Estate Taxation, Inherited Wealth and Rising Wealth Inequality

Donghoon Koo*
University of Melbourne

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Abstract

What are the effects of changes in estate taxation on wealth distribution? Has the recent relaxation of estate tax policy contributed to rising wealth inequality in the U.S.? To address these questions, I developed a quantitative general equilibrium life-cycle model that incorporates generation-skipping transfers from grandparents. In the model, where return heterogeneity is the main source of wealth inequality, substantial transfers from parents and grandparents help young heirs accumulate wealth faster by securing excess returns, even without drawing high productivity. Calibrated to the U.S. economy, I find that relaxing estate taxes (with a 2 percentage-point decrease in the estate tax rate and a doubling of the exemption threshold from the benchmark) leads to a 1.2 percentage-point increase in the share held by the top 1 percent in the model. I also show that the grandparents-grandchild link (G-G link) is important for wealth accumulation, particularly for those at the top of the distribution. Shutting down the G-G link reduces wealth holdings by the top 5 percent by 1.2 percentage points and, also weakens the distributional effects of estate taxes.

JEL Codes: D14, D15, D31, D64, E21, H31
Keywords: Intergenerational transfers, Household wealth, return heterogeneity, wealth inequality, estate Tax

*Ph.D. Candidate, Department of Economics, The University of Melbourne, 111 Barry St, Victoria 3010, Australia. E-mail: donghoonk@unimelb.edu.au

1 Introduction

Rising wealth inequality is a central concern for policymakers in developed countries around the world, particularly in the U.S. Over the past three decades, wealth has become increasingly concentrated in the U.S., with the aggregate Gini coefficient rising from 0.79 in 1989 to 0.86 in 2019 (Figure 1, left panel). At the same time, the federal estate tax policy in the U.S. has become more lenient since the turn of the century, with the exemption threshold rising from \$1 million (in 2019 values) to over \$12 million in 2022 and the maximum estate tax rate declining from 55 percent in 2001 to 40 percent in 2022. This implies that, under the current tax policy, only estates above \$12 million are subject to federal estate tax (Figure 1, middle panel). The current administration's proposal includes a return to the 2009 provision starting from 2026.[1] Furthermore, there has been a substantial increase in the size of inheritances over the same period, and this trend is likely to persist as households from the aging baby-boom generation are set to pass on their wealth to offspring (Figure 1, right panel).

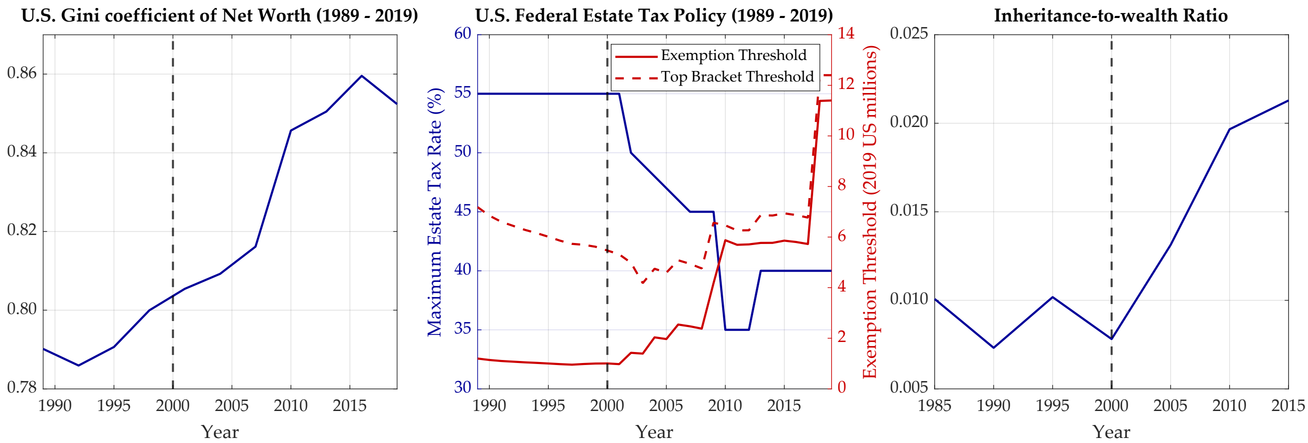

Figure 1: U.S. Gini coefficient, Estate Tax Policy and Inheritance-to-wealth Ratio

What are the effects of changes in estate taxation on wealth distribution? Has the recent relaxation of estate tax policy contributed to rising wealth inequality? While inheritances have frequently been considered as one of potential contributing factors to wealth concentration, the extent to which bequests are a major source of wealth inequality remains a topic of debate, with previous studies failing to reach a consensus. This leaves the actual impact and the implications of estate taxation indeterminate and unresolved.

To address these questions, I develop, calibrate and simulate a quantitative general equilibrium life-cycle model with bequests to examine the long run aggregate and distributional consequences of relaxing estate tax policy.[2] The economy is populated by overlapping generations of finitely-lived households facing age-dependent survival probabilities. Households derive utility from consumption and bequests (net of taxes), which they begin planning from

[1]See, Appendix A.1 for more detail on the recent major legislative reforms in the U.S.

[2]Among others, refer to relevant papers such as Huggett (1996); Gokhale et al. (2001); De Nardi (2004), which study the impact of bequests and Cagetti and De Nardi (2009); De Nardi and Yang (2016); Guo (2022) for insights into the distributional effects of estate tax reforms within a life-cycle framework.

retirement. Intended bequests are luxury goods that not every household can afford. Importantly, if households live long enough to witness their grandchildren entering the economy, they derive utility from leaving bequests to grandchildren and children. Households may leave accidental bequests in case they pass away prematurely.[3] Workers supply labour inelastically until they retire and households save by lending capital to firms.

Several challenges arise when attempting to address this question. First, it is essential to have a model framework capable of generating sufficiently high concentration at the top of wealth distribution, as observed in the data. Second, in achieving the first, the model should incorporate various potential contributing factors to wealth inequality including bequests. In doing so, it is crucial to consider channels through which inheritances interact with existing heterogeneities in the model. Previous literature has utilised a so-called "superstar" productivity (Castaneda et al., 2003) to capture the thick tail of wealth distribution. However, a trade-off emerges when studying the impact of estate tax reforms. On the one hand, while this approach enables the model to generate high concentration of wealth, it may relegate inherited wealth to a negligible role, unless other mechanisms, such as human capital investment through inheritances, are allowed to capture the effects of inheritances. On the other hand, without simultaneously targeting both earnings and wealth, as proposed by Castaneda et al. (2003), it becomes challenging for the earnings process alone to explain the thick tail observed in the wealth distribution.

To this end, I introduce heterogeneity in rates-of-return to match the wealth distribution in addition to earnings inequality. A growing body of literature documents a strong relationship between households' overall wealth and return characteristics.[4] This setup allows the model to capture wealth concentration while the earning process is calibrated solely to match the earnings distribution. Moreover, I assume that both return and risk increase with the level of wealth, following Hubmer et al. (2021).[5] This assumption naturally interacts with bequests in the model, as together they imply heterogeneity in returns on *inherited* wealth. Second, I explore another aspect that has not been addressed previously, namely, the grandparent-grandchild link (G-G link, hereafter). Empirical evidence suggests that for younger households, the link between households and their grandparents is particularly strong, with the size of inheritances from grandparents being significant and, even larger than those from parents. The introduction of the G-G link also creates greater heterogeneity in bequests in terms of both the size and the timing of the transfers. This aspect is also particularly crucial for accurately assessing estate tax reforms in countries like the U.S., where a separate estate tax applies to generation-skipping transfers.

[3]The terms, bequest, estate and inheritance are used interchangeably in this paper.

[4]See, Benhabib et al. (2011); Fagereng et al. (2020); Bach et al. (2020); Hubmer et al. (2021), among others.

[5]This type of specification is known as *scale* dependent heterogeneity. See Gabaix et al. (2016) and Xavier (2021) for other mechanism.

The main contribution of this paper is twofold. First, it extends previous life-cycle models of bequests that study the impact of inheritances and estate taxes by incorporating generation-skipping transfers from grandparents. Second, it uses the calibrated framework to assess the long-run aggregate and distributional effects of estate tax reforms and to investigate the importance of inheritances from grandparents for individual wealth accumulation and estate tax implications.

In Section 2, I provide evidence, using data from the Survey of Consumer Finances (SCF), that, for younger households, the link between households and their grandparents is particularly strong. In this section, I also provide evidence of return heterogeneity arising from wealth portfolio composition: wealthy households hold a greater proportion of high-return assets. Therefore, young heirs from wealthy families are likely to accumulate wealth earlier and also, at a faster rate: not only because of the size of the inheritance they receive but also because of the nature of the wealth they inherit.[6]

I calibrate the model to match the key characteristics of the U.S. economy between 1990-2000, a period where estate tax policy was relatively stable. This involves matching the earnings and wealth distribution, the proportion of estates subjected to estate tax, the government revenue accrued from these taxes, and importantly, the fraction of young households who inherit from grandparents and the relative size of the transfers based on SCF data. The baseline model generates cross-sectional distributions of both earnings and wealth, as well as other moments that closely align with empirical counterparts. The baseline model features an estate tax exemption threshold of $6.4 million and an estate tax rate of 18 percent, each within a reasonable range in effective terms.[7]

To assess the aggregate and distributional consequences of changes in estate taxes, I consider counterfactual revenue-neutral estate tax reforms where the government adjusts the capital income tax to balance the budget. Specifically, I relax model estate tax parameters (with a 2 percentage-point decrease in the estate tax rate to 16 percent and a doubling of the exemption threshold to $12.9 million), mimicking, to some extent, the actual changes in the estate tax policy in the U.S. over the sample period. Comparing the pre-reform and post-reform steady-states, this policy change results in increased capital and output, but it also amplifies wealth concentration in the long run. The share held by the top 1 percent in the model increases by 1.2 percentage points (from 32.1 percent to 33.3 percent). This accounts for 25 percent of the observed increase in the top 1 percent share in the U.S. from 2001 to 2019. When the estate tax policy in the model is further relaxed, the share held by the top 1 percent increases by an additional 2 percentage points.

[6]While this implies that they should earn higher returns for a given level of wealth in practice, in this paper, I assume that they earn higher returns as they inherit larger size of wealth.

[7]In practice, estate tax is also progressive. However, in this paper, I assume estate taxation as a piece-wise linear function, $T(b) = \max\{0, \tau_b(b - \chi_b)\}$ where τ_b is the estate tax rate and χ_b is the exemption threshold. Using data from the Internal Revenue Service, I estimate the average effective estate tax rate over 1989-2001 was 18.2 percent and the highest tax bracket threshold was $6.2 million (in 2019 values).

I find that the G-G link has non-negligible implications. When the G-G link is removed, the model economy converges to a new stationary distribution with reduced capital accumulation by the wealthiest top 5 percent; the share held by the top 5 percent reduces by 1.2 percentage points. Furthermore, it reduces wealth inequality across all age groups in the model, and this reduction in inequality tends to increase with age. Applying the same estate tax reforms, I show that, in the absence of the G-G link, the same policy change increases the share held by the top 1 percent by only 0.6 percentage points, which is half the effect observed in the model where the G-G link is active. These findings confirm that this channel is important for wealth accumulation, particularly for those at the top of the distribution.

I then examine the individual effects of each of these tax instruments by relaxing one parameter at a time while holding the other at the benchmark. When the government only relaxes the exemption threshold, it increases the share of wealth held by the 95-99 percentile while reducing the share held by the top 1 percent. However, when the government only relaxes the estate tax rate, the distributional effect is the opposite; it lowers the share of wealth held by the 95-99 percentile and increases the share held by the top 1 percent. This is because relaxing the exemption threshold primarily benefits the marginal household group (who are sitting on 95-99 percentile in the model), which directly benefits from the policy change. In contrast, households with wealth exceeding the new threshold even before the tax reform lose their shares, despite reduced estate tax burdens due to reduced returns on capital and increased capital income tax. Conversely, relaxing the estate tax rate only benefits wealthy households previously subject to estate tax by reducing their tax burden. In this case, all other groups see their shares decline due to reduced returns on capital. When both instruments change simultaneously, some offsetting effects from each dimension cancel out: the share held by the 95-99 percentile remains roughly the same, while the top 1 percent's share increases, causing the aggregate Gini to rise from 0.833 to 0.838.

1.1 Related Literature

This paper contributes to the literature examining the impact of inheritances and estate taxes. A number of studies find inheritances have equalising effects and estate taxes would counteract the equalising effects unless estate tax revenues are re-distributed.[8] Recently, Nekoei and Seim (2023), using a quasi-experimental design and Swedish administrative data, find that such equalising effects are reversed in the long run since the different depletion rates, arising from return heterogeneity, widen the inequality in inherited wealth over time.

Among others, this paper is closely related to previous studies by De Nardi and Yang (2016) and Guo (2022), both of which investigate estate tax reforms within a life-cycle framework and conclude that estate tax does not have significant effects on wealth concentration. None of

[8]This view reflects the notion that wealth transfers are greater for poorer than richer ones relative to their pre-inheritance wealth. See Wolff and Gittleman (2014); Elinder et al. (2018) among others.

these studies have considered inheritances from grandparents within a life-cycle framework, that are potentially important in shaping wealth distribution and for estate tax implications.

While De Nardi and Yang (2016) abstracts from return heterogeneity, Guo (2022) builds on the general equilibrium framework developed by Castaneda et al. (2003), incorporating return heterogeneity, to quantify the importance of estate taxation for wealth distribution. Guo (2022) compares a model that matches the inheritance-to-wealth ratio of the top 1 percent with another model that does not match this moment and find that these models yield different implications.[9] In the model that matches the low inheritance-to-wealth ratio of the top 1 percent, the top 1 percent's share drops by only 3.5 percentage points when the estate tax rate is raised to 100 percent. In the comparison model, she notes that the share of the top 1 percent decreases from 35 percent to 26 percent when the estate tax rate moves from 0 to 100 percent.

In this paper, I choose not to match the inheritance-to-wealth ratio of the top groups. Comparing the value of inheritances at the time of receipt and the current net worth of households may not fully reflect the true contribution of past inheritance to their current net worth. It is likely that households only report the value at the time of receipt and do not incorporate any capital gains or interest earned on the inherited wealth. Assuming a uniform interest rate to any past inheritances to obtain the aggregate estimate is also problematic if households from wealthy families inherit high-return assets for example, private businesses.[10]

This paper is also similar to Gokhale et al. (2001) in that, both use SCF data to compute a portfolio-weighted rate of return to characterise return heterogeneity. Gokhale et al. (2001) find that most of wealth inequality stems from earning inequality rather than heterogenous in rates-of-return and conclude that bequests reduce wealth inequality in the absence of social security. They assume different rates are randomly assigned to each household in their simulation, which implies, zero correlation between rates of return earned by parent and child households. In contrast, I assume returns are increasing in the level of wealth, implicitly creating some correlation between rates of return earned within dynasties. Returns persist across generations because wealth is.

