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IZA DP No. 17389

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ISSN: 2365-9793

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ABSTRACT

Evidence from the Dead: New Estimates of Wealth Inequality Using the Distribution of Estates*

This paper studies the estimation of wealth distribution using estates left at death. We establish formal conditions for adopting a simplied version of the classic estate multi- plier method, using only minimal information on estates and mortality. We empirically validate these conditions and apply the simplied approach to produce novel long-run top wealth share series for Belgium, Japan, and South Africa, where estate data have not yet been exploited. This approach may vastly expand the range of countries and years for which wealth inequality can be estimated, where estate data exist but the standard method cannot be applied.

JEL Classification: D3, H2, N3

Keywords: wealth inequality, estate tax, mortality rates, public economics

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* We thank Joan Madia for excellent research assistance. We also wish to thank Carolyn Fisher, Matthieu Gomez, Jonathan Goupille-Lebret, Oleg Kitov, Wojciech Kopczuk, and Luis Valenzuela for helpful comments and suggestions, along with seminar participants at King's College London, the London School of Economics, the Stone Center on Socio-Economic Inequality, City University of New York, KU Leuven, the University of Warwick and Vienna University of Economics and Business, and conference participants at the CRIW- NBER conference on \Measuring and Understanding the Distribution and Intra/Inter-Generational Mobility of Income and Wealth," the 2019 ECINEQ meeting, the 2022 Annual Congress of the International Institute of Public Finance, the LSE III / LIS Comparative Economic Inequality Conference 2023, and the SIEP 2022 Annual Conference. We acknowledge nancial support from the Agence Nationale de la Recherche (YB), INET (FA and SM), ESRC/DFID (Grant ES/I033114/1) (FA), and the European Research Council (ERC Grants 340831 and 856455) (FA). Earlier versions appeared in the past as Berman and Morelli (2021, 2022).

1 Introduction

"Statistics on wealth distribution," wrote Atkinson (1978), "play a key political role" and they are "as sensitive an issue as the balance of payments or unemployment figures." However, from a quantitative perspective, our knowledge about the inequality of wealth at a global level is severely limited: individual or household data on private wealth holdings on reasonably long—or even short—periods of time are rare, and mostly limited to a small number of developed nations. Hence, the direct estimation of wealth inequality seems often not feasible for many countries and for many years. Such data and estimates, particularly concerning top wealth shares, have become increasingly important from both a normative perspective, and for policy considerations. This is especially true in light of recent debates and proposals about wealth taxation (Saez and Zucman, 2019; Advani, Chamberlain and Summers, 2020; Landais, Saez and Zucman, 2020; Guvenen et al., 2023; Jakobsen et al., 2024).

Traditionally, five main sources of evidence about the distribution of wealth have been used (Atkinson and Harrison, 1978): (i) household surveys, such as the Survey of Consumer Finances in the United States, or the Wealth and Asset Survey in the United Kingdom (see, *e.g.*, Kuhn, Schularick and Steins (2020) and Pfeffer and Waitkus (2021)); (ii) administrative data on personal wealth derived from wealth registers or wealth taxes (Alvaredo and Saez, 2009; Epland and Kirkeberg, 2012); (iii) administrative data on investment income, capitalized to yield estimates of the underlying wealth (Saez and Zucman, 2016; Garbinti, Goupille-Lebret and Piketty, 2021; Smith, Zidar and Zwick, 2023); (iv) lists of large wealth-holders, such as the Forbes 400 list (Klass et al., 2006; Baselgia and Martínez, 2024); and (v) administrative data on individual estates at death, multiplied-up to yield estimates of wealth among the living through the estate multiplier method (Kopczuk and Saez, 2004; Alvaredo, Atkinson and Morelli, 2018; Acciari, Alvaredo and Morelli, 2024).

In recent decades, scholars have devoted major efforts to generate incremental methodological improvements and to get access to better data, thus contributing to expanding the coverage in terms of countries and years. Nevertheless, the picture is still very partial. High-quality estimates based on the methods mentioned above are almost exclusively restricted to North America and Western Europe.[1]

[1]A number of open access databases, such as the UBS (formerly Credit Suisse) Global Wealth Report (UBS, 2024) and the World Inequality Database (World Inequality Database, 2022), provide estimates of personal wealth distribution for most countries and over many years. It should be stressed, however, that the vast majority of these figures are not based on direct data on the distribution of wealth, but rather on correlations and imputations derived from income data or from neighboring countries and regions.

This paper derives personal wealth concentration measures using only minimal and coarse information on the wealth left at death (informed by estate and inheritance taxes) and on average mortality rates. To this end, we study the general conditions that permit adopting a simplified version of the classic estate multiplier method (Mallet, 1908; Atkinson and Harrison, 1978). We first test these conditions for Australia, France, Italy, South Korea, the United Kingdom, and the United States. We then produce novel long-run top wealth share series for Belgium, Japan, and South Africa, where estate data have not yet been exploited.

The potential of a simplified estate multiplier approach, when no other viable alternatives exist to produce estimates of the distribution or the concentration of wealth, should not be understated. It unlocks a wide array of existing and previously unexploited data on wealth holdings that do not allow for the application of the standard mortality method. This, in turn, expands the range of countries and periods for which wealth inequality can be estimated. Notably, inheritance, estate, or gift taxes exist or have existed in more than a third of the world's countries, including many middle and low-income countries, covering more than half of the world's population (Morelli et al., 2023).

Detailed information on estates (the net value of worldwide real and financial property of a deceased person) has long been used to estimate wealth inequality. However, the distribution of wealth of the living is conceptually different from that of the decedents. Death does not "sample" randomly the population. Older individuals, males, and those from poorer backgrounds generally have higher mortality risks, all else being equal. Therefore, differential mortality multipliers should be used to convert the estate data into estimates of wealth among the living. Under the assumption that death is random within specific cells of observed demographic and social strata, one can view death occurrence as an effective sampling of the living.

The rationale of the method is straightforward: the set of decedents is treated as a sample of the living, with each estate expanded by a multiplier (weight) equal to the inverse probability of death. This multiplier represents the number of living individuals who share the decedent's characteristics that determine mortality.

Mallet (1908) and Mallet and Strutt (1915) were among the first to use the estate multiplier method to analyze wealth inequality in the United Kingdom at the beginning of the 20th century. In these early papers, applying age and gender multipliers was considered a solution to the "fatal" flaw of earlier analyses, which had overlooked mortality heterogeneity. As they noted, "the accumulated wealth of an individual increases with years [...] and is usually greatest when a man dies" (Mallet (1908), p. 67).

More recently, Saez and Zucman (2016) revisited this issue, highlighting concerns about the estate multiplier method. They argue that failure to properly account for the lower mortality of wealthier individuals—beyond the age-gender gradient—may lead to significant underestimation of top wealth shares, a point previously raised by Atkinson and Harrison (1978).

These considerations suggest that the resulting top wealth shares could be very sensitive to multipliers. Certainly, from a theoretical perspective, applying multipliers that account for differential mortality based on age, gender, and wealth may either increase or decrease wealth shares. These multipliers can also potentially alter the time patterns of the wealth distribution with respect to the distribution of estates. The extent of these changes depends on how the age, gender, and wealth profiles evolve over time. However, recent research has highlighted an important empirical finding. Conclusions about the degree of wealth concentration, based on the estate multiplier method, do not differ significantly from those based on the concentration of estates. This suggests that the application of mortality multipliers may not significantly alter the estimates of top estate shares as previously thought (Alvaredo, Atkinson and Morelli, 2018).[2]

Inspired by these observations, we derived top wealth shares using simple tabulations by estate ranges and average multipliers, even in the absence of decedents' demographic characteristics and detailed multipliers. Data on the distribution of estates based on inheritance or estate tax records often lack demographic characteristics such as age and gender (in most of the countries and years for which they are available), making the application of more granular mortality rates impossible. Given the modest data requirements, the *simplified multiplier approach* can thus be effectively implemented in such cases to estimate historical trends of wealth concentration.

As a first step, we describe closed-form expressions for top wealth shares using the classic estate multiplier method. Most importantly, we also establish the conditions under which these expressions yield levels of wealth concentration that are similar to the levels of estate concentration. We show that whether these levels are similar depends on two determinants: the correlation between wealth and mortality at the top of the estate distribution; and the difference between the average mortality multiplier and the individual mortality multipliers also at the top of the estate distribution. If both are low, the levels of wealth concentration among the living and estate concentration (and thus the respective top shares) are expected to be very close.

There are reasons to believe that the aforementioned conditions are likely to be met in practice. *Within the top group* of the wealth distribution, age matters less for wealth ac-

[2] Piketty, Postel-Vinay and Rosenthal (2006) and Moriguchi and Saez (2008) implicitly assume this point.

cumulation on average. This is because wealth typically accumulates up to a certain age, but no further (Jakobsen et al., 2020; Garbinti et al., 2024). Consequently, the correlation between wealth and age, the main determinant of mortality risk, is low among the wealthiest individuals.[3]

Moreover, the top of the wealth distribution is largely composed of older-than-average individuals. This makes their mortality risk higher than average. However, their substantial wealth may offset this increased risk, due to factors such as better nutrition, healthier lifestyle, and better access to specialized healthcare. This could bring the average mortality multiplier at the top closer to the average multiplier of the entire adult population. This key factor explains why both the simplified multiplier approach (using an average multiplier) and more detailed methods can produce similar estimates of wealth concentration.[4]

We empirically validate the aforementioned conditions for similarity using two key tests. First, we apply the simplified approach to estate and inheritance tax data in six countries: Australia, France, Italy, South Korea, the United Kingdom, and the United States. In each case, we obtain a series of top wealth shares. These series are then compared to existing estimates from the literature. The comparison reveals a striking similarity in trends, as well as in levels, in all countries. In some of the countries, the high similarity is persistent over many decades. Notably, this is evident in the United States, where multiple series using different methods exist in the literature (see Saez and Zucman (2020b); Smith, Zidar and Zwick (2023)), as well as in the United Kingdom.

An additional test involves a detailed examination of the specific case of Italy. We begin by considering the use of heterogeneous mortality multipliers differentiated by demographic characteristics (*i.e.*, age and gender). This is an important starting point as mortality rates by age and gender typically capture most of the variability in mortality observed in a country within a given year. Applying the estate multiplier method using the demographic multipliers yields a series of top wealth shares. Clearly, such a series could be somewhat biased since it does not take into account heterogeneity in mortality that is due to socio-economic characteristics. Accounting for this heterogeneity using the estate multiplier method creates a more accurate picture of mortality, and leads to a more realistic estimation of top wealth shares. Next, we compare these two series (with heterogeneous multipliers), to the top

[3]The term 'top group' refers to a top quantile, such as the top 10%, 1%, or 0.1% of the estate and wealth distributions. We provide a more precise definition in the detailed description of our methodology.

[4]We note that aspects of the simplified approach are not entirely new. Simplifying the estate multiplier method by approximating the estate distribution and the wealth distribution has been discussed in the past (*e.g.*, in Piketty, Postel-Vinay and Rosenthal (2006)). Moreover, some of the mathematical observations that are necessary for the validity of the simplified approach, as will be described below, appeared in Kopczuk and Saez (2004).

wealth share series resulting in the simplified approach, when using a single, homogeneous multiplier. We find that the latter series closely aligns with the top wealth shares obtained using heterogeneous multipliers that account for socio-economic characteristics. This, again, supports the validity of the simplified method's assumptions.

We also confirm the theoretical conditions for top share similarity. In Italy, after accounting for both demographic heterogeneity (age and gender) and economic heterogeneity (wealth) in mortality, we find that the correlation between wealth and mortality among the top 1% of decedents is very low. Additionally, the average multiplier among the top 1% is close to that of the overall adult population, deviating by up to 20%. In contrast, when accounting only for age and gender, the average multiplier among the top 1% is 30% to 50% lower than the average multiplier in the adult population.

We then produce new long-run top wealth share series for Belgium, Japan, and South Africa, where estate data have not been previously exploited for this purpose. Existing work on wealth inequality in these countries is very limited. To apply the simplified multiplier approach, we use estate tax tabulations manually collected from archives of national tax administrations, in addition to aggregate mortality data from the Human Mortality Database (2022). The estimated top 0.1% wealth shares are presented in Figure 1.

In Belgium, we find a persistent and almost monotonic decrease in wealth inequality between the 1930s and the mid-1990s. The top 0.1% wealth share decreased from about 20% in the 1930s to 5%–10% during the late 1980s and early 1990s. This aligns well with existing estimates for later years (Blanchet and Martínez-Toledano, 2023). It is also similar in levels and trends to relevant reference countries, such as France (see Garbinti, Goupille-Lebret and Piketty (2021)).

In Japan, the top 0.1% wealth share between 1970 and 2017 is largely similar in levels to those found in European countries such as France, Italy, and the United Kingdom. However, the dynamics are markedly different. Wealth inequality in Japan remained stable during the 1970s and early 1980s, with a top 0.1% wealth share of about 9%. It then increased rapidly from the mid-1980s and until the early 1990s, reaching 16%, before declining to 6%. Interestingly, this dynamic coincides with the Japanese asset price bubble. From the early 2000s, top wealth shares remained stable.

In South Africa, our estimates suggest that wealth inequality was very high by international standards before the 1950s, followed by a decline between the 1950s and the 1980s. The top 0.1% wealth share fell from 30%–40% in the 1920s–1940s to 10%–15% in the early 1980s. The dynamics of top wealth shares in South Africa resemble those found for the United States during the same period, although the levels in South Africa were significantly higher for most

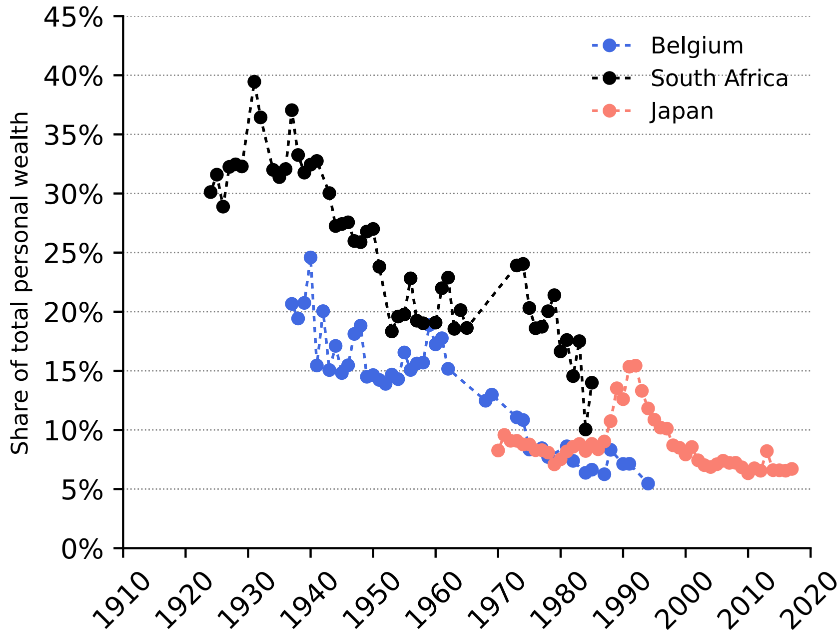

Figure 1: New evidence of wealth concentration for Belgium, South Africa, and Japan: Top 0.1% wealth shares.

