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Angaben zur Veröffentlichung / Publication details:

Heer, Burkhard. 2001. "Wealth distribution and optimal inheritance taxation in life-cycle economies with intergenerational transfers." The Scandinavian Journal of Economics 103 (3): 445–65. https://doi.org/10.1111/1467-9442.00254.

Wealth Distribution and Optimal Inheritance Taxation in Life-cycle Economies with Intergenerational Transfers

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Abstract

Intergenerational transfers are introduced into a general equilibrium life-cycle model in order to explain observed levels of wealth heterogeneity. In our overlapping generations model, heterogenous agents face uncertain lifetime and leave both accidental and voluntary bequests to their children. Furthermore, agents face stochastic employment opportunities. The model is calibrated with regard to the characteristics of the US economy. Our results indicate that bequests only account for a small proportion of observed wealth heterogeneity. The introduction of an inheritance tax increases both welfare, as measured by the average lifetime utility of a newborn, and equality of the wealth distribution.

Keywords: Wealth distribution; overlapping generations; bequests; optimal taxation

JEL classification: *D*31; *D*91; *H*21; *C*68; *E*21

I. Introduction

Wealth is much more unequally distributed than earnings. For the US economy, Henle and Ryscavage (1980) estimate a Gini coefficient of earnings for men of approximately 0.42 during 1958−1977, while Wolff (1987) estimates a wealth Gini coefficient equal to 0.72 based on data from the 1983 Survey of Consumer Finances (SCF).[1] There are numerous reasons why wealth is distributed much more unequally than earnings. In this paper, we concentrate on intergenerational transfers as one possible explanation for this stylized fact. Our motivation for the study of bequests is founded on the work of Kotlikoff and Summers (1981). They separate total wealth in the US into a non-governmental transfer component and a life-cycle wealth compo-

Preliminary versions of this paper were presented at the conference on "Intergenerational Transfers, Taxes and the Distribution of Wealth" in Uppsala, 1999, and the Econometric Society European Meeting in Santiago de Compostela, 1999.

I would like to thank Lutz Hendricks, Michael Kaganovich, John Laitner, James Smith, Frank Stafford, and Carl Cristian von Weizsäcker for comments on earlier versions of the paper. All remaining errors are mine.

[1] For detailed descriptions of the US distribution of earnings, income, and wealth, see Díaz-Guiménez, Quadrini, and Ríos-Rull (1997) and Davies and Shorrocks (1999).

nent. According to their estimates, the former contributes about 80 percent to total wealth.

Standard life-cycle models with a representative agent and certain lifetime fail to reproduce observed wealth heterogeneity. In these models, wealth is only dispersed between generations but not within generations. In recent years, due to the advance of computational methods in economics, models of heterogenous-agent economies have received increasing attention. In such models, households may differ with regard to their earnings and their asset holdings, even within generational cohorts, and the distribution of wealth is derived endogenously. [2] Huggett (1996) studies a life-cycle economy where agents face uncertain lifetime. In addition, labor productivity is stochastic and calibrated in order to match US earnings inequality. In the absence of annuity markets, the model is able to successfully replicate the US wealth Gini coefficient. The model only fails to produce the wealth holdings of the very rich households.[3] As shown by Krusell and Smith (1998), the same result holds in the stochastic Ramsey model if one assumes preference heterogeneity.[4]

Both Huggett (1996) and Krusell and Smith (1998) neglect voluntary bequests.[5] Furthermore, they do not explicityly account for a parent−child link. In this paper, we consider a life-cycle economy and contrary to Huggett (1996) and Krusell and Smith (1998), we introduce an altruistic bequest motive.[6] Every family consists of a parent and his child, and the individual child forms his decision depending on the expected bequest from his respective parent. Agents are not allowed to borrow or leave negative bequests. Using this model, we are able to study the question as to whether bequests, both accidental and voluntary, help to explain observed wealth heterogeneity. As one of our main results, we find the voluntary bequest motive to be of negligible importance, while accidental bequests give rise to a modest increase in wealth inequality.

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[2] Quadrini and Ríos-Rull (1997) review recent studies of endogenous wealth inequality in models of heterogenous agents with uninsurable idiosyncratic exogenous shocks to earnings, including attempts to include business ownership, higher rates of return on high asset levels, and changes in health and marital status, among others.

[3] In this paper, "the rich" are taken to mean wealth-rich households.

[4] In particular, Krusell and Smith assume that the discount factor β can take three values and follows a Markov process with average duration of 50 years at the highest and lowest value of β.

[5] Huggett (1996) assumes accidental bequests to be redistributed in equal amounts to all living agents. He also reports results from experiments where the receipt of bequests was random, but where the distribution from which bequests were drawn was the same for all agents.

[6] Our paper is related to Flemming (1979). However, in his partial equilibrium model, Flemming assumes that agents spread consumption uniformly over their maximum expected lifespan, whereas we consider a microfounded general equilibrium model with an intertemporal optimal allocation of consumption.

Our second focus of analysis is to examine inheritance taxation. Inheritance taxation is often regarded as an appropriate policy in order to redistribute wealth and increase equality of opportunities. However, the deteriorating effect on wealth accumulation is often cited as a major argument against inheritance taxation.[7] Here, we introduce inheritance taxation and compute its quantitative effects on both wealth accumulation and distribution. Furthermore, we compute the optimal inheritance tax rate using the expected lifetime utility of the newborn generation as our measure of welfare. As our second main result, inheritance taxation is shown to reduce wealth inequality and increase welfare in our model. The optimal tax rate on inheritance is demonstrated to amount to approximately 95 percent, implying a consumption equivalent welfare gain of 2.43 percent.

The organization of the paper is as follows. Section II introduces the model. In Section III, the model is calibrated with regard to characteristics in the US economy. Our numerical results are reported in Section IV and Section V concludes.

