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Bequests, taxation and the distribution of wealth in a general equilibrium model

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This paper examines the role of bequests and of taxation on bequests for the distribution of wealth. We investigate a model with overlapping generations and heterogenous households where parents derive utility directly from their bequests. Using the coefficient of variation as measure of equality, bequests per se diminish the inequality of wealth since they raise private savings and hence average wealth holdings more than the dispersion of wealth. From a policy perspective, taxing bequests and redistributing government revenue lump-sum among the young generation further decreases wealth inequality. These results also hold when measuring inequality by the Gini coefficient.

Keywords: bequest, taxation, wealth inequality, OLG model, analytical solution
JEL classification numbers: D 310, H 230

1 Introduction

Most industrial countries levy a tax on wealth transfers. However, there are substantial differences in the legal framework of the tax system. In France and Germany, on the one hand, the tax is levied on inheritances. The institutional setting further forces donors to divide their estate equally among their own children. In the United States and in the United Kingdom on the other hand, there is a tax on estates and donors enjoy absolute freedom of bequests (see Cremer and Pestieau, 2003). What many countries seem to have in common is an ongoing and controversial debate about taxation of wealth transfers. Some countries, including the US, contemplate to phase out taxes on wealth transfer in the near future.

One of the main arguments in the public and academic discussion is the role of wealth transfers for the inequality of wealth. Wealth is highly concentrated: in many industrial countries, the share of the richest 1% of households in net worth is estimated to be 20-30% (see Davies and Shorrocks, 2000), whereas an equal distribution would imply that any $\pi\%$ of the population earn $\pi\%$ of wealth. Wealth transfers in form

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of bequests or inter vivo transfers are often seen as one of the major culprits for the wealth inequality.² Since there is some concern about the level of concentration, the taxation of wealth transfers is frequently identified as an adequate policy to mitigate the concentration of wealth.

This paper investigates the role of bequests for the distribution of wealth and the effects of redistributive taxation.³ We construct a simple model with stochastic individual income to analyze distributional effects by comparing steady state distributions in an overlapping generations setting. We find first that intergenerational wealth transfers per se have an equalizing effect on the distribution of wealth, when the coefficient of variation is chosen as the measure of inequality. Second, this result can be seen in general equilibrium only. Therefore, we consider general equilibrium analysis as being important. In our model, there is an increase in the variance of wealth due to wealth transfers, since wealth holdings are determined not only by own income but by a weighted sum of own *and* ancestor's income. Also, private savings are enhanced due to bequests. This in turn increases average wealth holdings so that greater average wealth can compensate for higher variance and the inequality of wealth, as measured by the coefficient of variation, falls. Further, we find that this result is robust when correlation across parent's and child's income is introduced into the model.

When we turn to economic policy, we allow the government to tax bequests and redistribute revenue among the young. We find that the redistributive policy reduces the variance of wealth while keeping the average wealth holding constant. As a result, inequality of wealth – again measured with the coefficient of variation – falls. Finally, we analyse how taxation affects the Gini-coefficient and another measure of inequality, the share of wealth owned by the richest $\pi\%$ of the population. Our results are robust to the choice of inequality measure - taxation and redistribution decreases inequality. We are therefore confident that our results can directly be used for the policy debate as the share of wealth owned by the richest $\pi\%$ is the standard measure used in the public. Note that due to the simplicity of our modeling choice, we are able to derive all results analytically.

The relation between intergenerational transfers and the wealth distribution has already found some attention among economists. In contrast to the frequently alleged concentration increasing influence, the results of diverse models indicate that intergenerational wealth transfers do not necessarily enhance wealth inequality, and that the taxation of wealth transfers might be an inappropriate policy that misses its aim of redistributing wealth. Two different strands can be identified in the literature.⁴

²See Charles and Hurst (2003) for an empirical analysis of the reasons for a positive relationship between wealth of parents and children *before* bequests. Bowles and Gintis (2002) discuss the various mechanisms through which economic status is transferred across generations. The effect of tax changes on the importance of gifts relative to bequests are analyzed by Bernheim et al. (2004).

³We do not study efficiency aspects as e.g. Blumkin and Sadka (2004) who analyse the efficiency cost of estate taxation. Another recent contribution with further references on the efficiency question is Grossmann and Poutvaara (2005).

⁴There is also a large literature that looks at wealth inequality and bequests from a quantitative perspective. Gokhale et al. (2001) are a recent example who also provide an overview of previous work.

First, there are models with an explicit bequest motive where parents derive utility from transferring wealth to their offspring (see e.g. Becker and Tomes, 1979, Laitner, 1979, Davies and Kuhn, 1991, or Cremer et al., 2003). Although there are substantial differences in these models, the framework usually is that of overlapping generations, and the underlying motive for intergenerational transfers is basically family altruism. Parents either care about the maximum utility their children can attain or about the wealth of their children. Furthermore, the models consider labour income, which depends on innate ability, education, or simply luck, as stochastic. Intergenerational transfers between parents and children are intended to alleviate differences in utility across the generations of a family. Capital accumulation, however, is not explicitly modelled or investigated. It is simply assumed that a stable steady state with stationary wage and interest rate exists. Second, Stiglitz (1969, 1978) investigates the distribution of income and wealth among individuals in the tradition of the Solow growth model. He shows that levying an estate tax may lead to an increase in inequality of income and wealth due to capital accumulation effects. Since his model is in the tradition of Solow, the saving rate and bequests are exogenous and not an outcome of utility maximizing households. Also, there is no explicit bequest motive as in the above mentioned literature.

From a modelling perspective, this paper brings together the two strands of the literature. We partly build on the model of Davies and Kuhn (1991), but in contrast to their model we take into account capital accumulation effects. Furthermore, as in the work of Blinder (1974) and Heer (2001), in our model intergenerational wealth transfers are based on what is called the joy-of-giving bequest motive or paternalism.⁵ In opposite to altruism, paternalistic parents attain utility either from the amount they bequeath for the “warm feeling” or from the amount the child inherits. We assume that the utility is derived from the amount the child receives so that there is at least a mild form of altruism. As Abel and Warshawsky (1988) have shown, with correct parameter specifications quantitative implications of altruism and paternalism coincide. However, results of the altruistic motive do not have to prevail for paternalistic transfers as has been shown by Andreoni (1989, 1990) for Ricardian neutrality and in the context of charitable giving.

