Government Consumption in the DINA Framework: Allocation Methods and Consequences for Post-Tax Income Inequality*

Lukas Riedel

ZEW Mannheim and University of Heidelberg

Holger Stichnoth†

ZEW Mannheim, University of Strasbourg, and IZA Bonn

May 1, 2024

Abstract

About half of government expenditure in the United States takes the form of government consumption (e.g., education, defense, infrastructure). In many studies of post-tax inequality based on the Dina framework (including the influential study by Piketty, Saez, and Zucman 2018), government consumption is allocated either proportionally to post-tax disposable income or on a per-capita basis, and the level of inequality is fairly sensitive to this choice. This paper provides direct evidence on how public education spending (a substantial part of government consumption) is actually distributed. An allocation proportional to post-tax disposable income is clearly rejected, while a lump-sum allocation is found to provide a good approximation.

Keywords: inequality, redistribution, education, in-kind transfers
JEL Codes: D31, H41, H52, I24

*We thank Christina Gathmann, Valentina Melentyeva, Sebastian Siegloch, Michaela Slotwinski, and David Splinter as well as seminar participants at Mannheim, Strasbourg, and ZEW, and conference participants at ECINEQ, IIPF, and Verein für Socialpolitik for valuable comments and suggestions. Hanne Albig and Lena Göhringer provided excellent research assistance.

†Corresponding author. ZEW Mannheim, Research Group Inequality and Public Policy. L7, 1 · 68161 Mannheim · Germany. holger.stichnoth@zew.de.

1 Introduction

The United States and many other countries have seen an increase in income inequality in recent decades that has received attention from academic researchers and the general public alike. However, while there is a broad consensus about the increase, there is a debate about its extent, in particular for post-tax income, i.e. income after taxes, transfers, and government expenditure (Auten and Splinter 2024; Bricker et al. 2016; Larrimore, Burkhauser, et al. 2021; Piketty, Saez, and Zucman 2018; Saez and Zucman 2020; Splinter 2020). The present paper contributes to this debate by showing that the level of post-tax inequality is fairly sensitive to assumptions regarding the allocation of government expenditure, and by providing evidence on the actual distribution of public education spending, an important part of government expenditure.

The measurement of income inequality has traditionally relied on micro data from surveys or administrative tax records. These data, however, capture only about 60% of macro totals from national accounts, so a substantial share of national income has been missing from the debate about inequality. In an important contribution, Piketty, Saez, and Zucman (2018) propose a method for constructing distributional national accounts (Dina) that measure how the entire national income is distributed among individuals. When computing post-tax income, this approach requires the allocation of the entirety of government expenditure to individuals. In recent years, about half of government expenditure in the United States has taken the form of government consumption (e.g., education, defense, infrastructure); depending on the year, this represents between 16% and 20% of national income.[1] In their main specification, Piketty, Saez, and Zucman assume that government consumption is distributed proportionally to post-tax disposable income, which corresponds to pre-tax income minus all taxes plus all individualized monetary transfers, but excluding in-kind transfers. This means that, by construction, an important part of national income is assumed to be distributionally neutral. The Dina Guidelines (Alvaredo et al. 2020) explicitly recognize the difficulty surrounding the allocation of government consumption, calling it "approximate and exploratory." As shown by Blanchet, Chancel, and Gethin (2022), Bozio et al. (2022), and Bruil et al. (2022), the level of post-tax inequality is fairly sensitive to this assumption. We confirm this for the US study by Piketty, Saez, and Zucman. When we replace their proportionality assumption with a lump-sum allocation, the Top 10% share of national income decreases by about 5 percentage points, while the share of the Bottom 50% increases by roughly the same amount.[2] As a result, the gap between the income shares of the Top 10% and

[1] See Appendix A for the definition and measurement of government consumption.

[2] Piketty, Saez, and Zucman (2018) themselves present a robustness check along these lines. However, they only allocate education spending on a different basis, not the remaining parts of government consumption. Moreover, they assign public education spending based on the number of children in the tax unit. This means that spending on tertiary education is typically allocated to the parents who claim their children as exemptions. As a result, the allocation is more regressive than when allocating the

the Bottom 50% is reduced by half, from about 20 to 10 percentage points in the most recent years.[3]

In light of this sensitivity, the contribution of the present paper is to provide direct evidence on how an important fraction of government consumption is actually distributed in the United States. We focus on public spending on education, which makes up about 30% of government consumption and 5% of national income in most OECD countries, and is much easier to assign individually than defense or infrastructure expenditure. Our paper is part of a series of recent studies on the allocation of in-kind transfers in the DINA framework (Insee 2021 for France, Bruil et al. 2022 for the Netherlands, Chatterjee, Czajka, and Gethin 2023 for South Africa, and De Rosa, Flores, and Morgan 2022 for Latin America).

Our data for the United States are from the 2017 wave of the American Community Survey (ACS). In addition to the large sample size (about 3.2 M individuals in 1.4 M households), the ACS has the advantage that participants are legally obligated to answer the survey questions. The ACS has information on whether household members are currently in education, and, importantly for our purpose, distinguishes between public and private institutions. Finally, the ACS includes individuals in group quarters, which is key for measuring public expenditure that goes to college students who no longer live with their parents. Annual public expenditure per student (net of tuition fees) at different levels of education is taken from the OECD.

We find that, for education at least, public expenditure is *not* proportional to income. On the contrary, average public education spending is highest in the poorest income decile and lowest in the richest decile. The Bottom 50% of the pre-tax income distribution receive an average of \$4.9 K per year in terms of public education spending, followed by the Middle 40% with \$4.7 K, and, as noted, the Top 10% with \$4.3 K. The differences are not great, however, so a lump-sum allocation provides a good approximation, at least when income is measured using the equal-split assumption of the DINA framework (i.e., household income is divided by the number of adults aged 20 and above).[4] When

expenditure to tax units of the students themselves, as we do in the present paper. Both approaches have their merits. However, we believe that allocating public education expenditure to the parents is a departure from the rest of their paper, in which they allocate all items of national income to tax units without taking economic links between these units into account. We will return to this point below. Finally, their robustness check does not take differences in per-capita expenditure between the different education levels into account.

[3] Our calculations are documented in Section A of the Appendix.

[4] Two caveats apply. First, the American Community Survey does not provide the comprehensive income measure that is the *raison d'être* of the DINA approach. While imputed rents tend to be concentrated at the bottom and middle of the income distribution and thus have an inequality-reducing effect, undistributed profits are concentrated among the higher deciles. The second caveat is that the ACS provides pre-tax income, while Piketty, Saez, and Zucman (2018) assume that government consumption expenditure is proportional to post-tax income. However, when we simulate post-tax income based on the ACS pre-tax measure and the NBER's TAXSIM model (Feenberg and Coutts 1993), we still clearly reject the proportionality assumption.

equivalized household income is used instead, the negative income gradient is steeper (i.e., the distribution is more progressive) and the approximation is less accurate.

These results are strongly driven by age effects. The most striking case are college students who no longer live with their parents. They receive substantial public expenditure while having low current income. [5] But public spending at other levels (pre-primary, primary, secondary) also has an age component, as parents with kindergarten- or school-age children are typically still below the peak of their age-income profiles.

Note that our analysis uses average expenditure per student at the national level and, in a robustness check, at the state level. While for primary and secondary education differences in average per-student expenditure between school districts are not large and U-shaped (with the richest and poorest districts spending the most, cf. De Brey et al. 2021), we cannot rule out that unobserved spending differences for tertiary education or, at all levels, within-district variation leads us to overestimate the progressivity of public education spending. However, we find such a strong departure from proportionality that these effects would have to be very large in order to justify the proportionality assumption.