II. A Model of Bequests

Our model is an extension of İmrohoroğlu, İmrohoroğlu and Joines (1995). In our economy, three sectors are depicted: the household sector, the production sector, and the government. Households maximize discounted lifetime utility. They inherit wealth from their parents and leave bequests to their children. Agents supply labor inelastically and differ with regard to their individual productivity and employment opportunity. In old age, they receive public pensions. Firms maximize profits. Output is produced using labor and capital. The government provides unemployment insurance and social security which are financed by a tax on income and inheritance.

Households

Households are of measure one and each newborn generation is of equal measure. Hence, we neglect population growth and aging of society. Agents begin working at age 20 corresponding to model period $t = 1$. Define age $t = 1$ as 20 years old, age $t = 2$ as 21 years old, and so on. Agents work $T = 40$ years and give birth to a child at age $t = 11$ when 30 years old. At

[7]Depending on the specific marginal utility function from bequests, the capital stock does not necessarily have to decline for higher inheritance tax rates; see Atkinson (1971a). Furthermore, even if the capital stock declines for higher inheritance tax rates, the distribution of earnings and wealth need not become more equal if, for example, unskilled labor has a higher degree of complementarity with capital than does skilled labor; this argument is taken from Bevan and Stiglitz (1979).

age $t = 41$, retirement is mandatory. Lifetime is uncertain and agents die for sure at age $t = T + T^R = 40 + 20$. We use a subscript s to denote calendar time and an argument t in parenthesis to denote age. A household born in period s maximizes his intertemporal utility.[8]

$$\max_{c(t)} E_s \sum_{t=1}^{T+T^R} \beta^{t-1} \left(\left[\prod_{j=1}^{t} \psi_j \right] u(c_{s+t}(t)) + \varsigma_0 \left[\prod_{j=1}^{t-1} \psi_j \right] (1 - \psi_t) v(b_{s+t}(t)) \right), \tag{1}$$

where $c_{s+t}(t)$, $b_{s+t}(t)$, and β denote the consumption of an agent at age t in period $s + t$, his bequests, and the discount factor, respectively. ψ_j is the conditional probability of survival from age $j - 1$ to age j, where ψ_1 is set equal to one. Expectations E_s are taken conditional on information in period s. Instantaneous utility from consumption is specified as a CES function:

$$u(c(t)) = \frac{c(t)^{1-\sigma} - 1}{1 - \sigma}, \tag{2}$$

where σ denotes the coefficient of relative risk aversion. If the agent dies at age t, he leaves bequests $b(t) = (1 - \tau_k)k(t)$ to his offspring, providing him with utility $\varsigma_0 v(b)$. Bequests are subject to an inheritance tax τ_k. $k(t)$ are the asset holdings of the t-year-old agent.[9] ς_o is a measure of parental altruism. The utility from bequest is also specified as a CES function:

$$v(b(t)) = \begin{cases} \dfrac{b(t)^{1-\varsigma} - 1}{1 - \varsigma} & k(t) \geqslant \tilde{K}(t) \\ 0 & \text{otherwise.} \end{cases} \tag{3}$$

Following Blinder (1975), we set $\varsigma = \sigma$.[10] In our analysis, we distinguish three different cases: (i) in the benchmark case, all agents have a bequest motive, $\tilde{K}(t) = 0$ for ages $t = 31, \ldots, 60$; (ii) only the most affluent agents have a bequest motive, $\tilde{K}(t) > 0$; and (iii) no bequest motive, $\varsigma_o = 0$. Our motivation for including the specification $\tilde{K} > 0$ is based on the empirical

[8]The additive separability of utility from consumption and bequests is adapted from Atkinson (1971a)

[9]As capital is the only kind of asset in the economy, we refer to k as assets, the capital stock, and wealth interchangeably.

[10]As pointed out by Blinder (1975), this argument is implied by results of Yaari (1965). Shorrocks (1979) investigates the circumstances under which the isoelastic form of utility from bequests follows from an extended life-cycle model, where individuals are concerned with the consumption standards of their descendants.

work of Menchik and David (1983) who regress bequests on lifetime earnings for actual data on both bequests and earnings. They find that for low income levels, the marginal propensity to bequeath out of earnings is not significantly different from zero. Hurd and Shoven (1985) even find that, in 1979, households in the top 10 percent of the wealth distribution held about 46 percent (55 percent excluding houses) of bequeathable wealth. In the third case, there is no altruistic bequest motive. All bequests are accidental. The third case serves as a comparison in order to evaluate the contribution of the bequest motive to explaining observed wealth heterogeneity.

In addition, we impose a simple generational structure in our model similar to Laitner (1992, 1993).[11] In particular, families only consist of one parent and his child. Following Kotlikoff and Summers (1981), we assume that the age gap between those leaving bequests and those receiving them equals $T^* = 30$ years. As a consequence, the households can be divided into two subsets: the parents who are of age $t > T^*$ and leave bequests, and the children who are of age $t \leqslant T^*$. The child is aware of his parent's wealth and he maximizes his lifetime utility (1) considering the probability and the amount of future bequests. Furthermore, we assume that $\psi_t = 1$ for $t \leqslant T^*$.[12]

During working time, $t \leqslant T$, agents supply one unit of labor inelastically. Working agents face a stochastic employment opportunity. Let $\rho_s(t) \in \{e, u\}$ denote the employment status in period s at age $t \leqslant T$ which is assumed to follow a first-order Markov process with invariant transition matrix $\Pi[\rho(t+1), \rho(t)] = \pi_{ij}$, $i, j = e, u$, where $\pi_{ij} = \text{Prob}\{\rho(t+1) = i | \rho(t) = j\}$. If $\rho = e$ ($\rho = u$), the agent is employed (unemployed). The employed agent ($\rho = e$) earns labor income $(1 - \tau_w)\bar{h}\epsilon(t)w_s$, where w is the aggregate wage per efficiency unit, τ_w is the tax rate on wage income, $\epsilon(t)$ denotes the efficiency index of the t year-old generation, and $\bar{h}$ are the (indivisible) hours worked. If unemployed ($\rho = u$), the agent receives unemployment compensation $\zeta(1 - \tau_w)\bar{h}\epsilon(t)w_s$, where ζ is the replacement ratio. After retirement, the agent receives pensions $p_s = \theta(1 - \tau_w)\bar{h}\bar{\epsilon}w_s$, with a replacement ratio θ relative to average net labor earnings of the employed agents.