The rest of the paper is organized as follows. The next section presents the basic model. Section 3 studies the evolution path of the economy and steady state properties. In section 4, we study the distribution of wealth and the role of bequests for inequality. We also allow for a correlation between parent’s and child’s income as an extension to the basic model. Section 5 then investigates distributional effects of taxation and checks robustness of our results by using the Gini coefficient as an alternative measure for inequality. The final section concludes.

⁵For a survey of transfer motives and some of their implications consult Masson and Pestieau (1997).

2 The model

We consider a society with overlapping generations. Each individual lives for two periods. In each period t there is a large number n of families or dynasties consisting of one parent and one child. When young, individuals work and earn labour income. When old, parents are retired, consume their savings, and leave a bequest to the child. We assume that workers differ with respect to their ability and hence productivity. Let l_{it} denote the effective inelastic labour supply of an individual i . At the beginning of period t , each worker draws l_{it} , where $l_{it} > 0$, from an identical distribution F with expectation and variance given by

$$E[l_{it}] = \bar{l} \equiv 1, \quad \text{Var}(l_{it}) = \sigma^2. \quad (1)$$

As the l_{it} are identically and independently distributed random variables, their covariance is zero, $\text{Cov}(l_{ir}, l_{is}) = 0$, for $r \neq s$. Without loss of generality, we set $\bar{l} = 1$.

Since in each period an equal number of individuals enters and leaves the economy, there is a stationary number of families. While the microeconomic level – that is individual income, inheritance, savings – is characterized by uncertainty, there is certainty on the per capita level – average efficient labour supply, capital-per-worker, and interest rate and wage are nonrandom variables. For example, the individual efficient labour supply l_{it} is a random variable with variance $\text{Var}(l_{it}) = \sigma^2$. The average efficient labour supply is $\sum_{i=1}^n l_{it}/n$ with $\text{Var}(\sum_{i=1}^n l_{it}/n) = \sigma^2/n$ which tends to zero for $n \rightarrow \infty$. This means for $n \rightarrow \infty$, the probability that the average efficient labour supply deviates from its expectation is zero.

2.1 Household behaviour

Individuals consume in both periods and leave a bequest that immediately passes to their child at the end of the second period. A person belonging to family i , born at the beginning of period t , maximizes lifetime utility

$$U_{it} = U(c_{it}^y, c_{it+1}^o, b_{it+1}),$$

choosing consumption c_{it}^y when young, c_{it+1}^o when old, and the bequest b_{it+1} passed on to the child. Note that utility depends on the amount b_{it+1} the child receives after tax. In the first period, the budget constraint for an individual of generation t is

$$w_t l_{it} + b_{it} + g_t = c_{it}^y + s_{it},$$

where b_{it} denotes after tax inheritance received from the parent, $w_t l_{it}$ stochastic income depending on wage w_t per efficiency unit and the random ability of the individual l_{it} , g_t the uniform lump-sum transfer received from the government in case that it levies a tax on bequests, and s_{it} savings. In the second period, the constraint is

$$s_{it}(1 + r_{t+1}) = c_{it+1}^o + (1 + \tau)b_{it+1},$$

where r_{t+1} is the interest rate and $\tau \geq 0$ the tax on bequests. Parents have to take into account that part of their wealth transferred to the child may be collected by

the government. With a positive tax rate τ , intending to leave b_{it+1} to the child, the parent has to bequeath $(1 + \tau)b_{it+1}$. The individual decision is under certainty, since bequests and labour income are received before deciding about consuming and saving in the first period, and the interest rate is not random.

To keep things as simple as possible, we assume a Cobb-Douglas utility function

$$U_{it} = \alpha \ln c_{it}^y + (1 - \alpha)[\beta \ln c_{it+1}^o + (1 - \beta) \ln b_{it+1}],$$

with $.5 < \alpha < 1$, $0 < \beta < 1$. The preference parameter α must be larger than .5 as otherwise individuals would value future utility from consumption and bequests more than utility from present consumption and the implied time preference rate would be negative. From the first-order conditions one can easily derive consumption in each period, savings, and bequests left to the child

$$\begin{aligned} c_{it}^y &= \alpha(w_t l_{it} + b_{it} + g_t), \\ s_{it} &= (1 - \alpha)(w_t l_{it} + b_{it} + g_t), \\ c_{it+1}^o &= (1 - \alpha)\beta(w_t l_{it} + b_{it} + g_t)(1 + r_{t+1}), \\ b_{it+1} &= \frac{(1 - \beta)s_{it}(1 + r_{t+1})}{1 + \tau}. \end{aligned} \tag{2}$$

$$\tag{3}$$

Independent of their ability or inherited wealth, individuals always consume the share α of their income $w_t l_{it} + b_{it} + g_t$ in the first period. The rest is saved and yields the return $1 + r_{t+1}$. At the end of the second period, the share β of savings plus the accrued interest is consumed, $1 - \beta$ is passed to the child.

Note that savings in equation (2) are independent of τ . The tax on wealth transfers drives a wedge between the relative prices of goods. As a consequence, households will substitute first period consumption for bequests. However, due to the Cobb-Douglas utility, substitution and income effect neutralize each other so that a tax on bequests does not influence individual savings.