In our second contribution, we examine two justifications for an allocation of government consumption proportionally to income that have been proposed in the DINA literature. Piketty, Saez, and Zucman (2017) argue for a proportional allocation by pointing to the positive correlation between public education spending and lifetime earnings. Using the American Community Survey and proxying for lifetime earnings using earnings at age 40–45 (where the rank correlation with lifetime earnings is maximal), we quantify this argument by showing that the 10% of individuals with the highest earnings have received average public education spending of \$335 K, about 1.4 times the amount that the bottom 50% received (\$234 K). The allocation is still not proportional to earnings, however; proportionality would require a factor of about 14. More importantly, adjusting for age effects in public education spending, but not in earnings, capital income, or certain cash transfers, would be inconsistent with the DINA framework, which so far has adopted a strictly cross-sectional perspective.

The DINA Guidelines (Alvaredo et al. 2020) argue that a lump-sum allocation would overestimate the extent of redistribution because of the unequal access to education observed in most countries. While the American Community Survey does not allow us to address this point, we use the Panel Study of Income Dynamics (PSID) to show that more public education spending indeed goes to children of more educated parents. On average, individuals with the most educated parents received about 30% more public education

[5] This result would be mitigated by assigning the spending on tertiary education to the parents even in cases in which the students no longer live at home. The data from the ACS do not allow us to do this, but even by shifting all spending on tertiary education from the first to the tenth decile (unlikely given that we consider only public education while private enrollment plays a large role in the top decile), the resulting distribution of public education spending would still be nowhere near a distribution that is proportional to post-tax disposable income.

spending than individuals with the least educated parents. However, while these intergenerational patterns are arguably more important than the cross-sectional results for the distributional debate, they again do not provide the right empirical basis for an allocation of government expenditure in the cross-section.

Related literature Following the paper by Piketty, Saez, and Zucman (2018) for the United States, the Dina approach has been applied to other countries. Garbinti, Goupille-Lebret, and Piketty (2018) study pre-tax income inequality in France using a Dina approach, and Bozio et al. (2022) extend this to post-tax income and compare France with the United States. Using a simplified approach, Blanchet, Chancel, and Gethin (2022) create distributional national accounts for the member countries of the European Union. Other applications of the Dina framework are for Austria (Jestl and List 2020), China (Piketty, Yang, and Zucman 2019), Germany (Bach, Bartels, and Neef 2021), the Netherlands (Bruil et al. 2022), and Sweden (Hammar et al. 2020). In a related effort, the OECD and Eurostat set up an expert group to disaggregate the household sector in the system of national accounts; see Zwijnenburg (2019) for a comparison with the Dina approach.

Our paper contributes to the discussion about methodological issues in the measurement of income inequality in the Dina framework and beyond. Note that we focus exclusively on the effect of government (in-kind) consumption and remain silent on the debate about issues in the measurement of pre-tax income, such as the allocation of business profits or untaxed pension income (Auten and Splinter 2024; Saez and Zucman 2020).[6]

There is a literature on the distribution of (in-kind) expenditure which precedes the Dina approach, dating back to Gillespie (1965). While a number of papers focuses on single countries—–typically the US or the UK (Gillespie 1965; Higgins et al. 2016; Horton and Reed 2010; Musgrave, Case, and Leonard 1974; O'Dea and Preston 2012; O'Higgins and P. Ruggles 1981; Reynolds and Smolensky 1977; P. Ruggles and O'Higgins 1981; Smeeding 1977; Wilson, Lambright, and Smeeding 2006)—–it is also common to compare several countries. Such comparisons are either made among selected high-income countries (Callan, Smeeding, and Tsakloglou 2008; Garfinkel, Rainwater, and Smeeding 2006; Smeeding et al. 1993) or across larger sets of OECD countries (Marical et al. 2006; Verbist, Förster, and Vaalavou 2012; Zwijnenburg, Bournot, and Giovannelli 2017). Education and health are by far the most common expenditure categories studied, followed by housing. The results of the studies that include education are, across the different countries, consistent with our results. In particular, none of the studies find that the allocation of public education spending is proportional to cash income. We contribute to this literature by using a much larger dataset that distinguishes between public and private

[6]There is a also a debate about measurement issues regarding wealth inequality, see Saez and Zucman (2016), Smith et al. (2019) and Saez and Zucman (2020).

education as well as different levels of education (pre-primary, primary, secondary, tertiary) and that includes students in group quarters, which is important for the allocation of public spending on tertiary education.[7] We also contribute by linking our findings to the Dina literature. In particular, we break down education spending by individualized income for adults age 20 and above, using the "equal-split" approach of Piketty, Saez, and Zucman (2018). Most non-Dina studies use equivalized household income instead, which we include as a robustness check. In independent work, Bruil et al. (2022) also study the distribution of education and other in-kind transfers using both the equal-split approach and the approach based on equivalized household incomes. Finally, while existing studies examine public spending in the cross-section, we additionally distinguish by lifetime earnings and by the socio-economic status of the parents.

This earlier literature has raised the important question of whether government in-kind expenditure should be measured at cost or should rather measure the increase in individual welfare that results from the expenditure (see O'Dea and Preston 2012, on this and other methodological issues). With an assignment based on cost, inefficiencies in the provision of public services show up as income, and there is no accounting for different needs of individuals. However, attempts to measure welfare instead of income or to account for different needs by adjusting equivalence scales (Aaberge, Bhuller, et al. 2010; Aaberge, Eika, et al. 2019; Aaberge, Langørgen, and Lindgren 2013; Paulus, Sutherland, and Tsakloglou 2010) depart from the Dina framework, which – following the practice in national accounts – measures government expenditure on a cost basis. Moreover, we see the issue of valuation as orthogonal to the question of correctly determining who receives the public expenditure in the first place.

The remainder of this paper is organized as follows. Section 2 describes the data and methods we use in our empirical study of how public education spending in the United States is actually allocated across the income distribution. Section 3 presents our results. We focus on the distribution in the cross-section, which is the perspective that has been adopted in the Dina literature, but also report the distribution by life-time earnings (proxied for by earnings at age 40–45). Finally, in a supplementary analysis based on PSID data, we study how public education expenditure varies by parents' educational attainment. Section 4 concludes.

[7]In their study of Brazil and the United States, Higgins et al. (2016) also use a large dataset, the Current Population Survey (CPS). However, the CPS allows no distinction between enrollment in private and public institutions. The authors therefore rely on the American Community Survey (ACS), but unlike us only in a supplementary role, i.e. they predict private vs. public enrollment based on the ACS and then merge this information into the CPS. Moreover, they do this only for primary and secondary education, although private enrollment also plays an important role in tertiary education. They also do not capture individuals living in group quarters such as college dormitories. Our in-depth look at education in the United States therefore complements their broader focus on several types of social spending in two countries.

2 Methods and Data

2.1 Overview

Given that the level of post-tax income inequality is sensitive to the assumption about how government consumption is allocated, we provide direct evidence on how an important part of this expenditure is actually distributed. We focus on public spending on education, which makes up about 5% of national income in the US and in most OECD countries and is much easier to assign individually than defense or infrastructure expenditure.

Our method for allocating public education expenditure is straightforward. We use a micro dataset—the American Community Survey 2017—that allows us to observe the income of the household and that has information on who in the household currently attends a *public* educational institution, distinguishing pre-primary, primary, secondary, and tertiary education. We then multiply the number of students per household with the average public expenditure for students of the respective education level, which we take from the OECD's "Education at a Glance" database. In a robustness check, we use state-level expenditure data from the National Center for Education Statistics (De Brey et al. 2021), which has only small effects on our results.