Notes: The figure plots the share of total personal wealth held by the richest 0.1% of individuals in each country over the past 100 years. The results were obtained by applying the simplified multiplier approach. More details on the data and methodology can be found in Section 2 and Section 3.

of the 20th century. Our estimates for South Africa align well with existing estimates for later years (Chatterjee, Czajka and Gethin, 2022).

Our methodological findings, as demonstrated in the cases of Belgium, Japan, and South Africa, exhume valuable data previously considered unreliable or unusable. The simplified estimates may naturally be refined if more and better data become available. However, the results show that in some cases, where estate tax is the only available data source, it is still possible to obtain reliable estimates of wealth inequality.

This paper contributes to different threads of the literature on the measurement of wealth inequality. Methodologically, it demonstrates the conditions under which it is feasible to estimate top wealth shares using minimal information on estates and overall population mortality. Importantly, this simplified approach enables the derivation of wealth concentration estimates in cases where estate tax data exist but the application of the standard estate multiplier method is substantially constrained. Empirically, we show the potential to vastly expand the range of countries and periods for which wealth inequality can be estimated. We focus on Belgium, Japan, and South Africa, where estate data have not yet been exploited, and where the historical evolution of wealth inequality remains largely unexplored.

The paper also contributes to the understanding of the relationship between mortality and wealth. While the relationship between mortality and income has been studied extensively in some countries (Chetty et al., 2016), much less is known about the relationship between wealth and mortality. Insights into this relationship are crucial not only for the application of the full estate multiplier method but also for policy. For example, understanding this relationship is key for designing pension and social security policies, as well as for evaluating wealth tax proposals.

The rest of the paper is organized as follows. Section 2 presents the simplified multiplier approach, compares it to the classic method, and validates it empirically. Section 3 uses the simplified approach to produce new top wealth share series in Belgium, Japan, and South Africa. Section 4 delves deeper into the simplified approach, and discusses in great detail its underlying assumptions and their empirical validity. We conclude in Section 5.

2 Estimating top wealth shares using the estate multiplier method

The classic estate multiplier method (Mallet, 1908; Atkinson and Harrison, 1978) uses information on the wealth and the demographic characteristics of decedents reported to the tax authorities for the administration of inheritance or estate taxes. By re-weighting the decedent population using the inverse of mortality rates, it is possible to estimate the wealth distribution of the living population. In this section, we show how to derive top wealth shares using both heterogeneous and homogeneous multipliers, and compare the resulting estimates of top shares.

Using mathematical notation, we consider the population of N_E decedents and the total value of their estates, W_E, obtained as the summation of all individual estates $w_{E,i}$ (arranged, for simplicity, in descending order, *i.e.*, $w_{E,i} \geq w_{E,j}$, if $i < j$).

We denote by $m_i \equiv \frac{1}{p_i}$ the mortality multiplier of decedent i, equal to the inverse of the individual mortality rate, p_i. Denoting the total (living) population as N, it follows that $N = \sum_{i=1}^{N_E} m_i$. Intuitively, m_i represents the number of living individuals corresponding to decedent i in the decedent population.

We also consider the average mortality multiplier, $\bar{m}$. It is equal to the arithmetic mean of individual multipliers, but also, by design, to N/N_E, the ratio between the number of the living, N, and the number of decedents, N_E.[5]

We are interested in estimating the wealth share of the top quantile $0 < q < 1$. $q = 0.1$ corresponds to 10%, $q = 0.01$ corresponds to 1%, *etc.*. The top q wealth share then corresponds to the share of wealth of the richest qN living individuals. To account for the total wealth of these qN individuals, we would need to multiply up the estates of a number of the richest decedents by their respective multipliers. Yet, the value of these multipliers affects the number of decedents needed to account for the top q quantile among the living. For example, if the multipliers of the rich decedents are high compared to the average multipliers in the population, fewer decedents would be required to account for the top qN individuals than when the multipliers of the rich decedents are lower. This number is represented by the index I_q such that $\sum_{i=1}^{I_q} m_i = qN$.[6]

Under these assumptions, we define the top q wealth share as

$$Sh_q^W \equiv (1 - L_q)^W = \frac{\sum_{i=1}^{I_q} m_i w_{E,i}}{W}. \tag{2.1}$$

where W is the total wealth among the living population.

2.1 A simplified estate multiplier approach

The application of the full estate multiplier method, as described above, depends on the availability of detailed mortality data. It also requires comprehensive estate microdata or tabulations, differentiated by demographic characteristics. However, such detailed data are rare. In most cases, the distribution of estates is given only by estate ranges lacking additional demographic information. Similarly, mortality data are often differentiated only by age and gender, abstracting from all other socioeconomic factors, and thus limiting the method's applicability.

In this scenario, we can derive the top wealth shares using an average multiplier (*i.e.*, $m_i = \bar{m}$). This is what we call from now on the *simplified multiplier approach.*

In doing so, we follow recent research that has highlighted the minimal impact of mortality multipliers on the distribution of estates, contrary to previous assumptions. Notably, Alvaredo, Atkinson and Morelli (2018) demonstrated that the concentration of estates at death and the derived concentration of wealth at the top following the application of detailed mortality multipliers are very close to one another. In their words, "the application of mortality

[5] $\bar{m} = \frac{1}{N_E} \sum_{i=1}^{N_E} m_i = \frac{N}{N_E}$.

[6] If there is no equality, I_q is defined as the smallest index such that $\sum_{i=1}^{I_q} m_i > qN$.

multipliers does not alter the picture concerning the distribution of the wealth of the living, as commonly believed."

Applying the average multiplier to all decedents results in equivalence between the estate distribution and the wealth distribution among the living. First, when using a limited dataset and the average mortality multiplier, the top q quantile among decedents represents exactly the top q quantile of the living (*i.e.*, $I_q = qN_E$). In addition, if all estates-at-death are multiplied up by their respective multipliers, their sum has to be equal to the total wealth among the living. Thus, the following relationship holds, $W = \sum_{i=1}^{N_E} m_i w_{E,i}$. When $m_i = \bar{m}$, then $W = \sum_{i=1}^{N_E} m_i w_{E,i} = \bar{m} \sum_{i=1}^{N_E} w_{E,i} = \bar{m} W_E$. We obtain[7]

$$Sh^W_{q,simp} = (1 - L_q)^W_{simp} = \frac{\sum_{i=1}^{I_q} m_i w_{E,i}}{W} = \frac{\bar{m}}{\bar{m}} \frac{\sum_{i=1}^{qN_E} w_{E,i}}{W_E} = (1 - L_q)^E = Sh^E_q \,. \tag{2.2}$$

Equation (2.1) represents the basic key result of the estate multiplier method. It shows how full knowledge of decedents' estates and their respective multipliers can be used to estimate top wealth shares among the living. In practice, however, the universe of individual estates is rarely available, as the coverage of estate and inheritance tax data is limited. For example, in the United States, only about 0.2% of decedents are captured in these data. The upshot is that those who are captured in the data are the richest decedents. Therefore, if the total personal wealth W is known from another data source, it is still possible to apply the formula in Equation (2.2) to the available top quantiles and obtain estimates of top wealth shares among the living.

2.2 A comparison of the simplified multiplier approach to existing series

Following the description of the simplified multiplier approach in the previous section, deriving measures of wealth concentration requires only three elements: the total personal wealth among the living, the average multiplier ($\bar{m} = N/N_E$), and the total value of estates of the top q quantile of decedents.[8]

Importantly, there is no a priori reason for the top wealth share derived in Equation (2.1) to

[7] See also Appendix A for more details.

[8] The value of the multiplier matters for Sh^W_q, and in principle, one could choose a different homogeneous multiplier that is not the average mortality multiplier. Appendix B discusses different possible choices of a homogeneous multiplier and the effect this has on estimates of wealth concentration. We continue our analysis using $\bar{m} = N/N_E$ as explained above, where N will be taken as the living adult population and N_E as the number of adult decedents.

match the estimate obtained through the simplified approach in Equation (2.2). However, in practice, they tend to match quite closely in most countries and years.

To demonstrate this, we compare the top wealth shares derived through the simplified multiplier approach with existing series from the literature for six countries: Australia, France, Italy, South Korea, the United Kingdom, and the United States. We use data from Katic and Leigh (2016) for Australia; Garbinti, Goupille-Lebret and Piketty (2021) for France; Acciari, Alvaredo and Morelli (2024) for Italy; Kim (2018) for South Korea; Alvaredo, Atkinson and Morelli (2018) for the United Kingdom; and Smith, Zidar and Zwick (2023) for the United States. The existing estimates considered are all based on estate and inheritance tax data using the classic estate multiplier method.

Figure 2 presents the results of this comparison for the top 1% wealth share (0.1% for the United States due to the lower coverage of the tax data). It highlights that in all countries. the top wealth shares estimated with the simplified multiplier approach strongly co-move with those reported in the literature and they are similar in level.[9]

A visible exception is the 2011 estimate for the United States. It is significantly higher in the analysis by Smith, Zidar and Zwick (2023), based on confidential microdata. Their estimate likely overstates inequality for that year, possibly due to a relatively young and extremely wealthy decedent to whom the method assigns a very high multiplier (Steve Jobs). This suggests that the simplified approach, by using a homogeneous average multiplier, is less sensitive to such anomalies and therefore less volatile.

The simplified multiplier approach estimates in Figure 2 are based on estate or inheritance tax data for each country. The average mortality multiplier $\bar{m}$ for each country and every year was calculated as the ratio between the number of living adults (aged 20 and above) to the number of adult deaths. This information is taken from the Human Mortality Database (2022). The total personal wealth in each country and every year was taken from the World Inequality Database (2022).[10]

The quality and characteristics of estate data vary significantly across these countries (see Appendix C). In Italy, for example, the data cover roughly 60% of decedents every year, however, only tabulations are publicly available. In France, the data cover a much smaller

[9] Figure 2 compares series produced in the literature through the application of the classic estate multiplier method. However, a similar picture would arise if other existing series were considered, where the estate-based series were found to be close to series produced using the capitalization method or other hybrid procedures (see Garbinti, Goupille-Lebret and Piketty (2021) and Saez and Zucman (2020b)).

[10] The estate data are available in the form of tabulations, rather than at the individual decedent level. To compute the sum $\bar{m}\sum_{i=1}^{I_q} w_{E,i}$ for the top share in the simplified approach, we apply the generalized Pareto curve interpolation method (Blanchet, Fournier and Piketty, 2022). This allows us to evaluate the sum for the exact value of I_q, without being constrained by the division of the tabulations into brackets.

share of the decedent population (about 10%), but microdata are available. In the United States, an even smaller share is covered (0.2% in recent years). Despite these differences in data coverage and availability, the simplified approach remains consistent across countries. It requires the same information: the values of estates at the top of the estate distribution (or equivalent tabulations), the average mortality multiplier, and the total personal wealth.

The estimates taken from the literature incorporate various adjustments to account for underreporting, tax avoidance, and evasion. In the United States, Kopczuk and Saez (2004) include estimates of wealth held in trusts and the cash surrender value of pensions and life insurance assets. In France, Garbinti, Goupille-Lebret and Piketty (2021) impute missing net wealth for consistency with official national balance sheet data for the household sector. Other works, such as Acciari, Alvaredo and Morelli (2024) for Italy, provide a full set of adjusted, unadjusted, and imputed series. As we are able to make use of the unadjusted series, which is derived from the pure application of mortality multipliers, we focus on the case of Italy to further evaluate the validity of the simplified approach in Section 4.

2.2.1 The simplified multiplier approach in the case of the United States

Figure 2 presented a comparison of top wealth share series produced using the simplified multiplier approach with other series for different countries. In the United States specifically, the estimation of top wealth shares has been a source for debate in recent years. Both Saez and Zucman (2016) and Smith, Zidar and Zwick (2023) used income tax data as the main source for estimating top wealth shares through the capitalization method. In the capitalization method, capital income is multiplied by its inverse rate of return to yield the stock of wealth. Perfect knowledge of capital income (assuming it covers all sources of wealth) and of the rates of return would enable the reconstruction of the wealth distribution. The difference between the top wealth share estimates in Saez and Zucman (2016) and Smith, Zidar and Zwick (2023) lies mainly in how they account for heterogeneity in rates of return.

In addition, wealth inequality can be estimated using the Survey of Consumer Finances (or SCF, see, *e.g.*, Kuhn, Schularick and Steins (2020)). The two main limitations of the SCF are its limited coverage of the top of the wealth distribution, and the difficulty of subjects to valuate their wealth. For these reasons, it is possible to expand the SCF by augmenting it with the Forbes 400 list, under the plausible assumption that none of the 400 richest people in the United States is included in the survey. This typically leads to higher estimates of top wealth shares.

Figure 3 presents a comparison between the most recent estimates using the capitalization method (see Saez and Zucman (2020b, 2022) and Smith, Zidar and Zwick (2023)) and the SCF with and without augmenting it with Forbes 400 data (taken from Smith, Zidar and Zwick (2023)), and the results of the simplified multiplier approach.

As described above, the simplified approach requires three key inputs: total personal wealth data (which we take from the updated series in Saez and Zucman (2020b)); the average mortality multiplier, taken from the Human Mortality Database (2022); and estate tax tabulations by year of death from the IRS (2022). These tabulations typically consist of 4 to 6 brackets in which the relevant data used is the threshold for each bracket (*e.g.*, \$0, \$5M, \$10M, \$20M, \$50M), the total number of decedents in each bracket, and the total value of estates in each bracket. This information, along with the control total wealth and average multiplier, is fed into the generalized Pareto interpolation method (Blanchet, Fournier and Piketty, 2022), to yield estimates of top wealth shares. Given the limited coverage of the estate tax data in the United States (about 0.2% of decedents), we focus on the top 0.01% and 0.001% wealth shares in Figure 3.