2.2 Firms

Firms use labour and capital as inputs and produce a single good that can be consumed or invested. Both factors are supplied inelastically. The good is chosen as numeraire. There is perfect competition, the firms make zero profits. Production exhibits constant returns to scale and is assumed to be of the usual Cobb-Douglas type. In intensive form, the production function can be expressed as $y_t = f(k_t) = Ak_t^\gamma$, where y_t and k_t are output per worker and capital per worker, respectively. In equilibrium, factors are paid their marginal products

$$r_t = \frac{\partial f(k_t)}{\partial k_t} - \delta = \gamma Ak_t^{\gamma-1} - \delta, \tag{4}$$

$$w_t = f(k_t) - k_t \frac{\partial f(k_t)}{\partial k_t} = (1 - \gamma)Ak_t^\gamma, \tag{5}$$

with the net interest rate r_t , depreciation rate δ , and wage w_t .

2.3 Government

The government is concerned about the distribution of wealth. The only tax instrument at its disposal is a tax on bequests. The government levies a tax $\tau \geq 0$ and redistributes revenue lump-sum among the young generation. The tax is modelled as a consumption tax that raises the price of the “good” bequest. In each period, the government’s budget is balanced. Every young individual receives the same transfer g_t that corresponds to the average tax revenue per tax case

$$ng_t = \tau \sum_{i=1}^n b_{it}. \quad (6)$$

Although there is variation in the individual bequest left to the child and accordingly different tax revenue per bequest, due to the large number of families the average tax revenue of the government is deterministic. Hence, the government does not need to form expectations about tax revenue.

3 Transitional dynamics and steady state

We are now in the position to study the dynamics of capital intensity k and to calculate its steady state value. Furthermore, we can investigate the development of the distribution of wealth: The law of large numbers tells us that if the individual probability to “draw” a certain amount of wealth equal to at most \bar{a} is given by $\pi\%$, then, in a large economy, a share of $\pi\%$ of the whole population will hold at most that amount of wealth \bar{a} . In order to understand the national distribution of wealth, we therefore just have to understand the properties of the distribution of individual wealth.

In what follows, we investigate convergence in two dimensions: convergence of the capital stock on a macroeconomic level and convergence of the distribution of wealth on a microeconomic level. The distribution of wealth will be studied under the assumption that the economy has already reached the macroeconomic steady state.

3.1 The capital stock

Let us first study the dynamics of k . From the goods’ market equilibrium it follows that households’ assets in period $t+1$ – all owned by members of the generation born in t – equal the period’s capital stock. We will show that a [deterministic] stable steady state exists. While such a proof is self-evident in deterministic settings, it is not obvious in our economy with stochastic productivity on an individual level. Using the same approach as for l_{it} mentioned at the beginning of chapter 2, we get

$$k_{t+1} = \frac{K_{t+1}/n}{L_{t+1}/n} = \frac{\sum_{i=1}^n s_{it}/n}{\sum_{i=1}^n l_{it+1}/n}.$$

Inserting s_{it} , b_{it} , and g_t from (2), (3), and (6) yields

$$k_{t+1} = (1 - \alpha)w_t \frac{\sum_{i=1}^n l_{it}/n}{\sum_{i=1}^n l_{it+1}/n} + (1 - \alpha)(1 - \beta)(1 + r_t)k_t \frac{\sum_{i=1}^n l_{it}/n}{\sum_{i=1}^n l_{it+1}/n}.$$

For a sufficiently large economy $\frac{\sum_{i=1}^n l_{it}/n}{\sum_{i=1}^n l_{it+1}/n}$ approaches unity, since $\sum_{i=1}^n l_{it}/n$ does not deviate from $E[l_{it}] = 1$ for $n \rightarrow \infty$. Substituting further for w_t and r_t from the factor market equilibrium, we obtain after rearranging

$$k_{t+1} = c_1 k_t^\gamma + c_2 k_t, \quad (7)$$

where $c_1 \equiv (1 - \alpha)(1 - \gamma)A + (1 - \alpha)(1 - \beta)\gamma A$ and $c_2 \equiv (1 - \alpha)(1 - \beta)(1 - \delta)$. Equation (7) determines the evolution of k starting with an initial value. Note that k is independent of the tax rate τ . Taxing wealth transfers *and* redistributing tax yields does not influence the growth path of the economy.

3.2 Macroeconomic steady state

To compute the steady state capital intensity, let $k_{t+1} = k_t = \bar{k}$ in (7) and solve for \bar{k}

$$\bar{k} = \left(\frac{c_1}{1 - c_2} \right)^{(1-\gamma)^{-1}}. \quad (8)$$

Wage \bar{w} and interest rate \bar{r} are calculated from the marginal product of labour and capital in the steady state. Plugging \bar{k} into the factor market equilibrium conditions (4) and (5), we derive

$$\bar{r} = \gamma A \frac{1 - c_2}{c_1} - \delta, \quad (9)$$

$$\bar{w} = (1 - \gamma)A \left(\frac{c_1}{1 - c_2} \right)^{\gamma/(1-\gamma)}. \quad (10)$$

Since $0 < \left. \frac{dk_{t+1}}{dk_t} \right|_{\bar{k}} = \gamma + (1 - \gamma)c_2 < 1$, the steady state is locally stable. A simple graphical analysis reveals that the steady state is also globally stable. Whatever the initial value of k is, the capital stock converges to \bar{k} .

3.3 The evolution of wealth and the limiting distribution

We now turn to the evolution on the microeconomic level. Wealth a_{it+1} of family i in period $t + 1$ is owned by the parent and consists of the savings of the previous period. Equation (2) implies

$$a_{it+1} = s_{it} = (1 - \alpha)(w_t l_{it} + b_{it} + g_t). \quad (11)$$

Substituting for b_{it} from (3) and g_t from (6) gives

$$a_{it+1} = (1 - \alpha)w_t l_{it} + \frac{(1 - \alpha)(1 - \beta)(1 + r_t)}{1 + \tau} a_{it} + \frac{\tau(1 - \alpha)(1 - \beta)(1 + r_t)}{1 + \tau} k_t, \quad (12)$$

a difference equation that describes the evolution of wealth holdings of a family. As can be seen from equation (12), several factors determine family wealth in $t + 1$. First,

wage and interest rate of the previous period, which again depend on the capital intensity of that period, have an influence. Second, stochastic income and family wealth of period t , which influences current wealth via bequests, play an important role. And finally, the third term of equation (12) reflects the government transfer the young generation receives.