Following the Dina framework, our main analysis is cross-sectional, i.e. we study the distribution of public education expenditure by current income. In addition, we analyze public education expenditure by lifetime earnings, proxied for by earnings at age 40–45. However, based on another dataset—the Panel Study of Income Dynamics, PSID (Survey Research Center 2022)—we also adopt an intergenerational perspective and document how the expenditure differs by parents' education and occupational prestige.

2.2 American Community Survey

Our main source of individual-level microdata is the American Community Survey (ACS). The ACS is conducted by the United States Census Bureau to collect information similar to the decennial census. Our data for the year 2017 is from the public use file of the ACS provided by IPUMS USA (S. Ruggles et al. 2020). It provides information on around 3.2 M individuals in 1.4 M households. In addition to the large sample size, the ACS has the advantage that—unlike in other datasets such as the Current Population Survey—respondents are legally obligated to answer the survey questions.

Enrollment The ACS has information on whether household members are currently enrolled in an educational institution, and, importantly for our purpose, distinguishes between public and private institutions.[8] Moreover, the ACS includes individuals in group

[8] The ACS has no information on the field of study for students who are currently enrolled in higher education (the information is only available for completed degrees), which means that we cannot take

quarters including college dormitories, which is key for measuring public expenditure that goes to college students who no longer live with their parents.

The ACS provides a very accurate picture of the number of individuals enrolled in the education system (Figure C.1 in the Appendix). For public institutions at the pre-primary, primary, and secondary levels in 2017, our own calculations based on the ACS result in 51.4 M students. The OECD (OECD Statistics 2020) and the National Center for Education Statistics (De Brey et al. 2021) report values of 50.6 M and 50.7 M, respectively. At the tertiary level, our ACS number is 16.8 M, which is a little higher than the value of 14.6 M reported by the OECD and the NCES.[9] For completeness, Figure C.1 also shows the number of students in private education, although we do not include these students when allocating public education expenditure. Private education is empirically relevant only at the pre-primary level (kindergarten) and then again at the tertiary level. Our ACS numbers are again close to the OECD values, while the numbers reported by the NCES are slightly lower.

Income concept Income is measured in the ACS as the aggregate of personal income from different sources over all household members above the age of 15. For individuals in group quarters, such as students in college dormitories, the concept of household income does not apply and only personal income is reported. Income in the ACS is pre-tax and post-cash-transfer.[10] The period of reference for the income measurement are the previous twelve months. Note that, as the ACS is administered throughout the year, this means that the income in most cases does not correspond to a calendar year. Also, despite the legal obligation to answer the survey, some of the individual income components are actually imputed by the data provider. In a robustness check, we drop all households in which more than half of household income is based on an imputation.

Regarding the comparison with the Dina approach, two additional caveats are in order. First, while the American Community Survey provides a fairly comprehensive measure of income, it falls short of the Dina approach, in which pre-tax income sums up to

into account differences in per-capita spending between students in science, technical or vocational tracks relative to humanities programs.

[9] In a robustness check, we scale down the ACS numbers accordingly.

[10] "Personal income, or 'money income,' as per the Census Bureau, is the income received on a regular basis (exclusive of certain money receipts such as capital gains and lump-sum payments) before payments for personal income taxes, Social Security and Medicare taxes, union dues, etc. It includes income received from wages, salary, commissions, bonuses, and tips; self-employment income from own nonfarm or farm businesses, including proprietorships and partnerships; interest, dividends, net rental income, royalty income, or income from estates and trusts; Social Security or Railroad Retirement income; Supplemental Security Income (SSI); any cash public assistance or welfare payments from the state or local welfare office; retirement, survivor, or disability benefits; and any other sources of income received regularly such as Veterans' (VA) payments, unemployment and/or worker's compensation, child support, and alimony." (`https://www.pewresearch.org/social-trends/2018/07/12/methodology-15/`). The income components such as wage or business income are top-coded at the 99.5^{th} percentile of the respective federal state. Higher values are coded as the state-specific average of all values above the threshold.

the whole of national income. While imputed rents tend to be concentrated at the bottom and middle of the income distribution and thus have an inequality-reducing effect, undistributed profits are concentrated among the higher deciles. The second caveat is that the ACS provides pre-tax, post-cash-transfer income, while Piketty, Saez, and Zucman (2018) assume that government consumption is proportional to post-tax disposable income, i.e. post-tax, post-cash-transfer income. However, when we simulate post-tax income using the NBER TAXSIM model, we still clearly reject the proportionality assumption.[11]

Unit of measurement In our main specification, we follow Piketty, Saez, and Zucman (2018) and the other Dina studies and measure income and transfers at the level of adult individuals aged 20 and above. For couples, we apply an equal-split rule, i.e. each adult gets assigned the same share of household income, while children are disregarded.[12] We apply this rule also in cases in which there are more than two adults in the household (e.g., children over 20 or other relatives). This equal-split approach departs from most of the established inequality literature (see Section 1). Often, the household is used as the unit of measurement with equivalence scales accounting for differences in household size and age composition. Common choices to equivalize household income are the square root scale (e.g., Congressional Budget Office 2023) or the modified OECD scale which we use as a robustness check. It assigns a value of 1 to the first adult in the household, of 0.5 to each additional household member aged 14 and above, and of 0.3 to each child below the age of 14.

Summary statistics Table 1, panel A, shows summary statistics for our main sample of adults age 20 and above. These represent about 2.4 M, or 75% of the 3.2 M individuals—adults and children—in the ACS. The average age in our sample is 48.4 years. Age is highest in the second and tenth deciles and first falls and then rises in the deciles in between. The first decile is not part of this U shape and stands out for having the lowest

[11]TAXSIM (Feenberg and Coutts 1993) simulates the tax liability for federal, state, and payroll taxes. We use TAXSIM version 32 (`https://users.nber.org/~taxsim/taxsim32/`). The simulations are for tax units, which we identify in our ACS household sample following the procedure outlined by Samwick (2013). We assume that all married couples file jointly.

[12]Unlike Piketty, Saez, and Zucman (2018), who use tax return data, we do not use the tax unit, but the household as the starting point. While tax return data has advantages over survey data, measuring inequality at the level of tax units is limiting, given that the household is arguably the more relevant sharing unit. Larrimore, Mortenson, and Splinter (2021) propose a method of identifying households in US tax return data. They show that cases with more than one tax unit per household are quite frequent, and that tax-unit based measures of inequality are found to be higher than those based on households. Ideally, we would do a similar exercise in reverse and identify tax units in our household data, in order to capture cases in which children living on their own still show up as dependents in their parents' tax declaration. These cases are particularly relevant for college students and thus matter for the allocation of public education expenditure. Unfortunately, the ACS data does not allow the reconstruction of tax units, however. In our analyses, we therefore treat individuals aged 20 either as their own economic units (if they no longer live with their parents) or assign public education spending to their parents (if they still live in their parents' household).

average age.

The first and the tenth deciles have the smallest household size on average (2.70 and 2.71). In between, the pattern is an inverted U, with a maximum of around 3.20 in deciles three and four. The differences in household size are mostly driven by the number rather than the presence of children. With the exception of the first decile, where the share of adults with children is not only much lower than the average but also noticeably less than in the decile just above, there is little variation in this share across the other deciles, with a slight increase towards the upper range of the income distribution. The age of the youngest child likewise increases with income. The same patterns with respect to age and household composition also hold when grouping individuals based on their post-tax disposable income (panel B).

Turning to the income measures themselves, the mean value of pre-tax income in our ACS sample for the year 2017 is \$43.9 K per adult, and the median is \$32.2 K. Our median is reasonably close to the value of \$36.0 K reported by Piketty, Saez, and Zucman (2018) for 2014, while our mean is much lower than the \$64.6 K that they find using their more comprehensive measure of income (see Figure A.1 above). For the mean, we can also compare the values by decile. The difference is mostly driven by the richest decile, where the average reported by Piketty, Saez, and Zucman is almost twice as high as the one we compute based on the income concept from the American Community Survey, which does not include imputed rents and undistributed profits (and additionally is right-censored).