I relate it to another strand of literature that studies the sources of life-time inequality by comparing one's initial condition and the shocks accumulated over life-time. These include Huggett et al. (2011) and Griffy (2021) among others. Huggett et al. (2011) find that initial human capital is substantially more important factors than learning ability or initial wealth in determining the life-time utility, earnings and wealth while Griffy (2021) finds a significant

[9]She documents that inheritances account for only 14 percent of the net worth of the richest one percent.

[10]For example, Feiveson and Sabelhaus (2018) compute the share of wealth directly accounted for by intergenerational trasnfers based on SCF 2016 and find that the choice of interest rate clearly matters. For top 10 percent group, intergenerational transfers account for 25%, using a real interest rate of 3% while the share increases to 51%, if a real interest rate of 5% is assumed.

role of initial wealth. The importance of initial wealth, however, hinges crucially on the role of initial wealth in these two studies. Huggett et al. (2011) consider initial human capital and initial wealth separately whereas in Griffy (2021), agents use initial wealth to attain initial human capital.[11]

The remainder of this paper is structured as follows: Section 2 documents, using data from SCF, inheritance patterns and return characteristics across different wealth groups, which motivated present analysis. Section 3 discusses, in a simple 3-period model, the impact of introducing the G-G link on household consumption-saving behaviour across different stages of life-cycle. In Section 4, I detail the full life-cycle quantitative model. Section 5 discusses the calibration strategy and compares the baseline models overall characteristics with empirical data. Section 6 presents the main quantitative results from counterfactual policy experiments, including the aggregate and distributional effects of estate taxes, with and without the G-G link. Finally, Section 7 concludes and suggests potential directions for future research.

[11] While this is also an interesting and potentially important aspect, I abstract from this channel. Nevertheless, scale-dependent return heterogeneity allows early inheritances, to some extent, to play a larger role without endogenising the human capital investments.

2 Survey of Consumer Finances

This section presents stylised facts on intergenerational transfers and household wealth using data from the SCF that motivated the current research. The SCF is a triennial survey that is very well-known to be useful in analysing cross-section wealth and income distributions in the U.S. due to its oversampling of rich households. The SCF also includes a distinct section on inheritance status and preferences, making it particularly valuable for studying the characteristics of heirs and the size and the source of transfers. Unless stated otherwise, the numbers reported in the tables in this section, represent the average across 11 sets of SCF data spanning from 1989 to 2019.[12]

2.1 Intergenerational Transfers

Stylised Fact 1: Intergenerational transfers, predominantly taking the form of inheritance, apply only to a small proportion of the population.

Table 1 shows that only 21 percent of the population has reported receiving substantial assets in the past, with more than 80 percent of the transfers taking the form of inheritances. Notably, for some households, such transfers are not one-time events and may occur multiple times. In contrast, the majority, 70 percent, neither have received nor expect to receive such transfers in the future.

	Future Transfers		Types of Transfers (%)		
	Expected	Not expected	Inheritance	Gift	Trust
(%) Received	4.4	16.6	81.4	13.9	4.7
(%) Not received	9.3	69.7			

Table 1: Status and Types of Intergenerational Transfers, SCF (1989 - 2019)

Stylised Fact 2: The link between households and their grandparents is particularly pronounced for younger households.

Table 2 highlights the importance of inheritances from grandparents for younger households. Among households under the age of 30 who reported receiving inheritances, 50 percent have inherited from their grandparents.[13] This is likely due to the fact that most households in this age group would typically have both, or at least one of their parents still alive at the time of the survey. The proportion of heirs generally increases with age, and the parent-child link begins to dominate as individuals reach middle age.

[12]See Appendix A.2.2 for SCF questions related to inheritances.

[13]The numbers in Table 2 are based on the households' age at the time of the survey. However, the G-G link in the early stages remains more prevalent than the parent-child link, even when accounting for households who were older than 30 at the time of the survey but had inherited before turning 30.

Age	% of Population Inherited	% Inherited from Grandparents	Parents	Others
Under 30	7.1	50.4	33.7	16.0
31 - 40	10.7	42.6	42.7	14.8
41 - 50	14.9	26.6	54.0	19.4
51 - 60	21.0	10.2	70.2	19.6
61 - 70	28.4	4.6	76.1	19.3
71 - 80	27.6	3.2	70.3	26.5
81 and over	25.5	5.1	61.2	33.7

Table 2: Percentage of Heirs across Different Age groups, SCF (1989 - 2019)

Stylised Fact 3: The distribution of bequest is highly skewed, predominantly concentrated within the highest wealth quintile.

Among the under 30 heirs, 45 percent belong to the 5th wealth quintile, yet their inheritances constitute over 80 percent of the total received. Table 3 show that, even within the highest wealth quintile, those who are positioned in the top 1 percent are allocated substantial inheritances. As well, the size of inheritance from grandparents is indeed mostly larger than those from parents for most wealth groups.

	Share of total sample (in %)							
	Weaith Quintiles					Top (%)		
	1st	2nd	3rd	4th	5th	90-95	95-99	99-100
(%) Heirs	11.0	8.2	14.1	21.4	45.3	12.9	11.5	4.8
From grandparents	7.6	4.1	6.1	11.2	21.3	7.0	5.0	2.1
From parents	1.4	2.4	5.9	6.7	16.8	4.2	4.9	1.0
From both	0.0	0.0	0.2	0.1	1.3	0.0	0.4	0.7
From others	2.0	1.7	1.9	3.3	4.6	1.7	0.7	0.7
(%) Total Inheritance	2.0	1.8	3.4	8.6	84.3	14.3	16.2	42.8
From grandparents	1.5	1.0	1.3	2.5	42.5	9.8	8.0	20.1
From parents	0.3	0.5	1.9	4.9	35.7	3.6	8.0	18.8
From others	0.3	0.3	0.2	1.1	6.1	0.9	0.2	3.9

Table 3: Distributions of Inheritances (Under 30 Heirs), SCF (1989 - 2019)

To summarise, Stylised Facts 1 to 3 highlight that the impact of intergenerational transfers, via inheritances, occurs earlier than previously understood. This is particulary important for understanding the wealth inequality since households receiving inheritances from grandparents in their early stages (typically when their parents are still alive) are also likely to inherit from their parents as they reach middle age. Abstracting from the G-G link can result in an underestimation of the role inheritances play in wealth inequality and, subsequently, in evaluations of the effectiveness of policy interventions aimed at mitigating wealth concentration. In the next subsection, I present some stylised facts on characteristics of household wealth across different wealth groups.

2.2 Household Wealth

In this subsection, I present evidence on return heterogeneity that stems from portfolio heterogeneity. In addition to early inheritances from grandparents, heterogeneity in returns is also crucial aspect in understanding the role inheritances play in individual wealth accumulation. In recent work, Bach et al. (2020) and Fagereng et al. (2020), document a strong relation between a household's overall wealth and return characteristics. While it may not offer the extensive details present in the Swedish and Norwegian administrative data, several prior studies such as, Fagereng et al. (2016), Xavier (2021), and Kartashova and Zhou (2021), employ SCF data to demonstrate that a similar pattern exists in the U.S.[14]

Stylised Fact 4: Substantial heterogeneity exists in the wealth portfolios across different wealth groups.

Table 4 shows that households at the top of the distribution hold a greater proportion of private and public equities, while real estate comprises the majority of net worth for most of the population.[15]

	Financial assets			Non-financial assets			Total Debt	
	Interest-earning asset	Public equity	Other	Real estate	Private business	Other		
Top 0.1%	0.11	0.23	0.04	0.14	0.49	0.01	(0.01)	1.000
Next 0.9%	0.13	0.26	0.06	0.26	0.32	0.01	(0.04)	1.000
Next 4%	0.13	0.28	0.09	0.36	0.20	0.02	(0.07)	1.000
Next 5%	0.13	0.26	0.12	0.47	0.10	0.03	(0.12)	1.000
Next 40%	0.13	0.18	0.11	0.74	0.06	0.08	(0.30)	1.000
Bottom 50%	0.26	0.18	0.16	2.55	0.04	0.63	(2.83)	1.000
Overall	0.13	0.24	0.09	0.45	0.21	0.04	(0.16)	1.000

Table 4: Heterogeneity in Wealth Portfolio Composition, SCF (1998 - 2019)

If different asset classes yield different rates, heirs from different wealth groups would earn different returns on their inherited wealth based on the nature of the wealth inherited from their parents and/or grandparents.

Stylised Fact 5: Wealthier households hold portfolios that lean more towards high-return assets.

Table 5 reports the average returns on each wealth component over the sample period. Private business (including both corporate and non-corporate businesses), have yielded persistently higher returns than other assets.[16]

[14]See Appendix A.2.2 for more information on methodology used in this section.

[15]The weights of each component are computed as a share of net worth such that the total assets and total debt must sum to 1. While the share of real estate for bottom 50% seems very high, but their net worth is negative as the value of debt exceeds the value of total assets.

[16]The lower average returns on public equity and real estate can be attributed to substantial declines during the Great Recession.

	Financial assets			Non-financial assets			Total Debt
	Interest-earning asset	Public equity	Other	Real estate	Private business	Other	
1999 - 2001	0.04	0.02	-	0.11	0.29	0.02	0.07
2002 - 2004	0.02	0.00	-	0.12	0.27	0.02	0.06
2005 - 2007	0.03	0.10	-	0.09	0.40	0.02	0.06
2008 - 2010	0.02	(0.06)	-	(0.07)	0.06	0.02	0.06
2011 - 2013	0.02	0.14	-	0.05	0.28	0.02	0.04
2014 - 2016	0.02	0.10	-	0.10	0.26	0.02	0.04
2017 - 2019	0.02	0.12	-	0.06	0.36	0.02	0.04
Average	0.02	0.06	-	0.06	0.21	0.02	0.06

Note. Values in parenthesis indicate negative returns.

Table 5: Average Returns on Each Wealth Component, SCF (1998 - 2019)

Having the portfolio shares and the average returns for each wealth component for each episode, Table 6 presents the average portfolio-weighted returns to net worth across different wealth groups over the sample period.[17] Both returns, and standard deviations generally exhibit an increasing trend with overall wealth, which is consistent with findings from Bach et al. (2020) and Fagereng et al. (2020).

Wealth Percentile	0 - 50	50 - 90	90 - 95	95 - 99	99 - 99.9	99.9 - 100
Average Return	-0.04	0.05	0.06	0.08	0.10	0.11
Stand. Dev	(0.01)	(0.01)	(0.02)	(0.03)	(0.05)	(0.07)

Table 6: Heterogeneity in Returns across Different Wealth Group, SCF (1998 - 2019)

In summary, the presence of return heterogeneity and the G-G link may support the idea that inheritances increase wealth concentration. In fact, the effects are not confined to middle-age when most households start to inherit from their parents; instead, they can begin much earlier than previously understood, potentially shaping wealth outcomes later in life. Inheritances are generally associated with very wealthy households. Hence, young heirs from affluent families are likely to begin their economic life with substantial wealth on hand, but are also likely to accumulate faster based on the nature of inherited wealth. This section focuses on how the G-G link would affect the recipients of inheritances, young households. In the next section, I briefly illustrate the implications the G-G link bring for the givers of inheritances – old households – using a simple 3-period model framework.

[17]It should be highlighted that households with greater wealth are likely to accrue higher returns from the same wealth components, possibly attributed to advanced education, skills, or information access. However, I abstract from within-class heterogeneity as it is beyond the scope of this exercise.

3 A Three-Period Framework

This section illustrates the implication of integrating the G-G link using a simple 3-period model. Consider an economy where individuals live for 3 periods with certainty: young, middle-aged and old. Population is growing at a constant rate n and households receive endowments in the first two periods and retire thereafter. The utility from consumption takes the standard CRRA form and the *warm-glow* bequest preference is taken from De Nardi and Yang (2016),

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}, \qquad h(b) = \frac{\phi_1}{1-\sigma}\left[(b+\phi_2)^{1-\sigma} - 1\right]$$

where σ is the risk-aversion coefficient, $\phi_1 > 0$ measures the bequest intensity and ϕ_2 reflects the extent to which bequests are luxury goods. Treating bequests as luxury goods naturally segments households into two groups: bequesters and non-bequesters. I introduce the G-G link by making following modification,

$$b = b_c^{\kappa} b_{gc}^{1-\kappa}$$

b_c and b_{gc} denote the bequest to child and grandchild respectively. Note that the preference parameter κ governs how the agent allocates the bequests between children and grandchildren, hence $\kappa = 1$ shuts down the G-G link.

In this section, I illustrate how the G-G link alters the consumption-saving behaviour of old households compared to a model without the G-G link. Given that it is the final period, they solve a static problem.

Old without G-G Link First consider the case where $\kappa = 1$, hence $b_{gc} = 0$. Let $x = (1+r)a$ be the beginning-of-period wealth, the maximisation problem can be read as,

$$\begin{aligned} v(3,a) &= \max_{a'} \left\{ u(x-a') + \beta \cdot h(b_c) \right\} \\ s.t. \quad b_c &= \begin{cases} a' & \text{if } a' \le \chi_b \\ a' - \tau_b\left(a' - \chi_b\right) & \text{otherwise} \end{cases} \end{aligned}$$

where τ_b and χ_b denotes the estate tax rate and extate exemption threshold respectively.[18]

$$a' = \begin{cases} 0 & \text{if } x < \Omega\phi_2 \\ \frac{x-\Omega\phi_2}{1+\Omega}, & \text{if } a' \le \chi_b \\ \frac{x-\Omega(\tau_b\chi_b+\phi_2)}{1+\Omega(1-\tau_b)} & \text{otherwise} \end{cases} \qquad \text{where} \quad \Omega = \begin{cases} (\beta\phi_1)^{-\frac{1}{\sigma}} & \text{if } a' \le \chi_b \\ \left((1-\tau_b)\,\beta\phi_1\right)^{-\frac{1}{\sigma}} & \text{if } a' > \chi_b \end{cases}$$

[18]Here I assume households care about the (intended) bequests net of taxes.

Households with insufficient wealth ($x < \Omega\phi_2$) cannot afford the luxury bequests hence consume all resources before exiting the economy. The exemption threshold, χ_b creates another kink in the solution.

Old with G-G Link Next consider the case where $\kappa < 1$. The maximisation problem is then,

$$v(3, a) = \max_{a'_c, a'_g} \left\{ u(x - a'_c - a'_g) + \beta \cdot h(b_c, b_{gc}) \right\}$$

$$s.t. \quad b_i = \begin{cases} a'_i & \text{if } a'_i \leq \chi_b \\ a'_i - \tau_b \left(a'_i - \chi_b \right) & \text{otherwise} \end{cases}, \quad \text{for } i \in \{c, gc\}$$

If the agent has enough wealth to afford the intended bequests, the solution is then,

$$b_c = \kappa \cdot \frac{(x - \Omega\phi_2)}{1 + \Omega\tilde{\kappa}} \qquad\qquad b_{gc} = (1 - \kappa) \cdot \frac{(x - \Omega\phi_2)}{1 + \Omega\tilde{\kappa}}$$

where

$$\Omega = (\beta\phi_1\tilde{\kappa})^{-\frac{1}{\sigma}} \qquad \text{and} \qquad \tilde{\kappa} = \kappa^{\kappa} \cdot (1 - \kappa)^{1-\kappa}$$

When the G-G link is active, we have $\tilde{\kappa} < 1$, which makes the bequests slightly more expensive by increasing Ω. More importantly, Figure 2 illustrates that it also raises the effective exemption threshold for estates that are subject to tax.