To calculate an explicit solution for the evolution of wealth a_{it} , we consider an economy where the capital stock has already reached its macroeconomic steady state value. In such a steady state, capital intensity k , wage w , and interest rate r take their values in (8), (9), and (10) so that we obtain from equation (12)

$$a_{it+1} = c_3 l_{it} + c_4 a_{it} + c_5, \quad (13)$$

where $c_3 \equiv (1 - \alpha)\bar{w}$, $c_4 \equiv \frac{(1-\alpha)(1-\beta)(1+\bar{r})}{1+\tau}$, $c_5 \equiv \frac{\tau(1-\alpha)(1-\beta)(1+\bar{r})}{1+\tau}\bar{k}$. When we solve equation (13) recursively, we obtain

$$a_{it} = c_5 \sum_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}. \quad (14)$$

Intuitively, one would want the value of c_4 to lie between zero and one as otherwise the sums do not converge. Analytically, it can be shown that this is indeed true (cf. app. 8.3). As one can see from equation (14), family wealth in period t depends on the initial wealth a_{i0} of the family at $t = 0$, the transfer of the government, and the stochastic productivity l_{is} of all preceding generations. The more luck the ancestors had, the higher was their labour income and the higher are wealth holdings of the current generation, since part of the ancestors' luck is shifted into the future via bequests. However, due to the factor c_4 , the influence of distant luck on current wealth is weaker than that of parent's luck.

Let us now turn to the characteristics of the distribution of wealth. The expected value of a_{it} is, taking (1) into account,

$$E[a_{it}] = c_5 \sum_{s=0}^{t-1} c_4^s + c_4^t a_{i0} + c_3 \sum_{s=0}^{t-1} c_4^{t-1-s} = c_4^t a_{i0} + (c_3 + c_5) \frac{1 - c_4^t}{1 - c_4}. \quad (15)$$

Its variance is, employing again (1) and its covariance implication,

$$\text{Var}(a_{it}) = c_3^2 \sigma^2 \sum_{s=0}^{t-1} (c_4^{t-1-s})^2 = c_3^2 \sigma^2 \frac{1 - c_4^{2t}}{1 - c_4^2}. \quad (16)$$

More precise results concerning the evolution of the expected wealth level of a family are possible if we make the assumption that in $t = 0$, the steady state capital stock is divided equally among families so that each family's wealth holding in period $t = 0$ is $a_{i0} = a_0 = \bar{k}$. Equation (14) then becomes with $a_{i0} = a_0$,

$$a_{it} = c_5 \sum_{s=0}^{t-1} c_4^s + c_4^t a_0 + c_3 \sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}. \quad (17)$$

The evolution of $E[a_{it}]$ is then again given by (15), only that $a_{i0} = a_0 = \bar{k}$. It can then be shown (see app. 8.4) that each family in expectations holds wealth equal to \bar{k} in every period and not only in the long run, $E[a_{it}] = \bar{k} \forall t$. Note that this is not

surprising when remembering that we are already in a macroeconomic steady state. As the latter implies that the average capital stock is given by \bar{k} for each t , it must be that the expected wealth holding of a representative family is also \bar{k} for each t .

When households differ in their initial wealth a_{i0} , they will nevertheless have all the same expected wealth \bar{k} , but only in the long run. Expected wealth increases over time when $a_{i0} < \bar{k}$, it decreases when $a_{i0} > \bar{k}$. The variance of wealth (16) unambiguously increases over time but approaches a constant.

When we look at the microeconomic steady state, i.e. at the long run for t approaching infinity, we obtain a constant mean that is independent of the initial value a_{i0} ,

$$E[a_{i\infty}] = \frac{c_3 + c_5}{1 - c_4} = \bar{k}. \quad (18)$$

This mean needs to be identical to the aggregate capital per worker stock \bar{k} as the aggregate capital stock is just the sum of individual wealth holdings and as all individuals are equal in this expected sense (see app. 8.4 for an analytical derivation). The variance also becomes a constant,

$$\text{Var}(a_{i\infty}) = \frac{c_3^2 \sigma^2}{1 - c_4^2}. \quad (19)$$

When we want to know whether the distribution of a_{it} as a whole, and not just its expected value and variance, converges to a limiting distribution, we need to understand whether the sum $\sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}$ in (14) converges for $t \rightarrow \infty$. While this is obvious for other terms in (14), this is less obvious for this term given the stochastic nature of individual productivity in l_{is} . As $0 < c_4 < 1$ and when we are willing to assume that $\text{var}(l_{is}) < \infty$, the two-series theorem – a simplified version of the well-known three-series theorem (Shiryayev, 1996, p. 386–387) – implies that $\sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}$ converges for $t \rightarrow \infty$ with probability 1.⁶ We may conclude that a limiting distribution for a_{it} exists in a fairly general setting.

4 Wealth inequality and bequests

In this section, we will investigate the role of bequests per se for the inequality of wealth within and across generations, leaving the analysis of tax effects for the next section. Knowing the expectation and the variance of wealth, we use as our measure of inequality the coefficient of variation $CV(a_{it})$,

$$CV(a_{it}) = \frac{\sqrt{\text{Var}(a_{it})}}{E[a_{it}]}, \quad (20)$$

⁶Note that the assumption of a finite variance is not satisfied for all possible distributional assumptions for l_{is} (e.g. Kleiber and Kotz, 2003) but note also that the empirical evidence suggests that $\text{var}(l_{is}) < \infty$ is a realistic assumption.