The comparison shows that the simplified approach results are very close in levels to both series using capitalized income tax data. In fact, the distance metric (sum of squared differences) between the simplified approach series to each of the Saez and Zucman (2020b) and Smith, Zidar and Zwick (2023) series is lower than the distance between Saez and Zucman (2020b) and Smith, Zidar and Zwick (2023) themselves. The simplified approach results are also close to the results based on the SCF when augmented by the Forbes 400 data. While the simplified approach results are clearly rough estimates, this serves as an additional indication for its general reliability, if when juxtaposed with the best available series that are based on other methods and different data, it provides a very similar picture.

We revisit the validation of the approach in Section 4, where it is further tested empirically and theoretically. Specifically, we derive the formal conditions under which the application of the average multiplier in the simplified approach yields levels of wealth concentration that are similar to those obtained with detailed multipliers. For now, however, we assume that the approach can be reliably used to provide estimates of top wealth shares, and proceed to the main empirical task of this paper – producing new estimates of top wealth shares using the simplified multiplier approach.

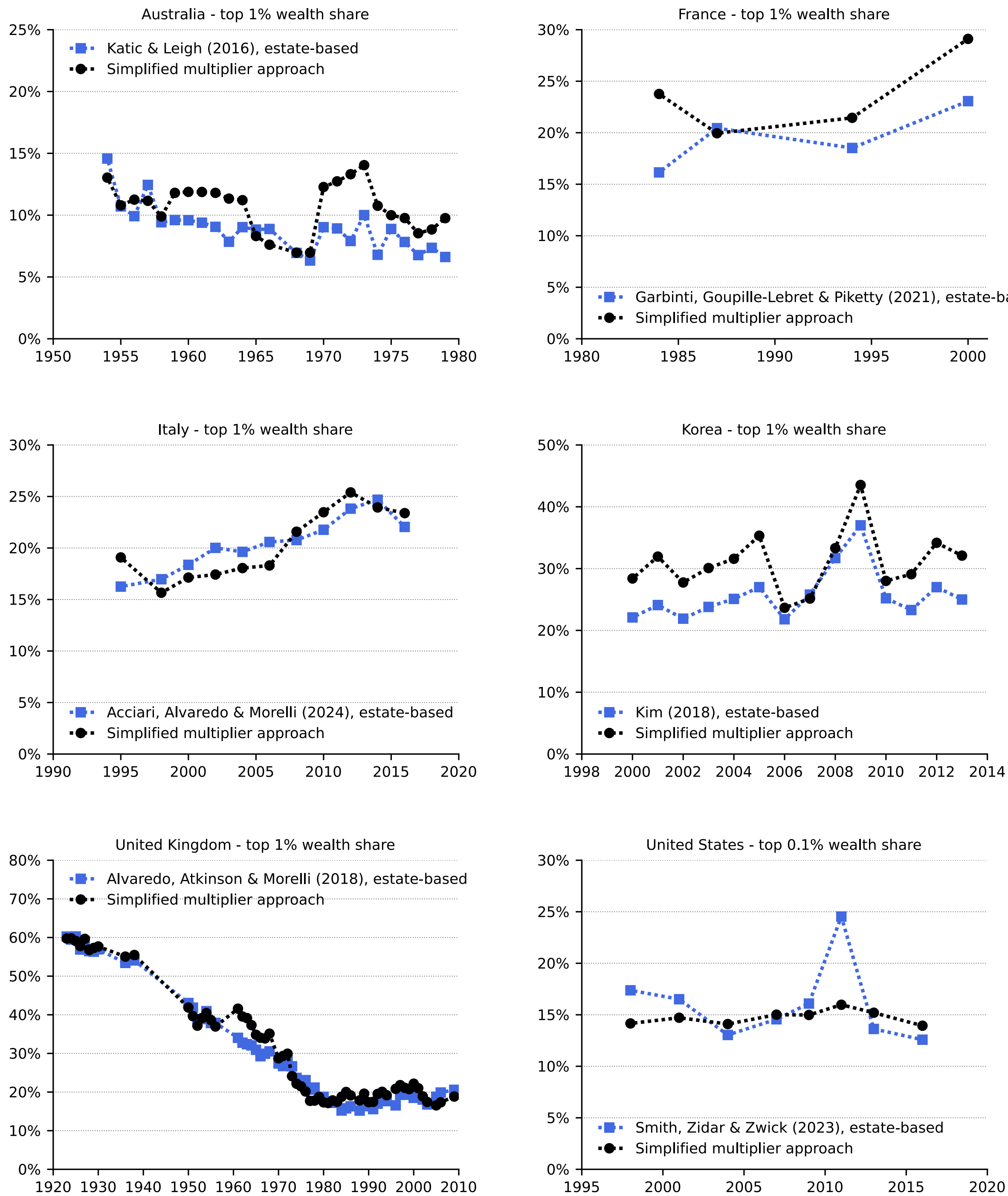

Figure 2: The top wealth shares in Australia, France, Italy, South Korea, the United Kingdom, and the United States.

Notes: Tabulations and the top wealth shares were taken from Katic and Leigh (2016) (Australia), Garbinti, Goupille-Lebret and Piketty (2021) (France), Acciari, Alvaredo and Morelli (2024) (Italy), Kim (2018) (Korea), Alvaredo, Atkinson and Morelli (2018) (United Kingdom), and Smith, Zidar and Zwick (2023) (United States, their *preferred* series), respectively. In the cases where there was more than one top share series available from these papers, we considered the series produced using estate or inheritance data. The estimated top wealth shares in the simplified approach were produced using the estate multiplier method assuming the average multiplier for all observed decedents. The mortality data were taken from the Human Mortality Database (2022).

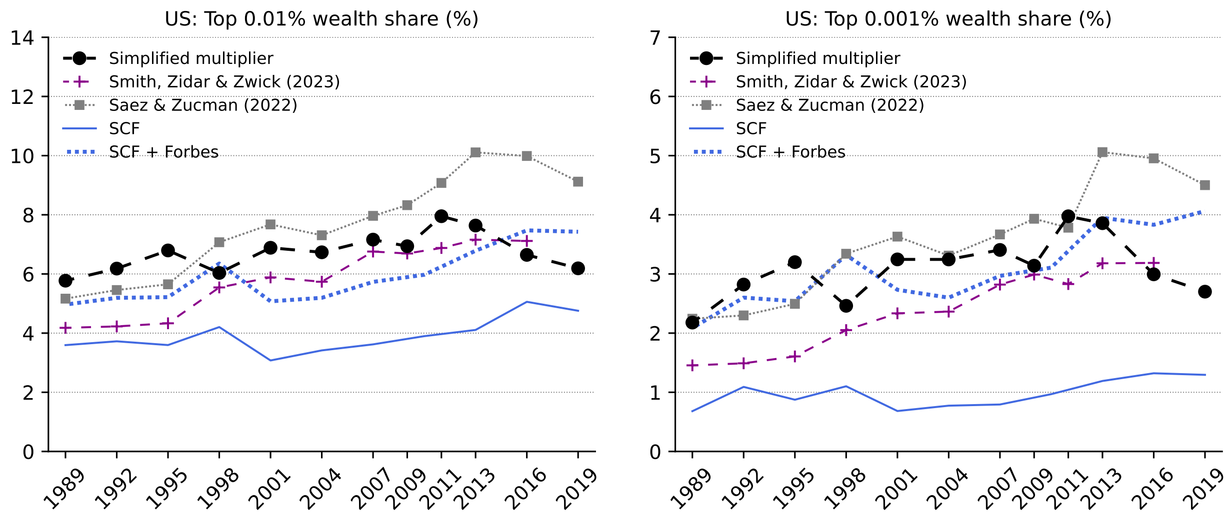

Figure 3: Top wealth shares in the United States.

Notes: The figure presents a comparison between the simplified multiplier approach (black) to the results using the capitalization method (Saez and Zucman, 2016, 2020b, 2022; Smith, Zidar and Zwick, 2023) and based on survey data (Smith, Zidar and Zwick, 2023).

3 New estimates of historical top wealth shares

We now use the simplified multiplier approach to produce new long run series of top wealth shares. As explained above, no reliable administrative data on wealth other than estate and inheritance tax records can be found in many countries. In addition, the ability to obtain detailed heterogeneous mortality multipliers and use the classic estate multiplier method, is often very limited. This is especially the case when only tabulated estate data are available. For example, historical estate tax tabulations for Belgium can be found in archives of its central statistical office. However, historical mortality data by age, gender, and other variables, may not be available. Similarly, the Japanese tax administration publishes estate tax return statistics annually since 1905.

We use these data to produce new series for the top 10%, 1%, 0.1%, and 0.01% wealth shares in Belgium, Japan and South Africa. We use the simplified approach in all cases and apply a homogeneous mortality multiplier – the average multiplier in the population – to all observed decedents. For Belgium the calculation is done for the years 1937–1994; in Japan for the years 1970–2017; in South Africa for the years 1924–1985. The tax tabulations were all manually collected from archives of national tax administrations. The mortality data were taken from the Human Mortality Database (2022) for Belgium and Japan and from the UN World Population Prospects (2022) for South Africa.[11]

The charts below detail the new estimates produced for Belgium, Japan, and South Africa using the simplified multiplier approach. The cases of the three countries differ substantially. In Belgium, the data cover 50%–70% of decedents, and a good estimate of an external wealth total cannot be found in the literature. The underlying assumption is thus that the identified wealth, $\bar{m} \sum_{i=1}^{N_E^*} w_{E,i}$, where N_E^* represents the number of observed decedents, is the total personal wealth among the living, W. In this case we call the total used *internal*. Estimates are given for the top 10%, 1%, 0.1%, 0.01% wealth shares.

For Japan and South Africa the coverage is 2%–10% in most years. Thus, we aim to use an external wealth total when possible, since the identified wealth would be substantially lower than the actual total. For Japan the total is taken from the World Inequality Database (2022) and we report estimates for the top 1%, 0.1%, 0.01% wealth shares only for 1970–2017, the years in which the total is available. Due to the lower coverage compared to Belgium, the charts for Japan and South Africa present the top 0.1% and 0.01% wealth shares, as these estimates would be more reliable than the top 1% share in these countries.

[11] The choice of these countries reflects data availability, together with a demonstration of how using the simplified approach extends substantially the available estimation of wealth inequality in term of countries, continents, and time periods.

For South Africa the external total is also taken from the World Inequality Database (2022). However, its availability only overlaps with the availability of the estate tax data from 1950 onward. Therefore, we use both an internal total series and an external total series that is imputed from the total national income. Imputing the external total is done as follows: for the years in which both national income and (external) total personal wealth are available from the World Inequality Database (2022), we calculate the wealth-to-income ratio. We then extrapolate back the ratio to earlier years in which the national income data are available, but the total personal wealth data are not. The imputed total wealth is then taken as the actual national income multiplied by the back-extrapolated wealth-to-income ratio.[12]

In each of the charts, we also aim to compare the resulting estimates with existing estimates from the literature, where this is possible. In the case of South Africa and Belgium there is no overlap in the years where the estimates are available. In the case of Japan there is some overlap and the estimates are quite different from one another. This is possibly since the wealth inequality estimates for Japan in the World Inequality Database (2022) are imputed from income inequality estimates, and are not based on wealth data (World Inequilty Lab, 2021). For tables with the full results for each country, see Appendix D.

Belgium

In Belgium, wealth inequality dramatically decreased during the course of the 20th century. The top 10% wealth share decreased from around 80% in the late 1930s to around 55% in the mid-1990s. Similar trends are found for the top 1% and 0.1%, as shown in Figure 4. These levels and trends closely follow those found in France (Garbinti, Goupille-Lebret and Piketty, 2021), which further improves our confidence in the relevance of the estimates.[13]

Japan

In Japan, wealth inequality rapidly increased between the late 1970s and the early 1990s, especially during the late 1980s. Inequality levels rapidly decreased in the years that followed. During the Japanese asset price bubble in the late 1980s, inequality rose to levels comparable

[12]The validity of this imputation is demonstrated for the United States in Appendix E. Furthermore, the results below show that the top share estimates for South Africa are not very sensitive to the choice of control total in this case and do not affect the overall long-term trend.

[13]We note that these estimates assume that decedents whose wealth is not reported in the estate tax data had no wealth at the time of their death. As explained, this is important because the total personal wealth in Belgium is not available from an external source, so an assumption on the wealth of the unobserved decedent population is essential for the application of the simplified multiplier approach. Robustness tests assuming that the unobserved decedents had wealth that is equal to 50% of the poorest observed decedent, and to 10% of the average reported estate, had only a negligible impact on our estimates.

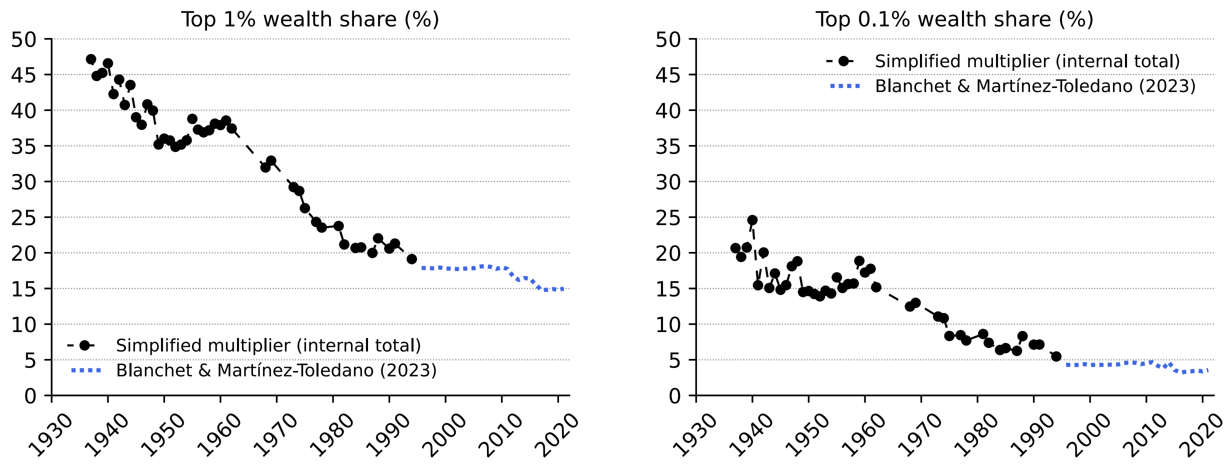

Figure 4: Top 1% and 0.1% wealth shares in Belgium.