The working agent faces the following budget constraint in period s:

[11] Contrary to the model of Laitner (1992, 1993), lifetime is assumed to be uncertain in our model. Hence, in the absence of annuity markets, we have both accidental and altruistic bequests. Furthermore, we assume that the child and the parents decide independently. Laitner assumes that the child and the parent form a decision entity, resulting in a gain of analytical tractability.

[12] This assumption is rather harmless considering that the empirical survival probabilities of the young agents are close to one. As an implicaton, every deceased household has a living heir.

$$k_{s+1}(t+1) + c_s(t) = (1 + r_s(1-\tau_r))k_s(t) + I_{\rho_s=e}(1-\tau_w)\epsilon(t)\bar{h}w_s + I_{\rho_s=u}\zeta(1-\tau_w)\epsilon(t)\bar{h}w_s + \vartheta_s(t), \tag{4}$$

where τ_r and r_s denote the tax rate on interest income and the interest rate, respectively, and $I_{\rho=e}(I_{\rho=u})$ is an index function taking the value one if the agent is employed (unemployed). Upon the death of his parent, the child inherits $\vartheta_s(t) = (1-\tau_k)k_s^p(t+T^*)$, where k^p denotes parental wealth; otherwise, $\vartheta_s(t) = 0$. We assume that death takes place at the beginning of period s and bequests are distributed to the heirs prior to the consumption allocation of period s.

The retired agent faces the budget constraint:

$$k_{s+1}(t+1) + c_s(t) = (1 + r_s(1-\tau_r))k_s(t) + p_s(t). \tag{5}$$

Since the retired agent does not have any living parent, he does not receive any bequests. In addition, agents are not allowed to borrow at any time and we impose the liquidity constraint $k \geqslant 0$.

Firms

Firms are of measure one and produce output with effective labor N_s and capital K_s. Labor N_s is paid the wage w_s. Capital K_s is hired at rate r_s and depreciates at rate δ. Production is characterized by constant returns to scale and assumed to be Cobb–Douglas:

$$F(K_s, N_s) = A_0 K_s^{\alpha} N_s^{1-\alpha}. \tag{6}$$

In a factor market equilibrium, factors are rewarded with their marginal product:

$$w_s = A_0(1-\alpha)\left(\frac{K_s}{N_s}\right)^{\alpha}, \tag{7}$$

$$r_s = A_0\alpha\left(\frac{N_s}{K_s}\right)^{1-\alpha} - \delta. \tag{8}$$

The Government

The government provides public pensions and unemployment compensation which are financed by taxation. The government policy is characterized by the vector $\Omega = \{\theta, \zeta, \tau_r, \tau_k\}$, while the labor income tax rate τ_w adjusts in order to keep the government budget balanced.

Stationary Equilibrium

Our analysis concentrates on stationary equilibria and adopts the stationary recursive equilibrium structure described in Stokey, Lucas, and Prescott (1989). For given government policy $\Omega = \{\theta, \zeta, \tau_r, \tau_k\}$, a stationary equilibrium for our economy satisfies the following:[13]

(1) Households maximize their intertemporal utility and firms maximize discounted profits.
(2) Individual and aggregate behaviour are consistent.
(3) All markets clear.
(4) The distribution of capital and employment is stationary.
(5) The government budget is balanced.

III. Calibration

The model can only be solved numerically.[14] For this reason, the model is calibrated in order to match the characteristics of the US economy. Parameter values were chosen from existing studies.[15]

Agents are born at a real-time age of 20 (model period 1) and live up to a maximum of 79 years (model period 60). Each year, a cohort of equal size is born. The sequence of conditional survival probabilities $\{\psi_j\}_{j=31}^{59}$ is set equal to the Social Security Administration's survival probabilities for men aged 50–78 for the year 1994.[16] ψ_{60} is set equal to zero, and ψ_j, $j = 1, \ldots, 30$ is set equal to one. The efficiency index $e(t)$ of the t-year-old worker is taken from Hansen (1993), and interpolated to in-between years. As a consequence, the model is able to replicate the cross-section age distribution of earnings of the US economy. Following İmrohoroğlu *et al.* (1995), we normalize the average efficiency index $\bar{e}$ to one and set the shift length equal to $\bar{h} = 0.45$

Empirical estimates of the intertemporal elasticity of substitution $1/\sigma$ vary considerably. Real business-cycle models, as in Kydland and Prescott (1982) and Hansen (1985), apply a value of σ equal to 1.5 and 1.0, respectively, while Jones, Manuelli, and Rossi (1997) use values in the range of 1.0 and 2.5. In our computation σ is set equal to 2.[17] ς is set equal to σ, as argued by Blinder (1975). We chose a value $\beta = 0.975$ for the discount rate

[13] A more detailed definition of the stationary equilibrium is provided in the Appendix.
[14] See Heer and Maussner (2001) for a detailed description of the solution algorithm.
[15] If not mentioned otherwise, the parameter values are taken from İmrohoroğlu *et al.* (1995).
[16] I thank Mark Huggett and Gustavo Ventura for providing me with the data.
[17] Our qualitative results are robust with regard to the choice of the parameters σ and β. A sensitivity analysis can be found in Heer (2000).

implying a capital–output ratio of 3.0, as found by Auerbach and Kotlikoff (1995). Utility from bequests relative to utility from consumption is given the weight $\varsigma_o = 1$ in our benchmark specification (case i), which implies an annual flow of aggregate bequests B relative to aggregate wealth K equal to 1.37 percent. In case iii without a bequest motive, $\varsigma_0 = 0$, bequests are only accidental and drop to 1.06 percent of aggregate wealth. Both numbers are in good accordance with empirical studies reviewed by Modigliani (1988).