4.1 Intragenerational inequality

Inserting (18) and (19) into (20), we get an expression for the coefficient of variation as a function of β . As the sign of $dCV(a_{i\infty})/d\beta$ remains ambiguous analytically,⁷ we obtain information about the effect of bequests on inequality by comparing two economies, A and B . We assume that they are identical, except that in economy B households bequeath wealth, i.e. $0 < \beta < 1$, while in A they do not ($\beta = 1$). In economy A , plugging (15) and (16) into (20) and observing that $\beta = 1$ implies $c_4 = 0$ and $c_5 = 0$, the coefficient of variation is constant for each point in time t ,

$$CV(a_{it}^A) = \sigma.$$

In economy B , the coefficient of variation from equation (20) increases over time as parents bequeath wealth to the child. In a steady state, the coefficient of variation CV from (20) with (18) and (19) is

$$CV(a_{i\infty}^B) = \frac{1 - c_4}{\sqrt{1 - c_4^2}} \sigma.$$

From $0 < c_4 < 1$ we obtain $1 - c_4 < 1 - c_4^2 < \sqrt{1 - c_4^2}$ so that

$$\frac{1 - c_4}{\sqrt{1 - c_4^2}} \sigma < \sigma \iff CV(a_{i\infty}^B) < CV(a_{i\infty}^A).$$

Inequality of wealth is lower in economy B , where parents bequeath part of their wealth, than in economy A , where parents derive no utility from leaving a bequest. In contrast to the intuition and general perception, bequests reduce the intragenerational inequality of wealth.

As Davies and Kuhn (1991) have mentioned, bequests may be equalizing through dampening shocks. An equalizing effect is also found in our model. But the reason for it to occur is different. Families in economy B are simply richer on average than families in economy A , because part of the wealth of the parent is transferred to the child. This leads to a rise in the denominator of CV in economy B , compared to economy A . The same happens to the numerator. While capital intensity is higher in economy B , workers' labour earnings in the steady state are also higher in relation to economy A so that the variance of wealth due to income uncertainty – one might call this the life-cycle component of savings – is higher. In addition, uncertainty of bequests also raises the variance of wealth. But since the effect on the denominator dominates, the coefficient of variation is smaller in economy B than in economy A .

4.2 Social mobility

Besides intragenerational inequality, one may also pay attention to other dimensions of inequality as for example social mobility across generations. Social mobility, as

⁷We were able to derive a sufficient (but not necessary) condition, $2 - 1/\alpha \leq \gamma$, under which $dCV(a_{i\infty})/d\beta \geq 0$. With $\gamma \approx 1/3$ and α close to .5, i.e. with relatively patient households, this would hold.

used here, is the degree to which child's wealth status may deviate from parent's status. It measures the ability of descendants of poor families to become rich and vice versa. Not surprisingly, in our model bequests have a negative influence on social mobility. While without bequests mobility is perfect, the wealth status of the child is solely determined by his own ability, bequeathing part of their wealth parents also transfer part of their wealth status.

As a formal measure of the degree of immobility, we use the correlation of parent-child wealth (e.g. Conlisk, 1974). With bequests and $\tau = 0$, according to equation (13), family wealth in $t + 1$ is defined as

$$a_{it+1} = c_3 l_{it} + c_4 a_{it}.$$

The correlation $\text{Cor}(a_{it+1}, a_{it})$ of wealth holdings between parent and child is then

$$\text{Cor}(a_{it+1}, a_{it}) = \frac{\text{Cov}(a_{it+1}, a_{it})}{\text{Var}(a_{it+1})^{1/2} \text{Var}(a_{it})^{1/2}} = \frac{E[(a_{it+1} - E[a_{it+1}])(a_{it} - E[a_{it}])]}{\text{Var}(a_{it+1})^{1/2} \text{Var}(a_{it})^{1/2}}.$$

Substituting $a_{it+1} = c_4 a_{it} + c_3 l_{it}$ yields

$$\text{Cor}(a_{it+1}, a_{it}) = \frac{c_4 \text{Var}(a_{it}) + E[c_3 l_{it} a_{it} - c_3 a_{it} - c_3 l_{it} E[a_{it}] + c_3 E[a_{it}]]}{\text{Var}(a_{it+1})^{1/2} \text{Var}(a_{it})^{1/2}}.$$

Given $\text{Cov}(l_{it}, a_{it}) = 0$ and therefore $E[l_{it} a_{it}] = E[l_{it}] E[a_{it}]$, we obtain

$$\text{Cor}(a_{it+1}, a_{it}) = c_4 \frac{\text{Var}(a_{it})^{1/2}}{\text{Var}(a_{it+1})^{1/2}} > 0,$$

so that there is indeed correlation between parent's and child's wealth. How strong this correlation is depends on the parameter c_4 and the variance of wealth, which from (16) depends on other parameters and time.

4.3 Correlation of income

In this section, we relax the assumption that ability and hence labour income of parent and child is uncorrelated. With positive correlation in earnings, the probability that children of high income parents earn themselves above average labour income is also high. In addition, these children receive relatively large inheritances so that wealth concentration increases. Hence, with correlating family incomes, wealth concentration could become higher in economy B than in economy A .

As Solon (1992) and Zimmermann (1992), who study intergenerational income mobility in the U.S., point out, there is substantial correlation in reality. Their results indicate that the correlation of sons' log earnings with respect to fathers' incomes is at least 0.4.

As a consequence of the correlation in ability, our model now also exhibits correlation between a_{it} and l_{it} . We still assume that government levies no tax on bequests so that $c_5 = 0$. Recall from equation (13) that family wealth in $t + 1$ is then given as

$$a_{it+1} = c_3 l_{it} + c_4 a_{it}.$$

We restrict ourselves to a analytically tractable form of correlation. Following Davies and Kuhn (1991), we assume that effective labour supply regresses to the mean across generations according to

$$l_{it+1} = \bar{l} + \nu(l_{it} - \bar{l}) + \epsilon_{it+1},$$

where \bar{l} denotes the expected effective labour supply, which for our purposes is set equal to one, ν with $0 < \nu < 1$ expresses the strength of correlation between fathers' and sons' ability, and ϵ_{it+1} is the realization of an independent and identical distributed shock with zero mean, finite variance and a lower-bound sufficient to keep $l_{it+1} > 0$. In $t = 0$, the process starts with $l_{i0} = \bar{l} + \epsilon_{i0}$, where $\bar{l} = 1$.