Notes: The estimates are produced using the simplified multiplier approach based on archival inheritance tax data. The mortality data were taken from the Human Mortality Database (2022). An internal total was used. The underlying assumption is thus that the identified wealth, $\bar{m}\sum_{i=1}^{N_E^*} w_{E,i}$, where N_E^* represents the number of observed decedents, is the total personal wealth among the living, W. The simplified multiplier approach estimates are juxtaposed with estimates for later years from Blanchet and Martínez-Toledano (2023), based on distributional financial accounts.

to inequality levels that characterize the United States nowadays, with the top 0.1% share being above 10%. Yet, during the 2000s and 2010s, the top 10% wealth share in Japan was between 40% to 50%, *i.e.*, relatively low in comparison to most developed countries. This is presented in Figure 5 for the top 0.1% and 0.01% shares.

South Africa

In South Africa, we find that wealth inequality was very high in international standards before the 1950s, and declined between the 1950s and the 1980s. The top 0.1% wealth share decreased from levels of 30%–40% during the 1920s–1940s, to 10%–15% in the early 1980s. The top wealth share dynamics in South Africa resemble the dynamics found for the United States in the same years. Their level, however, is very high in comparison for most of the 20th century. Our estimates for South Africa fit well existing estimates for later years (Chatterjee, Czajka and Gethin, 2022).

Figure 6 presents two series of estimates using the simplified approach, each based on a different control total. The first series is derived using an internal total, like in the case of Belgium. However, as noted earlier, the relatively low data coverage means the internal total could significantly underestimate the actual total wealth for each year. To address this, we also include a series based on an external total, where the control total is imputed

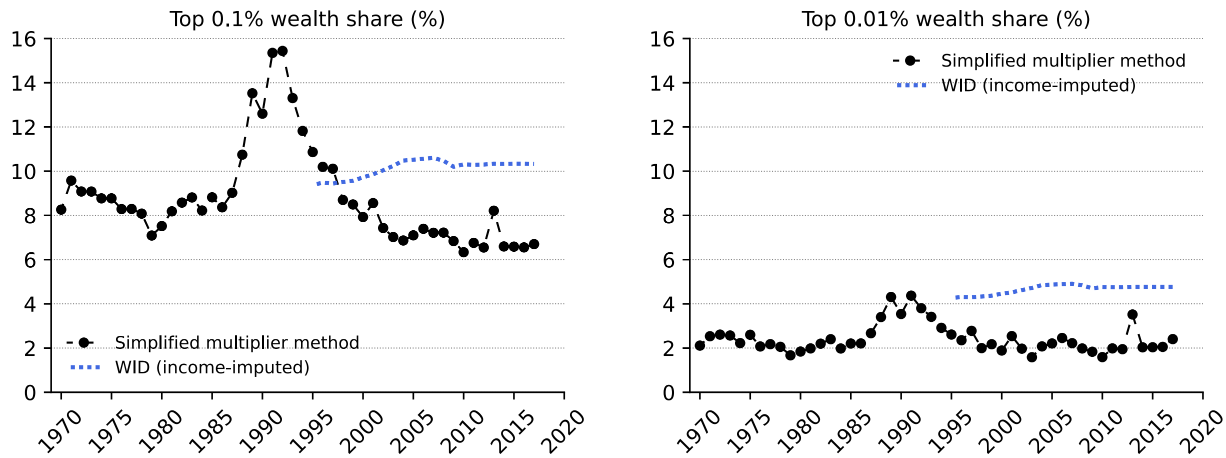

Figure 5: Top 0.1% and 0.01% wealth shares in Japan.

Notes: The estimates are produced using the simplified multiplier approach based on archival inheritance tax data. The mortality data were taken from the Human Mortality Database (2022). An external total was used, taken from the World Inequality Database (2022). The simplified multiplier approach estimates are juxtaposed with estimates from World Inequilty Lab (2021). We note that the estimates in World Inequilty Lab (2021) are imputed from income inequality estimates, and are not based on wealth data or capitalized income data.

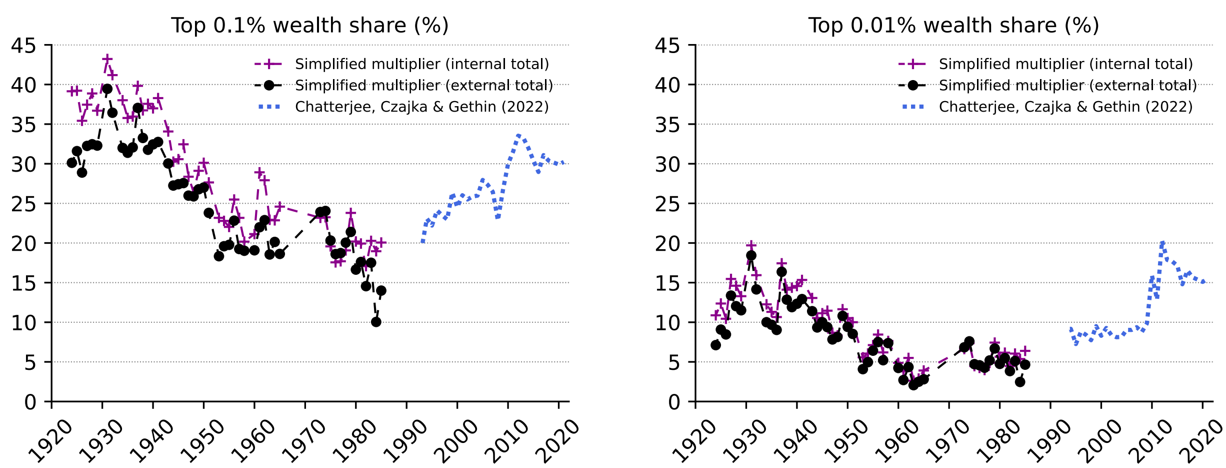

Figure 6: Top 0.1% and 0.01% wealth shares in South Africa.

Notes: The estimates are produced using the simplified multiplier approach based on archival inheritance tax data. The mortality data were taken from the UN World Population Prospects (2022). Both internal and external totals were used, for comparison, since the availability of an external total is limited, and is imputed for some of the years. The simplified multiplier approach estimates are juxtaposed with estimates for later years from Chatterjee, Czajka and Gethin (2022), based on capitalized income tax data.

from national income for the years 1924–1949. The external total is consistently higher than the internal one, resulting in slightly lower top share estimates. Nonetheless, the small differences between the two series reinforce confidence in the overall results.

4 Gaining a better understanding on the sensitivity of estimates to the choice of multipliers

Figure 2 showed that the simplified multiplier approach provides top wealth share estimates that are close to estimates of wealth inequality from the literature, and, in particular, from the application of the standard mortality method. It also enabled producing new concentration series in cases where estate tax tabulations and aggregate mortality data are available.

We now turn to the formal explanation behind these findings. First, we will compare wealth inequality estimates derived using the simplified approach with those obtained through the classic estate multiplier method. This formal comparison will test the sensitivity and robustness of the simplified approach.

To understand how sensitive the results can be to the choice of multipliers, we use Equation (2.1) and derive the conditions for the equality of the top wealth shares with the average multiplier and with heterogeneous multipliers:

$$\frac{\sum_{i=1}^{I_q} m_i w_{E,i}}{W} = \bar{m}\frac{\sum_{i=1}^{qN_E} w_{E,i}}{W} \iff \sum_{i=1}^{I_q} \frac{m_i}{\bar{m}} w_{E,i} = \sum_{i=1}^{qN_E} w_{E,i} \ \ ,^{*} \tag{4.1}$$

and the equality is trivially satisfied if multipliers do not vary across the population (*i.e.*, $m_i = \bar{m}$).

We define

$$\bar{w}_{qN_E} = \frac{\sum_{i=1}^{qN_E} w_{E,i}}{qN_E} \ ; \ \bar{w}_{I_q} = \frac{\sum_{i=1}^{I_q} w_{E,i}}{I_q} \tag{4.2}$$

and

$$\bar{w}_{qN_E} - \bar{w}_{I_q} = \frac{I_q}{\bar{m}qN_E}\text{Cov}\left[m_i, w_{E,i}\right] \ , \tag{4.3}$$

where $\text{Cov}\left[m_i, w_{E,i}\right] = \frac{1}{I_q}\sum_{i=1}^{I_q}\left(m_i - \frac{1}{I_q}\sum_{j=1}^{I_q} m_j\right)\left(w_{E,i} - \bar{w}_{I_q}\right)$.

Now, rearranging terms, it is possible to explicitly derive the difference between the top wealth shares in the simplified approach and in the classic method. Via the above notation and using the same expansion we obtain

$$\begin{aligned} Sh_q^W - Sh_{q,simp}^W &= \frac{\bar{m}qN_E}{W}\left(\bar{w}_{I_q} - \bar{w}_{qN_E}\right) + \frac{I_q}{W}\text{Cov}\left[m_i, w_{E,i}\right] \\ &= \frac{I_q}{W}\left[\bar{m}_{I_q}\left(\bar{w}_{I_q} - \bar{w}_{qN_E}\right) + \text{Cov}\left[m_i, w_{E,i}\right]\right] \ , \end{aligned} \tag{4.4}$$

where $\bar{m}_{I_q}$ is the average multiplier at the top of the estate distribution ($\Sigma_{i=1}^{I_q} m_i / I_q$).

The right-hand side of Equation (4.4) shows that the difference between top wealth shares depends on an average level effect of the multipliers, $\bar{m}_{I_q}\left(\bar{w}_{I_q} - \bar{w}_{qN_E}\right)$, and on the covariance between multipliers and estate value within the top group, $\text{Cov}\left[m_i, w_{E,i}\right]$. The average level effect is such that the closer the average of the multipliers at the top is to the average multiplier, the closer the index I_q is to qN_E, and hence, the closer the difference $\bar{w}_{I_q} - \bar{w}_{qN_E}$ would be to zero, leading to a smaller difference between the two top wealth shares estimated with heterogeneous and homogeneous multipliers.

In practice, the average multiplier at the top tends to be lower than $\bar{m}$. This outcome is largely due to life cycle effects – mortality is primarily influenced by age, and older individuals tend to have higher wealth (Shorrocks, 1975; Modigliani, 1986). As a result, the top of the estate distribution is likely to consist of people who are older than the average age of the adult population. To account for the top qN living individuals, more than qN_E decedents are thus needed (since $\bar{m} = \frac{N}{N_E}$). Consequently, the difference $\bar{w}_{I_q} - \bar{w}_{qN_E}$ is typically negative, meaning that using the average multiplier would lead to an overestimation of the top wealth shares when compared to results using heterogeneous demographic multipliers.

However, if a steep wealth gradient is applied to these heterogeneous multipliers, the multipliers at the top of the estate distribution would increase. This could potentially result in a higher average multiplier at the top compared to the overall average. In turn, this would tend to produce the opposite effect on the difference between the top wealth shares. It is possible that life cycle effects and the wealth gradient together create an average multiplier at the top that is close to the overall average multiplier. This would act to bring the difference in top wealth shares closer to zero.

The covariance ($\text{Cov}\left[m_i, w_{E,i}\right]$) also tends to be negative in practice, but it is generally small. Mortality rates increase exponentially with age above the age of 40 (see Appendix F). Wealth increases with age more weakly and the variability of age within wealth groups is large. Thus, the covariance between estates and multipliers at the top of the estate distribution is negative but close to zero, which may lead to a similarity between the top wealth shares derived above.

Figure 7 illustrates this point for France, using the observed richest decedents obtained from estate tax records (Garbinti, Goupille-Lebret and Piketty, 2021). It shows the large variability in age across wealth levels at the very top of the estate distribution. There is a very weak correlation between age and wealth among those rich decedents (accounting for about 0.5%–1% of decedents in each year). In 2000, the correlation is even slightly negative (although not statistically different from zero). In all cases, the coefficient of determination of a linear best fit is very low (less than 0.005), to the extent that age has no predictive power on wealth among the top decedents. The consistency of this result in all years supports the stability of the low-covariance condition. Similarly, Garbinti et al. (2024) show that the average age among the richest individuals in France is essentially independent on wealth.