Note that the income values in the first decile are very low, with a median of \$6.3 K and a mean of \$5.6 K per year. In the study by Piketty, Saez, and Zucman, the mean is even lower at \$1.3 K.[13] Like them, we find a number of zero or even negative values in the ACS data. In our case, the zeros are often for young adults who report receiving private transfers, which are not part of the standard ACS income measure that we use. When dropping the negative values or all values below the 1st percentile, the results regarding the income-gradient of public education spending are essentially unchanged.

For post-tax disposable income, we find a mean of \$32.7 K and a median of \$26.3 K based on the ACS data and our simulation using TAXSIM. Piketty, Saez, and Zucman have a mean of \$46.5 K. The difference again arises in the upper half of the income distribution, especially in the top decile. For the bottom 50%, where undistributed profits play not much of a role, our ACS + TAXSIM measure is fairly close to what Piketty, Saez, and Zucman find. With the exception of the bottom decile, our numbers are a bit lower than theirs even for this group, however, despite our use of a more recent year (2017 vs. 2014).

[13] The low values obtained by Piketty, Saez, and Zucman (2018) for the first decile could be the result of their treatment of net operating business loss carryovers. Auten and Splinter (2024) argue that these carryovers should not affect current-year income and that adjusting for them can change the position of individuals in the income distribution substantially.

Table 1: Summary Statistics

	Decile										Total
	1	2	3	4	5	6	7	8	9	10	
A. Pretax income											
Annual Income (Median)	6.3	13.1	18.5	23.8	29.3	35.5	43.2	53.5	70.0	118.0	32.2
Annual Income (Mean)	5.6	13.1	18.5	23.7	29.3	35.6	43.4	53.7	71.0	147.2	43.9
Annual Income (Mean, PSZ)	1.3	9.6	16.0	23.0	31.1	41.3	53.6	69.6	96.8	303.9	64.6
Household Size	2.70	3.10	3.19	3.20	3.12	3.08	2.97	2.86	2.79	2.71	2.97
Children in HH (0/1)	0.30	0.35	0.37	0.37	0.36	0.37	0.37	0.38	0.39	0.40	0.37
Age	46.8	50.3	49.3	48.7	48.1	47.7	47.3	47.4	48.2	50.1	48.4
Age Youngest Child	7.4	7.4	7.6	7.9	8.2	8.3	8.3	8.5	8.7	8.8	8.1
B. Posttax cash income											
Annual Income (Median)	6.3	12.5	16.8	20.6	24.6	28.9	34.0	40.3	50.2	78.6	26.7
Annual Income (Mean)	5.6	12.5	16.8	20.7	24.6	28.9	34.0	40.4	50.7	95.8	33.0
Annual Income (Mean, PSZ)	3.5	11.9	17.4	22.4	27.5	33.5	40.8	50.5	66.8	190.3	46.5
Household Size	2.63	3.08	3.21	3.24	3.14	3.07	2.96	2.89	2.79	2.70	2.97
Children in HH (0/1)	0.25	0.33	0.38	0.39	0.38	0.38	0.37	0.39	0.39	0.39	0.37
Age	46.7	49.1	47.7	47.4	47.8	47.9	48.1	48.3	49.5	51.4	48.4
Age Youngest Child	7.8	7.6	7.5	7.6	8.0	8.2	8.3	8.4	8.6	8.9	8.1

Notes: The table shows summary statistics for our estimation sample with respect to income and household composition. With the exception of the final column (which is for the sample as a whole), the columns report values within deciles. The cells report mean values; in one case (annual income), the median is shown as well. The income measures are compared with the values reported by Piketty, Saez, and Zucman (2018). The upper panel divides adult (aged 20 and above) into deciles based on their pre-tax income. In the lower panel, the deciles are based on post-tax disposable income instead. Pre-tax income is taken directly from the ACS, while post-tax disposable income is simulated using TAXSIM. Source: Own calculations based on the American Community Survey 2017. For comparison with the Dina approach, in households with more than one adult, household income is divided by the number of adults (equal-split). The income reported in the table is annual income in thousand US Dollars. N=2,375,184 adult individuals (aged 20 and above). For the sake of presentation and given the large sample size, standard errors are omitted. HH: Household. PSZ (Piketty, Saez, and Zucman 2018): Pre-tax income from Appendix Tables II-B4 (deciles 1-9, computed as the average over percentiles 0-9, 10-19 etc.) and II-B3 (overall mean and decile 10). Post-tax cash income from Appendix Tables II-C4b (deciles 1-9, computed as the average over percentiles 0-9, 10-19 etc.) and II-C3e (overall mean and decile 10). Piketty, Saez, and Zucman report averages for post-tax disposable income by percentile of post-tax income (including non-cash transfers), while the averages for post-tax disposable income in our ACS data are computed for deciles of post-tax disposable income only, because the focus of our paper is to probe the assumption that the non-cash componenents (in our case, education) are distributed proportionally to post-tax disposable income. However, as Piketty, Saez, and Zucman allocate non-cash transfers proportionally to post-tax disposable income, the deciles for post-tax disposable income and post-tax income should coincide in their case.

2.3 Public Expenditure on Education

Per-student values Annual public expenditure on education in the United States in 2017 is taken from the OECD's "Education at a Glance" database (OECD Statistics 2020), subsection "Educational finance indicators". The information is available for different levels of education, based on the ISCED 2011 classification (Table 2). Total public expenditure in 2017 is \$56 B at the pre-primary level (ISCED 0), \$296 B at the primary level (ISCED 1), \$328 B at the secondary level (ISCED 2–3), and \$308 B at the tertiary level.[14] Note that this is public expenditure net of tuition paid, which is important especially in the US context. In line with the practice of national accounting and the DINA approach, public expenditure is valued at cost, as opposed to the valuation that students or their parents put on this expenditure, which is much more difficult to measure.

The numbers are for "all expenditure types" in the OECD nomenclature. This includes both current expenditure (a large share of which are salaries and wages) and capital outlays, but excludes R&D as well expenditure for ancillary services. R&D expenditure is relevant only at the tertiary level, where it amounts to \$37 B in 2017. As part of our robustness checks, we use both a narrower (only current expenditure) and a broader (all expenditure types plus R&D and ancillary services) definition of public education spending. This has little effect on the results, which are mostly driven by differences in enrollment across the income distribution.

The OECD calculates expenditure per student on the basis of full-time equivalents. In these calculations, students in part-time education—relevant only at the pre-primary and the tertiary level—are assumed to represent one-third of a full-time equivalent. Since we do not observe part-time student status in the ACS, we assign the expenditure per full-time equivalent to all students.

Public per-student expenditure in 2017 is around \$13 K at both the pre-primary and the primary level and slightly higher (\$14.5 K) at the secondary level.[15]

At the tertiary level, expenditure per student is \$29.1 K. This is an average over 2-Year and 4-Year colleges. As part of our robustness checks, we try to distinguish between the two categories. While the annual per-student expenditure can be calculated by going back to the NCES data on enrollment and expenditure, which is more detailed than what the OECD provides, there is no information in the ACS on the type of college. However, the ACS distinguishes between undergraduate studies on the one hand and graduate and professional schools on the other. In a robustness check, we assign all graduate students to 4-Year colleges, and randomly assign undergraduates to either 2-Year or 4-Year colleges, based on the relative importance of the two types as reported by the NCES.