Despite the correlation of income, the model behaves almost exactly as before: capital intensity still evolves according to equation (7). In economy A , where bequests are absent and $\beta = 1$, $c_4 = 0$ so that family wealth a_{it+1}^A is defined as

$$a_{it+1}^A = (1 - \alpha)\bar{w}^A l_{it} = c_3^A \left[1 + \sum_{j=0}^t \nu^{t-j} \epsilon_{ij} \right],$$

where $c_3^A = (1 - \alpha)\bar{w}^A$. The expected wealth holding is $E[a_{it+1}^A] = c_3^A$, variance of wealth is $\text{Var}(a_{it+1}^A) = (c_3^A)^2 \sigma^2 \sum_{j=0}^t \nu^{2j}$, and the coefficient of variation is given as $CV(a_{it+1}^A) = \sigma(\sum_{j=0}^t \nu^{2j})^{1/2}$. In contrast to section 4.1, the concentration of wealth increases with time although parents do not bequeath wealth. Due to income correlation, the variance of income and hence the dispersion of wealth increases. We can write the coefficient of variation $CV(a_{it}^A)$ also as

$$CV(a_{it}^A) = \sigma \left(\frac{1 - \nu^{2t}}{1 - \nu^2} \right)^{1/2}. \quad (21)$$

Recall that $0 < \nu < 1$ so that the limit of equation (21) is

$$CV(a_{i\infty}^A) = \sigma \left(\frac{1}{1 - \nu^2} \right)^{1/2}.$$

In society B , where $0 < \beta < 1$ so that parents transfer part of their wealth to the child, the wealth accumulating process is more complicated. It is possible to calculate a solution at least in case that $\nu = c_4$. Obviously, there is no reason to believe that both parameters coincide but this is a useful example to gain some intuition. Later we will argue that this solution should hold for $\nu \neq c_4$, too.

According to equation (13), with $c_5 = 0$, we get $a_{it}^B = c_4^t a_0 + c_3 \sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}$. The expected value is still easy to calculate and given by $E[a_{it}^B] = \bar{k} = \frac{c_3}{1-c_4} = \frac{c_3}{1-\nu}$. As is described in more detail in app. 7, for $\nu = c_4$, the variance is

$$\text{Var}(a_{it}^B) = c_3^2 \sigma^2 \sum_{k=1}^t k^2 \nu^{2k-2}. \quad (22)$$

Thus, the coefficient of variation is

$$CV(a_{it}^B) = \sigma(1 - \nu) \left(\sum_{k=1}^t k^2 \nu^{2k-2} \right)^{1/2}, \quad (23)$$

or, as shown in the appendix, for $t \rightarrow \infty$

$$CV(a_{i\infty}^B) = \sigma(1 - \nu) \left(\frac{1 + \nu^2}{(1 - \nu^2)^3} \right)^{1/2}. \quad (24)$$

Comparing the two coefficients of variation of (21) and (24) and building the ratio for $t \rightarrow \infty$ yields

$$\frac{CV(a_{i\infty}^B)}{CV(a_{i\infty}^A)} = \frac{(1 - \nu)(1 + \nu^2)^{1/2}}{1 - \nu^2}.$$

For $0 < \nu < 1$ the ratio is below one so that in economy B wealth is still more equally distributed than in economy A .

This result should also hold even when $\nu \neq c_4$: In economy B , the coefficient of variation would then be

$$CV(a_{it}^B) = \sigma(1 - c_4) \left[\sum_{l=1}^t \left(\sum_{s=0}^{l-1} c_4^{l-1-s} \nu^s \right)^2 \right]^{1/2}. \quad (25)$$

This expression gets largest for $c_4 \rightarrow 0$ (e.g. for $\beta = 1$) and the limit is exactly the case without bequests. Hence, economy B attains the highest level of inequality if parents do not bequeath wealth as in economy A . For $c_4 \neq \nu$, we conjecture that the sum in equation (25) will not get larger than for $c_4 = \nu$. Hence, even in the general case with $c_4 \neq \nu$ family wealth will be distributed more equally when parents transfer wealth to their children as in economy B than without bequests as in economy A .

Nevertheless, as mentioned at the beginning, the correlation indeed seems to neutralize at least part of the equalizing effect of bequests. In the previous section, without correlation of abilities, the ratio of the coefficient of variation between the bequest case (economy B) and the base case without bequests (economy A) was $\frac{1-c_4}{\sqrt{1-c_4^2}}$, which decreases with c_4 . The limit of the ratio for $c_4 \rightarrow 1$ is 0. This would require that $\beta = 0$ so that the bequest motive is strong in economy B and parents bequeath all of their savings. In contrast to that, with correlation of income, $c_4 = \nu$, and $c_4 \rightarrow 1$ the ratio of the coefficient of correlation between the bequest case and the base case, again derived with L'Hôpital's rule, is $\sqrt{1/2}$. Wealth is more concentrated in economy A with and without correlation of ability, but the minimal ratio of the coefficient of variation between economy A and B is higher when there is correlation of income across generations.

5 Wealth inequality and taxation

The previous section has shown that parental willingness to bequeath wealth reduces the intragenerational inequality of wealth. We now ask how policy should react to this. Does taxing bequests further decrease inequality?

5.1 Taxing bequests

Recall that in our model taxing bequests with a tax rate $\tau > 0$ does not have any influence on private savings. For the sake of simplicity, we assume that $\text{Cov}(l_{it+k}, l_{it}) =$

0 so that there is no correlation of labour income across generations. Given our starting point that $a_0 = \bar{k}$, the expectation $E[a_{it}]$ of family wealth is \bar{k} , no matter if there is a redistributive taxation of bequests or not. Instead of calculating the coefficient of variation, we therefore simply concentrate on the variance of wealth as measure of inequality.