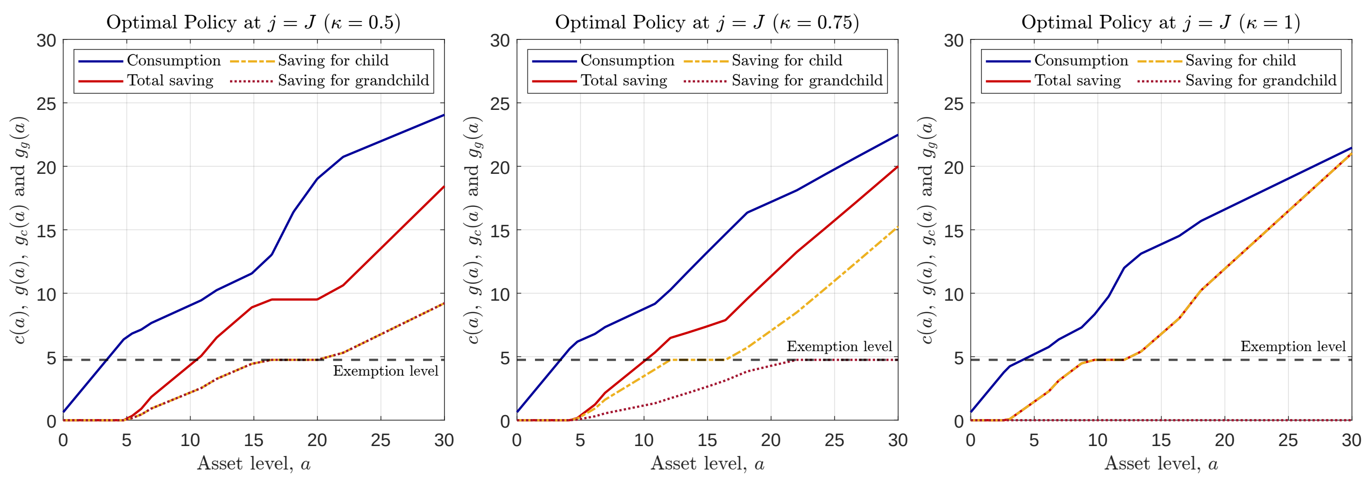

Figure 2: Optimal Consumption and Saving Policy Functions at the Final Period

First, old households with lower wealth do not leave bequests, hence the consumption policy is steeper at the lower level. In the absence of the G-G link ($\kappa = 1$), household stops saving as it hits the exemption threshold to avoid the tax (Figure 2, right panel). On the other hand, when the G-G link is active ($\kappa = 0.5$), the same agent with the same cash on hand continues to save more and only when both a'_c and a'_g hit the threshold, they start to switch to consume more. That is, it essentially doubles the effective exemption threshold (Figure 2, left panel).

When he cares more about his own children than grandchildren ($\kappa = 0.75$), b_c hits the exemption threshold first but the agent can still increase the savings as they can use up the GST exemption to leave bequests to grandchild. However, the agent would not keep b_c at the threshold until b_g hits the threshold (Figure 2, middle panel).

This is a crucial element in estate tax analysis as it integrates the notion of the "generation-skipping transfers (GST) tax". It is worthnoting that before its introduction in 1976, the GST were tax-exempt in the U.S. Considering that the initial purpose of the legislation was to prevent families from avoiding the estate tax by skipping one generation, this channel is a necessary component that should be considered when analysing the aggregate and distributional consequences of inheritances and estate taxes. Estate tax policy is designed to target only affluent households who leave bequests above the exemption threshold level. Consequently, changes in estate tax effects would be more pronounced when the G-G link is active, as the policy change would apply to both the estate to child and estate to grandchild in the model, particularly for those at the upper end of the wealth distribution.

The introduction of the G-G link is likely to alter the consumption-saving behavior of young and middle-aged households compared to a model without the G-G link, as the timing and size of the transfers are now different. Households reduce their savings when anticipating inheritances in the future to smooth their consumption over the life cycle. In a model with only a parent-child link, this implies that households reduce their savings both when young and when middle-aged, as the inheritances will be received in the last period. On the other hand, when the G-G link is active, although the young may save even less when young, the fact that they receive inheritances from grandparents implies that they will have a larger wealth at the beginning of middle age, which can more than offset the reduced saving when young. Appendix A.3 further discusses in this regards. In the next section, I present my baseline model framework with realistic features such as life-time uncertainty, heterogeneities in earnings, rate-of-returns and preferences towards estate planning.

4 Quantitative Life-Cycle Model

In this section, I develop a general equilibrium life-cycle model with bequests to examine the aggregate and distributional consequences of relaxing estate tax policy. The baseline model features heterogeneities in earnings and wealth returns as motivated from Section 2. The economy is populated by overlapping generations of finitely-lived households facing age-dependent survival probabilities. Households derive utility from consumption and bequests (net of taxes), which they begin planning from retirement. Intended bequests are luxury goods that not every household can afford. Importantly, if households live long enough to witness their grandchildren entering the economy, they derive utility from leaving bequests to grandchildren as well. Households may leave accidental bequests in case they pass away prematurely. Workers supply labour inelastically until they retire and households save by lending captital to firms.

Model Demographics One period in the model is equivalent to 5 years. Households enter the economy at age 25 ($j = 1$) as workers after which they consume, and accumulate wealth. Households supply labour inelastically until age 60 ($j = 8$) and retire from age 65 ($j = J_r = 9$). The maximum age is chosen to be 85 ($J = 13$) after which they pass away with certainty.

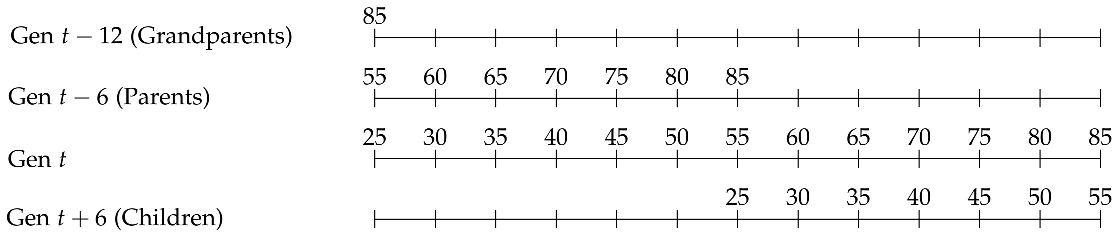

Figure 3: Model Demographics

At any age $j < J$, households face a conditional probability of reaching from age j to $j+1$ denoted as γ_j and hence $\gamma_J = 0$. The unconditional probability of reaching age j is therefore denoted by $\gamma^j = \Pi_{m=1}^{j}\gamma_m$. As households give birth at age 30, children will enter the economy when parents are at age 55. For simplicity, I assume households survive with certainty until their children enter the economy, that is, $\gamma_j = 1$ for $j \leq 6$. This assumption is to ensure that all households have their parents alive when entering and no households die before their parents.

The total population alive at any given time t, is given by:

$$N_t = \sum_{j=1}^{J} N_{j,t}$$

$$N_{j+1,t+1} = \gamma_{j,t} N_{j,t}, \quad \forall j \in \{1, J\}$$

$$N_{1,t} = (1+f) N_{1,t-6}$$

where the last equation describes the total population of new households entering at $t = 1$ that is given by the population of their parents generation ($N_{1,t-6}$) multiplied by the fertility rate f.

I assume that the population grows at a constant rate n such that:

$$N_{1,t+1} = (1+n)N_{1,t}$$

Hence, in a steady-state where age-dependent survival probabilities and fertility rate are constant, the rate of total population growth is determined as

$$n = (1+f)^{\frac{1}{6}} - 1$$

Normalising the total population to 1, we have:

$$\begin{aligned} N &= \sum_{j=1}^{J} N_j \\ N_{j+1} &= \frac{\gamma_j}{1+n} N_j, \quad \forall j \\ N_1 &= \bar{N}_1 \end{aligned}$$

where $\bar{N}_1$ is the size of age-1 households, which is equal to

$$\bar{N}_1 = \left(\sum_{j=1}^{J} \frac{\gamma^{j-1}}{(1+n)^{j-1}} \right)^{-1}$$

Technology The supply side of the economy is modelled as standard. A representative firm hires capital and labour from households and produce consumption goods in this economy using the constant returns-to-scale Cobb-Douglas production technology:

$$Y = AK^{\alpha} L^{1-\alpha}$$

where A and α denote the level of productivity and capital share in the production respectively and capital depreciates at rate δ_k in each period.

Earnings Process Each household supplies one unit of labour inelastically in each period until they retire. The total labour productivity of worker i at age j is given by

$$\log e_j^i = z_j^i + \epsilon_j$$

where ϵ_j is the deterministic age-efficiency profile and z_j^i denotes the stochastic earnings process that follows AR(1):

$$z_j^i = \rho_z z_{j-1}^i + \mu_j^i, \quad \mu_j^i \sim \mathcal{N}(0, \sigma_z^2)$$

Moreover, I assume the productivity of a household at entry (at $j = 1$) follows productivity of his/her parents at age 55 (at $j = 7$) to capture imperfect intergenerational transmission of earnings ability as in De Nardi and Yang (2016).

$$z_1 = \rho_h z_7$$

as there is a a 30-year age gap between parents and child by construction.

Rate-of-return on Capital I introduce rate-of-return heterogeneity into the model in which return and risk increase in the level of wealth as in Hubmer et al. (2021).[19] Hence the gross return in the model takes the form:

$$1 + \underline{r} + r^X(a) + \sigma^X(a) \cdot \eta$$

where $\underline{r}$ is an aggregate return component, $r^X(\cdot)$ and $\sigma^X(\cdot)$ are mean and standard deviations of excess returns and η is an *i.i.d.* standard normal idiosyncratic shock.

Hubmer et al. (2021) argue that this specification allows for a limited amount of return persistence: returns are persistent because wealth is, but conditional on the level of wealth, returns are uncorrelated over time. This also implies, within the model, that return on inherited wealth are heterogeneous due to heterogeneity in the size of the transfers. Households from wealthy families are like to inherit larger amounts of wealth and also enjoy higher returns on their inherited wealth precisely because they have inherited more wealth. Therefore, parental background and early inheritance are likely to play a larger role in determining the wealth concentration in addition to the earnings ability transmission.

[19] See Gabaix et al. (2016) and Xavier (2021) for other mechanism.

4.1 Government

The government collects taxes from labour earnings, capital income, and estates to finance its consumption and the interest payments on its debt. In addition to the tax on labour earnings, the government operates a balanced-budget social security program, which collects separate social security taxes from workers to provide benefits to retirees.

Labour Income Tax In the model, the progressive labour earnings tax is characterised by a two-parameter tax function of the form:

$$T_\ell(w \cdot e) = w \cdot e - (1 - \chi_e)(w \cdot e)^{1-\mu_e}$$

as in Benabou (2002) and Wu and Krueger (2021) where μ_e and χ_e are two parameters governing the progressivity and the level of income tax respectively.

Estate Tax I assume the estate tax in the model is characterised by an exemption threshold χ_b and the tax rate τ_b such that only estates above the threshold are taxed at rate τ_b as in De Nardi and Yang (2016).[20]

$$T(b) = \max\{0, \tau_b(b - \chi_b)\}$$

Social Security Tax The government also collects separately social security taxes from workers to finance social security benefits to retirees. I assume a simplified social security system that pays a common retirement benefit to all retirees in the model.[21] Following Wu and Krueger (2021), the flat payroll tax in the model τ_{ss} is set to 7.65% based on the actual Social Security and Medicare tax rates on pre-tax income of employees. The amount of benefit is then computed based on,

$$s \int \cdot \mathbb{1}_{\{j \geq J_r\}} \, d\Phi = \tau_{ss} \int w \cdot e(j, z) \, d\Phi$$

Capital Income Tax Finally, the government also collects taxes on capital income earned by households. Capital incomes are taxed at a constant rate τ_a and the tax rate will be chosen to balance the government budget in every period.

[20] In practice, the U.S. estate tax is also progressive. In this study, I follow a commonly used specification in the existing literature by targeting relevant moments using τ_b and χ_b. The estimation of changes in actual estate tax progressivity is left for future research.

[21] This assumption is to avoid an additional continuous state variable (e.g., average indexed monthly earnings) to track agent's future retirement benefit.

4.2 Household's Problems

Preference As in the 3-period framework, the period utility from consumption takes a standard CRRA form:

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma}$$

and the *'warm-glow'* preference takes the form of,

$$h(b_c, b_{gc}) = \frac{\phi_1}{1-\sigma}\left[(b_c^{\kappa_j} b_{gc}^{1-\kappa_j} + \phi_2)^{1-\sigma} - 1\right], \quad \text{where} \quad \begin{cases} \kappa_j = 1 & \text{if} \quad j < J \\ \kappa_j < 1 & \text{if} \quad j = J \end{cases}$$

where σ is the risk-aversion coefficient, $\phi_1 > 0$ measures the bequest intensity and ϕ_2 reflects the extent to which bequests are luxury goods. With $\phi_2 > 0$, poor households will decide not to leave bequests at the final period. b_c and b_{gc} denote the bequest to gchild and grandchild respectively.

Here, I make two simplifying assumptions. First, I assume in this setup whereby, only if households live long enough to witness their grandchildren entering the economy have active bequest motives. Given the model demographics, when agents pass away prematurely before reaching the maximum age J, their grandchildren has not entered the economy yet and therefore all bequests left should inherited by their children. However, if one lives long enough they are willing to leave a portion to their grandchildren hence $\kappa_J < 1$. This formulation allows some agents to receive inheritance earlier in their lives. Again, $\kappa_J = 1$ shuts down the G-G link as in the basic model. Second, I assume households begin their estate planning as they transition to retirement stage. Given the model demographics, households live with certainty until they children enter the economy at age 55 and they retire from age 65. While households face positive mortality rates between age 55 - 65, I consider this as part of accidental bequests.

The above specification allows households to become bequester-type regardless of parents' type (conditional on surviving long enough); that is, even without wealthy parents, if an agent is a "self-made" wealthy at retirement, he/she becomes bequester-type and is willing to leave bequests to their offsprings. On the other hand, this also captures some persistency within wealthy families; an agent who receive substantial inheritances are more likely to become a bequester at retirement. Finally, this allows the composition of bequesters and non-bequesters to vary as changes in estate tax policy affect stationary distribution.

Next, I describe households' problem at each age $j = 1$ to $J = 13$. Since it is a finite-horizon life-cycle model, I start from retirees' problems then move to workers' problems. In doing so, I describe separately, households whose parents (or grandparents) are alive, and parents are retired or working.