In our benchmark calibration, every agent has a bequest motive, $\tilde{K} = 0$. In our second specification, only the wealthy parents has an operative bequest motive. Empirical results of Menchik and David (1983) suggest that only the top quintile of the distribution of earnings (including inherited wealth) has an operative bequest motive. For this reason, we also analyze the case where only agents in the top quintile of the wealth distribution in each generation $t = 31, \ldots, 60$ leave voluntary bequests.[18] In order to obtain a ratio of bequest relative to wealth equal to $B/K = 1.37$ percent as in case i, ς_0 is set equal to 2.5.

Following Prescott (1986), capital's share in output is set equal to $\alpha = 0.36$. The annual rate of decpreciation is set equal to $\delta = 0.08$. The technology level A_0 is normalized to one. Employment follows the first-order Markov process:

$$\Pi[\rho(t+1), \rho(\text{t})] = \begin{matrix} 0.94 & 0.06 \\ 0.94 & 0.06 \end{matrix} . \tag{9}$$

By this choice, the probability of employment is equal to 0.94, independent of the employment status in the preceding period.

The unemployment insurance replacement ratio, $\varsigma = 0.4$, is taken from İmrohoroğlu *et al.* (1995). The replacement ratio of social security benefits, $\theta = 0.5$, is taken from İmrohoroğlu, İmrohoroğlu and Joines (1998). Lucas (1990) provides an estimate of the capital income tax rate $\tau_r = 0.36$. The inheritance tax rate τ_k is set equal to zero in our benchmark case, following Grüner and Heer (2000). The labor income tax rate τ_w adjusts in order to keep the government budget balanced. In our benchmark case, $\tau_w = 13.1$ percent. The parameterization is summarized in Table A1 in the Appendix.

[18]Note that, in our model, there is no wealth mobility between the retired agents within each generation. As a consequence, agents do not change their type and either leave voluntary bequests or not in old age. I would like to thank James Smith for bringing this to my attention.

IV. Results

Equilibrium Properties

Our results are reported for the alternative formulations of the bequest motive i, ii, and iii. In our benchmark case i, all agents have an operative bequest motive. Bequests influence wealth heterogeneity in our economy as rich parents will also have rich children. However, this effect is reduced by the forward-looking behavior of the children. Children of rich parents also consume more than children of poor parents because they expect higher bequests in the future.

The average wealth–age profiles of cases i, ii and iii are illustrated in Figure 1. The hump-shape of the profile is typical for the life-cycle model. Agents build up savings during working life, and assets start to fall after retirement. Note that, in the benchmark case, there is a jump in wealth between real-time age 49 and 50, resulting from our assumption that all agents die at age 80 and leave bequests to their 50-year-old children. Compared to case iii without a bequest motive, agents build up a higher stock of capital and dissave less in old age.

As stated, a main objective of this paper is the explanation of observed wealth heterogeneity. Empirically, wealth is distributed much more unequally than income. Greenwood (1983), Wolff (1987), Kessler and Wolff

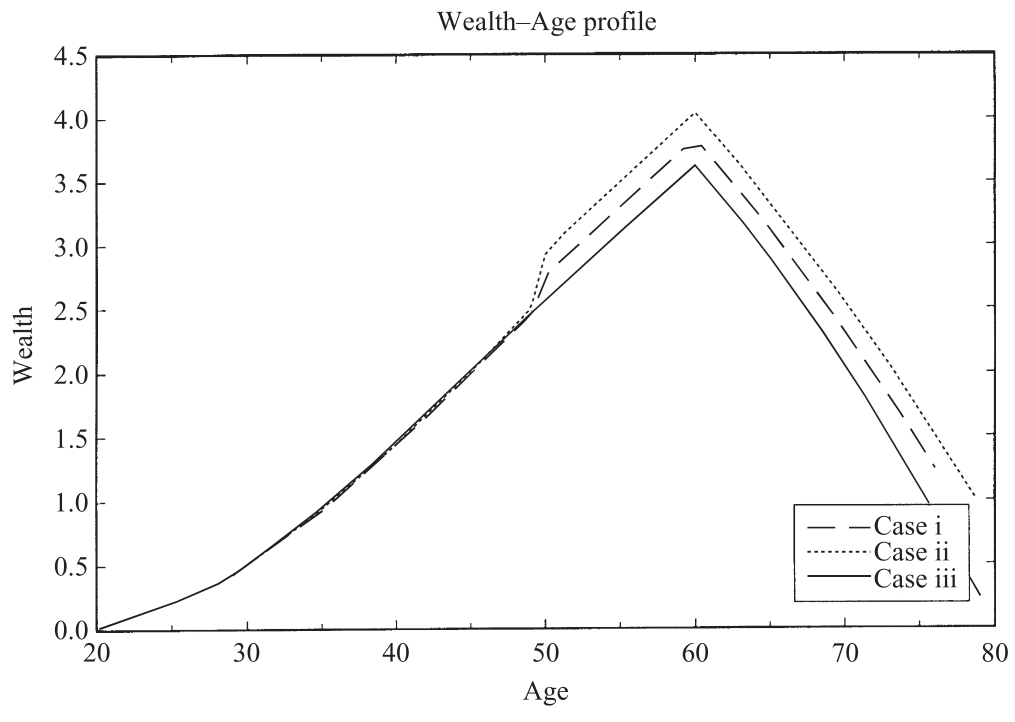

Fig. 1. Wealth–age profile

(1992), and Wolff (1994) estimate Gini coefficients of the wealth distribution for the US economy in the range 0.72–0.81. In standard life-cycle models without bequests, the implied Gini coefficient is usually significantly lower. For example, in our model without bequest ($\varsigma_0 = 0$) and certain lifetime ($\psi_j = 1$ for $j < 60$, $\psi_{60} = 0$), the Gini coefficient amounts to only 45.7 percent. Without a bequest motive but with stochastic survival probability (case iii), the Gini coefficient increases to 48.8 percent (see Table 1). Hence, the contribution of accidental bequests to wealth heterogeneity is rather modest. In the presence of a voluntary bequest motive for all agents (case i), agents increase savings from $K = 1.703$ (case ii) to $K = 1.803$ (case i). However, wealth dispersion does not change significantly and, in fact, even falls, with the Gini coefficient equal to 48.5 percent. To some extent, the negligible impact of altruistic bequests on wealth heterogeneity is caused by our generational structure. Most altruistic bequests are inherited from the 50-year-old child as the parent deceases at the maximum length of life at the end of his 79th year. At age 50, however, life-cycle wealth is below its peak at age 60.