[14] We abstract from post-secondary non-tertiary education, where annual public expenditure in 2017 is a mere \$1.2 B.

[15] The distribution of funds among the ISCED levels 0, 1, 2, and 3 are estimated by the OECD. The National Center for Education Statistics (De Brey et al. 2021) reports only a single value for these levels.

Table 2: Public Expenditure on Education

	Per student ($ K)	Total ($ B)			
	OECD	ACS	OECD	NCES	NIPA
Pre-primary	13.0	38	56	n.a.	n.a.
Primary	13.0	283	296	n.a.	n.a.
Secondary	14.5	384	328	n.a.	n.a.
Sum	.	705	681	681	666
Tertiary	29.1	488	308	335	288
Total	.	1,192	990	1,016	954

Notes: The table reports the per-student values for annual public expenditure on education (net of tuition fees) that we use in our calculations (column 1) and the aggregates that we find when combining these values with our ACS enrollment data (column 2). These aggregates are compared with statistics published by the OECD, the National Center for Education Statistics (NCES), and National Accounts (NIPA). Sources: OECD: OECD Statistics (2020). Post-secondary non-tertiary education (ISCED level 4) is negligible and omitted for simplicity. OECD per-student expenditure is for full-time equivalents. The OECD assumes that part-time students receive one-third of a full-time equivalent. The distinction between full-time and part-time is only relevant at the pre-primary and the tertiary levels. ACS: Own calculations based on enrollment as observed in the American Community Survey 2017, combined with the per-student expenditure numbers of the OECD. NCES: National Center for Education Statistics, Digest of Education Statistics 2019 (De Brey et al. 2021), Table 236.10: Summary of expenditures for public elementary and secondary education and other related programs, by purpose: Selected years, 1919-20 through 2016-17. NIPA: Table 3.16. Government Current Expenditures by Function (Data published on March-26-2021 in connection with the Third estimates for 2020 Q4). NIPA Codes: Total: G16029; Elementary and secondary: G16030; Tertiary = Higher (G16031; $195 B) + Libraries (G16032; $13 B) and Other (G16033; $81 B).
Remarks: (1) The US national sources only report aggregates for elementary and secondary education. The breakdown into pre-primary, primary, and secondary is estimated by the OECD. (2) Piketty, Saez, and Zucman (2018) report a lower value for education spending, which corresponds to current expenditure only (NIPA code G17019). The value reported in their paper is $762 B in 2014 (see Section A above). The NIPA value for 2014 has since been updated to $789 B. In the 2020 update of their analysis, Piketty, Saez, and Zucman use the same measure that we employ in this paper (NIPA Code G16029) and report values of $884 B for 2014 and $956 B for 2017 (see PSZ2020AppendixTablesI(Aggreg).xlsx, Sheet DataIncome, Column PF, available at `http://gabriel-zucman.eu/usdina/`, which is almost identical to the $954 B reported in the table, the small difference being likely due to an update of the NIPA data.

The education expenditure includes all levels of government—this is important as most public education spending in the US occurs at the state and local levels. The OECD only provides the national average of education spending. As part of our robustness checks, we use averages by state provided by the National Center for Education Statistics.[16]

Unfortunately, we do not have data on per-capita public expenditure at the sub-state level that would allow us to capture differences between richer and poorer school districts or neighborhoods. This means that the differences in public spending by income that we document are driven by different enrollment rates, different propensities to choose public vs. private institutions, and, in the robustness check, by differences across states. We do *not* capture any remaining variation in per-capita spending. As this remaining variation is likely positively related to income (e.g., tuition fees are higher and thus net public expenditure is lower for students with high-income parents, especially from out of state), this means that we do not capture one component that would work towards the proportionality assumption used as the benchmark in the Dina approach. However, we find such a strong departure from proportionality that the within-state differences in per-capita spending would have to be very large in order to justify the proportionality assumption. Moreover, at least at the level of school districts, the difference by income is less pronounced than one might think, and is characterized by a U-shape instead of a monotonous increase with income. Average per-pupil expenditure in public elementary and secondary schools is \$12.9 K in low-poverty districts, \$11.2 K in middle-low poverty districts, \$10.8 K in middle-high poverty districts, and \$13.0 K in high-poverty districts (De Brey et al. 2021, Table 236.85). There is a rural-urban divide: while in cities high-poverty districts have substantially higher public per-pupil spending than low-poverty districts, the difference is smaller in suburban districts and turns in favor of low-poverty districts in towns and rural areas.[17]

Aggregates Table 2 also shows aggregate annual expenditure. Our own numbers—obtained from combining the enrollment observation in the ACS with the OECD values for per-student expenditure—are compared with the OECD aggregates, information from the National Center for Education Statistics (NCES), and with the national accounts (NIPA)

We run a robustness check in which we discard the small differences and use the NCES number.

[16]State-level information is taken from the National Center for Education Statistics, Digest of Education Statistics 2019 (De Brey et al. 2021). For the pre-primary, primary, and secondary levels, we use the values from Table 236.75: Total and current expenditures per pupil in fall enrollment in public elementary and secondary schools, by function and state or jurisdiction: 2016-17. To compute public per-student expenditure at the tertiary level, we divide total expenditure (Table 334.20: Total expenditures of public degree-granting postsecondary institutions, by level of institution, purpose of expenditure, and state or jurisdiction: 2014-15 through 2017-18) by the number of students (Table 304.15: Total fall enrollment in public degree-granting postsecondary institutions, by state or jurisdiction: Selected years, 1970 through 2018).

[17]Note that we focus on the cross-section in our analysis. See Hoxby (2001) for the dynamics of school finance equalization.

data published by the Bureau of Economic Analysis, which is the source that Piketty, Saez, and Zucman (2018) use. (They only report the total, without the breakdown by education level.)

At ISCED levels 0-3 (pre-primary, primary, secondary), we obtain an aggregate expenditure of \$705 B, close to the \$681 B reported by both the OECD and the NCES, and only about 5% higher than the NIPA figure of \$666 B. That our value is slightly higher than the OECD figure is due to two factors. First, as shown in Figure C.1, the ACS enrollment numbers are slightly higher than what is reported by the OECD (51.4 M vs. 50.6 M). Second, some of the children in pre-primary education attend kindergarten only part of the day. When computing full-time equivalents, the OECD assigns individuals in part-time education a weight of 0.3. In the ACS, we do not observe part-time status, and assign all individuals the full-time equivalent expenditure reported by the OECD. This amounts to the assumption that all individuals are in fact in full-time education, which leads us to overestimate the annual expenditure.

Both factors are aggravated at the tertiary level. In the ACS, there are 16.8 M students enrolled in public tertiary institutions, while the OECD and the NCES report 14.6 M students, a difference of 2.2 M or about 15% (Figure C.1).[18] Moreover, the part-time share is even higher than for pre-primary education.[19] As a result of both factors, our estimate of annual public expenditure at the tertiary level of \$488 B is substantially higher than the numbers reported by the OECD, the NCES, and the Bureau of Economic Analysis, which range between \$288 B and \$335 B.

As part of our robustness checks, we address these issues by rescaling the enrollment numbers in the ACS so that we have the same number of full-time equivalent students as the OECD. We do this both in a neutral way—by assuming that the excess number of full-time equivalents is independent of income—and as a bounds analysis in which we assume that the excess mass is concentrated in either the bottom or the top half of the income distribution.

[18] Part of the difference is probably due to students at private non-profit institutions. According to the NCES, 1.1 M students attended such an institution in 2017. If some of these declared to be in a public institution in the ACS because they equated not-for-profit with public, this could explain part of the higher number of students at public institutions that we find. Note, however, that we also overestimate the total number of students at the tertiary level, so the measurement issue does not only concern the classification of institutions into public or private.