Retirees The set of state variables for retirees are his age j, current asset holdings a and idiosyncratic shock η. Let V_r denotes the value functions, the recursive problem is given by:

$$V_r(j,a,\eta) = \max_{c,a'_c,a'_{gc}} \left\{ u(c) + \beta \mathbb{E}\left[\gamma_j V_r(j+1,a',\eta') + (1-\gamma_j)\cdot h(b_c, b_{gc}) \right] \right\}$$

subject to

$$\begin{aligned} c + a' &= s + (1+r^n)\cdot a \\ b_c &= a'_c - T_b(a'_c) \\ b_g &= a'_g - T_b(a'_g) \end{aligned}$$

where $r^n = (1-\tau_a)(\underline{r} + r^X(a) + \sigma^X(a)\cdot\eta)$ denotes the net return on capital and s is the social security benefit provided by the government. b_c and b_{gc} again denote bequests to child and grandchild respectively. $T_b(a'_c) = \max\{0, \tau_b(a'_c - \chi_b)\}$ is the estate tax. Note also that for $J_r \le j < J$, $a'_g = 0$ and hence $b_{gc} = 0$ as $\kappa_j = 1$.

Workers without parents Let V_w be the value function of a working agent without parents,

$$V_w(j,a,z,\eta) = \begin{cases} \max_{c,a'} \left\{ u(c) + \gamma_j \beta \mathbb{E}\left[V_r(j+1,a',\eta') \right] \right\} & \text{if} \quad j = J_r - 1 \\ \max_{c,a'} \left\{ u(c) + \gamma_j \beta \mathbb{E}\left[V_w(j+1,a',z',\eta') \right] \right\} & \text{if} \quad j < J_r - 1 \end{cases}$$

subject to:

$$c + a' = (1-\tau_{ss})\cdot w \cdot e(j,z) - T_\ell(w\cdot e) + (1+r^n)\cdot a$$

where $T_\ell(w\cdot e)$ and τ_{ss} are progressive labour income tax and social security tax respectively and the productivity z is part of their state variables.

Workers with retired parents Let V_w^{pr} be the value function of a working agent with retired parents,

$$\begin{aligned} V_w^{pr}\left(j,a,z,\eta,S_p\right) = \max_{c,a'} \Bigg\{ u(c) + \gamma_j \beta \mathbb{E}\Bigg[& \gamma_{j+6}\cdot V_w^{pr}\left(j+1,a',z',\eta',S'_p\right) \\ & + (1-\gamma_{j+6})\cdot V_w\left(j+1, a' + \frac{b_p}{1+f}, z', \eta'\right) \Bigg] \Bigg\} \end{aligned}$$

where $S_p = \{a_p, \eta_p\}$ denotes the parent's state variables which includes parents' asset holding a_p, and their current realisation of the idiosyncratic shock η_p.[22]

[22]Note that parents' age is relundant as there is a constant age gap between parents and child by construction.

Therefore, with probability $(1-\gamma_{j+6})$ if parents do not survive, he/she will inherit the accidental bequest $b_p = a'(j+6, S_p)$ from parents[23] and proceed the next period with:

$$V_w(j,a,z,\eta) = \max_{c,a'} \left\{ u(c) + \gamma_j \beta \mathbb{E}\left[V_w\left(j+1, a', z', \eta'\right)\right]\right\}$$

where parents' states become relundant hence can be dropped without loss of generality.

Workers with working parents Let V_w^{pw} be the value function of an agent with working parents,

$$\begin{aligned} V_w^{pw}\left(j,a,z,\eta,S_p\right) = \max_{c,a'} \Big\{ u(c) + \gamma_j\beta\mathbb{E}\Big[& \gamma_{j+6} \cdot V_w^{pr}\left(j+1, a', z', \eta', S_p'\right) \\ & + (1-\gamma_{j+6}) \cdot V_w\left(j+1, a' + \frac{b_p}{1+f}, z', \eta'\right)\Big]\Big\} \end{aligned}$$

where $S_p = \{a_p, z_p, \eta_p\}$ denotes the parent's state variables.

Age-1 with grandparents Finally, at age $j=1$ in case if an agent's grandparents are alive:

$$\begin{aligned} V_w^{pg}\left(j,a,z,\eta,S_p,S_g\right) = \max_{c,a'} \Big\{ u(c) + \gamma_j\beta\mathbb{E}\Big[& \gamma_{j+6} \cdot V_w^{pw}\left(j+1, a' + \frac{b_g}{(1+f)^2}, z', \eta', S_p'\right) \\ & + (1-\gamma_{j+6}) \cdot V_w\left(j+1, a' + \frac{b_g}{(1+f)^2} + \frac{b_p}{1+f}, z', \eta'\right)\Big]\Big\} \end{aligned}$$

where $S_g = \{a_g, \eta_g\}$ denotes the grandparent's state variables. At entry, if the agent's grandparents are alive, the agent will inherit bequests from grandparents with uncertainty.

[23] As in De Nardi and Yang (2016), I assume that children have full information about their parents' state variables and infer the size of the bequests they are likely to receive according to their parents' policy function.

4.3 Stationary Equilibrium

I consider a stationary equilibrium of the model economy in which factor prices $(r^*, \underline{r}, w)$, demographic processes (f, n, γ), and age-wealth distribution are constant over time.

Definition: Given government consumption G, government debt D, a tax system characterised by $(\tau_a, T_\ell(e), \tau_b, \chi_b)$ and a social security system characterised by (τ_{ss}, s), a stationary recursive competitive equilibrium with population growth is a collection of value functions $\{V_w^{pg}, V_w^{pw}, V_w^{pr}, V_w, V_r\}$ and relevant policy functions $\{c(x), a'(x)\}$, optimal input choices $\{K, L\}$ of firms, and equilibrium prices $(r^*, \underline{r}, w)$ with following properties:

i. Given prices $(r^*, \underline{r}, w)$ and government policies $(\tau_a, T_\ell(e), \tau_b, \chi_b, \tau_{ss}, s)$, the functions $V(x)$, $c(x)$ and $a'(x)$ solve the household's maximisation problem in state x.

ii. Given prices $(r^*, \underline{r}, w)$, the optimal choices of the representative firm satisfy:

$$r^* = A\alpha\left(\frac{K}{L}\right)^{\alpha-1} - \delta_k, \qquad w = A(1-\alpha)\left(\frac{K}{L}\right)^{1-\alpha}$$

iii. Φ is the invariant distribution of households over the state variables, $\Phi(X) = 1$.

iv. Government policies satisfy the government budget constraints:

$$G + ((1-\tau_a)r^* - n)D = \tau_a r^* K + \int T(w \cdot e(j,z))\, d\Phi + \tau_b \int (1-\gamma_j) \max\left(a' - \chi_b, 0\right)\, d\Phi$$
$$\int s \cdot \mathbb{1}_{\{j \geq J_r\}}\, d\Phi = \tau_{ss} \int (w \cdot e(j,z))\, d\Phi$$

v. All markets clear:

- The labour market clears,

$$L = \int e(j,z)\, d\Phi$$

- The capital market clears,[24]

$$(1+n)(K+D) = \int a'(x)\, d\Phi$$
$$r^* \int a(x)\, d\Phi = \int \left(\underline{r} + r^X(a) + \sigma^X(a)\eta\right) \cdot a\, d\Phi$$

- The goods market clears,

$$\int c(x)\, d\Phi + (n+\delta)K + G = Y$$

[24]Non-trivial excess return schedule requires an additional equilibrium condition that the aggregate capital income equals to the aggregated individual capital income. The condition pins down the aggregate return component, $\underline{r}$.

5 Calibration

This section describes the parameter choices for the baseline model economy. The model is calibrated to match the characteristics of the U.S. economy in 1990-2000, a period where the estate tax policy was relatively stable. I choose a subset of parameters based on model-exogenous information and calibrate remaining parameters internally so that model moments closely match their data counterparts. Table 7 summarises the parameters that are externally calibrated. I report parameters at an annual frequency (unless stated otherwise) though they are converted to 5-year frequency in the computation.

Parameter		Value	Target/Data
Annual population growth rate	n	1.10%	
Age-dependent survival probability	γ_j	$*$	U.S. Life table (2001)
Capital share in production	α	0.360	
Risk aversion coefficient	σ	1.500	
Productivity state	z	$*$	See text
Age-efficiency profile	ϵ_j	$*$	SCF (2001)
5-year labour productivity persistences	ρ_z	0.850	De Nardi (2004)
5-year labour productivity variance	σ_z^2	0.300	De Nardi (2004)
Productivity transition probability	Q_z	$*$	See text
Productivity transmission probability	Q_h	$*$	See text
Excess return schedule	r^X	$[5.1\%, 7.5\%]$	SCF (2001-2019)
Std. deviation of excess return	σ^X	$[0.023, 0.051]$	SCF (2001-2019)
i.i.d. idiosyncratic shock	η	$[-1, 0, 1]$	
Government consumption-to-GDP	G/Y	18.0%	FRED (A822RE1Q156NBEA)
Government debt-to-GDP	D/Y	55.0%	FRED (DEBTTLUSA188A)
Labour income tax progressivity	μ_e	0.1327	Wu and Krueger (2021)
Labour income tax level	χ_e	0.1575	Wu and Krueger (2021)
Social security payroll tax rate	τ_{ss}	0.0765	Wu and Krueger (2021)

Note. Unless stated otherwise, parameters are reported at an annual frequency.

Table 7: Externally Calibrated Parameters

First, I set the population growth rate to $n = 1.1\%$ and the age-dependent survival probabilities $\{\gamma_j\}$ are obtained from the U.S. Life Table (2001). The capital share in the production is set to $\alpha = 0.36$ and the risk aversion coefficient is set to $\sigma = 1.5$.

Second, since labour supply is inelastic in the model, earnings process can be calibrated externally to match earnings distribution observed in the data. The labour productivity persistence ρ_z, variance σ_z^2 as well as the earnings transmission persistence ρ_h are taken from De Nardi (2004). I calibrate model earnings process à la Castaneda et al. (2003) and Kindermann and Krueger (2021). Specifically, the stochastic component z is approximated by a 4-state Markov Chain where I use Tauchen (1986) to obtain the first 3 states and 3×3 transition probabilities.

Then I calibrate remaining parameters (including the earnings transmission matrix, Q_h) to match earnings concentration observed in the data. In doing so, I differ from the usual *"superstar"* process in that, I only use information from the empirical earnings distribution, and I do not target wealth distribution. This yields 4 productivity states,

$$z = [0.3923,\ 1.000,\ 2.5492,\ 23.3975]$$

and the implied initial distribution at age-1 as,

$$\mu_1 = [34.48\%,\ 5.51\%,\ 59.62\%,\ 0.39\%]$$

I use the mean earnings for households age between 25 - 60 from the SCF 2001 for the model deterministic age-efficiency profile of labour productivity, ϵ_j.[25] I then normalise the age-efficiency profile such that the average earnings (before tax) at age-1 is equal to unity.[26]

Third, the return heterogeneity in the model is characterised by a step function. For an individual i with asset holding a_i,

$$1 + r_i = \begin{cases} 1 + \underline{r} & \text{if } a_i < \underline{a}_1 \\ 1 + \underline{r} + r_1^X + \sigma_1^X \cdot \eta & \text{if } \underline{a}_1 \leq a_i < \underline{a}_2 \\ 1 + \underline{r} + r_2^X + \sigma_2^X \cdot \eta & \text{if } \underline{a}_2 \leq a_i \end{cases}$$

where the *i.i.d.* standard normal idiosyncratic shock η takes values of $[-1, 0, 1]$ with probabilities $[0.3085,\ 0.3829,\ 0.3085]$. There are 6 parameters to be calibrated: I set $\{r_1^X, r_2^X\} = \{0.051, 0.071\}$ and $\{\sigma_1^X, \sigma_2^X\} = \{0.023, 0.051\}$ respectively based on Table 7 while the remaining two threshold parameters $\{\underline{a}_1, \underline{a}_2\}$ are internally calibrated to match the concentration at the top of distribution.[27]

Next, the social security payroll tax rate, $\tau_{ss} = 7.65\%$ and the parameters governing the progressivity of labour earnings income, $\mu_e = 0.1327$ and $\chi_e = 0.1575$ are taken from Wu and Krueger (2021).[28] Lastly, I assume government consumes a constant fraction of output ($G/Y = 18\%$) in each period and outstanding government debt B is set such that the government debt-to-GDP ratio is 55% in the initial equilibrium. Both are taken from the FRED.

[25] I set $\epsilon_j = 0$ for $j \geq J_r$ due to mandatory retirement at age 65 (i.e. $j = 9$) in the model.

[26] The normalisation used in exercise is such that 1 unit in the model corresponds to 5-year average earnings of households at age 25, $\$53,488 \times 5 = \$267,440$ in 2019 US dollars based on SCF (2001). See Appendix A.4 for more information on the calibration of earnings process.

[27] See Appendix A.5 for more information on the choices of excess returns and standard deviations.

[28] Wu and Krueger (2021) estimate the two parameters, μ_e and χ_e for the U.S. by running the OLS regression: $\ln(e - T_\ell(e)) = \ln(1 - \chi_e) + (1 - \mu_e)\ln(e)$ where the tax liabilities $T_\ell(e)$ are defined as federal income taxes minus eligible amounts of the Earned Income Tax Credit (EITC) and food stamp benefits.

Table 8 below summarises the remaining parameters that are internally calibrated. Some parameters can be fixed directly by the equilibrium conditions. For instance, I assume the initial equilibrium annual real interest rate is $r = 7\%$ which requires capital to depreciate at $\delta_k = 3.85\%$ annually. The level of technology is normalised $A = 1.096$ such that the equilibrium wage rate per efficiency unit of labour is $w = 1$ following Kindermann and Krueger (2021). Given the exogenously chosen social security tax rate of $\tau_{ss} = 7.65\%$, the common social security benefits each retiree receive is equivalent to $32,190 in 2019 US dollars.

Parameter		Value	Target/Data
Time discount factor	β	0.9613	$K/Y = 3.10$
Bequest intensity	ϕ_1	1.40	$B/W = 0.01$
Bequest luxury parameter	ϕ_2	1.10	Sources of transfers to under 30
Bequest preference at age J	κ	0.77	Flow of transfers to under 30
Technology level	A	1.096	$w = 1$
Capital depreciation rate	δ_k	3.85%	$r^* = 7\%$
Aggregate return component	$\underline{r}$	5.28%	$r^* \int a \, d\Phi = \int \left(\underline{r} + r^X(a) + \sigma^X(a)\eta\right) \cdot a \, d\Phi$
1st excess return threshold	$\underline{a}_1$	$ 7.4 M	Share of wealth held by 95-99th percentile
2nd excess return threshold	$\underline{a}_2$	$ 39.7 M	Share of wealth held by top 1%
Social security benefit	s	$32,190	Social security budget balance
Capital income tax rate	τ_a	10.60%	Government budget balance
Estate tax rate	τ_b	18%	Estate tax revenue (as % of GDP)
Estate tax exemption threshold	χ_b	$ 6.4 M	% of estates that are subject to tax

Note. Unless stated otherwise, parameters are reported at an annual frequency.