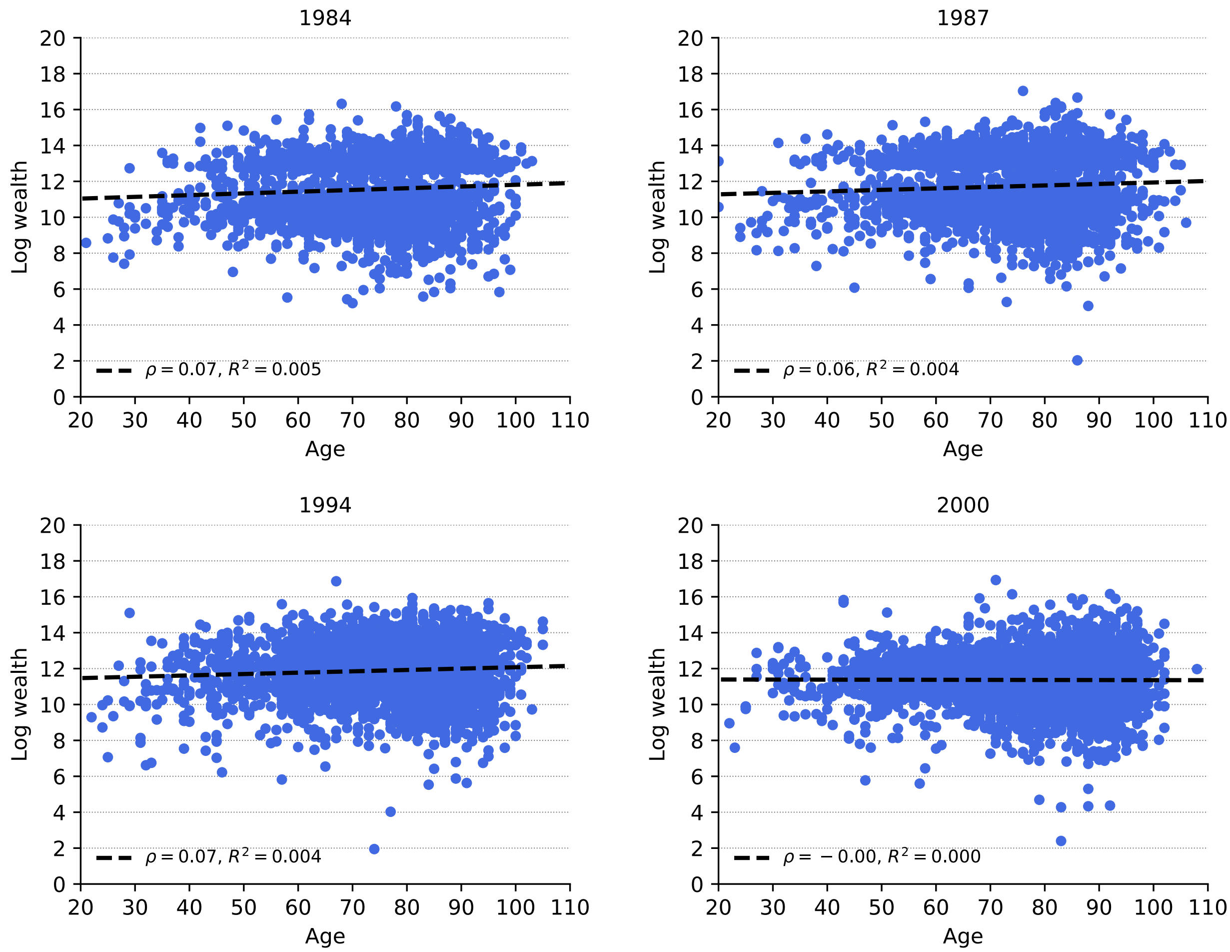

Figure 7: The relationship between age and wealth among the richest decedents in France in 1984, 1987, 1994, and 2000.

Notes: Each subplot is a scatterplot of the log wealth (measured in log of thousand French Francs) of decedents plotted against their age at death. The dashed black line is the linear line of best fit.

We note that a similar derivation to the comparison between top wealth shares (Equation (4.4)) can be used to compare the coefficient of variation (CV) of the wealth distribution with homogeneous and heterogeneous multipliers (see Appendix G). It clarifies the intuition for the result obtained for top shares above. In particular, it shows that the difference between the CV in the simplified approach and the classic multiplier methods is mainly driven by the multipliers at the top of the estate distribution. This supports the observation that a similarity between the multiplier at the top of the estate distribution and the average mortality multiplier would result in a similarity between the estimated concentration of wealth in both methods.

4.1 Accounting for multipliers graduated by wealth levels

Mortality rates are clearly influenced by demographic factors, such as gender and age. However, social and economic conditions can also exert a substantial influence on the longevity of individuals (Chetty et al., 2016). In particular, higher wealth levels may be systematically associated with lower mortality rates, over and above the effect of demographics and other factors. Failure to account for this additional source of heterogeneity in mortality rates may lead to systematic biases in the application of the estate multiplier method (Atkinson and Harrison, 1978; Saez and Zucman, 2016, 2020a). To account for the contribution of wealth to lower mortality over and above the effect of age, we use Italian estate tabulations from Acciari, Alvaredo and Morelli (2024) and apply mortality rate adjustment factors for wealth used by Garbinti, Goupille-Lebret and Piketty (2021).

The formalization described by Equation (4.4) is well suited to address this issue and explain the main findings. Accounting for the mortality-wealth gradient does, indeed, increase the covariance between the value of multipliers and the value of estates at the top of the estate distribution, all else being equal. This may create a positive association between estates and multipliers. At the same time, the gradient increases the average multiplier at the top, making it slightly higher than the average multiplier $\bar{m}$. This would, in turn, increase the difference $\bar{w}_{I_q} - \bar{w}_{qN_E}$, *i.e.*, make it closer to zero. We should also expect, therefore, that the top wealth shares derived via wealth-gradient multipliers will be higher than those derived through demographic multipliers alone.

The results are presented in Figure 8, where the derived series of top wealth shares using a mortality-wealth gradient is compared to those derived using the simplified multiplier approach, as well as when only using heterogeneous multipliers by demographic characteristics. The results show that a steep mortality-wealth gradient can have a salient effect on the top wealth shares.[14]

Nevertheless, as suggested above, the wealth effect on mortality can counterbalance the small negative correlation between multipliers and estates at the top. Combined, the wealth and age effects on mortality may lead to correlation that is very close to zero. If, indeed, the decreasing mortality of wealthy individuals is not accounted for, the correlation would be underestimated. At the same time, decreasing mortality by wealth acts to increase the

[14] We note that it is possible that the mortality-wealth gradient described in Garbinti, Goupille-Lebret and Piketty (2021) may not be representative of Italy.

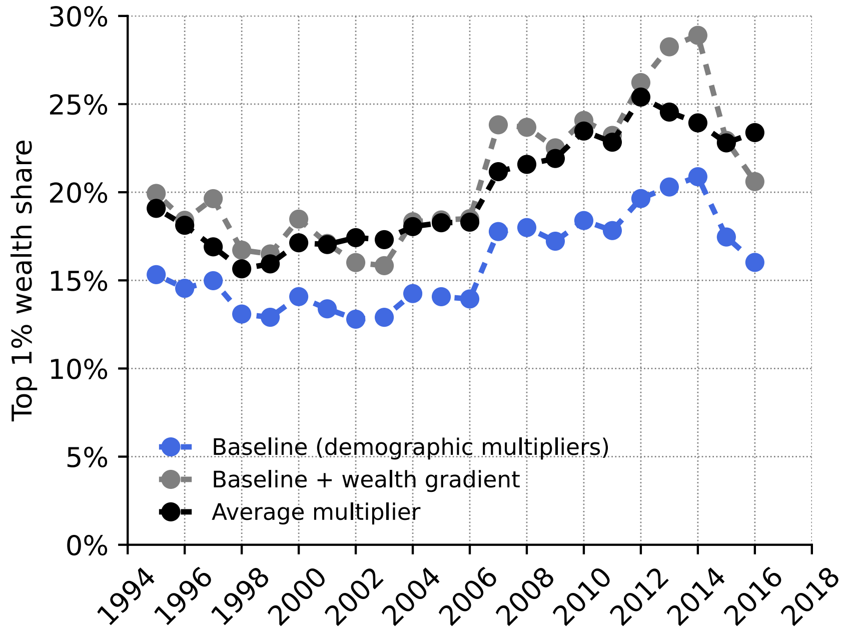

Figure 8: The top 1% wealth shares in Italy using different multiplier choices, 1995–2016.

Notes: Each series was estimated using a different choice of multipliers: heterogeneous demographic multipliers (blue); wealth-adjusted heterogeneous demographic multipliers (gray); average multiplier, *i.e.*, simplified multiplier approach (black).

life expectancy of older, wealthy individuals. This, in turn, leads to the decrease of the covariance between multipliers and estates at the top. For these reasons, a large positive covariance between estates and multipliers at the top, which will lead to large positive differences between the top wealth shares with and without heterogeneous multipliers, is implausible.

Figure 9 demonstrates these observations for Italy. It confirms the theoretical conditions for the top share similarity between the simplified multiplier approach and the estate multiplier method. The left panel displays the correlation between wealth at death and mortality multipliers among the top 1% of decedents. By definition, this correlation is zero when a homogeneous multiplier is applied, as in the simplified approach. In the standard estate multiplier method, the correlation is generally negative yet very small. After accounting for both demographic heterogeneity and economic heterogeneity in mortality, the correlation fluctuates between -0.04 and 0.04, without a clear trend over time. It averages at -0.008, with a standard deviation of 0.018 across years. This fits in with a low, potentially insignificantly-different from zero covariance in Equation (4.4). Moreover, the lack of trend is important as it indicates that the validity of the underlying assumptions is consistent over time.

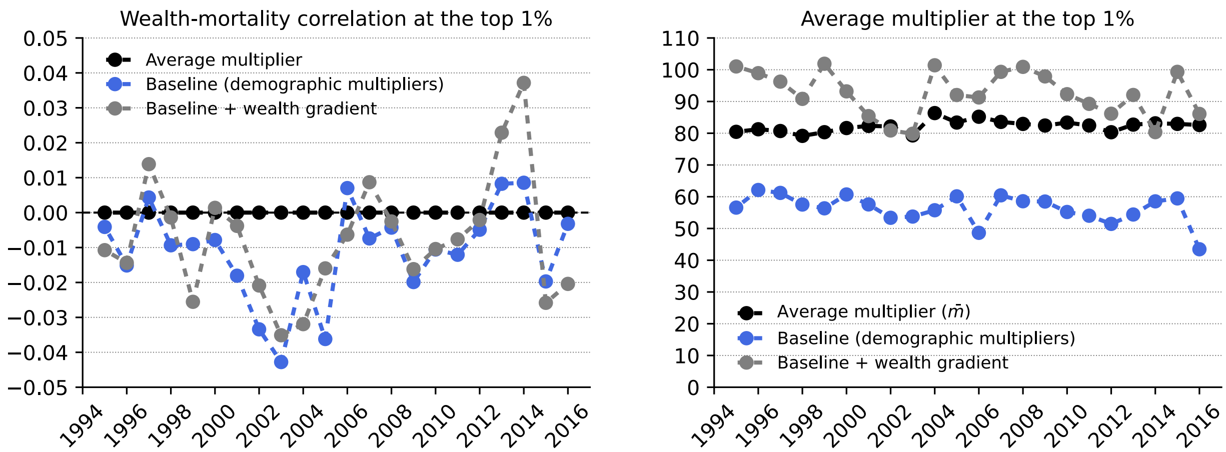

Figure 9: Confirming the theoretical conditions for the validity of the simplified multiplier apprach for Italy, 1995–2016.

Notes: Left) The correlation between mortality multipliers and estates at the top 1% of decedents by year, when taking into account demographic heterogeneity and economic heterogeneity in mortality (*i.e.*, using age and gender and applying a mortality-wealth gradient); Right) The average multiplier at the top 1% of decedents using different multiplier choices: heterogeneous demographic multipliers (blue); wealth-adjusted heterogeneous demographic multipliers (gray); average multiplier, *i.e.*, simplified multiplier approach (black).

The right panel in Figure 9 displays the average multiplier among the top 1% of decedents. In the simplified approach, this is simply $\bar{m}$, which changes only slightly over time. After accounting for both demographic and economic heterogeneity in mortality, the average multiplier among the top 1% is only 0%–20% higher than the average multiplier for the adult population. However, when accounting only for age and gender, the average multiplier among the top 1% is 30%–50% lower than that of the overall adult population. This suggests that, as expected, the wealth effect on mortality can counterbalance the demographics – the regularity that the wealthier individuals tend to be older on average.

Figure 8 also shows that the top wealth series derived using the simplified multiplier approach using average multipliers provides very similar results to those obtained by applying detailed multipliers by demographic and wealth status. That might not be surprising following similar results for other countries, as shown in Figure 2. Yet, this indicates that the wealth gradient of mortality rates reduces the mortality rates of the richest individuals, increasing multipliers. This means that wealth provides a mortality premium to older rich individuals. In turn, this leads to mortality multipliers at the top of the estate distribution that are close to the average multiplier in the overall adult population.

A further indication for the empirical validity of the underlying assumptions of the simplified approach can be shown using the Forbes 400 list of the richest 400 individuals in the United

States (Forbes Magazine, 2022). The list is a panel, so it is possible to identify attrition that is due to death. The list also provides knowledge on the age and gender of the included individuals. It is thus possible to compare the actual mortality rate of the richest 400 individuals, defined as the number of deaths of listed individuals in a given year divided by 400, to the average multiplier in the United States in the same year. Figure 10 presents this comparison. It shows that there is no clear trend over time in the wealth-mortality gradient.

It is also possible to compare the number of deaths in a given year predicted by the age and gender of listed individuals, to the actual number of deaths of listed individuals. Figure 10 shows that there are clearly less deaths than predicted by age and gender alone. This is due to the mortality premium of the very rich. Yet, the gap between the prediction, which does not take into account the mortality premium, and the actual number of deaths is relatively stable over time as observed in the case of Italy.[15]

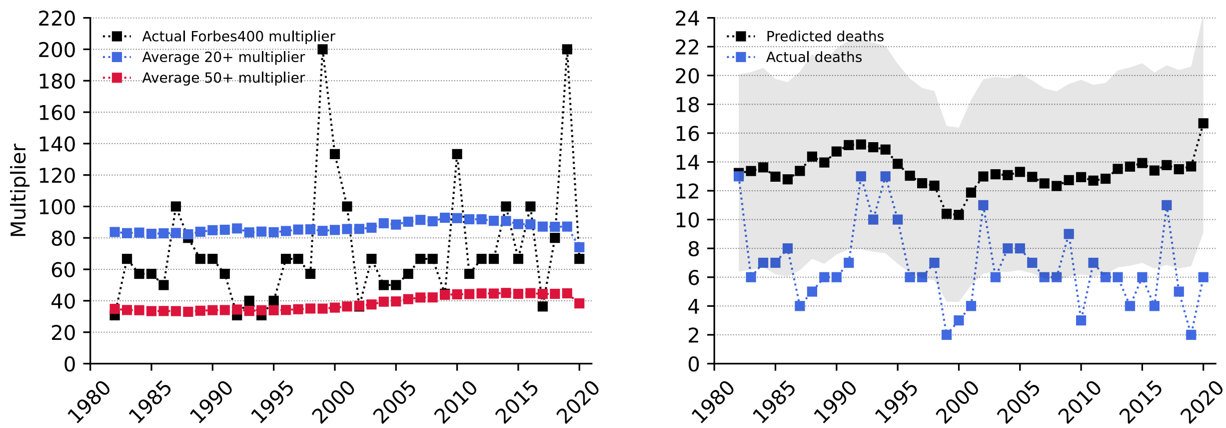

Figure 10: Mortality in the Forbes 400 list 1982–2020.

Notes: Left) The empirical multiplier of the richest 400 individuals in the United States (black), in comparison to the average multiplier in the overall population among all adults (blue) and among 50 year olds and older (red); Right) The number of annual deaths of individuals included in the Forbes 400 list (blue), compared to the predicted number of deaths (black). The prediction is done by considering individual mortality rates based on age and gender only. The shaded area represents 95% confidence bounds on the prediction, produced by bootstrapping.