[19] According to the OECD, 1.6 M out of 5.1 M children (68%) in pre-primary education attend kindergarten only part-time. At the tertiary level, there are 6.4 M part-time students (43% of the total 14.6 M). At the primary and secondary levels, all pupils attend school full-time.

3 Results

3.1 Distribution of Public Education Spending

Allocation Based on Actual Enrollment Figure 1 shows how public education spending (net of tuition fees[20]) in the United States in 2017 is distributed among the deciles of the income distribution.[21] Following Piketty, Saez, and Zucman (2018), the distribution is for adults age 20 and above; in households with more than one adult, income is split equally. Income is pre-tax income as reported in the American Community Survey; below, we report results when we use simulated post-tax income instead, as a first step towards the more comprehensive measure of post-tax disposable income used by Piketty, Saez, and Zucman.

Public education spending is highest in the first decile—with an average of $6.0 K per adult—and lowest in the tenth decile of the pre-tax income distribution, where the average is $4.3 K. In deciles 2 to 9, the means of per-capita spending are fairly close together, at between $4.5 K and $4.8 K. The overall average is $4.8 K. The Bottom 50% of the pre-tax income distribution receive an average of $4.9 K per year in terms of public education spending, followed by the Middle 40% with $4.7 K, and, as noted, the Top 10% with $4.3 K.

Turning to the different levels of education, we see little differences by income for pre-primary and primary education. Per-capita expenditure on secondary education tends to grow with income, with an average of $1.4 K allocated to each adult in decile 1 and about $1.9 K in deciles 9 and 10. Public spending on tertiary education shows the opposite pattern. It is the driver behind the progressivity of public education spending, being concentrated in the bottom decile of the income distribution, where average annual spending is $3.3 K, more than three times the average in the top decile ($1.0 K).[22] The high average in the poorest decile is mostly explained by college students who no longer live with their parents. By contrast, the public expenditure on students who are still in the parental household is spread out much more evenly across the income distribution.

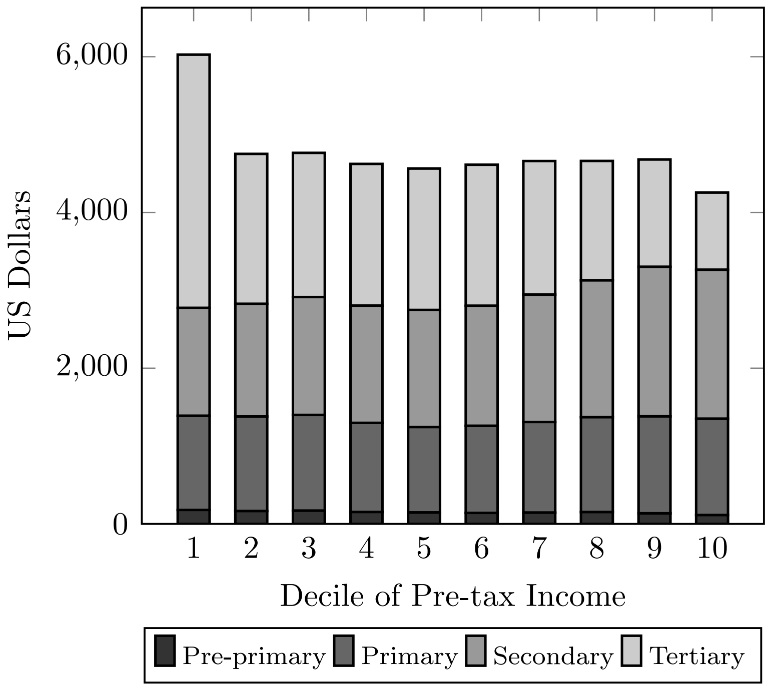
Comparison with Proportional and Lump-Sum Allocations Figure 2 contrasts the actual distribution based on the American Community Survey with the proportional

[20]There is a literature that studies the distribution of (higher-)education spending net not only of tuition fees, but of taxes as well (e.g., Hansen and Weisbrod 1969; Johnson 2006). We refrain from doing so as we see our analysis as a building block in the DINA framework, which provides a much more comprehensive measure of the tax burden than these earlier studies, although similar caveats regarding tax incidence apply. Regarding the related question of how income inequality affects tuition fees and college attendance, see the recent article by Cai and Heathcote (2022).

[21]The numerical values are reported in Table C.1 in the Appendix.

[22]Figure C.2 in the Appendix expresses public education spending as a share of income, which makes the progressivity (i.e., expenditure representing a higher share of income for lower-income groups) directly visible.

Figure 1: Public Education Spending by Pre-tax Income, Allocated Based on Actual Enrollment



Notes: The figure shows how public education spending in the United States in 2017 is distributed among the deciles of the pre-tax income distribution. For each decile, the bars show the average values of annual public education spending (in 2017 US Dollars) at the pre-primary, primary, secondary, and tertiary levels of education. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Household income is likewise split equally among all adults.

allocation used by Piketty, Saez, and Zucman (2018). For public spending on education (about 30% of government consumption in the United States), a proportional allocation is clearly not a good assumption. It implies annual per-capita spending of \$0.6 K in the poorest decile, only a tenth of the value that we find based on actual enrollment data from the American Community Survey. At the top of the income distribution, the proportionality assumption allocates \$18.4 K to each adult in the richest decile, more than four times the value based on the ACS. Furthermore, as pointed out in Section A in the Appendix, given the unequal distribution of pre-tax income even within the top decile, a proportional allocation implies implausibly high per-capita values among individuals in, say, the Top 1% or Top 0.1% of the distribution.

As microdata on enrollment in education is easily available for the United States and other countries, we believe that the precision of the DINA approach can be improved at little cost by replacing the proportionality assumption with an allocation based on actual enrollment. An even easier fix consists in replacing the allocation proportional to post-tax disposable income—which the DINA Guidelines recommends as the benchmark—by a lump-sum allocation. As Figure 2 shows, assigning the mean of \$4,783 to each adult is a good approximation to the distribution based on actual enrollment.

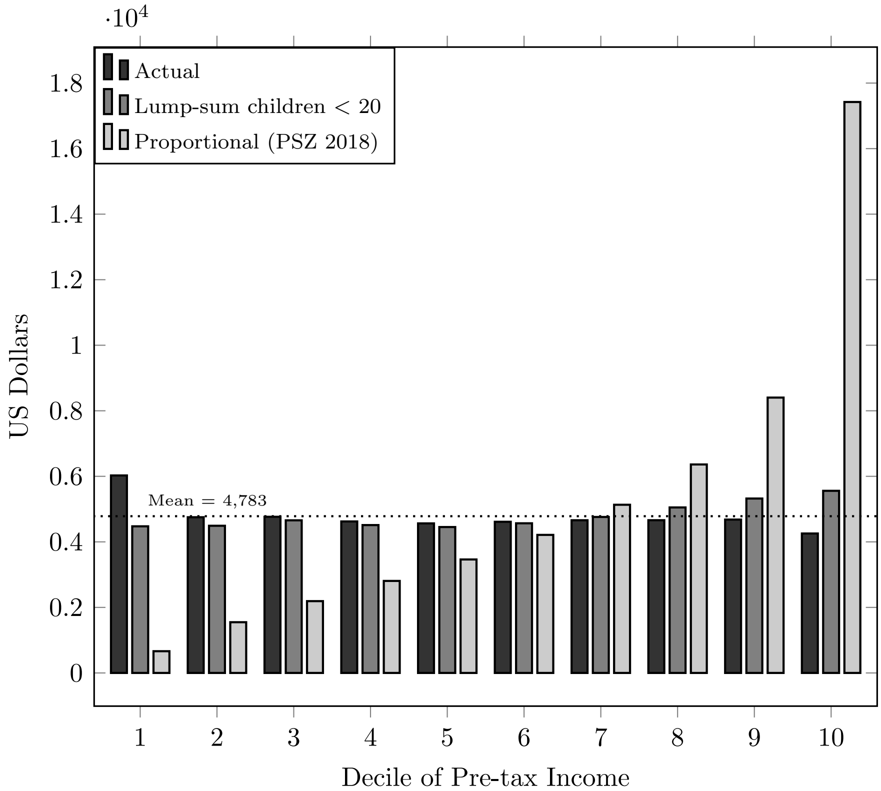
Figure 2 also includes the distribution that arises from allocating public education spending as a lump-sum transfer per child below the age of 20, as in the robustness check in the paper by Piketty, Saez, and Zucman (2018). This assumption performs much better than the proportional allocation. The differences with respect to our baseline results arise from the fact that this shortcut method does not take into account the differences in per-capita expenditure by level of education (tertiary education is much more expensive than the rest, at least in the United States), and especially that it does not capture public spending that goes to college students age 20 and above.