Table 8: Internally Calibrated Parameters

Remaining parameters are chosen jointly to match the target moments. First, the discount factor, β and the bequest intensity parameter, ϕ_1 are chosen to match the capital-labour ratio of 3.10 and bequest-wealth ratio of 1% respectively. The bequest luxury parameter, ϕ_2 endogenously segments age-J households into bequesters and non-bequesters and only bequesters leave bequests to grandchild, I choose ϕ_2 to target the fraction of households who inherit from grandparents. The bequest preference at the final age, κ_J is chosen to match the relative size of inheritance from grandparents.[29]

The exogenous wealth thresholds to earn excess returns, $\{\underline{a}_1, \underline{a}_2\}$ are chosen to match the shares held by 95-99th percentile and top 1%. These require $\underline{a}_1 = \$7.4$ million and $\underline{a}_2 = 39.6$ million respectively. The aggregate return component, $\underline{r}$ that equalises the aggregate capital income and the aggregated individual capital income, is found to be 5.28% in the baseline. Lastly, the main estate parameters, τ_b and χ_b are chosen to match the fraction of estate tax revenue to output (0.33%) and the fraction of estates that are subject to tax (2.0%) respectively, as in De Nardi and Yang (2016). In the baseline, the estate tax rate is set to 18% and the estate exemption threshold is $6.4 million. The capital income tax rate, $\tau_a = 10.60\%$ is then chosen to balance the government budget.

[29] The model bequest parameters implies that for households at $j = J$, the intended bequest motive is active if the beginning-of-period wealth is greater than $384,140.

5.1 Calibration Results

Table 9 reports the distribution of labour earnings and wealth in both the data and the model along with their respective Gini coefficients. The baseline model produces cross-sectional distributions of both earnings and wealth that closely align with empirical counterparts. In particular, it generates a substantial concentration of wealth at the upper end of the wealth distribution.

	Share of total sample (in %)								
	Quintiles					Top (%)			
	1st	2nd	3rd	4th	5th	90-95	95-99	99-100	Gini
Earnings									
Data	0	5	12	21	62	11	16	19	0.63
Model	0	5	12	20	63	10	16	19	0.62
Wealth									
Data	0	1	4	12	83	12	25	32	0.81
Model	0	0	3	12	85	12	28	32	0.83

Table 9: Earnings and Wealth Distributions in Benchmark Economy

Table 10 and Table 11 report a list of targeted moments and aggregate variables in the baseline model. The calibrated earnings process generates both parent-child earnings correlation and the earnings mean-to-median ratio that are close to the data. The model is also able to generate overall bequest characteristics. In the model, only 2.20% of estates are taxable and the ratio of government estate tax revenue to output is 0.37%. Moreover, it also matches both extensive and intensive margins of inheritances from grandparents.

Target	Source	Target/Data		Model	
Capital-output ratio	·	3.10		3.10	
Aggregate interest rate	·	7.00		7.00	
Share held by 95-99th percentile	SCF (2001)	0.25		0.28	
Share held by Top 1%	SCF (2001)	0.32		0.32	
Parent-child earnings correlation	Solon (1992)	0.40		0.40	
Earnings mean-median ratio	SCF (2001)	1.71		1.71	
Bequest-to-wealth ratio	SCF (2001)	1.10%		1.89%	
Estate tax revenues (as % of GDP)	Gale et al. (2001)	0.33%		0.37%	
% of estates that are subject to tax	Gale et al. (2001)	2.00%		2.20%	
		From Grandparents	Parents	From Grandparents	Parents
Flow of Transfers to under 30	SCF (1989 - 2019)	52%	48%	52%	48%
Sources of Transfers to under 30	SCF (1989 - 2019)	52%	48%	53%	47%

Note. Unless stated otherwise, parameters are reported at an annual frequency.

Table 10: Targeted Moments and Empirical Counterparts

Parameter	Value	Parameter	Value
Capital	310.0%	Tax revenues	
Government debt	55.0%	- Labour income	18.32%
		- Capital income	4.27%
Consumption	67.5%	- Estate	0.37%
Investment	14.5%	Pension System	
Government Consumption	18.0%	Contribution rate (in %)	7.65%

Note. All variables in % of GDP if not indicated otherwise.

Table 11: Macroeconomic Variables

Figure 4 presents the life-cycle earnings and wealth profiles in the baseline economy. The calibrated earnings process reasonably replicates the mean earnings profile over the life cycle until retirement age.[30]

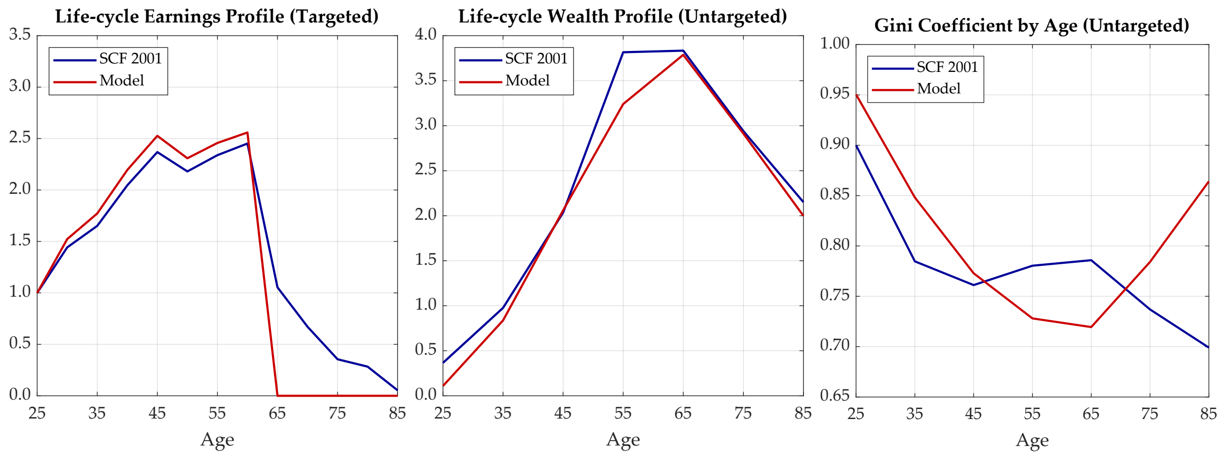

Figure 4: Life-cycle Earnings and Wealth Profile and Gini coefficient by Age

The average wealth by age aligns well with empirical data for younger and middle-aged households; it accurately reflects the hump-shaped profile and the gradual depletion of wealth by older households observed in empirical data.[31] The model also accurately reproduces the pronounced wealth inequality observed in early life stages, gradual decrease in wealth inequality towards the middle-age, but it exaggerates inequality among retirees. A possible explanation is that, in reality, some households continue to work and earn labour income, as shown on the left panel whereas, in the model, they rely solely on uniform social security transfers and previously accumulated wealth. The bequest motive could also contribute to the elevated inequality observed among older households.

Having calibrated a model economy to the broad characteristics of the U.S. economy from 1990-2000, next section describes the counterfactual policy experiment and presents the main result of this paper.

[30] Any discrepancy post age 65 is attributed to the mandatory retirement in the model.

[31] Note that the average wealth at age 55 in SCF (2001) is somewhat higher than in SCF (1998) or SCF (2004). This discrepancy may be due to sampling error in the survey data.

6 Results

In this section, I investigate the aggregate and distribution effects of changes in estate tax policy in the model, by adjusting the two estate tax parameters, namely the estate exemption threshold level, χ_b and the estate tax rate, τ_b.

$$T(b) = \max\{0, \tau_b(b - \chi_b)\}$$

Implementing estate tax reforms can take the form of adjusting the exemption threshold, the tax rate, or both. Yet, they affect households in different ways. For example, a relaxation of estate taxation through raising the threshold implies (i) estates previously subjected to tax are now exempt if they fall below the new threshold, and (ii) such estates incur less tax if they exceed the new threshold. That is, changes in the exemption level affect both the magnitude of taxable estates and the tax burden. On the other hand, reducing the tax rate only lessens the tax load for those households which were already in the tax net.

Counterfactual Policy Experiment This involves implementing government revenue-neutral estate tax reforms. Specifically, I vary χ_b and/or τ_b and simulate the model until it converges to a new stationary distribution to analyse the long run impact of changes in estate tax policy on wealth distribution. In doing so, the capital income tax is adjusted to restore government budget balance.

Table 12 shows the policy changes considered in this section. During the period 1990-2000, the average estate exemption threshold was $1 million (in 2019 values), the highest tax bracket threshold was $6.2 million, and the average effective estate tax rate was 18 percent.[32] By 2019, the exemption threshold had increased to $11.4 million, and the highest tax bracket threshold had doubled to $12.4 million, leading to a decrease in the effective tax rate to 16 percent. Since I abstract from the progressivity of estate taxes and that the calibrated tax parameters are close to the highest tax bracket threshold, I consider a main counterfactual scenario involving a 2 percentage-point decrease in the estate tax rate and a doubling of exemption threshold.

	Data			Model		
	1990-2000	2019		Baseline	Counterfactuals	
Estate Exemption Threshold	$1.04	$11.40	χ_b	$6.4	$12.9	$26.1
Highest Tax Bracket Threshold	$6.16	$12.40				
Effective Estate Tax Rate	18.2%	15.8%	τ_b	18%	16%	14%

Note. All numbers with $ are in 2019 US millions.
Source. Internal Revenue Service.

Table 12: Counterfactual Policy Experiments

[32] In practice, estate taxes are also progressive, hence the gap between the exemption threshold and the highest tax bracket threshold. During 1990-2000, the estate tax rates above the exemption level ranged from 18 percent to 55 percent.

Table 13 presents the aggregate and distributional effects of simultaneously relaxing estate tax policy in both dimensions. Panel *a* shows that these policy changes result in increased capital and output in the economy, which in turn, leads to raising wage w, and reducing the aggregate return component $\underline{r}$. Capital-output ratio increases and the bequest-to-wealth ratio increases as expected. Additionally, due to the decreased fraction of taxable estates and the resulting reduction in estate tax revenue caused by the increased exemption level, the capital income tax must increase to re-establish the government budget.

a. Aggregate Effects

	τ_b	χ_b	τ_a	K	Y	K/Y	B/W	r^*	$\underline{r}$	Frac.	Govnerment Revenue: Estate	Labour	Capital
*	0.18	\$ 6.4	10.60	7.656	2.470	3.100	1.89%	7.00	5.28	2.20%	0.37%	18.32%	4.27%
	0.16	\$12.9	10.94	7.748	2.480	3.124	1.93%	6.93	5.18	0.31%	0.21%	18.35%	4.36%
	0.14	\$26.1	10.90	7.840	2.491	3.148	1.95%	6.87	5.00	0.10%	0.16%	18.37%	4.29%

b. Distributional Effects

	τ_b	χ_b	Gini	Top 20%	Percentile (%): 90-95	95-99	99-99.9	99.9-100
*	0.18	\$ 6.4	0.8328	85.1	12.1	28.1	19.5	12.6
	0.16	\$12.9	0.8390	85.8	11.8	28.2	19.4	13.9
	0.14	\$26.1	0.8477	86.7	11.3	28.1	20.7	14.7

Note. All numbers with \$ are in US millions. Government revenues are as % of GDP.

Table 13: Aggregate and Distributional Effects of Relaxing Both χ_b and τ_b

In terms of the wealth distribution, it unambiguously amplifies the wealth concentration in the economy. The share held by the top 1 percent group increases by 1.2 percentage points (from 32.1 percent to 33.3 percent). In the data, the share held by the top 1 percent increased by 5 percentage points (See Table 1). This suggests that the model explains one-fourth of the observed increase in wealth concentration in the data. Aggregate Gini slightly increases from 0.833 to 0.839. As an additional exercise, I consider the scenario when the estate tax policy is further relaxed to an estate tax rate of 14 percent and an exemption level of \$26.1 million, the share held by the top 1 percent increases by an additional 2 percentage points, causing the aggregate Gini to increase to 0.848.

This finding is in stark contrast to De Nardi and Yang (2016), considering the magnitude of changes in estate tax policy. De Nardi and Yang (2016) found that the share held by the top 1 percent increased by 1.7 percentage points following the complete abolition of the estate tax (i.e., relaxing the estate tax rate from 21 percent to 0). The differences arise because the main driving forces are different in the two models. De Nardi and Yang (2016) use an earnings process that targets both earnings and wealth distribution, whereas in my model, earnings heterogeneity alone cannot generate such a high concentration of wealth. Hence, when return heterogeneity is employed to generate wealth inequality, the role of inheritance in wealth accumulation becomes crucial. The main result in this paper is also broadly consistent with

Nekoei and Seim (2023) in that, inheritances increase wealth inequality in the long run since the different deplation rates, arising from return heterogeneity, widen the inequality in inherited wealth over time.

For a more comprehensive understanding of how each tax parameter affects the economy differently, I revisit the counterfactual experiment by relaxing one component while keeping the other fixed at the benchmark.

Estate Tax Exemption Threshold Table 14 presents the aggregate and distributional effects of changes in exemption threshold level while holding estate tax rate fixed at the benchmark.

Panel *a* presents the aggregate effects of relaxing the exemption level. It substantially reduces the fraction of taxable estates. This allows relatively wealthier households to pass on more wealth to their offsprings, thereby increasing the bequest-to-wealth ratio slightly. This leads to higher capital and output in the economy, which in turn increase wages and put downward pressure on return to capital. While increased wage slightly raises government revenue from labour income, reduced government revenue from estate tax implies that the capital income tax has to rise to re-establish the government budget.

a.	Aggregate Effects										Govnerment Revenue		
	τ_b	χ_b	τ_a	K	Y	K/Y	B/W	r^*	$\underline{r}$	Frac.	Estate	Labour	Capital
$*$	0.18	\$ 6.4	10.60	7.656	2.470	3.100	1.89%	7.00	5.28	2.20%	0.37%	18.32%	4.27%
	0.18	\$12.9	11.08	7.702	2.475	3.112	1.92%	6.97	5.25	0.31%	0.20%	18.33%	4.43%
	0.18	\$26.1	11.10	7.764	2.482	3.128	1.94%	6.92	5.10	0.08%	0.16%	18.35%	4.41%

b. Distributional Effects					Percentile (%)			
	τ_b	χ_b	Gini	Top 20%	90-95	95-99	99-99.9	99.9-100
$*$	0.18	\$ 6.4	0.8328	85.1	12.1	28.1	19.5	12.6
	0.18	\$12.9	0.8348	85.4	12.0	28.9	19.7	12.1
	0.18	\$26.1	0.8425	86.2	11.7	28.8	21.3	12.2

Note. All numbers with \$ are in US millions. Government revenues are as % of GDP.

Table 14: Aggregate and Distributional Effects of Changing χ_b

Panel *b* presents the aggregate effects of increasing the exemption level. This change amplifies aggregate inequality; the Gini coefficient slightly increases from 0.833 to 0.835. However, the distributional effect is heterogeneous across different wealth groups. The share held by households in the 95-99 percentile increases, while the share held by the top 1 percent decreases. Relaxing the exemption level increases the share of wealth held by the marginal household group, who directly benefit from being fully exempt from taxes following the tax reform. On the other hand, households with wealth exceeding the new threshold even before the tax reform lose their share. Despite the reduced tax burden that may allow them to pass more wealth tax-free when the new policy is introduced, it is not sufficient for their heirs to accumulate wealth to the same extent as their ancestors in the long run due to the reduced interest rate and increased capital income tax.

Estate Tax Rate Next, Table 15 presents the aggregate and distributional effects of relaxing the estate tax rate while holding exemption threshold fixed at the benchmark.