4.2 The use of average and disaggregated multipliers: some caveats

The estate multiplier method, and, in particular, the application of a mortality-wealth gradient to the data, may give rise to several conceptual and practical issues. Such issues are not

[15] Additional evidence on the United States, in which the simplified approach can be compared to a variety of data sources with different estimates, was presented in Section 2.2.1.

commonly taken into account when the using the multiplier method. The mortality-wealth gradient leads to mortality multipliers among the wealthiest individuals that are higher than otherwise would be. This makes the resulting average wealth among the living higher than without applying the gradient. If the gradient applied is very steep, *i.e.*, if the health premium for wealth is very high, then μ, the ratio between the average wealth at death to the average wealth among the living, might be less than 1. $\mu < 1$ is a very unlikely case, implying that the decedents are poorer, on average, than the living. This is possible, in theory, if the rich are very unlikely to die, but that is an extreme case, rarely documented so far (see, for example, Alvaredo, Garbinti and Piketty (2017); Alvaredo, Atkinson and Morelli (2018)).

An additional potential issue with the application of a steep mortality-wealth gradient is an overestimation of total identified wealth. As described by Cowell (1978), referring to Atkinson and Harrison (1978), "though the particular refinement of mortality multiplier that is used considerably affects the calculation of total wealth, the resultant effect on top wealth shares is not all that great." This may be an issue if the coverage of the data is relatively high. If the coverage is particularly low, *e.g.*, in France or in the United States, the problem may be less visible, but might still exist and go unnoticed. This potential issue is easily visible from Equation (2.2). The total personal wealth W must be equal to the sum $\sum_{i=1}^{N_E} m_i w_{E,i}$, assuming perfect knowledge of the mortality multipliers m_i. Thus, if in practice m_i are not directly observed and a steep mortality-wealth gradient is assumed, it could be that $\sum_{i=1}^{N_E} m_i w_{E,i} > W$. Such a situation could be an indication that the mortality-wealth gradient applied is too steep.

Figure 11 demonstrates these issues for Italy. It shows the evolution of various variables under the estate multiplier method with different multiplier choices, and under the simplified multiplier approach. In particular, it shows that the mortality-wealth gradient used might be too steep in the Italian case, as it implies that μ is less than one for almost the entire period. Additionally, when including the mortality-wealth gradient (as well as when using the average multiplier), it is possible for the identified wealth to exceed the total personal wealth recorded in the national accounts. This could occur if the unobserved population (*i.e.*, the bottom share of the estate distribution not covered by the tabulations) has negative net wealth, although this represents an extreme scenario. These observations require verifying the validity of the mortality-wealth gradient applied.

Figure 11 also demonstrates that, in practice, even with a steep wealth gradient, the ratio $\frac{I_q}{qN_E}$ is greater than one. This confirms that when using the multiplier method, more than qN_E decedents are required to account for the top qN living individuals.

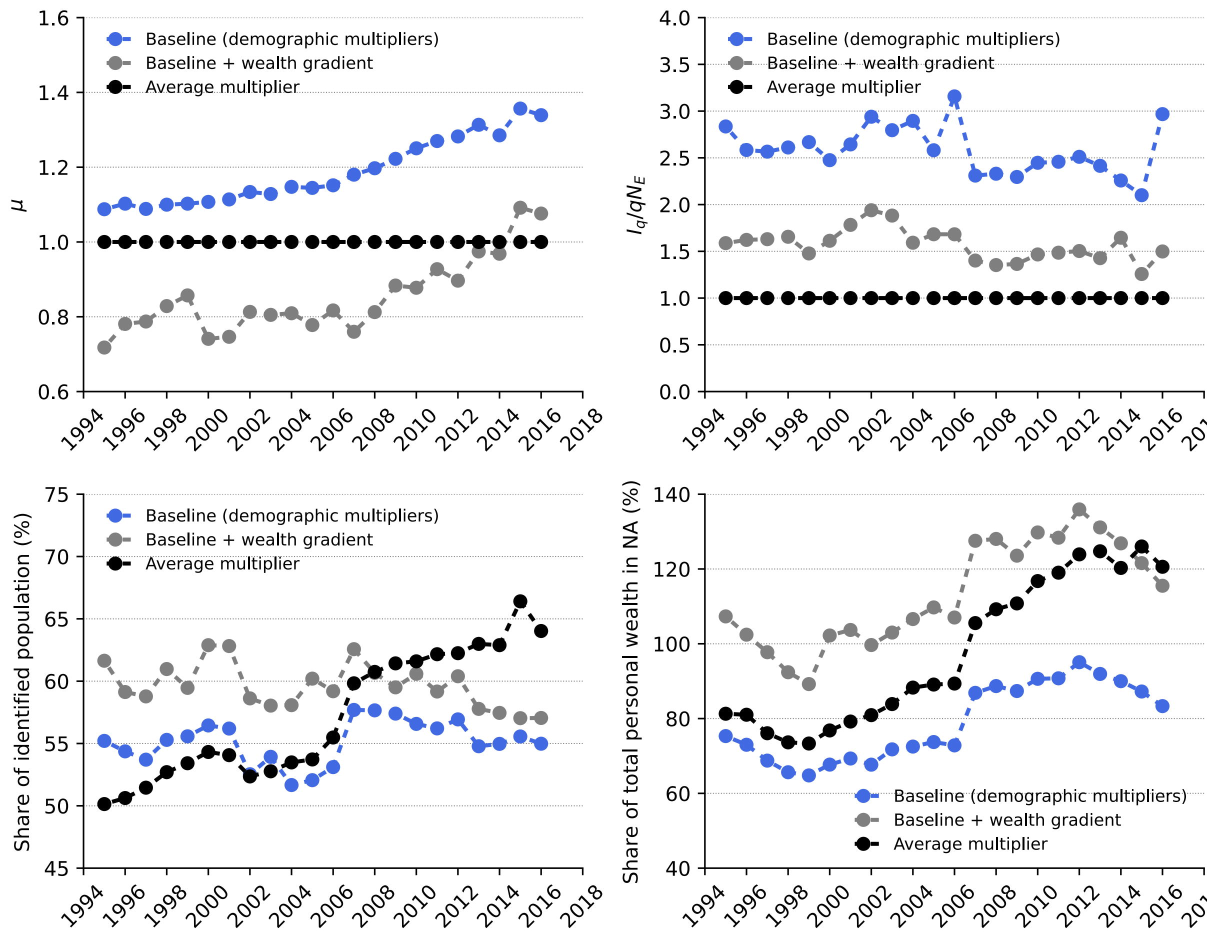

Figure 11: The evolution of key variables in Italy using different multiplier choices.

Notes: Top left) μ; Top right) $\frac{I_q}{qN_E}$; Bottom left) The share of identified population from total population; Bottom right) The identified wealth as share of total personal wealth from the national accounts. Mortality data are taken from the Human Mortality Database (2022), the estate tabulations and demographic data as well as the total personal wealth are taken from Acciari, Alvaredo and Morelli (2024). The mortality-wealth gradients used were those used for France in Garbinti, Goupille-Lebret and Piketty (2021).

5 Conclusion

Employing and assessing the implications of a simplification of the estate multiplier method, this paper contributes to the evolving literature on wealth distribution estimation, as well as on the important ongoing methodological debate surrounding the estate multiplier method itself.

On the one hand, the validation of the empirical finding that top estate and wealth shares co-move and have similar levels (Alvaredo, Atkinson and Morelli, 2018) can be crucial for the expansion of severely sparse data series on wealth distribution, both across countries and over time. Indeed, in the case of the United Kingdom, the close relationship between estate distribution and wealth distribution provides a strong measurement benchmark in order to extend the wealth concentration series back in time to 1895 and to fill in missing years. Similarly, construction of long series can become possible in other countries when the relevant information for the application of the mortality multiplier (*i.e.*, detailed estate tabulations or detailed mortality rates) method cannot be retrieved.

Inspired by these observations, we describe the application of a *simplified multiplier approach* requiring only inheritance tax tabulations organized by ranges of estates, and simple average mortality rates in the population. The approach thus unlocks a wide array of aggregate tabulations that were previously thought to be unreliable and unusable, as many countries have published detailed data on the distribution of estate taxes. These are only rarely accompanied by demographic characteristics such as age and gender, hence one cannot apply heterogeneous mortality rates. The simplified multiplier approach may be implemented in such cases for estimating historical trends of wealth concentration.

We first validate the simplified multiplier approach empirically using estate and inheritance tax data in six countries: Australia, France, Italy, South Korea, the United Kingdom, and the United States. In each case, we obtain series of top wealth shares. The series are then compared to existing estimates from the literature. The comparison reveals a striking similarity in trends, as well as in levels, in all countries. In some of the countries, the high similarity is persistent over many decades.

We then contribute to the empirical literature on wealth distribution providing novel long-run top wealth share series for Belgium, Japan, and South Africa, where estate data have not been exploited yet. Existing work on wealth inequality in these countries is very limited. To apply the simplified multiplier approach we use estate tax tabulations collected ad-hoc from archival data. This confirms the possibility that the simplified approach can expand the range of countries and time periods for which wealth inequality can be estimated. The number of countries where inheritance, estate, and gifts taxes were present at some point in the country's history is fairly large, encompassing more than a third of the countries in the world, including many low-income countries, and covering more than half of the world's population.

In analyzing the simplified approach more closely, we formulate closed-form expressions for top wealth shares under both the simplified and the classic approach (assuming perfect knowledge of individual multipliers). We are able to derive the conditions for which the application of the average multiplier in the simplified approach yields levels of wealth concentration that are similar to the levels with detailed multipliers.

We also study the specific case of Italy in greater detail. We begin by considering the case of heterogeneous mortality multipliers differentiated by demographic characteristics (*i.e.*, age and gender). This is an important starting point as mortality rates by age and gender generally map most of the variability in mortality observed in a country in a given year. Applying the estate multiplier method using the demographic multipliers yields a series of top wealth shares. Clearly, such a series could be somewhat biased since it does not take into account heterogeneity in mortality that is due to socio-economic characteristics. Accounting for this heterogeneity using the estate multiplier method creates a more accurate picture of mortality, and leads to a more realistic estimation of top wealth shares. Next, we compare these two series (with heterogeneous multipliers), to the top wealth share series resulting in the simplified approach, when using a homogeneous multiplier. We find that the latter series is very close to the top wealth shares obtained with heterogeneous multipliers if accounting for socio-economic characteristics. This, again, supports the validity of the simplified approach's assumptions.

We specifically discuss the relevance of unobserved heterogeneity in mortality rates, such as the potential wealth effect on mortality that is operating over and above the effect of demographic characteristics. Accounting for a mortality-wealth gradient would create a more accurate picture of mortality multipliers and hence lead to a more realistic estimation of top wealth shares. We find that the difference between the top wealth shares obtained with or without mortality-wealth gradients cannot be large under realistic assumptions and given the observed regularities of the interrelation between the wealth distribution and demographic characteristics. While the mortality-wealth gradient can be steep for younger age groups, it is not as steep for older age groups, as economic status does not counterbalance the biological limitations to human longevity. Therefore, adjusting the multipliers at the top of the distribution and taking into account the mortality-wealth gradient is muted by the fact that relatively older people are more represented among the richest decedents. Also, within the top of the estate distribution, there is only a weak dependence of age on wealth rank. As a result, the multipliers at the top may continue to be poorly correlated with wealth ranks, and may continue to be close to the average multiplier of the overall population.

This leads to the important finding that taking into account both demographic multipliers and mortality-wealth gradient yields very similar top wealth shares to those obtained using the average multiplier. Although individuals at the top of the estate distribution have higher mortality rates (as they are relatively older on average), this is counterbalanced by their higher economic status, which may lead to healthier lives and better medical care, reducing their probability to die, other things being equal. As a result, the differences between the mortality multipliers at the top of the estate distribution to the average mortality multiplier of the entire decedent population are small enough to create only a limited discrepancy between the two top wealth shares estimated with refined multipliers and the average multiplier.

We end with an important practical remark. Information about the wealth gradient of mortality rates is scarce, and we know little about how this gradient has evolved over time. In only a few cases, such as France and the United States during the last several decades, do we have some information about the income gradient of mortality and its trend. Hence, in practice, the application of a mortality-wealth gradient is surrounded with considerable uncertainty. Thus, applying such gradients may not necessarily be satisfactory. At the same time, applying an average multiplier to the entire decedent population, as we suggest, can also create a similar problem. For these reasons, we highlight the need to be careful and transparent when using the estate multiplier method and to make use of as much data as possible for consistency. Applying the population average multiplier to all decedents may indeed provide reliable estimates of top wealth shares, especially in a historical context. Yet, they still need to be taken with the necessary caution.

We also note that this paper operates under the assumption that the reported value of estates at death is reliable. However, in some instances, the estates recorded by tax authorities may be imprecise due to factors such as significant exemptions, tax evasion, or the effects of tax planning. In such cases, concerns regarding the use of mortality multipliers may be secondary to the broader issue of the estates' inaccuracy in reflecting the true personal wealth of the deceased. A more detailed discussion of these issues exceeds, however, the scope of this paper.

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A The concentration of estates at the top

As shown by Alvaredo, Atkinson and Morelli (2018), relying on unadjusted tax data on estate value can also be informative about the concentration of wealth at the top. To show that, we first need to define the top estate share of quantile q:

$$Sh_q^E = (1 - L_q)^E = \frac{\sum_{i=1}^{qN_E} w_{E,i}}{W_E} \,. \tag{A.1}$$

This requires summing the estates of the richest qN_E decedents and estimating the total value of estates of the full decedent population, W_E. However, the estimation of the latter is not trivial in practice, if not 100% of the decedent population is observed in the data. Estimating W_E requires the estimation of the total value of unobserved estates of the deceased excluded from the tax records, W_E^{exc}. This creates uncertainty in the top estate share estimates.

In practice, estimating W_E^{exc} can be done using the total wealth of the living population not represented by the re-weighted tax records (excluded population), $N^{exc} = N - \sum_{i=1}^{N_E} m_i$. The latter can be directly estimated from external sources of data, such as surveys or other administrative records, if the general identity of the excluded population could be inferred.