Progressivity Driven by Age Effects The progressivity of public education spending in the cross-section is strongly driven by age effects (Figure 3). Individuals aged 20 to 24 receive a lot of education spending on average, mostly for their own (tertiary) education. At the same time, they have by far the lowest current income of all age groups. Pre-primary and primary education does not play a large role in this age group, as the share of parents is still low. Spending on secondary education is a bit higher because some individuals are still in secondary education themselves.

In the age group 25–29, average public education spending is much lower. (Own) tertiary education is still significant, but less so than for individuals in their early 20s. Secondary education also drops in importance, while public expenditure on pre-primary and primary education starts building up as individuals in this group have more (and older) children than in the age group just below.

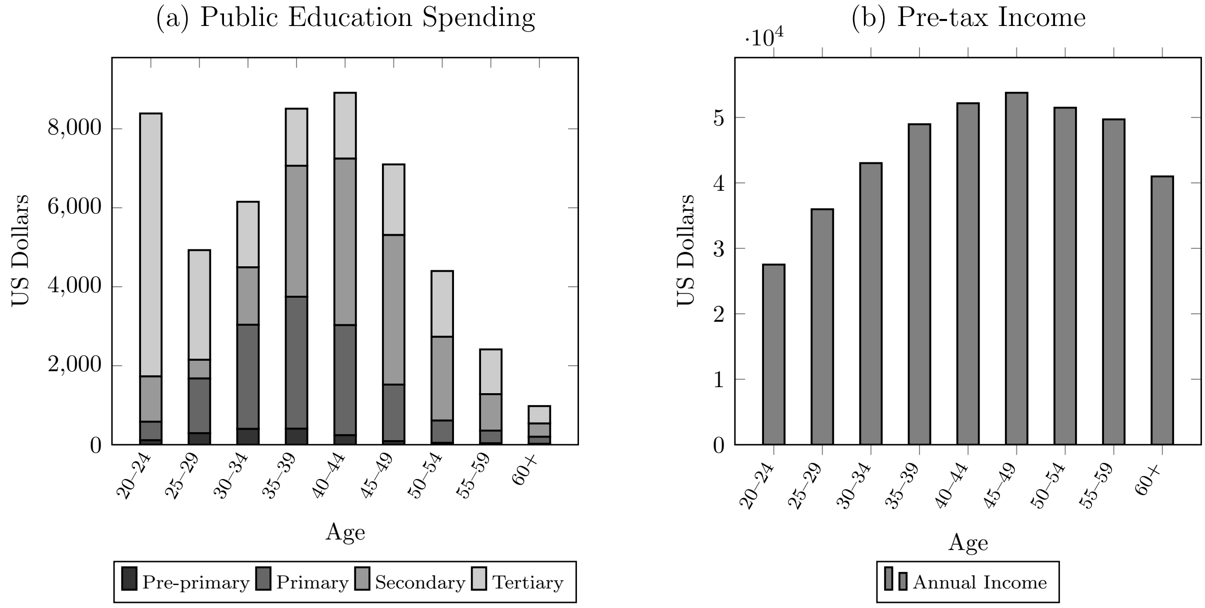
In the older age groups, the share of parents and the age of their children continue

Figure 2: Public Education Spending by Pre-tax Income: Comparison of Allocation Methods



Notes: The figure compares the actual distribution of public education spending (in black, this is the same distribution as in Figure 1) with the distributions that result from an allocation that is proportional to pre-tax income as in the paper by Piketty, Saez, and Zucman (2018) ("PSZ", dark gray) and from a lump-sum transfer (light gray) to all children below age 20, irrespective of actual enrollment and disregarding the differences in per-capita spending between pre-primary, primary, secondary, and tertiary education. The figure also shows the value of $4,783 that would result from a lump-sum allocation to all adults. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Pre-tax household income is likewise split equally among all adults.

Figure 3: Public Education Spending and Pre-tax Income by Age



Notes: The left panel of the figure shows how the average value of public education spending (allocated based on actual enrollment) differs by age. The right panel depicts average pre-tax income for the same age categories. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Pre-tax household income is likewise split equally among all adults.

to rise, as reflected in the increasing public expenditure at the pre-primary, primary, and secondary levels. While the first two peak in the age group 35–39, spending on secondary and tertiary education continues into age groups 40-44 and 45–49, respectively. At later ages, expenditure falls for them as well as children leave the parental household. The maximum of total public education spending is reached in the age group 40–44. Pre-tax income, by contrast, peaks at age 45–49, and is still fairly high thereafter while public education spending declines steeply for individuals in their late 40s and in their 50s. Together with the high level of tertiary education spending for the poorest age group 20–24, this drives the progressivity of public education spending in the cross-section.

3.2 Robustness Checks

Post-tax Cash Income So far, our results have been for pre-tax income, which is directly observable in the American Community Survey. However, Piketty, Saez, and Zucman (2018) assume that education and other items of government consumption are allocated proportionally to post-tax disposable income. We therefore run a robustness check in which we use our measure of post-tax disposable income—simulated using TAXSIM—to divide adults into deciles (Figure C.3 and Table C.1 in the Appendix). As for pre-tax income, the proportionality assumption is rejected, while a lump-sum allocation is a reasonable approximation except for the bottom and the top of the income distribution.[23]

Household Equivalence Income As noted in Section 1, there are also several non-Dina studies that augment the standard survey measures of disposable (money) income by different components of public in-kind spending, often with a cross-country focus. These studies measure income at the household level and attempt to make households of different size and age composition comparable through equivalence scales. As Figure C.5 in the Appendix shows, public education spending remains progressive when adopting such a household perspective.[24] The average amount of public education spending received is now higher as the transfers are measured at the household level and not divided equally among adults. When the deciles are defined based on pre-tax income, average spending declines throughout the distribution. For a distribution based on post-tax disposable income, a lump-sum allocation is a decent approximation for the bottom three or four deciles, but the upper half of the distribution is again characterized by a negative relationship between public education spending and household income.

The finding that public education spending declines with household income is in line with the study by Zwijnenburg, Bournot, and Giovannelli (2017) who report the percentage of total education spending by quintiles of household disposable income for the United States and several other countries. In the United States in 2012, 25.4% of public education spending goes to households in the bottom quintile, compared with 15.3% in the top quintile. In our data for 2017, the shares are similar, but the progressivity is even more pronounced: 26.3% of public spending goes to the 20% of households with the lowest post-tax disposable income, while the richest 20% receive 11.1% of the total.