Again, we will compare two situations: one, where the government levies no tax ($\tau = 0$) and one with taxation of bequests ($\tau > 0$). We denote the variance with $\text{Var}(a_{it}^{wt})$ in the case 'with tax' and $\text{Var}(a_{it}^{nt})$ for 'no tax'. We can calculate $\text{Var}(a_{it}^{wt})$ and $\text{Var}(a_{it}^{nt})$ from equation (16). Note that in the 'no tax' case, we can relate c_4^{nt} to the definition of c_4 after (13) by $c_4^{nt} = c_4(1 + \tau)$. Hence, the ratio is

$$\frac{\text{Var}(a_{it}^{wt})}{\text{Var}(a_{it}^{nt})} = \frac{\sum_{s=0}^{t-1} c_4^{2s}}{\sum_{s=0}^{t-1} [c_4(1 + \tau)]^{2s}}.$$

From $0 < c_4 < 1$ and $\tau > 0$, we know that $c_4 < c_4[1 + \tau]$ and thus for $t \geq 2$

$$\sum_{s=0}^{t-1} c_4^{2s} < \sum_{s=0}^{t-1} [c_4(1 + \tau)]^{2s}.$$

Hence, the dispersion of family wealth decreases when government levies a tax on bequests and redistributes revenue among the young generation. Therefore, $CV(a_{it}^{wt}) < CV(a_{it}^{nt})$ from $t \geq 2$ on so that the redistributive policy of the government reduces intragenerational inequality.⁸

In the first period, redistribution does not yet work because we assumed that wealth is distributed equally in $t = 0$. Hence, bequests of that period are also equally distributed and taxation and redistribution can not alter the concentration of wealth: wealth already is completely equally distributed. But from $t = 2$ on, the tax starts working and wealth is less concentrated subsequently. Taxation furthermore increases wealth mobility. The higher the tax rate τ , the less parental wealth determines the wealth status of the child. The status of the child is then primarily related to own ability.

The equalizing effect of bequest taxation hinges on several aspects. First, as mentioned at the beginning, reactions of parents and children depend on the underlying motive for wealth transfers. Second, in this model taxing bequests and redistributing tax revenues does not effect private savings. And third, if wealth is implicitly "lost" in transit, this in turn would have an influence on private savings and the evolution path of the economy with the result that the average wealth holding of families could decrease. Although the redistribution diminishes the dispersion of wealth, lower average wealth holdings could then lead to an increase in inequality. Furthermore, one could argue that the tax on bequests might change the willingness to bequeath. If government tried to confiscate bequests, for example, or would be able to prohibit bequests, even households with an intrinsic bequest motive would probably stop bequeathing wealth. This would, as has been shown in the previous section, result in increased inequality of wealth.

⁸One should not think of redistribution, as modeled here, to correspond in the real world to a real per capita transfer of taxes collected by the government. Instead one can think of redistribution as an implicit transfer, caused e.g. by a reduction of other taxes.

5.2 Lorenz curves and the Gini coefficient

A measure of inequality widely used in the public is the amount of wealth owned by the richest $\pi\%$ of the population. As this amount is generally far higher than $\pi\%$ of total wealth, a society is viewed to have become more equal if this amount reduces. Perfect equality would mean if for any $\pi \in [0, 100]$, $\pi\%$ of the population own $\pi\%$ of wealth. The corresponding Gini-coefficient would then be zero.

We want to use a similar measure in our model, as we would like to compare our coefficient of variation results with these more common measures. To obtain such a measure, take as starting point equation (17). As stochastic labour productivities l_{is} are iid, we can replace $\sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}$ by $\sum_{s=0}^{t-1} c_4^s l_{is}$. Expressed for the steady state, i.e. $t \rightarrow \infty$,

$$a_{i\infty} = c_5 \sum_{s=0}^{\infty} c_4^s + c_3 \sum_{s=0}^{\infty} c_4^s l_{is}. \quad (26)$$

In order to be able to obtain properties of the distribution of wealth, we need to make specific assumptions about individual productivities l_{is} .⁹ As the l_{is} determine the wage distribution, we should use a distribution that is known to reflect observed wage and income distributions relatively well. One plausible candidate as our density function for productivities l_{is} (see Kleiber and Kotz, 2003, for a recent survey) is the gamma density with $\lambda > 0$ and $\phi > 0$,

$$f(x) = \frac{1}{\lambda^\phi \Gamma(\phi)} x^{\phi-1} e^{-x/\lambda}, \quad x > 0, \quad (27)$$

suggested by Salem and Mount (1974). As empirically plausible parameters we choose $\phi = 3$ and $\lambda = 1/3$ (which is also consistent with our model assumption of $E(l_{it}) = 1$ as the expected value of a gamma random variable is $\phi\lambda$).

Given this distributional choice for individual productivities l_{is} , we now have to understand the distributional properties of $a_{i\infty}$. As this is analytically not feasible, we use well-known approximation methods that allow to reasonably well proxy the distribution of $a_{i\infty}$ (also) by a gamma distribution. This is done by " χ^2 -type approximations" (e.g. Mathai and Provost, 1992, pp. 163 - 165), i.e. matching moments of the gamma distribution and the moments predicted by (26). The latter moments were computed explicitly in (18) and (19) without making a specific assumption concerning l_{is} . Hence, they are valid for our gamma assumption for individual productivities. Matching the mean and variance, we obtain

$$\phi\lambda = \frac{c_3 + c_5}{1 - c_4}, \quad (28)$$

$$\phi\lambda^2 = \frac{c_3^2 \sigma^2}{1 - c_4^2}, \quad (29)$$

where the left-hand sides show the mean and variance of the assumed gamma distribution for $a_{i\infty}$ and the right-hand sides are moments from (18) and (19). Dividing the

⁹Our coefficient of variation results were more general in the sense that they only required the existence of the first and second moment of a_{it} . Hence, we only had to specify the expected value and variance of individual productivities l_{it} in (1).

second by the first gives $\lambda = c_3^2 \sigma^2 / [(c_3 + c_5)(1 + c_4)]$ and reinserting into (28) gives $\phi = (c_3 + c_5)^2 (1 + c_4) / ((1 - c_4) c_3^2 \sigma^2)$.