In case ii, only the wealthy agents have a bequest motive. Recall that the second case seems to be among the most realistic according to the study of Menchik and David (1983). Even in this case, wealth inequality does not change significantly compared to the benchmark case i, with a Gini coefficient equal to 48.56 percent. The Lorenz curves for cases i–iii are displayed in Figure 2 and compared to the empirical distribution.[19] In

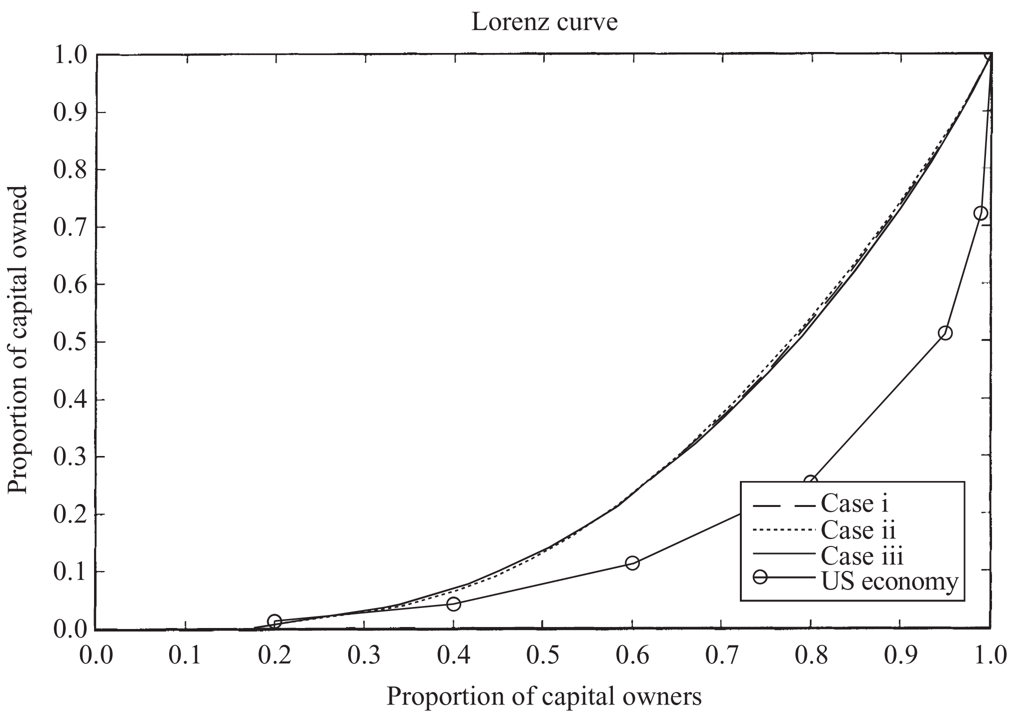

Fig. 2. Lorenz curve

Table 1. *Equilibrium properties for different bequest motives*

Case	ς_0	$\tilde{K}$	K	τ_w	r	K/Y	Gini	B
i	1	0	1.803	13.11%	3.62%	3.09	48.54%	0.0247
ii	2.5	>0	1.992	12.73%	4.04%	2.99	48.56%	0.0285
iii	0	0	1.706	12.70%	4.04%	2.99	48.83%	0.0180

our model, the poorest 20 percent of the agents hold approximately zero wealth, whereas the richest 5 percent hold about 20 percent of wealth. As reported by Wolff (1994), the empirical numbers amount to zero wealth and 50 percent of total wealth, respectively. Like in Huggett (1996) and Krusell and Smith (1998), our model performs rather well in reproducing a high proportion of agents holding zero wealth, but it performs poorly in reproducing the high concentration of wealth among the richest agents.

There are numerous reasons why the endogenous wealth heterogeneity of our model is smaller than observed empirically: (1) We neglect any productivity heterogeneity within generations. (2) Unemployment benefits and pensions are not related to the earnings history of the recipient. (3) We neglect any asset-based means tests of social security.[20] (4) Importantly, we only consider transfer of physical wealth, but not human wealth.[21] (5) Agents are not allowed to borrow against anticipated bequests implying a credit limit $k \geqslant 0$. For lower binding constraints, $k < 0$, wealth heterogeneity increases, as demonstrated by Huggett (1996). In particular, the proportion of agents holding zero and negative assets increases. Accounting for the features (1)–(5) in our model is likely to result in an increase of wealth inequality for agents characterized by low to high asset holdings; however, we are skeptical as to whether it proves successful in reproducing the observed wealth concentration among the very rich.[22]

[19]The data for the empirical distribution of wealth are taken from Huggett (1996). The Lorenz curves for cases i–iii are almost identical.

[20]Hubbard, Skinner, and Zeldes (1995) show that, in the presence of social insurance programs with means tests, low-income households are likely to hold virtually no wealth across their lifetime.

[21]Loury (1981) analyzes parental human capital investment in their offspring. The allocation of training and hence childrens' earnings depend on the distribution of earnings among the parents. Becker and Tomes (1979) present a model framework comprising both human and non-human capital transfers from parents to children.

[22]As the only exception to these modeling choices (known to me), Quadrini (1999) presents a promising approach in order to explain the high concentration of wealth among the very rich agents. He introduces entrepreneurship into a dynamic general equilibrium model.