The total identified wealth is known through the multipliers and observed estate values:

$$W^{iden} = \sum_{i=1}^{N_E^{tax}} m_i w_{E,i} \,. \tag{A.2}$$

In the absence of heterogeneous multipliers this becomes

$$W^{iden} = \sum_{i=1}^{N_E^{tax}} \bar{m} w_{E,i} = \bar{m} W_E^{iden} \,. \tag{A.3}$$

The total excluded wealth is then

$$W^{exc} = W - W^{iden} \,. \tag{A.4}$$

At the same time

$$W^{exc} = \bar{m}^{exc} W_E^{exc} \,, \tag{A.5}$$

where $\bar{m}^{exc}$ is the average multiplier of the excluded decedents. $\bar{m}^{exc}$ can be estimated depending on how refined the demographic data and mortality data available are. If mortality by age and gender is available, it is possible to define a different multiplier for the excluded decedents in each age and gender:

$$m_{a,g}^{exc} = \frac{N_{a,g}^{exc}}{N_{E,a,g}^{exc}}\,, \tag{A.6}$$

where $N_{a,g}^{exc}$ is the number of living with age a and gender g not observed by the tax records, and $N_{E,a,g}^{exc}$ is the number of decedents with age a and gender g not observed by the tax records. In this case $\bar{m}^{exc}$ would be the average of all multipliers $m_{a,g}^{exc}$. Alternatively, in the absence of such data, $\bar{m}^{exc}$ can be defined as the ratio between the excluded living population and the excluded decedent population:

$$\bar{m}^{exc} = \frac{N^{exc}}{N_E - N_E^{tax}}\,. \tag{A.7}$$

It is clear that different sets of multipliers would lead to different estimates of W_E^{exc}. This leads to different total values of estates, which, in turn, leads to different top estate share estimates. In Section 4 we use this calculation to provide different estimates of top estate shares and compare them to top wealth shares reported in the literature.

B Which homogeneous multiplier?

For implementing the simplified multiplier approach one has to choose the homogeneous multiplier to be applied. The choice in the average multiplier of the adult population, $\bar{m}$, is only one possible choice. In the absence of detailed demographic data for the decedents included in the estate tax records, it is possible to use an approximation for their mortality multiplier to estimate the top wealth shares. Even when demographic data are available, homogeneous multipliers can simplify the estimation process. We list below several possible choices of a homogeneous multiplier and present the differences between them, and demonstrate their corresponding resulting top wealth shares in the case of Italy:

- m_1: A simple and natural choice of such a multiplier is the average multiplier $\bar{m}$, which is the ratio between the population size of the living and the dead. Considering such a multiplier makes an implicit assumption that the mortality rate of the observed decedents is similar to that of the unobserved decedents.

- m_2: If detailed demographic data are available, it is possible to take the arithmetic average of the individual multiplier m_i. m_2 is expected to be lower than m_1, since the average multiplier among the observed decedents tends to be lower than the average multiplier; however, this is not always the case.

- m_3: m_2 changes the identified wealth compared to the case in which the individual multiplier m_i is considered, because $\Sigma_i^{N_E} m_i w_{E,i} \neq \frac{\Sigma_i^{N_E} m_i}{N_E} \Sigma_i^{N_E} w_{E,i}$. Another possible choice of homogeneous multiplier would be a multiplier that is consistent with the identified wealth: $m_3 = \frac{\Sigma_i^{N_E} m_i w_{E,i}}{\Sigma_i^{N_E} w_{E,i}}$.

- m_4: If no demographic data are available, but mortality data are, it is possible to assume that the representative multiplier of the observed decedents is the multiplier that corresponds to an individual whose age is the average age at death, based on the mortality data. Typically, since this age is higher than the average age of decedents in the tax records, this multiplier will be substantially lower than the other choices of multiplier.

- m_5: The same m_2 but after adding a mortality-wealth gradient to the demographic data to obtain heterogeneous individual multipliers.

The evolution of these multipliers over time and the resulting top 1% wealth shares are presented in Figure B.1. The choice of a homogeneous multiplier matters for the estimated top shares. Yet almost all the options considered lead to levels of inequality that closely follow the results when heterogeneous multipliers are used.

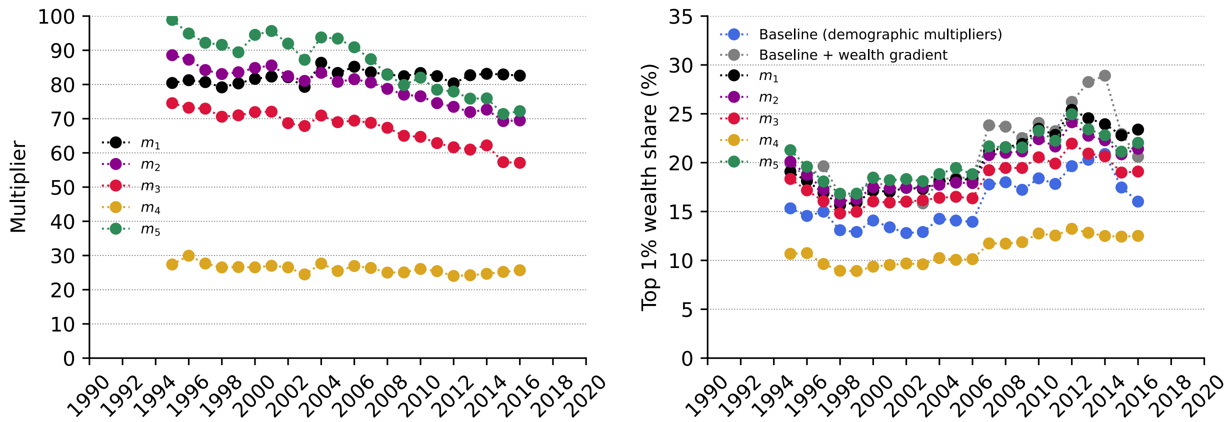

Figure B.1: Homogeneous mortality multipliers in Italy 1995–2016.

Notes: Mortality data were taken from the Human Mortality Database (2022), and the estate tabulations and demographic data were taken from Acciari, Alvaredo and Morelli (2024). The mortality-wealth gradients used were those used for France in Garbinti, Goupille-Lebret and Piketty (2021). The homogeneous multipliers used are: m_1—the average multiplier $\bar{m}$, the ratio between the population size of the living and the dead; m_2—the arithmetic average of the individual multiplier m_i; $m_3 = \frac{\Sigma_i^{N_E} m_i w_{E,i}}{\Sigma_i^{N_E} w_{E,i}}$; m_4—the multiplier that corresponds to an individual whose age is the average age at death, based on the mortality data; m_5 – the same m_2 but after adding a mortality-wealth gradient to the demographic data.

The major exception is m_4, the multiplier that corresponds to the average age of decedents in a given year. m_4 is much lower than the other suggested choices, as it effectively ignores the presence of younger decedents among the wealthiest decedents. As seen previously for France in Figure 7, top wealth groups include a significant presence of younger individuals. Since mortality rates are approximately exponential in age, the impact of these younger individuals on the most representative multiplier for decedents is, in fact, substantial.[16]

[16]This is a direct implication of Jensen's inequality for the exponential function:

$$e^{[E[a]]} < \mathrm{E}\left[e^{[a]}\right] , \tag{B.1}$$

where a is decedent age. Because the multipliers depend exponentially on age, the multiplier corresponding to the average age at death is much lower than the average multiplier. Had the dependence of the mortality rate on age been linear, for example, the two quantities would have been equal.

C Estate data coverage

Estate data usually represent only a share of the decedent population, with substantial heterogeneity across countries. Figure C.1 shows the share of the decedent population represented in the data in the group of countries analyzed in Figure 2.

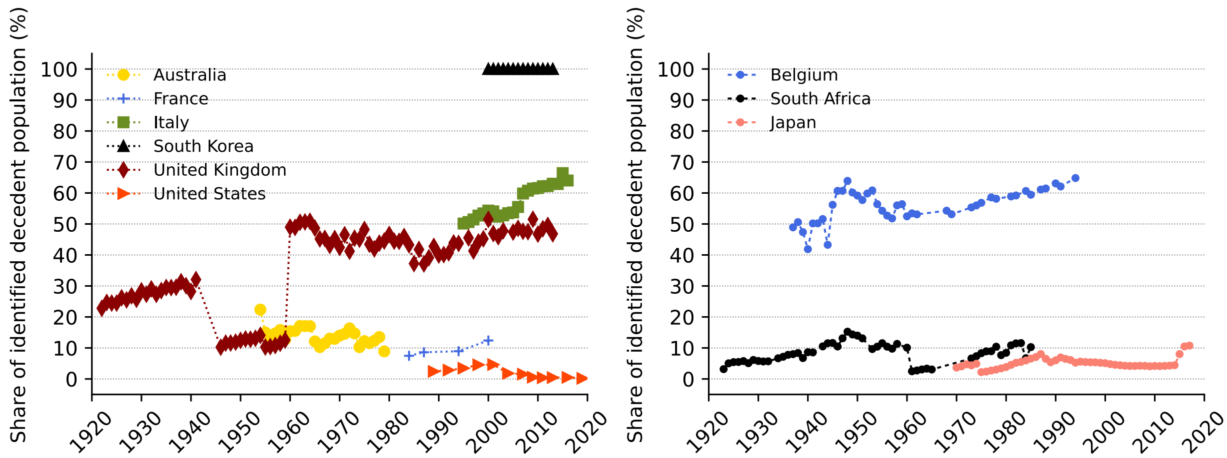

Figure C.1: The coverage of estate data in different countries.

Notes: Left) The share of decedents covered in the estate data in Australia, France, Italy, Korea, the United Kingdom, and the United States. The data were taken from Katic and Leigh (2016), Garbinti, Goupille-Lebret and Piketty (2021), Acciari, Alvaredo and Morelli (2024), Kim (2018), Alvaredo, Atkinson and Morelli (2018), and Saez and Zucman (2016), respectively, combined with mortality data from the Human Mortality Database (2022); Right) The share of decedents covered in the estate data in Belgium, South Africa, and Japan.

D Novel wealth inequality estimates for Belgium, Japan, and South Africa

The tables below detail the new top wealth series produced for Belgium, Japan, and South Africa in Section 3.

Table D.1: Belgium: Top wealth shares (% of total personal wealth)

	Top 10%	Top 1%	Top 0.1%	Top 0.01%
1937	81.16	47.15	20.66	6.04
1938	79.69	44.80	19.43	6.34
1939	80.01	45.22	20.74	4.68
1940	81.18	46.57	24.59	11.30
1941	78.64	42.26	15.45	3.78
1942	79.56	44.29	20.05	5.44
1943	77.97	40.73	15.07	4.30
1944	82.39	43.54	17.11	4.39
1945	74.94	39.00	14.81	4.05
1946	73.27	37.95	15.47	3.91
1947	74.56	40.82	18.12	5.96
1948	73.87	39.94	18.82	7.85
1949	71.72	35.19	14.50	3.67
1950	72.93	36.01	14.64	4.53
1951	72.26	35.76	14.23	4.20
1952	70.86	34.86	13.90	3.47
1953	70.42	35.17	14.68	5.08
1954	71.30	35.78	14.30	3.87
1955	73.12	38.78	16.55	5.09
1956	73.12	37.28	15.07	5.38
1957	72.97	36.89	15.62	6.21
1958	72.26	37.18	15.70	4.73
1959	72.31	38.11	18.87	11.84
1960	73.06	37.91	17.24	5.85
1961	72.98	38.55	17.76	7.71
1962	70.99	37.43	15.17	4.30
1968	69.44	31.96	12.47	3.34
1969	70.08	32.92	12.99	3.91
1973	66.77	29.21	11.06	3.73
1974	65.70	28.68	10.84	3.07
1975	64.19	26.25	8.34	1.97
1977	61.71	24.33	8.46	2.32
1978	61.08	23.54	7.71	2.23
1981	59.46	23.76	8.62	2.52
1982	56.94	21.17	7.38	1.65
1984	56.60	20.68	6.37	1.61
1985	57.06	20.76	6.64	1.76
1987	56.02	19.98	6.25	1.52
1988	56.74	22.03	8.32	3.15
1990	56.24	20.59	7.12	2.35
1991	57.16	21.30	7.14	2.27
1994	55.23	19.12	5.46	1.34

Table D.2: Japan: Top wealth shares (% of total personal wealth)

	Top 1%	Top 0.1%	Top 0.01%
1970	25.24	8.26	2.11
1971	29.34	9.58	2.53
1972	27.10	9.08	2.61
1973	28.35	9.08	2.57
1974	27.96	8.77	2.22
1975	27.49	8.77	2.60
1976	26.80	8.29	2.07
1977	26.50	8.29	2.18
1978	25.92	8.08	2.06
1979	24.04	7.09	1.67
1980	24.03	7.52	1.84
1981	26.27	8.18	1.98
1982	27.33	8.58	2.20
1983	27.40	8.81	2.40
1984	27.06	8.22	1.98
1985	28.18	8.82	2.20
1986	26.47	8.37	2.21
1987	26.66	9.02	2.67
1988	29.94	10.75	3.40
1989	35.17	13.52	4.31
1990	35.86	12.60	3.54
1991	43.91	15.35	4.37
1992	46.70	15.44	3.80
1993	41.31	13.31	3.41
1994	36.82	11.82	2.91
1995	35.34	10.86	2.61
1996	33.16	10.20	2.35
1997	31.92	10.11	2.78
1998	29.21	8.70	2.00
1999	27.93	8.49	2.17
2000	26.33	7.93	1.89
2001	26.61	8.56	2.54
2002	24.44	7.43	1.97
2003	23.42	7.02	1.59
2004	22.37	6.86	2.08
2005	22.09	7.10	2.21
2006	22.38	7.39	2.46
2007	22.22	7.21	2.22
2008	22.49	7.22	1.98
2009	21.92	6.84	1.83
2010	21.16	6.34	1.59
2011	21.14	6.76	1.99
2012	20.79	6.55	1.95
2013	22.12	8.21	3.52
2014	20.26	6.60	2.03
2015	20.07	6.59	2.04
2016	19.87	6.55	2.05
2017	19.81	6.70	2.41

Table D.3: South Africa: Top wealth shares (% of total personal wealth)