The advantage of the gamma distribution is its property that implied Lorenz curves do not intersect (e.g. Kleiber and Kotz, 2003, p. 164). A higher ϕ implies a Lorenz curve that is closer to the 45°-line. Inequality as measured by the Gini coefficient or the share of wealth owned by the richest $\pi\%$ of the population therefore decreases in ϕ . Hence, in order to understand the effects of taxation on inequality measured in this way, we simply need to understand whether ϕ increases in τ . As this is the case, i.e. $d\phi/d\tau \geq 0$ (cf. app. 8.1), higher taxation leads to lower inequality also if the measure of inequality used is the Gini coefficient or the amount of wealth owned by the richest $\pi\%$.

6 Conclusion

This paper analysed the distributional impact of wealth transfers for a bequest-as-consumption motive. Summarizing, the role of bequests for the inequality of wealth is mixed. From a preference perspective, willingness to bequeath causes mobility to decrease, while the intragenerational equality of wealth is increased. In our model, β is the parameter that covers parents' willingness to bequeath. The higher β , the lower is the share of parental wealth the child receives. As has been shown in this paper, expected wealth and variance of wealth go down with β . Since the effect on expected wealth dominates, the coefficient of variation also goes down: Bequests decrease wealth inequality.

From a policy perspective, levying a wealth transfer tax and redistributing revenue among the young generation, the government can further reduce the concentration of wealth. The higher the tax τ on bequests, the lower is the variance of wealth, while average wealth holdings are not effected. As a consequence, the coefficient of variation is reduced by the tax. Hence, the government can follow a bequest taxation policy in order to reduce wealth inequality, even though the willingness to bequeath wealth, as captured by the preference parameter β , does not result in increased wealth inequality. However, if government undertook some legal action to prohibit wealth transfers, or if government introduced a complete confiscatory tax, then the distributional impact could change. This would happen, if parents' willingness to bequeath is driven to zero so that they consume all their savings when old instead of bequeathing part of their wealth.

While these results hold for the coefficient of variation as a measure of inequality, we have shown that they also hold for other, "more popular" measures like the Gini coefficient of the share of wealth held by the richest $\pi\%$ of the population. Taxing bequests reduces the Gini coefficient and reduces the amount of wealth owned by the richest parts of the population.

Clearly, there are certain limitations in our setup. In order to derive explicit solutions, we had to develop a model as simple as possible with fairly simple utility and production functions. Future work should relax some of these assumptions. For example, it would be interesting to consider a CES utility function and to investigate

the dependence of results on the elasticity of substitution. While a closed-form solution would still be possible, a CES utility would allow for a richer inter-dependence between taxation and savings which opens up new channels neglected here.

7 Appendix

We investigate here the mean reverting process introduced in section 4.3 and its implications for the variance of wealth in equation (22) in more detail. Section 4.3 builds on the stochastic process $l_{it+1} = \bar{l} + \nu(l_{it} - \bar{l}) + \epsilon_{it+1}$. Given $l_{i0} = \bar{l} + \epsilon_{i0}$ we obtain $l_{it+1} = \bar{l} + \sum_{j=0}^{t+1} \nu^{t+1-j} \epsilon_{ij}$ with expectation $E[l_{it+1}] = \bar{l}$ and variance $\text{Var}(l_{it+1}) = \nu^2 \text{Var}(l_{it}) + \sigma^2 = \sigma^2 \sum_{j=0}^{t+1} \nu^{2j}$. Covariance $\text{Cov}(l_{it+k}, l_{it})$ between the ability of the child of family i in period $t+k$ and the ability of the ancestor working in period t is defined as

$$\text{Cov}(l_{it+k}, l_{it}) = E[(l_{it+k} - E[l_{it+k}])(l_{it} - E[l_{it}])].$$

Inserting l_{it+k} and taking into account that $E[\epsilon_{it+m} l_{it}] = E[\epsilon_{it+m}] E[l_{it}] = 0$ for $m > 0$, since ϵ_{it+m} and l_{it} are independent for $m > 0$, the expression simplifies to

$$\text{Cov}(l_{it+k}, l_{it}) = \nu^k E[(l_{it} - E[l_{it}])^2] = \nu^k \text{Var}(l_{it}).$$

Remember, equation (17) describes the evolution of family wealth. With $c_5 = 0$ equation (17) simplifies to $a_{it} = c_4^t a_0 + c_3 \sum_{s=0}^{t-1} c_4^{t-1-s} l_{is}$. Since one has to take into account $\text{Cov}(l_{it+k}, l_{it})$, the expression for the variance of wealth $\text{Var}(a_{it})$ becomes rather complicated. Assuming that $c_4 = \nu$, which is at least possible for both variables are between zero and one, $\text{Var}(a_{it})$ is as in (22)

$$\text{Var}(a_{it}) = c_3^2 \sigma^2 \sum_{k=1}^t k^2 \nu^{2k-2}$$

which can be seen from calculating the expression for the variance for the first periods or proved by mathematical induction. Recall that $E[a_{it}] = \bar{k} = \frac{c_3}{1-c_4} = \frac{c_3}{1-\nu}$. The coefficient of variation $CV(a_{it})$ from equation (23) therefore is

$$CV(a_{it}) = \sigma(1-\nu) \left(\sum_{k=1}^t k^2 \nu^{2k-2} \right)^{1/2}.$$

With some further manipulations one can simplify the sum to

$$\sum_{k=1}^t k^2 \nu^{2k-2} = 2 \frac{1-\nu^{2t}}{(1-\nu^2)^3} - \frac{1+(2t-1)\nu^{2t}}{(1-\nu^2)^2} - \frac{t^2 \nu^{2t}}{1-\nu^2},$$

so that for $t \rightarrow \infty$ the limit of $CV(a_{it})$ as in equation (24) is

$$CV(a_{i\infty}) = \sigma(1-\nu) \left(\frac{1+\nu^2}{(1-\nu^2)^3} \right)^{1/2}.$$

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