Inheritance Taxation

The quantitative effect of the inheritance tax rate τ_k on aggregate bequests depends on the magnitude of the elasticity $v'(k(1-\tau_k))$ with respect to bequests. For our calibration with $\varsigma = 2$, agents increase their before-tax bequests for higher τ_k (see Table 2). An increase in inheritance taxation, however, allows for a reduction in the wage tax in order to keep the government budget balanced. Hence, net labor earnings and consequently, pensions increase. While the former effect increases aggregate savings, the latter reduces savings. The net effect is negative for tax rates τ_k below 70 percent, and aggregate wealth declines following an initial rise in inheritance taxation. Furthermore, wealth heterogeneity declines for two reasons. First, after-tax inherited wealth decreases. And second, the factor income distribution changes. For our Cobb–Douglas specification of the production function, capital and labor are paid the shares α and $1-\alpha$ of income before taxes, respectively. As the wage tax is reduced, the after-tax labor share in net income increases. Following an increase in the inheritance tax rate from 0 percent to 10 percent, for example, the Gini coefficient falls from 48.54 percent to 47.83 percent. For $\tau_k = 50$ percent, the Gini coefficient amounts to 45.6 percent, and is approximately as low as in the case of no bequests and certain lifetime. In this case, the inequality resulting from inherited wealth is eliminated.[23]

The last column of Table 2 displays the welfare effects of inheritance

Table 2. *Effects of inheritance taxation*

τ_k	K	W	B	τ_w	r	K/Y	Gini	Δ_c
0%	1.803	−4.819	0.0247	13.11%	3.62%	3.09	48.54%	0%
10%	1.785	−4.796	0.0251	12.48%	3.70%	3.08	47.83%	+0.147%
20%	1.767	−4.773	0.0254	11.83%	3.81%	3.05	47.14%	+0.294%
30%	1.750	−4.747	0.0259	11.16%	3.85%	3.04	46.52%	+0.461%
40%	1.735	−4.717	0.0266	10.36%	3.94%	3.02	46.16%	+0.654%
50%	1.722	−4.687	0.0272	9.74%	3.98%	3.00	45.58%	+0.848%
60%	1.713	−4.657	0.0282	8.96%	4.03%	2.99	45.29%	+1.043%
70%	1.710	−4.618	0.0296	8.09%	4.03%	2.99	45.13%	+1.297%
80%	1.720	−4.572	0.0320	7.07%	3.98%	3.00	45.10%	+1.598%
90%	1.767	−4.509	0.0369	5.62%	3.77%	3.06	45.15%	+2.010%
95%	1.849	−4.447	0.0435	4.31%	3.43%	3.15	45.21%	+2.426%

[23] As already argued by Atkinson (1971b), when considering equity we are not concerned with the wealth inequality resulting from the difference in life-cycle savings at different ages (in the absence of incomplete markets and borrowing constraints), but rather with the wealth inequality resulting from inherited bequests.

taxation. Welfare is measured by the average lifetime utility of the newborn generation (see Appendix) and Δ_c describes the consumption equivalent change associated with a change in the inheritance tax rate. There are numerous opposing effects of inhertiance taxation on welfare in our model. First, the capital stock decreases away from the golden-rule steady-state capital stock for $\tau_k < 70$ percent.[24] Second, the tax burden is shifted from the young agents (who are, if unemployed, credit-constrained during the first periods of life) to the old agents as we increase inheritance taxation and decrease labor income taxation. Third, the increase in wealth equality results in an increase in average lifetime utility, as the value function is a concave function of the capital stock. Fourth, utility from bequests declines with increasing inheritance taxation. The net effect of a marginal increase in τ_k on welfare is positive in our benchmark economy. Of course, complete inheritance taxation is not optimal as utility from bequest goes to minus infinity as τ_k approaches 100 percent. However the optimal inhertiance tax rate is found to even exceed 90 percent. For $\tau_k = 95$ percent, the long-run change in welfare is equivalent to a consumption rise of 2.43 percent.

If bequests are accidental, it is not surprising that the optimal tax rate should be sufficiently high. In this case, the imposition of an inheritance tax will have no disincentive effect. However, if people are motivated to accumulate savings by the idea of leaving their families an inheritance, a tax on bequests and a tax on capital income have similar effects, as they both reduce the returns on savings.

The optimal taxation of capital in a second-best economy has been studied by Chamley (1986) and Judd (1985). In a Ramsey model with an infinite-lived representative individual, they show that the optimal capital tax rate is zero in the long run.[25] However, zero capital taxation need not be optimal in a life-cycle model, cf. e.g. Atkinson and Sandmo (1980), Summer (1981) and Auerback, Kotlikoff, and Skinner (1983), or in models with incomplete markets with borrowing constraints, c.f. e.g. Aiyagari (1994, 1995) and İmrohoroğlu (1998). In an overlapping generations model, Boadway, Marchand, and Pestieau (2000) show that, if ability and inheritance are unobservable, it is even optimal to use positive interest income taxation to indirectly tax inherited wealth because capital income taxation can improve the income distribution.

The value of our optimal inheritance tax rate, $\tau_k = 95$ percent, should be

[24] In our benchmark case, the capital stock differs from the golden-rule capital stock because of incomplete markets, borrowing constraints, capital income taxation, and the provision of social security.

[25] Jones *et al.* (1997) demonstrate that the asymptotic Chamley–Judd result no longer holds if there are restrictions on the feasible tax rates and if profits are generated. In addition, changes in the technology may result in optimal positive long-run tax rates on capital.

interpreted with care. One major welfare-enhancing effect of inheritance taxation is the reduction in wealth concentration. In our model, we assumed that each parent has one child and that all children of equal age have equal earning abilities. Taxation of wealth transfers, however, might adversely affect redistribution within families if parents have children of different abilities.[26] Bequests might be compensatory in that low-income children inherit more than their advantaged contemporaries.[27] In addition, we assumed that parents are altruistic toward their children but only give them transfers in the form of physical capital. Parents also invest, however, in their children's human capital. In this case, a higher inheritance rate or, similarly, a wealth tax affects the parents' optimal mix of intergenerational transfers in the form of physical and human wealth and parents will increase total spending on their children's education. In a model of human capital accumulation based on Lucas (1990), Grüner and Heer (2000) demonstrate that a positive wealth tax increases both the growth rate and welfare. In sum, we would like to emphasize that these real-life features, children of different abilities and the role of human capital in the growth process, should be taken into account in future research on the optimal tax rate on inheritance.