Panel *a* presents the aggregate effects of relaxing the estate tax rate. Similar to the exemption level, this policy change leads to more capital and output in the economy, subsequently increasing equilibrium wages and reducing the interest rate. However, it does not affect the fraction of taxable estates since this policy change only targets households who were already subject to the estate tax. As a result, government estate tax revenue remains unaffected. In fact, the government accrues more taxes from wealthy households who benefit from the reduced estate tax rate and increase their wealth. Therefore, the capital income tax rate is reduced to balance the government budget.

a. Aggregate Effects											Govnerment Revenue		
	τ_b	χ_b	τ_a	K	Y	K/Y	B/W	r^*	$\underline{r}$	Frac.	Estate	Labour	Capital
*	0.18	\$ 6.4	10.60	7.656	2.470	3.100	1.89%	7.00	5.28	2.20%	0.37%	18.32%	4.27%
	0.16	\$ 6.4	10.52	7.714	2.476	3.115	1.91%	6.96	5.19	2.19%	0.36%	18.34%	4.21%
	0.14	\$ 6.4	10.48	7.761	2.482	3.127	1.92%	6.92	5.11	2.20%	0.34%	18.35%	4.17%

b. Distributional Effects						Percentile (%)			
	τ_b	χ_b	Gini	Top 20%	90-95	95-99	99-99.9	99.9-100
*	0.18	\$ 6.4	0.8328	85.1	12.1	28.1	19.5	12.6
	0.16	\$ 6.4	0.8376	85.6	11.8	27.6	19.2	14.3
	0.14	\$ 6.4	0.8422	86.0	11.6	27.2	19.1	15.9

Note. All numbers with \$ are in US millions. Government revenues are as % of GDP.

Table 15: Aggregate and Distributional Effects of Changing τ_b

Similarly, relaxing the estate tax rate amplifies the wealth inequality. The aggregate Gini coefficient increases from 0.833 to 0.838. Nevertheless, it affects the households in the opposite way. The share held by top 0.1% increases while all other groups' shares decline including households at 95-99.9 percentile. This is because for other groups, reduction in return to capital dominates the reduced capital income tax and estate tax rates in the long run.

In summary, relaxing estate tax policy leads to higher capital and output in the economy, but it also amplifies wealth concentration. However, several opposing effects are at play. For instance, relaxing the exemption level increases capital income tax, while relaxing the tax rate decreases capital income tax to restore government budget balance. In terms of wealth distribution, both tax parameters affect the household groups that directly benefit from the policy changes. Relaxing the exemption level increases the share held by the 95-99 percentile group, which benefits from being fully exempt from taxes, whereas relaxing the estate tax rate increases the share held by the top 1 percent, who were already subject to the tax. When both parameters are relaxed simultaneously, these offsetting effects from each dimension cancel out: the share held by the 95-99 percentile remains unaffected, while the wealth of the top 1 percent increases.

Inheritances & Return Heterogeneity How does inheritance interact with the return heterogeneity in the model? Recall that the return heterogeneity is modelled in a simplified way; both return and risk increase in the level of wealth, returns are persistent because wealth is. Specifically, households earn the first excess return if their wealth exceeds \$7.4 million and earn the second excess return if their wealth exceeds \$40 million.

In the model, agents enter the economy at age 25 with zero wealth, at which point they begin to supply labour, earn wages, pay taxes, consume and save. Table 16 shows that there is a very small but certainly positive mass of households that earn excess returns at age 30. However, the calibrated earnings process and the tax system in the model imply that it is impossible, in the absence of inheritances, for these newly entered households to accumulate sufficient wealth in just one model period to earn excess returns.[33] In the baseline, 0.076% and 0.0042% of age 30 households earn first and second excess returns respectively. Therefore, heirs from wealthy families start their lives at the top of the distribution and are likely to stay there, accumulating wealth faster than others by securing excess returns from the very beginning.[34]

			% Age 30 Households access to	
	χ_b	τ_b	1st Excess Return ($a \geq \$7.4$)	2nd Excess Return ($a \geq \$40$)
Baseline	\$ 6.4	0.18	0.076	0.0042
Δ both	\$12.9	0.16	0.093	0.0053
	\$26.1	0.14	0.102	0.0050
$\Delta\chi_b$	\$ 12.9	0.18	0.095	0.0041
	\$ 26.1	0.18	0.105	0.0042
$\Delta\tau_b$	\$ 6.4	0.16	0.077	0.0053
	\$ 6.4	0.14	0.078	0.0063

Table 16: Fraction of Age 30 Households Attaining Excess Returns

[33] The calibrated earnings process implies that agents can earn at most \$3.5 million (5-year) at entry by drawing the highest productivity state. They are subject to progressive labor income tax, social security payroll tax, and taxes on capital income if invested.

[34] Given the current demographic structure, there exist three possibilities: First, agents may inherit accidental bequests if his parents pass away prematurely. Second, they may receive bequests from affluent grandparents even if the parents survive. Lastly, some may inherit from both parents and grandparents.

Relaxing the estate tax slightly increases the proportion of age 30 households attaining excess returns. Increasing the thresholds raises the fraction of households attaining the first excess return at age 30, whereas decreasing the estate rate increases the fraction of households attaining the second excess return at age 30. This explains why the two tax reforms affect households at the top 0.1 percent and 95-99.9 percentile differently in the experiments.

G-G Link Finally, I investigate the extent to which the G-G link has any implications in the model by shutting down the G-G link, setting $\kappa = 1$ holding all else constant. That is, starting from the benchmark economy, I shut down the G-G link and simulate the model until it converges to a new stationary distribution. Table 17 presents the aggregate and distributional effects in the long run when households are allowed to pass on wealth only to their direct children in the model.

a.	Aggregate Effects									Govnerment Revenue		
	κ	τ_a	K	Y	K/Y	B/W	r^*	$\underline{r}$	Frac.	Estate	Labour	Capital
$*$	0.77	10.60	7.656	2.470	3.100	1.89%	7.00	5.28	2.20%	0.37%	18.32%	4.27%
	1.00	10.75	7.623	2.466	3.091	1.90%	7.02	5.40	2.14%	0.35%	18.31%	4.35%

b.	Distributional Effects							
					Percentile (%)			
	κ	Gini	Top 20%	90-95	95-99	99-99.9	99.9-100	
$*$	0.77	0.8329	85.1	11.8	28.1	19.5	12.6	
	1.00	0.8285	84.7	12.3	27.7	19.2	12.1	

Table 17: Steady-state with and without G-G Link

Eliminating the G-G link weakens wealth concentration, with the share held by the top 1 percent decreasing by 0.8 percentage points, and the share held by the 95-99 percentile dropping by 0.4 percentage points. This highlights the significance of the G-G link in wealth accumulation, particularly for those at the top of the distribution. Since these households are unable to accumulate as much wealth, both capital and output in the economy decrease and the aggregate return component, $\underline{r}$, increases from 5.28 percent to 5.40 percent to achieve equilibrium.

Table 18 compares Gini coefficients by age with and without the G-G link.[35] On average, it amplifies wealth inequality across all age groups, and this discrepancy tends to increase with age. This highlights that inequality induced by the G-G link persists throughout the life-cycle. There is a noticeable difference in inequality within age 30 households compared to age 35 and 40. The discrepancy starts to get larger in middle-age at 50-55 as households receive second inheritances from parents. From retirement onward, the gap continues to widen due to mandatory retirement, uniform social security benefits, and return heterogeneity: house-

[35] The data Gini for age 25 is calculated using date from households aged between 23 and 27 in SCF. The model Gini is computed based on households' beginning-of-period wealth. Since households begin with zero wealth, Gini at age 25 in the model is effectively 0.

holds who accumulated sufficient wealth continue to earn excess returns while others rely on common social security benefits.

Age	Data	Model With G-G Link	Model Without G-G Link	Δ
25	0.976	n/a	n/a	n/a
30	0.760	0.898	0.895	0.0034
35	0.795	0.850	0.849	0.0003
40	0.763	0.836	0.836	0.0005
45	0.756	0.795	0.793	0.0017
50	0.777	0.748	0.744	0.0038
55	0.764	0.734	0.727	0.0065
60	0.797	0.721	0.710	0.0112
65	0.755	0.707	0.697	0.0103
70	0.785	0.734	0.722	0.0121
75	0.710	0.767	0.753	0.0139
80	0.776	0.809	0.792	0.0172
85	0.685	0.864	0.840	0.0246
Aggregate	0.805	0.833	0.829	0.004

Table 18: Gini coefficient by age in model with and without G-G Link

Table 19 explains the noticeable difference in inequality within age 30 households compared to age 35 and 40. It is clear that shutting down the G-G link reduces slightly the fraction of households attaining excess returns at age 30 compared to the model with the G-G link. In particular, it reduces share of households attaining the second excess return more than the share attaining the first excess return.[36] While applying the same estate tax reforms increase these fractions, they do not increase as much compared to the model with the G-G link.

			With G-G Link		Without G-G Link	
			% Age 30 Households access to		% Age 30 Households access to	
	χ_b	τ_b	1st Excess Return ($a \geq \$7.4$)	2nd Excess Return ($a \geq \$40$)	1st Excess Return ($a \geq \$7.4$)	2nd Excess Return ($a \geq \$40$)
Benchmark	\$ 6.4	0.18	0.076	0.0042	0.066	0.0027
Δ both	\$12.9	0.16	0.093	0.0053	0.084	0.0029
	\$26.1	0.14	0.102	0.0050	0.088	0.0033

Table 19: Fraction of Age 30 Households Attaining Excess Returns without G-G Link

Finally, Table 20 compares the distributional effects of changes in estate taxes with and without the G-G link. Following the same estate tax reforms, the increase in the aggregate Gini coefficient (compared to their respective benchmarks) is relatively consistent between the two scenarios. However, the increase in wealth concentration is more pronounced in the model with the G-G link. For instance, when applying estate tax reforms that mimic the actual changes between 2000 and 2019, the share held by the top 1 percent increases by 1.2 percent-

[36]It is worthnoting that they are still positive due to accidental bequests from parents.

age points when the G-G link is active, while it increases by 0.6 percentage points when the G-G link is absent. Further relaxation of estate taxes also results in a more substantial increase in the top 1 percent's wealth holding when the G-G link is active (3.28 percentage points vs. 2.88 percentage points). I conclude that the G-G link tends to amplify the qualitative effects of estate tax reforms, though the quantitative magnitude remains modest.

Distributional Effects			With G-G Link				Without G-G Link			
	χ_b	τ_b	Gini	95-99	99-99.9	99.9-100	Gini	95-99	99-99.9	99.9-100
Benchmark	\$ 6.4	0.18	0.833	28.1	19.5	12.6	0.829	27.7	19.2	12.1
	\$ 12.9	0.16	0.839 (+0.006)	28.2 (+0.10)	19.4 (−0.10)	13.9 (+1.31)	0.835 (+0.006)	28.5 (+0.77)	19.3 (+0.15)	12.6 (+0.43)
	\$ 26.1	0.14	0.848 (+0.015)	28.1 (+0.00)	20.7 (+1.28)	14.7 (+2.09)	0.844 (+0.015)	28.2 (+0.46)	20.5 (+1.33)	13.7 (+1.55)

Note. Values in parentheses represent changes relative to the benchmark.

Table 20: Distributional Effects in model with and without G-G Link

This is not surprising because when the G-G link is active, wealthy households at the final period can split their wealth between children and grandchildren, in which case separate estate taxes apply to each transfer. Hence, when estate taxes are relaxed, such relaxation applies separately to inheritances given to children and grandchildren, amplifying the effects of estate tax reforms.

7 Concluding Remarks

In this paper, I investigate the long-term aggregate and distributional implications of the recent relaxation in estate taxes in the U.S. Empirical evidence suggests that, for younger households, the link between households and their grandparents is particularly strong, with the size of inheritances from grandparents being significant and even larger than those from parents. As well, wealthy households tend to have portfolios that lean more towards assets with high returns. Motivated by these, I develop a general equilibrium life-cycle model that features heterogeneities in earnings, rates-of-returns and bequests.

Counterfactual experiments demonstrate that relaxing estate taxes increases wealth concentration. In the model, inheritances play a significant role in shaping wealth concentration. Households from wealthy families not only inherit substantial wealth but also benefit from higher returns on the inherited wealth. This allows them to accumulate wealth more rapidly than others from the beginning. Furthermore, I find that shutting the G-G link leads to lower capital and output and weakens wealth concentration at the top of the distribution.These findings highlight the importance of investigating the potential significance of the G-G link in shaping wealth accumulation dynamics and its broader implications, emphasising the need for further research in this area.

While the presented model fits key characteristics of the U.S. quite well, there are several dimensions in which it can be further improved and expanded. Firstly, the estate tax is represented in the model using a simple piece-wise linear function. Given that detailed estate tax schedules are readily available, incorporating the actual progressive estate tax schedules, would significantly enhance the precision and depth of the quantitative analysis presented in this study.

Second, I abstract from labour supply distortions resulting from inheritances and estate tax reforms. Furthermore, I introduced return heterogeneity such that households who inherit larger wealth are entitled to earn a higher return on inherited wealth. While this specification captures the strong relationship between household's overall wealth and return characteristics in a simplified way, endogenising these aspects could be potentially important and valuable extensions to the existing literature. Furthermore, I assume there is only one period of overlap between grandparents and children in the model due to computational limitations, whereas the relationship remains quite strong until age 40 in the data. Hence, the present model may fail to fully capture the effects arising from this channel. It would be necessary to have multiple periods of overlap between grandparents and child to explore this link more precisely.

Finally, the current study focuses on steady state analysis and only looks at the aggregate and distribution effects of estate tax reforms. It would be interesting to study transition dynamics, welfare implications and the optimal estate tax policy in the future.

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A Appendix

A.1 Estate Tax Policy in the United States

Indeed, estate taxation in the U.S. has undergone various reforms depending on the political party in power at the time, with many of these reforms being amended by succeeding administrations. Major legislative reforms include Economic Growth and Tax Relief Reconciliation Act of 2001 and Jobs and Growth Tax Relief Reconciliation Act of 2003 during the Bush Administration, Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010 and American Taxpayer Relief Act of 2012 during the Obama Administration and most recently, Tax Cuts and Jobs Act 2017 during the Trump Administration that increased the exemption threshold to over $11 million. Following table shows the evolution of federal estate tax policy in the U.S. since 1989.

Year	Tax Rate Range	Exemption Threshold	Exemption Threshold (2019 USD)	Highest Bracket Threshold	Highest Bracket Threshold (2019 USD)	Effective Estate Tax Rate
1989	(18 - 55)	0.600	1.197	3.600	7.185	0.180
1992	(18 - 55)	0.600	1.074	3.600	6.445	0.177
1995	(18 - 55)	0.600	1.002	3.600	6.013	0.179
1998	(18 - 55)	0.625	0.982	3.625	5.695	0.190
2001	(18 - 55)	0.675	0.977	3.675	5.318	0.181
2004	(18 - 48)	1.500	2.035	3.500	4.748	0.205
2007	(18 - 45)	2.000	4.180	4.000	4.943	0.199
2009	(18 - 45)	3.500	5.694	5.500	6.568	0.186
2011	(18 - 35)	5.000	5.876	5.500	6.263	0.142
2013	(18 - 40)	5.250	5.769	6.250	6.868	0.171
2016	(18 - 40)	5.450	5.805	6.450	6.870	0.173
2019	(18 - 40)	11.400	11.400	12.400	12.400	0.158

Note. All values with $ are in US millions.
Source. Internal Revenue Service.

