \pi_1(1-p_1)u'(b_1^E - b_1^L) > 0$ and $B = u'(c_1) - \pi_2 p_2 H'(b_1^E - b_1^D) - \pi_2(1-p_2)u'(b_1^E - b_1^L)$, we can rewrite the above expression as

$$\begin{aligned} &n_1 A - [n_1(1-\pi_1) - \lambda(1-\pi_2)]v'(b_1^E) = \lambda B \\ &\Rightarrow n_1 A - \lambda B = v'(b_1^E)(1-\pi_1)\left[n_1 - \lambda\frac{1-\pi_2}{1-\pi_1}\right]. \end{aligned}$$

Rearranging terms, we obtain the marginal rate of substitution between savings and early bequests, i.e., equation (14), where $C \equiv B/A$ can be rewritten as follows:

$$\begin{aligned} C &= \frac{u'(c_1) - \pi_2 p_2 H'(b_1^E - b_1^D) - \pi_2(1-p_2)u'(b_1^E - b_1^L)}{u'(c_1) - \pi_1 p_1 H'(b_1^E - b_1^D) - \pi_1(1-p_1)u'(b_1^E - b_1^L)} \\ &= \frac{1 - \pi_2\left[\frac{p_2 H'(b_1^E - b_1^D) + (1-p_2)u'(b_1^E - b_1^L)}{u'(c_1)}\right]}{1 - \pi_1\left[\frac{p_1 H'(b_1^E - b_1^D) + (1-p_1)u'(b_1^E - b_1^L)}{u'(c_1)}\right]}, \end{aligned}$$

which corresponds to equation (15). In order to find whether at the second best, early bequests of type 1 individuals should be taxed or subsidized at the margin, we need to find whether $(1-\pi_2)/(1-\pi_1) \gtrless C$ or equivalently, whether

$$\frac{1-\pi_2}{1-\pi_1} \gtrless \frac{1 - \pi_2\left[\frac{p_2 H'(b_1^E - b_1^D) + (1-p_2)u'(b_1^E - b_1^L)}{u'(c_1)}\right]}{1 - \pi_1\left[\frac{p_1 H'(b_1^E - b_1^D) + (1-p_1)u'(b_1^E - b_1^L)}{u'(c_1)}\right]}. \tag{A1}$$

If the LHS of the above expression is greater (respectively smaller) than its RHS, then the RHS of expression (14) is smaller (respectively greater) than 1 and $\theta'(s_1 + b_1) > 0$ (respectively $<$).

Assume that $p_1 = p_2 = p$ so that only survival probabilities are different and such that $\pi_2 > \pi_1$. In that case, we unambiguously obtain that

$$\frac{1-\pi_2}{1-\pi_1} > \frac{1-\pi_2 K}{1-\pi_1 K},$$

where $K = \frac{pH'(b_1^E - b_1^D) + (1-p)u'(b_1^E - b_1^L)}{u'(c_1)} > 1$.[19] This implies marginal taxation of early bequests, i.e., $\theta'(s_1 + b_1) > 0$.

Let us now assume that $\pi_1 = \pi_2 = \pi$ and that $p_2 < p_1$. It is possible to show that in expression (A1), the expressions inside brackets are increasing in p_i (because $H'(b_1^E - b_1^D) = v'(b_1^E) > u'(b_1^E - b_1^L) = v'(b_1^L)$) so that the RHS of this expression is greater than 1, while the LHS is equal to 1 and $\theta'(s_1 + b_1) < 0$.

Let us finally consider the general case where $\pi_2 > \pi_1$, $p_2 < p_1$ and $\pi_2 p_2 < \pi_1 p_1$, but the differences between the unconditional probabilities $(\pi_i p_i)$ across types are small. Let us rewrite the RHS of (A1) as follows:

$$C = \frac{1 - \left[\frac{\pi_2 p_2 (H'(b_1^E - b_1^D) - u'(b_1^E - b_1^L)) + \pi_2 u'(b_1^E - b_1^L)}{u'(c_1)}\right]}{1 - \left[\frac{\pi_1 p_1 (H'(b_1^E - b_1^D) - u'(b_1^E - b_1^L)) + \pi_1 u'(b_1^E - b_1^L)}{u'(c_1)}\right]}, \tag{A2}$$

with $H'(b_1^E - b_1^D) - u'(b_1^E - b_1^L) > 0$ and $u'(d_1) \equiv u'(b_1^E - b_1^L) > u'(c_1)$ (see footnote 19). It is possible to show that, if $\pi_2 p_2 \to \pi_1 p_1$, expression (A2) is smaller than $(1-\pi_2)/(1-\pi_1)$. Therefore, it is optimal to tax early bequests, i.e., $\theta'(s_1 + b_1) > 0$.

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19 To see that $K > 1$, rewrite K as $K = \frac{p(H'(b_1^E - b_1^D) - u'(b_1^E - b_1^L)) + u'(b_1^E - b_1^L)}{u'(c_1)}$. From the second-best FOCs, we have that $H'(b_1^E - b_1^D) = v'(b_1^D)$ and $u'(b_1^E - b_1^L) = v'(b_1^L)$ so that $H'(b_1^E - b_1^D) - u'(b_1^E - b_1^L) > 0$. We also have that $u'(b_1^E - b_1^L) \equiv u'(d_1) > u'(c_1)$ so that $K > 1$.

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