V Conclusion

The effects of bequests and inheritance taxation on wealth accumulation, wealth distribution, and welfare are examined in a general equilibrium life-cycle model with intergenerational transfers, incomplete markets, and borrowing constraints. The model is calibrated with regard to the characteristics of the US economy. Our results can be summarized as follows. First, wealth inequality increases after accounting for inherited bequests, with the Gini coefficient of wealth distribution rising from 45.7 to 48.5 percent. We find that the altruistic bequest motive only accounts for a small proportion of actual wealth inequality and inherited wealth is not a primary source of wealth inequality. Second, inheritance taxes increase both wealth equality and welfare. If we require (i) the government budget to be balanced and (ii) any increase in the inheritance tax rate to be offset by a reduction in the wage tax, the optimal tax rate on inheritance is found to amount to approximately 95 percent.

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[26]Cremer and Pestieau (2001) study the design of the optimal inheritance tax if bequests are observable but parents' wealth and children's earning abilities are not. Parents have two children of different abilities. The optimal tax schedule combines incentive and corrective features, i.e., the tax schedule increases redistribution both within families and between families.

[27]Tomes (1981) presents empirical evidence that inheritance received by children is inversely related to children's income.

Appendix

Stationary Equilibrium

The concept of equilibrium applied in this paper uses a recursive representation of the consumer's problem following Stokey *et al.* (1989). Let $V_s(x_s(t),\ t)$ be the value of the objective function of a t-year-old agent in period s characterized by a state vector $x_s(t)$. The state vector $x_s(t)$ of the parent, $t > T^*$, is given by his own capital $k_s(t)$ (which simply takes the value of zero after his decease) and his employment status $\rho_s(t)$ (which takes the value $\rho = r$ during retirement, $t > T$, and $\rho = d$ for the deceased parent). The child's state vector $x_s(t)$ comprises his own capital stock $k_s(t)$, his employment status $\rho_s(t)$ as well as his parental wealth $k_s^p(t + T^*)$ and employment status $\rho_s^p(t + T^*)$, $x_s(t) = (k_s(t),\ \rho_s(t),\ k_s^p(t + T^*))$ for $t \leqslant T^*$. Furthermore, let $g_s(x(t))$ denote the density of $x(t)$ at time s, with initial distribution $g_0(\cdot)$ given.

$V_s(x_s(t),\ t)$ is defined as the solution to the dynamic program:

$$V_s(x_s(t),\ t) = \max_{c,k'} [u(c) + \beta\psi_{t+1} E_s\{V_{s+1}(x_{s+1}(t+1),\ t+1)\} + \beta(1-\psi_{t+1})\varsigma_0 E_s\{v(b_{s+1}(t+1))\}], \tag{A1}$$

subject to the budget constraints (4) and (5) for the child and the parent, respectively. k' denotes the next-period capital stock.

We define a stationary equilibrium for given government policy Ω and stationary distribution of the state variable, $g(x(t),\ t)$. The time index is omitted from stationary variables such as the wage rate w, the interest rate r, aggregate capital stock K and employment N, and the distribution of the state variable $g(x(t),\ t)$.

Definition. A stationary equilibrium for a given set of government policy parameters $\Omega = \{\theta,\ \zeta,\ \tau_r,\ \tau_k\}$ is a collection of value functions $V(x(t),\ t)$, individual policy rules $c(x(t),\ t)$ for consumption and next-period capital, respectively, an age-dependent, time-invariant distribution of the state variable $g(x(t),\ t)$ for each generation $t = 1, 2, \ldots, T + T^R$, relative prices of labor and capital $\{w,\ r\}$, such that:

(1) Relative prices $\{w,\ r\}$ solve the firm's optimization problem by satisfying (7) and (8).
(2) Given relative prices $\{w,\ r\}$ and the government policy arrangement Ω, the individual policy rules $c(\cdot)$ and $k'(\cdot)$ solve the consumer's dynamic program (A1).
(3) Individual and aggregate behaviour are consistent, i.e., the aggregate capital stock K and aggregate bequests B are given by the sum of the assets and the bequests of all households, respectively, and aggregate effective employment is given by the effective labor supply of all employed workers.
(4) The goods market clears:

$$A_0 K^{\alpha} N^{1-\alpha} = \sum_{t=1}^{T^*} \sum_{\rho(t)} \sum_{\rho^p(t+T^*)} \iint c(x(t),\, t) g(x(t),\, t) \mathrm{d}k(t) \mathrm{d}k^p(t+T^*)$$

$$+ \sum_{t=T^*+1}^{T+T^R} \sum_{\rho(t)} \int c(x(t),\, t) g(x(t),\, t) \mathrm{d}k(t) + \delta K. \tag{A2}$$

(5) The age-dependent time-invariant distribution $g(x(t),\, t)$ satisfies:
(i) In period $t = 1$:

$$g(k(1),\, \rho(1),\, k^p(T^* + 1),\, \rho^p(T^* + 1),\, 1)$$

$$= \begin{matrix} g(k(T^* + 1),\, \rho(T^* + 1),\, T^* + 1) \cdot \pi_{\rho(1),\rho(1)} & \text{for } k(1) = 0 \\ 0 & \text{otherwise.} \end{matrix} \tag{A3}$$