Evolution of Federal Estate Tax Policy in the U.S.

A.1.1 Inheritance/Estate Tax at the State Level

While they are often used interchangeably in the literature, inheritance tax and estate tax are different in practice. The estate tax applies to the decedent's estate, while the inheritance tax applies to the beneficiaries who inherit the assets. As of 2022, there are 12 states[37] and the District of Columbia that impose estate taxes at the state level and 6 states[38] impose inheritance taxes at the state level. Maryland is unique in having both of these taxes, and the specific rules and exemptions can vary depending on the relationship between the decedent and the beneficiary.

[37] These include Connecticut, Hawaii, Illinois, Maine, Maryland, Massachusetts, Minnesota, New York, Oregon, Rhode Island, Vermont and Washington

[38] These include Iowa, Kentucky, Maryland, Nebraska, New Jersey and Pennsylvania.

A.2 Data: Suvey of Consumer Finances

A.2.1 Evolution of Wealth Inequality in the U.S.

Following table shows the recent trends in the wealth inequality in the U.S based on household net worth in SCF. There has been a marked increase in overall inequality with only the wealthiest 5 percent groups have seen their shares of wealth increase.

Year	Gini	HH in Wealth Quintiles					The Wealth-Rich		
		1st	2nd	3rd	4th	5th	90-95%	95-99%	Top 1%
1989	0.790	-0.2	1.2	5.2	13.0	80.7	12.9	24.3	29.9
1992	0.786	-0.2	1.5	5.4	13.2	80.1	12.6	24.3	30.1
1995	0.791	-0.2	1.6	5.5	12.5	80.6	11.8	21.2	34.8
1998	0.800	-0.3	1.4	5.1	12.4	81.4	11.4	23.3	33.8
2001	0.805	-0.1	1.2	4.5	11.8	82.5	12.2	25.1	32.2
2004	0.809	-0.2	1.1	4.4	11.8	82.9	12.0	24.2	33.2
2007	0.816	-0.2	1.1	4.5	11.2	83.4	11.1	26.7	33.6
2010	0.846	-0.7	0.7	3.3	9.9	86.7	13.5	26.8	34.1
2013	0.850	-0.7	0.6	3.2	9.8	87.0	12.1	27.3	35.5
2016	0.860	-0.5	0.6	2.9	8.6	88.3	11.9	26.5	38.5
2019	0.852	-0.5	0.8	3.4	9.0	87.4	11.5	27.7	37.2

Evolution of Wealth Inequality in the U.S., SCF (1989 - 2019)

A.2.2 Intergenerational Transfers

The SCF includes a distinct section on inheritance status and preferences, making it particularly valuable for studying the characteristics of heirs and the size and sources of transfers. I leverage responses to following questions from 1989 to 2019 to motivate my current research.

SCF Code	Questions
x5801	Have you ever received an inheritance, or been given substantial assets?
x5803	Was that an inheritance, a trust or something else?
x5804	What was its approximate value at the time it was received?
x5805	In what year was it received?
x5806	From whom was it received?
x5819	Do you expect to receive a substantial inheritance or transfer of assets in the future?

List of Questions in Section X, SCF (1989 - 2019)

A.2.3 Return Heterogeneity

While it may not offer the extensive details present in the Swedish and Norwegian administrative data, several prior studies such as Fagereng et al. (2016), Xavier (2021) and Kartashova and Zhou (2021), employ SCF data to demonstrate that a similar pattern eists in the U.S. In this work, I generally adhere to the methodologies employed by these studies.

Defining Returns to Net worth. Let $a_{i,j,t}$ and $d_{i,k,t}$ denote the value of asset j and the value of debt k held by household (or household group) i at the beginning of period t. Given J assets and K debt categories, the household (or household group) i's net worth is given by

$$w_{i,t} = \sum_{j=1}^{J} a_{i,j,t} - \sum_{k=1}^{K} d_{i,k,t}$$

Let $r^A_{i,j,t}$ and $r^D_{i,j,t}$ denote the average return on asset j and debt k earned (or paid) by the household (or group) i respectively. Then the return on net worth $r_{i,t}$ is then computed as the weighted average of the returns on individual wealth components,

$$r_{i,t} = \sum_{j=1}^{J} \omega^A_{i,j,t} \times r^A_{i,j,t} - \sum_{k=1}^{K} \omega^D_{i,k,t} \times r^D_{i,k,t}$$

where the weights are given by the share of net worth invested in an asset or debt category.

Due to its non-panel structure, this methodology requires two consecutive SCF datasets for each period. For example, the SCF 2016 and SCF 2019 are utilised to compute the average return over the 2017-2019 period. Consequently, I use eight sets of SCF data, spanning from 1998 to 2019, to calculate average returns for intervals ranging from 1999-2001 to 2017-2019.

Measuring weights. First, I define Households' assets into 6 categories: (i) interest-earnings asset, (ii) public equity (iii) other financial assets (iv) Real estate, (v) Private Business and (vi) other non-financial assets. For debts, I follow pre-defined categories by the SCF: (i) debt secured by primary residences, (ii) debt secured by other real estates (iii) other lines of credit, (iv) credit card debt (v) instalment loans (including education loans and vehicle loans) and (vi) other debt. Next, for each SCF dataset, households are grouped into 6 wealth bins: 0-50, 50-90, 90-95, 95-99, 99-99.9 and 99.9-100 percentiles.

For each SCF dataset and for each wealth group, I aggregate the values of each asset and each debt and divide by the aggregated value of net worth. Then the portfolio shares of each wealth group for a given time period, is simply the average of the values obtained from two consecutive SCF surveys. Table 5 shows the average portfolio shares across different wealth group over the sample period 1998-2019. It is evident that while real estate comprises the majority of net worth for most of the population, households at the top of the distribution hold a greater proportion of private and public equities.

Measuring returns. The return on any asset j is defined as the sum of yield component and capital gain component.

$$r_{i,j,t} = y^*_{i,j,t} + g_{i,j,t}$$

where the yield component is computed as,

$$y^*_{i,j,t} = \left(1 + \frac{y_{i,j,t}}{a_{i,j,t} + 0.5\left(a_{i,j,t+3} - a_{i,j,t} - \tilde{y}_{i,j,t}\right)}\right)^{\frac{1}{3}} - 1$$

following Fagereng et al. (2016) and Kartashova and Zhou (2021). Here, $a_{i,j,t}$ and $a_{i,j,t+3}$ are the reported market values of an asset (or debt) in two consecutive surveys and $y_{i,j,t}$ in the numerator is the total flow income (payment) generated over 3 years. The denominator takes into account potential net flows invested between t and $t+3$. Note that $y_{i,j,t}$ and $\tilde{y}_{i,j,t}$ are specific to the asset type.

For the capital gains component, I infer their changes based on the growth rates of their aggregate counterparts. Following external data series are used to compute capital gains component when calibrating the excess return schedules.

Data Series (FRED code)	Source
Financial assets	
Personal interest income (PII)	BEA
Personal dividend income (PDI)	BEA
Wilshire 5000 Total Market Index (WILL5000IND)	Wilshire Associates
Non-financial assets	
Imputed Rental of Owner-occupied housing (A2013C1A027NBEA)	BEA
Personal rental income (RENTIN)	BEA
Corporate Profits After Tax (without IVA and CCAdj) (CP)	BEA
Net profit of nonfarm proprietorships and partnerships (B1207C1A027NBEA)	BEA
Commercial Property Return Index (CPRI)	Green Street
Households and Nonprofit Organisations;	
Owner-Occupied Real Estate (inc. vacant land and mobile homes) (HOOREVLMHMV)	Financial Accounts
Real Estate at Market Value (HNOREMV)	Financial Accounts
Corporate Equities; Asset, Market value Levels (HNOCEA)	Financial Accounts
Proprietors' Equity in Noncorporate Business (ENBABSHNO)	Financial Accounts
Debts	
Households and Nonprofit Organisations;	
One-to-Four-Family Residential Mortgages (HMLBSHNO)	Financial Accounts
Consumer Credit (CCLBSHNO)	Financial Accounts

List of External Data Series

Interest-earning assets. This includes all types of transaction account (liquid assets), certificate of deposit, directly and indirectly held bonds, cash value of whole life insurance and other interest-earning assets invested through annuities and trusts. The income flow generated from these assets is the total interest income reported by households. In the SCF 2019, households report annual interest income earned for 2018. Following Kartashova and Zhou (2021), I use growth rates of interest income from the Bureau of Economic Analysis (BEA) to obtain annual interest income earned in 2017 and 2019 and sum all to obtain $y_{i,j,t}$ over 2017-2019. As in Fagereng et al. (2020) and Kartashova and Zhou (2021), all interest incomes are capitalised into $a_{i,j,t+3}$ and no capital gains for interest-earning assets hence, $\tilde{y} = y_{i,j,t}$.

Public equities. Public equities are directly and indirectly held stocks including stocks invested through annuities and trusts. The income flow generated from public equities is the total dividend income reported by households. Similar to the interest incomes, I use the growth rates of dividend income from the BEA to obtain total flow dividend income over 2017-2019. I use Wilshire 5000 Total Market Index to obtain the capital gains component of public equities. Following Kartashova and Zhou (2021), I assume dividend income and capital gains are capitalised into $a_{i,j,t+3}$, hence $\tilde{y}_{i,j,t} = y_{i,j,t} + g_{i,j,t}a_{i,j,t}$.

Other financial assets. Other financial assets is computed as the total financial assets minus the interest-earning assets and public equity. I assume no income is generated from these assets.

Real estate. This category includes primary residence, other residential properties, and net equity in non-residential real estates. Since the yield on primary residence is unobserved, I use aggregate counterparts to compute the yield on primary residences. I divide imputed rental of owner-occupied housing by the market value of owner-occupied real estates to compute the annual yield on primary residences. Following Kartashova and Zhou (2021), I subtract the annual depreciation rate of 2.3% (estimated by the BEA) and the average effective property tax rate 1.03%. For non-primary residential properties, I use the annual rent income reported in SCF by households. Since the rent income collected by the SCF include rent income plus other incomes from trusts or royalties, I condition on households who own non-primary residential properties (but not the commercial properties and/or any other miscellaneous assets such as royalties) to isolate the rent income. As before, I use growth rates of rent income to obtain $y_{i,j,t}$. For this asset, $\tilde{y}_{i,j,t} = (g_{i,j,t} - 3\delta^R)a_{i,j,t}$ where $\delta^R = 3.64\%$ is the annual depreciation of residential rental properties. As before, I further subtract the average effective property tax rate of 1.03%. Finally, I use the commercial property return index (CPRI) from the Green Street as the return on non-residential real estate as in Kartashova and Zhou (2021).

Private Business. This includes the share of net equity in the non-publicly traded businesses owned reported by households. This can be sub-divided into two: corporate equities (S and C corporations) and non-corporate equities (proprietorships and partnerships). I follow Moskowitz and Vissing-Jørgensen (2002) and Kartashova (2014) to compute the yield component. From the reported net business income, I adjust for corporate taxes (30% for C corporations and 0% for S-corporations and non-corporate businesses) and retained earnings (40% for C-corporations and 20% for S-Corporations and non-corporate businesses). In order to account for labour incomes of entrepreneurs who actively manage the business but report no salary, I regress the wage rate of households (who actively manage and report salary) on households' age, gender, education, working hours and size of business to impute the labour income of these households. As before, I use growth rates of corporate profit and non-corporate profit to obtain $y_{i,j,t}$ over 2017-2019 and I assume $\tilde{y}_{i,j,t} = g_{i,j,t}$ to compute the return on each type of business.

Other non-financial assets. Other non-financial assets is computed as the total non-financial assets minus the private businesses and real estates. I assume constant return at 2% as in Kartashova and Zhou (2021) over the sample period.

Debt. The income flow (i.e. payments) generated from each debt category is computed as the reported annual interest rate multiplied by the total amount owed. If households report multiple loans within each debt component, I used geometric average of the interest rates reported. Once the interest payments are obtained, I use growth rates of mortgages (if secured by residential properties) and consumer credits (for other types of debt) to obtain $y_{i,j,t}$ and set $\tilde{y}_{i,j,t} = y_{i,j,t}$ to compute the return on each debt category.

Having the portfolio shares and the average returns for each wealth component for each episode, I calculate the portfolio-weighted average wealth returns of households across different wealth groups for each episode from 1991-2001 to 2017-2019. I then further average over the entire sample period to characterise the return heterogeneity. It is evident that both returns, and standard deviations generally exhibit an increasing trend with overall wealth, which is broadly consistent with findings from Bach et al. (2020) and Fagereng et al. (2020).

	Percentile (%)					
	0-50	50-90	90-95	95-99	99-99.9	99.9-100
1991 - 2001	0.07	0.08	0.10	0.09	0.09	0.08
	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)	(0.06)
2002 - 2004	0.08	0.08	0.07	0.08	0.10	0.11
	(0.00)	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)
2005 - 2007	0.00	0.07	0.09	0.13	0.16	0.18
	(0.01)	(0.01)	(0.02)	(0.04)	(0.07)	(0.10)
2008 - 2010	-0.48	-0.08	-0.05	-0.04	-0.04	-0.03
	(0.01)	(0.01)	(0.02)	(0.03)	(0.05)	(0.08)
2011 - 2013	-0.10	0.05	0.07	0.10	0.13	0.15
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)
2014 - 2016	0.12	0.08	0.09	0.11	0.11	0.14
	(0.01)	(0.01)	(0.01)	(0.03)	(0.04)	(0.06)
2017 - 2019	0.04	0.07	0.09	0.11	0.12	0.13
	(0.01)	(0.02)	(0.03)	(0.06)	(0.09)	(0.14)
Average	-0.04	0.05	0.06	0.08	0.10	0.11
	(0.01)	(0.01)	(0.02)	(0.03)	(0.05)	(0.07)

Note. Values in parentheses indicate standard deviations.

Heterogeneity in Returns across Different Wealth Groups and Episodes

A.3 A Three-Period Framework (Continued)

Middle-aged Now consider the optimal choice during the second period. The value function of a middle-aged household is given by:

$$v(2,a) = \max_{c,a'} \left\{ u(c) + \beta \cdot v\left(3, a' + \frac{b_p}{1+n}\right) \right\}$$
$$s.t.\ c + a' = w_2 + (1+r)a$$

where w_2 is the endowment they receive in second period and let $x = w_2 + (1+r)a$ be the cash on hand. He takes into account that his parents (who is currently old) will leave some bequests (denoted as b_p) when making optimal decision today.
Using backward induction, I derive middle-aged agent's policy functions as:

$$a' = \frac{1}{1+\beta^*}\left[\beta^* x - \left(\frac{b_p}{1+n} + \frac{1}{1+r}\frac{\Omega\phi_2}{\Omega\tilde{\kappa}}\right)\right]$$

where $\beta^* = \beta(1 + (\tilde{\kappa}\Omega)^{-1})$. It is clear from the policy functions that b_p decreases saving by middle-aged. As the bequest from parents serves as an additional income to finance consumption during the retirement, the larger the amount of bequest the lesser the incentives to save during middle-aged.