	Top 0.1% (internal total)	Top 0.1% (external total)	Top 0.01% (internal total)	Top 0.01% (external total)
1924	39.14	30.12	10.88	7.11
1925	39.22	31.59	12.36	9.08
1926	35.42	28.89	10.44	8.46
1927	37.46	32.25	15.46	13.37
1928	38.87	32.46	14.61	12.03
1929	36.70	32.29	13.29	11.51
1931	43.22	39.45	19.70	18.43
1932	41.18	36.43	15.94	14.15
1934	38.01	32.00	12.26	10.01
1935	35.77	31.38	11.31	9.68
1936	35.96	32.06	10.66	9.03
1937	39.83	37.05	17.44	16.36
1938	36.74	33.25	14.11	12.85
1939	37.56	31.76	14.36	11.91
1940	36.99	32.44	14.57	12.33
1941	38.28	32.75	15.34	12.92
1943	34.07	30.03	13.06	11.40
1944	30.26	27.25	10.54	9.34
1945	30.58	27.42	11.14	10.00
1946	32.45	27.56	11.46	9.38
1947	28.36	25.98	8.68	7.83
1948	26.42	25.88	8.34	8.14
1949	29.11	26.78	11.64	10.80
1950	30.12	27.00	10.53	9.41
1951	27.64	23.80	10.01	8.53
1953	23.17	18.33	5.58	4.08
1954	22.79	19.59	6.05	4.96
1955	22.03	19.77	7.12	6.41
1956	25.49	22.82	8.45	7.50
1957	23.17	19.24	6.20	5.21
1958	20.17	19.02	7.64	7.37
1960	21.13	19.08	4.87	4.23
1961	28.92	21.99	3.81	2.71
1962	27.92	22.89	5.50	4.35
1963	22.93	18.55	2.63	2.06
1964	22.86	20.14	2.90	2.49
1965	24.59	18.62	3.91	2.81
1973	23.18	23.91	6.62	6.84
1974	23.25	24.04	7.36	7.59
1975	19.57	20.31	4.47	4.71
1976	17.56	18.60	4.24	4.57
1977	17.69	18.73	3.98	4.26
1978	19.07	20.04	4.88	5.19
1979	23.80	21.40	7.43	6.69
1980	20.19	16.64	5.65	4.75
1981	19.93	17.61	6.16	5.48
1982	17.08	14.55	4.47	3.84
1983	20.27	17.51	6.05	5.10
1984	18.96	10.04	5.36	2.47
1985	20.06	13.99	6.39	4.65

E Imputation of total personal wealth

In Section 3, total wealth data for South Africa are unavailable for the years 1924—1949. To address this, we impute the missing values using national income data from the World Inequality Database (2022). For the years 1950–1985, where both national income and personal wealth data are available, we calculate the wealth-to-income ratio and extrapolate it back to 1924. The imputed personal wealth for each year t ($1924 \leq t \leq 1949$) is then obtained by multiplying the national income by the extrapolated wealth-to-income ratio. This method assumes a relatively stable relationship between total wealth and income over time.

To validate the imputation method, we apply it to the same years (1924–1949) in the United States, where actual personal wealth data are available for comparison. This comparison, shown in Figure E.1, reveals that the imputed and actual wealth series are closely aligned and follow the same trend. The imputed series is neither consistently higher nor lower than actual wealth, suggesting that while not directly estimated, the imputed values provide a reasonable approximation of total wealth. Additionally, the small differences between the two top share estimates in Figure 6 above further support the reliability of the imputation and the overall results.

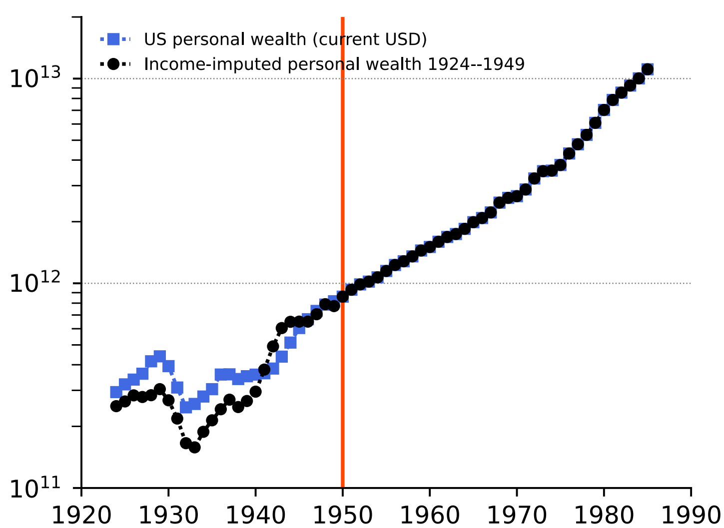

Figure E.1: Personal wealth in the United States 1924–1985.

Notes: The figure shows the actual personal wealth in the United States (blue) and the imputed series based on the national income and the back-extrapolation of the wealth-to-income ratio for the years 1924–1949 (black). After 1950, the two series are identical. Data are taken from the World Inequality Database (2022).

F Mortality rates by age

Age is the most important statistical determinant of mortality. Figure F.1 shows the mortality rates in France, Italy, the United Kingdom, and the United States in 1950, 1970, 1990, and 2010, based on the Human Mortality Database (2022) data. It illustrates that mortality rates increase exponentially with age above the age of 40.

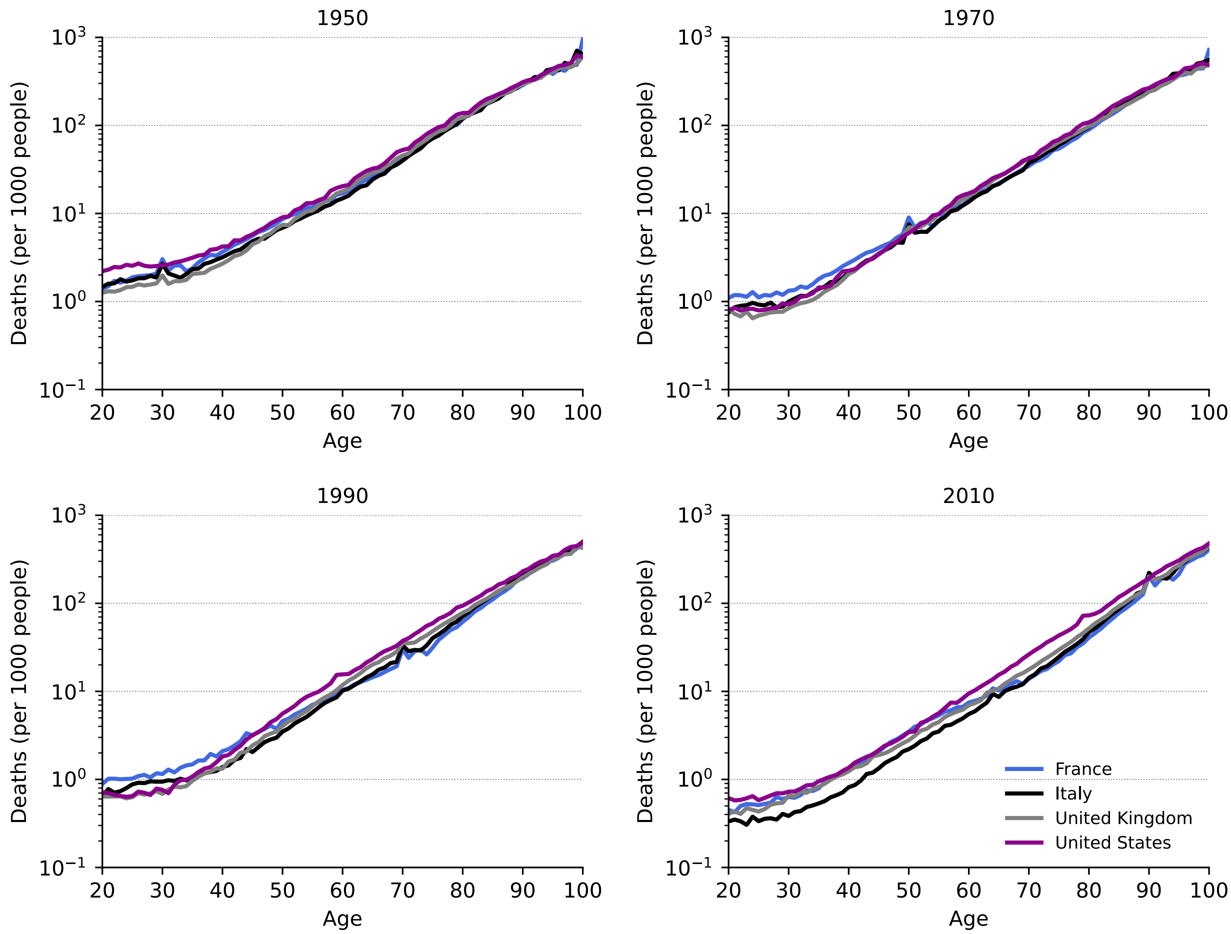

Figure F.1: Mortality rates in France, Italy, the United Kingdom, and the United States in 1950, 1970, 1990, and 2010.

Notes: Data are taken from The Human Mortality Database (2018).

G The coefficient of variation of estates and wealth

To illustrate the similarity between the concentration of wealth and of estates it is possible to compare the coefficient of variation (CV) of the wealth distribution with and without multipliers. The derivation is inspired by the one presented in Atkinson and Harrison (1978), comparing the CV between capital income and wealth from the capitalization method. It clarifies the intuition for the result obtained for top shares discussed in the paper. Yet it is conceptually simpler, since the index I_q does not play a role in the CV. It is also not limited to a specific quantile q, but involves the entire distribution.

The coefficient of variation of estates, denoted Y_E, follows

$$Y_E^2 = \frac{\sigma_E^2}{\bar{w}_E^2} \,. \tag{G.1}$$

The coefficient of variation of wealths, denoted Y_E, follows

$$Y_W^2 = \frac{\sigma_W^2}{\bar{w}_W^2} \,, \tag{G.2}$$

where σ_E^2 is the variance of estates, σ_W^2 is the variance of wealths, $\bar{w}_E$ is the average estate, and $\bar{w}_W$ is the average wealth.

We begin by writing down expressions for the variance estates and wealths:

$$\sigma_E^2 = \tfrac{1}{N_E} \textstyle\sum_{i=1}^{N_E} w_{E,i}^2 - \tfrac{1}{N_E^2} \left(\sum_{i=1}^{N_E} w_{E,i} \right)^2 ; \tag{G.3}$$

$$\sigma_W^2 = \tfrac{1}{N} \textstyle\sum_{i=1}^{N_E} m_i w_{E,i}^2 - \tfrac{1}{N^2} \left(\sum_{i=1}^{N_E} m_i w_{E,i} \right)^2 . \tag{G.4}$$

Therefore we get

$$Y_E^2 = \frac{\tfrac{1}{N_E} \sum_{i=1}^{N_E} w_{E,i}^2 - \tfrac{1}{N_E^2} \left(\sum_{i=1}^{N_E} w_{E,i} \right)^2}{\tfrac{1}{N_E^2} \left(\sum_{i=1}^{N_E} w_{E,i} \right)^2} \,, \tag{G.5}$$

and

$$Y_W^2 = \frac{\tfrac{1}{N} \sum_{i=1}^{N_E} m_i w_{E,i}^2 - \tfrac{1}{N^2} \left(\sum_{i=1}^{N_E} m_i w_{E,i} \right)^2}{\tfrac{1}{N^2} \left(\sum_{i=1}^{N_E} m_i w_{E,i} \right)^2} \,. \tag{G.6}$$

μ is the ratio between the average estate and the average wealth

$$\mu = \frac{\tfrac{1}{N_E} \sum_{i=1}^{N_E} w_{E,i}}{\tfrac{1}{N} \sum_{i=1}^{N_E} m_i w_{E,i}} = \bar{m} \frac{\sum_{i=1}^{N_E} w_{E,i}}{\sum_{i=1}^{N_E} m_i w_{E,i}} \,, \tag{G.7}$$

so

$$\frac{1}{N^2}\left(\sum_{i=1}^{N_E} m_i w_{E,i}\right)^2 = \frac{1}{\mu^2}\cdot\frac{1}{N_E^2}\left(\sum_{i=1}^{N_E} w_{E,i}\right)^2 , \tag{G.8}$$

and therefore

$$Y_W^2 = \frac{\frac{1}{N}\sum_{i=1}^{N_E}\mu^2 m_i w_{E,i}^2 - \frac{1}{N_E^2}\left(\sum_{i=1}^{N_E} w_{E,i}\right)^2}{\frac{1}{N_E^2}\left(\sum_{i=1}^{N_E} w_{E,i}\right)^2} . \tag{G.9}$$

We can then rearrange Y_W^2 and get

$$Y_W^2 = Y_E^2 - \frac{\frac{1}{N_E}\sum_{i=1}^{N_E} w_{E,i}^2}{\frac{1}{N_E^2}\left(\sum_{i=1}^{N_E} w_{E,i}\right)^2} + \frac{\frac{1}{N}\sum_{i=1}^{N_E}\mu^2 m_i w_{E,i}^2}{\frac{1}{N_E^2}\left(\sum_{i=1}^{N_E} w_{E,i}\right)^2} . \tag{G.10}$$

Taking $N = \bar{m}N_E$ we get

$$Y_W^2 = Y_E^2\left(1 + \frac{\frac{1}{N_E}\sum_{i=1}^{N_E}\left(\frac{\mu^2 m_i}{\bar{m}} - 1\right) w_{E,i}^2}{\sigma_E^2}\right) . \tag{G.11}$$

This result leads to several important observations that clarify the similarity between inequality of estates and of wealth. First, the difference between the CV of wealth and estates is mainly driven by the multipliers at the top of the distribution. This is because the difference $\left(\frac{\mu^2 m_i}{\bar{m}} - 1\right)$ is weighted by the level of estates. Thus, the similarity between Y_W and Y_E, like the top shares, mainly depends on the interaction between estates and multipliers among the richest decedents.

Second, there is a dampening effect that limits the extent to which Y_W and Y_E are distant from one another. If the multipliers at the top are high in comparison to the average multiplier then $m_i/\bar{m} > 1$. μ is then likely to be lower than 1. The inverse is true if $m_i/\bar{m} < 1$. This creates a dampening effect that makes the expressions $\left(\frac{\mu^2 m_i}{\bar{m}} - 1\right)$ in Equation (G.11) generally close to zero.

Third, comparing the coefficients of variation further demonstrates that the similarity in inequality measures between estates and wealth may not be limited to top shares, but also when full distributions are taken into account.