(ii) In period $t = 1, \ldots, T^*$:

$$g(x(t+1),\, t+1) \tag{A4}$$

$$= \psi_{t+T^*+1} \sum_{\rho(t)} \sum_{\rho(t+T^*)} \sum_{k(t+1)=k'(x(t),t)} \sum_{k(t+T^*+1)\in\mathscr{K}^1}$$

$$\times\, g(x(t),\, t) \pi_{\rho(t+T^*+1),\rho(t+T^*)} \pi_{\rho(t+1),\rho(t)}$$

$$+ (1 - \psi_{t+T^*+1}) \sum_{\rho(t)} \sum_{\rho(t+T^*)} \sum_{k(t+1)\in\mathscr{K}^2} \sum_{k(t+T^*+1)\in\mathscr{K}^1}$$

$$\times\, g(x(t),\, t) \pi_{\rho(t+T^*+1),\rho(t+T^*)} \pi_{\rho(t+1),\rho(t)}$$

where

$$\mathscr{K}^1 = \{k(t + T^* + 1) | k(t + T^* + 1) = k'(k(t + T^*),\, \rho(t + T^*),\, t + T^*)\}$$

and

$$\mathscr{K}^2 = \{k(t+1) | k(t+1) = k'(x(t),\, t) + (1 - \tau_k) k(t + T^* + 1)\}$$

(iii) In period $t = T^* + 1, \ldots, T$ for $\rho(t+1) \in \{e,\, u,\, r\}$:

$$g(k(t+1),\, \rho(t+1),\, t+1) = \psi_{t+1} \sum_{\rho(t)\in\{e,u\}} \sum_{k(t+1)=k'(x(t),t)} g(x(t),\, t) \pi_{\rho(t+1),\rho(t)}, \tag{A5}$$

and for the measure of deceased agents:

$$g(0,\ d,\ t+1) = g(0,\ d,\ t) + (1-\psi_{t+1}) \sum_{\rho(t)\in\{e,u\}} \int g(x(t),\ t)\mathrm{d}k(t). \tag{A6}$$

(iv) In period $t = T+1, \ldots, T+T^{\mathrm{R}}-1$ for $\rho(t+1) = r$:

$$g(k(t+1),\ r,\ t+1) = \psi_{t+1}) \sum_{k(t+1)=k'(k(t),t)} g(k(t),\ r,\ t) \tag{A7}$$

and for the measure of deceased agents:

$$g(0,\ d,\ t+1) = g(0,\ d,\ t) + (1-\psi_{t+1})\int g(k(t),\ r,\ t)\mathrm{d}k(t). \tag{A8}$$

(6) The government budget is balanced:

$$\begin{aligned}
&\tau_w wN + \tau_r rK + \tau_k B \\
&= \sum_{t=1}^{T^*} \sum_{\rho(t)=u} \sum_{\rho^p(t+T^*)} \iint \zeta(1-\tau_w)\epsilon(t)\bar{h}wg(x(t),\ t)\mathrm{d}k(t)\mathrm{d}k^p(t+T^*) \\
&+ \sum_{t=T^*+1}^{T} \sum_{\rho(t)=u} \int \zeta(1-\tau_w)\epsilon(t)\bar{h}wg(x(t),\ t)\mathrm{d}k(t) \\
&+ \sum_{t=T+1}^{T+T^R} \sum_{\rho(t)=r} \int pg(x(t),\ t)\mathrm{d}k(t).
\end{aligned} \tag{A9}$$

Welfare Measure

In Section IV, we compare alternative government policies Ω quantifying the effects on welfare. The welfare associated with a government policy $\Omega = \{\theta,\ \zeta,\ \tau_r,\ \tau_k]$ is measured by the expected discounted utility of a newborn:

$$W(\Omega) = \sum_{\rho\in\{e,u\}} \sum_{\rho^p\in\{e,u\}} \int V(0,\ \rho,\ k^p,\ \rho^p,\ 1)g(0,\ \rho,\ k^p,\ \rho^p,\ 1)\mathrm{d}k^p. \tag{A10}$$

The welfare effect of a change in government policy from Ω to Ω' is measured by the consumption equivalent increase Δ_c as suggested by McGrattan (1994):

$$W(\Omega') = \sum_{t=1}^{T+T^R} \int \beta^{t-1} \left[\prod_{j=1}^{t} \psi_j \right] u((1+\Delta_c)\tilde{c}(\tilde{x}(t), t)) + \varsigma_0 \left[\prod_{j=1}^{t-1} \psi_j \right] (1-\psi_t) v(\tilde{b}(\tilde{x}(t), t)) \Bigg) \tilde{g}(\tilde{x}(t), t) \mathrm{d}\tilde{x}, \quad \text{(A11)}$$

where $\tilde{x}(t)$, $\tilde{c}(\cdot, t)$, $\tilde{b}(\cdot, t)$, and $\tilde{g}(\cdot, t)$ denote the state vector, the consumption function, the bequest function, and the distribution of the state vector in period t under government policy Ω. As our reference economy with government policy Ω and $\Delta_c = 0$, we take our benchmark economy with $\tilde{K} = 0$ and $\varsigma_0 = 1$ (case i) as shown in Table A1.

Parameter Calibration

Table A1. *Calibration of parameter values for the US economy*

Description	Function	Parameter
Utility from consumption	$u(c) = \dfrac{c^{1-\sigma} - 1}{1-\sigma}$	$\sigma = 2$
Utility from bequests	$\varsigma_0 v(b) = \varsigma_0 \dfrac{b^{1-\varsigma} - 1}{1-\varsigma}, k \geqslant \tilde{K}$	
Case i		$\varsigma_0 = 1.0, \varsigma = 2, \tilde{K} = 0$
Case ii		$\varsigma_0 = 2.5, \varsigma = 2, \tilde{K} > 0$
Case iii		$\varsigma_0 = 0$
Discount factor	β	$\beta = 0.975$
Production function	$y = A_0 k^{\alpha} n^{1-\alpha}$	$\alpha = 0.36, A_0 = 1$
Depreciation	δ	$\delta = 0.08$
Shift length	$\bar{h}$	$\bar{h} = 0.45$
Government policy		
Tax rates		
Capital income	τ_r	$\tau_r = 36\%$
Inheritance	τ_k	$\tau_k = 0\%$
Replacement ratios		
Unemployment compensation	ζ	$\zeta = 0.4$
Public pensions	θ	$\theta = 0.5$

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