Young Finally, the young agent who enters the economy with zero wealth faces,

$$v(1,a,a_p,a_g) = \max_{c,a'} \left\{ u(c) + \beta \cdot v\left(2, a' + \frac{b_{gp}}{(1+n)^2}\right) \right\}$$
$$s.t. \quad c + a' = w_1$$

Similar to the middle-aged, the agent receive an endowment w_1 and considers the bequests from grandparents (denoted as b_{gp}) when making decision. Again, using backward induction, I obtain the following policy function:

$$a' = \frac{1}{1+\hat{\beta}}\left[\hat{\beta} w_1 - \left(\frac{b_{gp}}{(1+n)^2} + \frac{1}{1+r}\left(w_2 + \frac{b_p}{1+n} + \frac{1}{(1+r)}\frac{\Omega\phi_2}{\Omega\tilde{\kappa}}\right)\right)\right]$$

where $\hat{\beta} = \beta(1+\beta^*)$ for notational simplicity. From the policy function above, we see that both b_p and b_{gp} decrease the saving by young individuals.

$$\frac{\partial a'(1,a)}{\partial b_{gp}} = -\frac{1}{1+\hat{\beta}}\frac{1}{(1+n)^2} < 0, \qquad \frac{\partial a'(1,a)}{\partial b_p} = -\frac{1}{(1+r)(1+\hat{\beta})}\frac{1}{1+n} < 0$$

Note that the negative effect on current saving is larger for b_{gp} as long as $r > n$. This is intuitive as the individual has to wait one more period to receive estate from parents whereas bequest from grandparents is received immediately in the following period. However, the sign of the effect changes when the agent becomes middle-aged. Although he/she may save less when young, the fact that they receive inheritance from grandparents implies they will have larger wealth in the beginning of middle-aged x'_m, that is given by:

$$\begin{aligned} x'_m &= (1+r)\left(a_y + \frac{b_g}{(1+n)^2}\right) \\ &= \frac{1}{1+\hat{\beta}}\left[(1+r)\,\hat{\beta}\left(w_1 + \frac{b_g}{(1+n)^2}\right) - \left(w_2 + \frac{b'_p}{1+n} + \frac{1}{(1+r)}\frac{\Omega\phi_2}{\Omega\tilde{\kappa}}\right)\right] \end{aligned}$$

where now there is a positive accumulated effect of bequests from grandparents.

$$\begin{aligned} \frac{\partial x'_m}{\partial b_g} &= (1+r)\left(\frac{\partial a'_y}{\partial b_g} + \frac{1}{(1+n)^2}\right) \\ &= (1+r)\left(\frac{1}{(1+n)^2}\left(\frac{\hat{\beta}}{1+\hat{\beta}}\right)\right) > 0 \end{aligned}$$

With increased beginning-of-period wealth x'_m, he can save more in the middle-aged as well.

$$a'_m = \frac{1}{1+\beta^*}\left[\beta^* x'_m - \left(\frac{b'_p}{1+n} + \frac{1}{1+r}\frac{\Omega\phi_2}{\Omega\tilde{\kappa}}\right)\right]$$

The above simple exercise suggests that the timing of inheritance can play role in determining the inequality and the impact can even be more prominent if there are more heterogeneities such as in earnings and rate-of-returns. This is in line with the notion that early inheritances alleviate financial situations of borrowing-constrained young households, it enables them make investments or take other financial risks that could potentially lead to a greater accumulation of wealth over time.

A.4 Calibration of Earnings Process

In the model, households in working stage supply one unit of labour inelastically and earn labour income which is given by:

$$\log e(j, z) = z + \epsilon_j$$

where z is the idiosyncratic stochastic component that follows an AR(1) process and ϵ_j is the deterministic age-efficiency profile.

I calibrate model earnings process à la Kindermann and Krueger (2021). Specifically, the stochastic component z is approximated by a 4-state Markov Chain where I use Tauchen (1986) to obtain the first 3 states and 3×3 transition probabilities for the lowest 3 states. Then I calibrate remaining parameters to match earnings concentration observed in the data. In doing so, I differ from the usual *"super star"* process in that, I only use information from the empirical earnings distribution and I do not target wealth distribution.

Since the model features (imperfect) transmission of productivity from parents to child as in De Nardi and Yang (2016), the stationary initial distribution of age-1 households μ_1 is obtained from:

$$\mu_1 = Q_h' \cdot (Q_z')^7 \mu_1$$

where Q_z is the productivity transition matrix and Q_h is the productivity transmission matrix that captures transmission of productivity from age 55 parents to age 25 children at entry. I make the following zero restrictions to reduce parameter space.

- Equal probabilities from lowest 2 states (i.e., z_1 and z_2) to the highest (i.e., z_4).
- No direct transition is possible from the highest to the lowest (i.e., $\pi_{z,41} = 0$).
- If parents are at any of first 3 states, child cannot be at the highest state at entry.
- If parents are at the highest at age 55, child cannot be at the lowest at entry.

The following Q_z matrix shows the zero restrictions and probabilities to be calibrated.

$$Q_z = \begin{bmatrix} \pi_{z,11}(1 - \tilde{\pi}_{z,14}) & \pi_{z,12}(1 - \tilde{\pi}_{z,14}) & \pi_{z,13}(1 - \tilde{\pi}_{z,14}) & \tilde{\pi}_{z,\cdot 4} \\ \vdots & \ddots & \vdots & \tilde{\pi}_{z,\cdot 4} \\ \pi_{z,31}(1 - \tilde{\pi}_{z,34}) & \cdots & \pi_{z,33}(1 - \tilde{\pi}_{z,34}) & \tilde{\pi}_{z,34} \\ 0 & * & \tilde{\pi}_{z,43} & \tilde{\pi}_{z,44} \end{bmatrix}$$

where $\tilde{\pi}$ are to be calibrated and π (without tilde) are pre-allocated from Tauchen (1986).

Similarly, below Q_h shows the parameters to be calibrated and zero restrictions imposed.

$$Q_h = \begin{bmatrix} \tilde{\pi}_{h,11} & \tilde{\pi}_{h,12} & * & 0 \\ \tilde{\pi}_{h,21} & \tilde{\pi}_{h,22} & * & 0 \\ \tilde{\pi}_{h,31} & \tilde{\pi}_{h,32} & * & 0 \\ 0 & * & \tilde{\pi}_{h,34} & \tilde{\pi}_{h,44} \end{bmatrix}$$

In total, there are 13 parameters (including $\tilde{z}_4$) to be calibrated. I use the following,

- 10 points on the Earnings Lorenz Curve (from SCF 2001)
- Earnings Gini coefficient (from SCF 2001)
- Earnings mean-median ratio (from SCF 2001)
- Earnings correlation between parents and child (from De Nardi and Yang (2016))

Finding a set of parameters that minimises the sum of squared residual gives:

$$z = \begin{bmatrix} 0.3923 & 1.0000 & 2.5492 & 23.3975 \end{bmatrix}$$

and the implied stationary initial distribution at age-1 is $\mu_1 = [34.48\%,\ 5.51\%,\ 59.62\%,\ 0.39\%]$.[39]

Resulting matrix Q_z suggests that productivity is reasonably persistent over 5-year period and earnings mean-to-median ratio equals its target at 1.71. Q_h implies earnings correlation between parents and child in the model equals its target at 0.4.

$$Q_z = \begin{bmatrix} 0.7230 & 0.2636 & 0.0105 & 0.0029 \\ 0.1959 & 0.6053 & 0.1959 & 0.0029 \\ 0.0103 & 0.2584 & 0.7086 & 0.0228 \\ 0.0000 & 0.1283 & 0.2201 & 0.6516 \end{bmatrix}, \quad Q_h = \begin{bmatrix} 0.6481 & 0.0424 & 0.3095 & 0.0000 \\ 0.3962 & 0.0273 & 0.5765 & 0.0000 \\ 0.0380 & 0.0905 & 0.8715 & 0.0000 \\ 0.0000 & 0.1892 & 0.6614 & 0.1495 \end{bmatrix}$$

I use mean earnings for households age between 25 to 60 from the SCF (2001) as the deterministic age-efficiency profile.[40] I then normalise the age-efficiency profile such that the average earnings (before tax) at age-1 households equal to 1. Therefore, 1 unit in the model corresponds to 5-year average earnings of households at age 25, $\$53,488 \times 5 = \$267,440$ in 2019 US dollars based on SCF (2001).

[39]Note that $\mu_{j+1} = Q_z' \cdot \mu_j$ for $j \to j = J_r - 1$ are now stationary given μ_1.

[40]Since the mandatory retirement in the model starts is 65, I set $\epsilon_j = 0$ for $j \geq J_r$.

A.5 Calibration of Return Heterogeneity

I assume return heterogeneity is characterised by a step function. For individual i with asset holding a_i,

$$1 + r_i = \begin{cases} 1 + \underline{r} & \text{if } a_i < \underline{a}_1 \\ 1 + \underline{r} + r_1^X + \sigma_1^X \cdot \eta & \text{if } \underline{a}_1 \leq a_i < \underline{a}_2 \\ 1 + \underline{r} + r_2^X + \sigma_2^X \cdot \eta & \text{if } \underline{a}_2 \leq a_i \end{cases}$$

where the *i.i.d.* standard normal idiosyncratic shock η takes the values of $[-1, 0, 1]$ with probabilities [0.3085, 0.3829, 0.3085].

There are 6 parameters to be calibrated, $\{r_1^X, r_2^X, \sigma_1^X, \sigma_2^X, \underline{a}_1, \underline{a}_2\}$. To reduce the dimension of parameter space for internal calibration, I fix the first 4 parameters, excess returns and standard deviations based on Table 7.

Wealth Percentile	0 - 50	50 - 90	90 - 95	95 - 99	99 - 99.9	99.9 - 100
Average Return	-0.04	0.05	0.06	0.08	0.10	0.11
Std. Dev	(0.01)	(0.01)	(0.02)	(0.03)	(0.05)	(0.07)
Average Return	0.022		0.073		0.097	
Std. Dev	(0.000)		(0.023)		(0.051)	
$r =$	$\underline{r}$		$\underline{r} + 0.051 + 0.023\eta$		$\underline{r} + 0.075 + 0.051\eta$	

Heterogeneity in Returns across Different Wealth Group, SCF (1998 - 2019)

First, I further reduce the wealth bins into 3, by taking weighted average of the two groups. Then, treating the low group's return as $\underline{r}$, compute the excess returns that the middle and high group earn relative to the lowest group by taking the difference. Consequently, I set $\{r_1^X, r_2^X\} = \{0.051, 0.071\}$ and $\{\sigma_1^X, \sigma_2^X\} = \{0.023, 0.051\}$ respectively. Remaining two threshold parameters $\{\underline{a}_1, \underline{a}_2\}$ are internally calibrated to match the concentration at the top of distribution.

A.6 Computation Details

The stationary equilibrium for the baseline economy is computed using constant real interest rate and capital income tax rate. I start first by guessing the capital income tax rate and compute the optimal policy and value functions for the last period $j = J$, then solve the household problems at earlier ages using the method of endogenous grid and backward induction.

In order to simulate the economy to achieve convergence, one needs to construct a transition matrix of the aggregate economy which in principle, should incorporate transitions of age, asset, productivity, idiosyncratic shocks as well as how agents' parents states evolve. Constructing a single massive transition matrix to find stationary distribution using eigenvalues methods is very computationally costly and slow. Instead, I construct age-dependent transition matrices $\Pi_{j,j+1}$ such that:

$$\mu_{j+1} = \Pi_{j,j+1}\mu_j$$

using the households' policy functions, Markov Chain transition matrix and probabilities for *i.i.d.* standard normal idiosyncratic shocks. For instance, retirees' states include (a, η) so that

$$\dim\left(\Pi_{j,j+1}\right) = (na \times n\eta) \times (na \times n\eta), \qquad \text{for all } j > J_r = 9$$

where $\Pi_{j,j+1}$ is constructed using retiree's policy and probabilities for idiosyncratic shocks:

$$\begin{aligned} \text{Prob}(a', \eta' | a, \eta) &= \text{Prob}(a' | a, \eta) \times \text{Prob}(\eta') \\ &= \mathbb{1}(a' = g(a, \eta, j)) \cdot \frac{\gamma_j}{1+n} \times \text{Prob}(\eta') \end{aligned}$$

This way I can ensure:

$$\sum \mu_{j+1} = \frac{\gamma_j}{1+n} \sum \mu_j$$

For workers (without parents alive) the individual states are (a, z, η) hence,

$$\dim\left(\Pi_{j,j+1}\right) = \begin{cases} (na \times nz \times n\eta) \times (na \times nz \times n\eta), & \text{for } j < 8 \\ (na \times nz \times n\eta) \times (na \times n\eta), & \text{for } j = 8 \end{cases}$$

where $\text{Prob}(z_{t+1}|z_t)$ is now given by the Markov transition matrix.

For younger workers whose parents are still alive, two matrices are needed. Young workers with retired parents may transition to:

$$(a, z, \eta, a_p, \eta_p) \rightarrow \begin{cases} (a, z, \eta, a_p, \eta_p) & \text{if parents survive} \\ (a, z, \eta) & \text{if parents pass away} \end{cases}$$

For those whose retired parents survive to the next period, transition matrix is constructed using their parents' policy as,

$$\text{Prob}(a'_p | a_p, \eta_p) = \mathbb{1}(a'_p = g(a_p, \eta_p, j+6))$$

whereas the indicator function used to construct the second case transition matrix accounts for bequests they may inherit.

Similar procedures to get transition matrices for age-2 and age-1. For age-2, we have:

$$(a, z, \eta, a_p, z_p, \eta_p) \rightarrow \begin{cases} (a, z, \eta, a_p, \eta_p) & \text{if parents survive and retiree} \\ (a, z, \eta) & \text{if parents pass away} \end{cases}$$

For age-1 households, we have two types depending on whether grandparent is alive or not. Fortunately, as agents start with zero wealth (hence η is irrelevant) both (a, η) can be dropped.

$$(z, a_p, z_p, \eta_p) \rightarrow \begin{cases} (a, z, \eta, a_p, \eta_p) & \text{if parents survive} \\ (a, z, \eta) & \text{if parents pass away} \end{cases}$$

$$(z, a_p, z_p, \eta_p, a_g, \eta_g) \rightarrow \begin{cases} (a, z, \eta, a_p, \eta_p) & \text{if parents survive} \\ (a, z, \eta) & \text{if parents pass away} \end{cases}$$

Finally, the initial distribution for age-1 (z, a_p, z_p, η_p) and $(z, a_p, z_p, \eta_p, a_g, \eta_g)$ are obtained using the *transmission* matrices from age-7 to age-1.

$$\mu_1^p = \Pi^p \mu_7$$
$$\mu_1^{pg} = \Pi^{pg} \mu_7^p$$

Once all the transition matrices are obtained, I then simulate the economy until a stationary distribution of households over the state space is achieved. The stationary distribution is then obtained when the age distribution, productivity distribution and average wealth across the households are all stabilised. Using the stationary distribution, I check whether the government budget is balanced and update the capital income tax accordingly. The procedure described above is repeated until the government budget is balanced.