Other Checks We also ran a number of other, more technical robustness checks. As noted above, despite the legal obligation to answer the survey, some of the individual income components are actually imputed by the data provider. When we drop all households in which more than half of household income is based on an imputation (slightly less than 20% of our sample), the results are virtually unchanged (Table C.2). The same holds when we drop all households with negative income or all households with income below the 1st percentile. When the threshold is increased to the 2.5th percentile, average public education spending in the first decile is reduced from \$6.0 K to \$5.4 K, but is still higher than in all other deciles. Dropping all households whose income is above the 99.5th percentile likewise has no effect on the results.

As seen in Figure C.1, the ACS slightly overestimates the enrollment in educational institutions by comparison with the numbers reported by the OECD and the NCES.

[23]Figure C.4 in the Appendix expresses public education spending as a share of post-tax income to visualize its progressivity.

[24]The numerical values are reported in Table C.1 in the Appendix.

When we scale down our ACS enrollment numbers to meet the NCES numbers, average public education spending goes down in all deciles, but the negative relationship with income is preserved.

In our main specification, we use a single value for per student expenditure at the different levels of education, as the OECD does not provide information on within-country variation. When we use state-specific values from the NCES instead, the difference between the first and the tenth deciles is slightly reduced, but the poorest decile still receives substantially more public education spending. A lump-sum allocation is again a good approximation for the deciles in between.

The OECD calculates expenditure per student on the basis of full-time equivalents; students in part-time education—relevant only at the pre-primary and the tertiary level—are assumed to represent one-third of a full-time equivalent. In the ACS, there is no information on whether individuals are enrolled only part-time, and we assign the expenditure per full-time equivalent to all students in our main specification. As a robustness check, we randomly assign part-time status based on the share of part-time students reported by the OECD. This brings down the average expenditure by decile, but leaves the negative income gradient intact.

The OECD only reports a single number for annual per-student expenditure at the tertiary level, which is an average over 2-Year and 4-Year colleges. In a robustness check, we assign all graduate students to 4-Year colleges, and randomly assign undergraduates to either 2-Year or 4-Year colleges, based on the relative importance of the two types as reported by the NCES. Average expenditure is higher than in the main specification, but the relationship between income and expenditure remains the same.

In our main specification, public expenditure per student includes both current expenditure (a large share of which are salaries and wages) and capital outlays, but excludes R&D—which is relevant only at the tertiary level—as well expenditure for ancillary services. Alternatively, we have used a narrower (only current expenditure) and a broader (all expenditure types plus R&D and ancillary services) definition of public education spending. This changes the level of expenditure, but has little impact on the income gradient.

3.3 Beyond the Cross-Section

The Dina literature invokes two arguments for assigning public education spending proportionally to post-tax disposable income: the unequal access to education by parental income—e.g., Alvaredo et al. (2020, p. 65) or Saez and Zucman (2020, p. 33)—and “a lifetime perspective where everybody benefits from education, and where higher earners attend better schools and for longer” (Piketty, Saez, and Zucman 2017, p. 27/28).

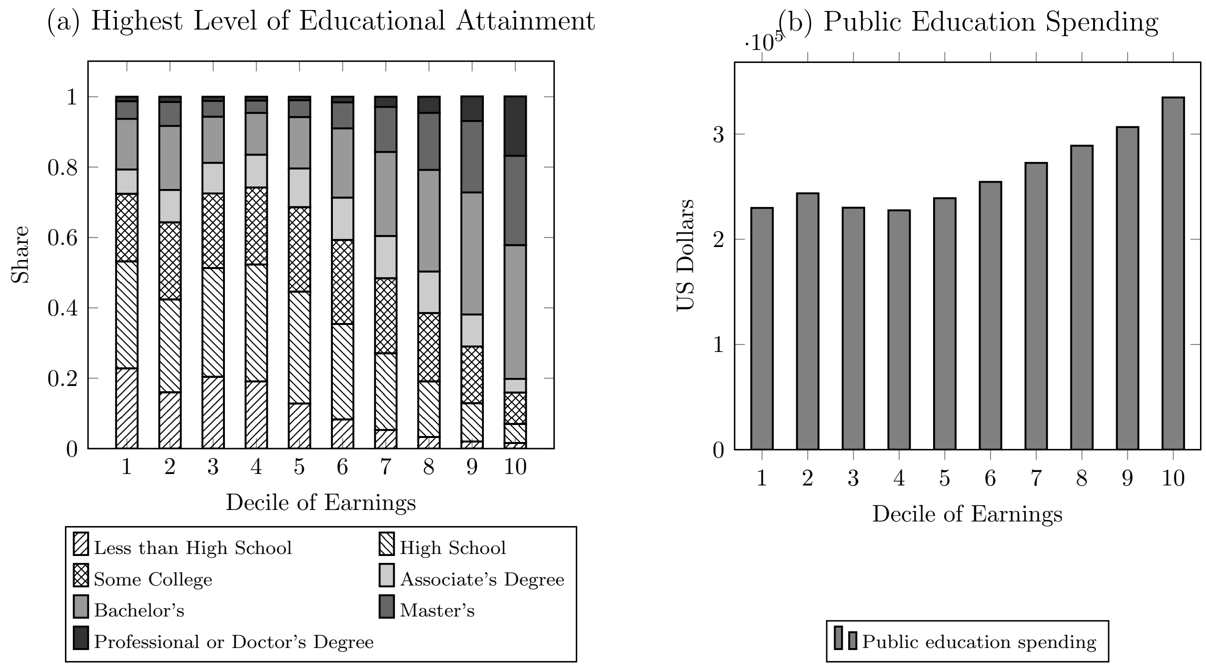
In the following, we show that individuals with higher lifetime earnings (proxied for by earnings at age 40–45) have indeed received substantially more public education spending in the past. We also show—based on PSID data—that more public education spending goes to children whose parents have a higher socio-economic status (proxied for by educational attainment). In both cases, we depart from the cross-sectional perspective we have adopted so far. In particular, we do not consider the public education spending received in a single year, but the sum of spending received in the education system. We classify individuals by their highest degree and assume that a given degree implies that the individual has passed through all the stages below, and that everyone needed the same number of years to complete each stage.[25] This is admittedly a simplification. For instance, not every child attends kindergarten, and some students repeat a year in school or take longer to finish a bachelor's or master's degree, and this variation is likely correlated with both lifetime earnings and parents' socio-economic status. However, with our data there is little we can do about this, and the differences that we find are so large that they are robust to different assumptions. A potentially more important qualification is that we do not observe whether individuals completed their education abroad. We have no information about this in our data, and assume that the entire schooling was obtained in the United States. Another shortcut that we take is to use the 2017 per-student values for public education expenditure (Table 2) although the cohort of individuals that we consider—40-45-year-olds in 2017, i.e. people born in the early and mid-1970s—obtained their education in the past. Given that we consider a cohort of only six years and that our interest is in the gradient and not the level of spending, this assumption should be fairly innocuous as well. Finally, moving beyond the cross-section—i.e., current educational enrollment—means that we cannot distinguish between public and private institutions anymore. We assume that all individuals obtained their degrees in the public education system. This means that we overestimate the level of expenditure and, more importantly, the income gradient, as graduating from a private college is positively correlated with both own lifetime earnings and parents' socio-economic status.

Differences by Lifetime Earnings We proxy for lifetime earnings using current earnings of individuals aged 40–45. At this age, the rank correlation between current earnings and lifetime earnings reaches its maximum (e.g., Bönke, Corneo, and Lüthen 2015; Haider and Solon 2006). As we now consider earnings and not income, we do not use the equal-split assumption that we adopt in the cross section, but directly use the personal earnings information available in the ACS.

Figure 4 shows how the highest degree and public education spending received vary with earnings. As expected, the highest degree is positively correlated with earnings (Panel a). While in the bottom half of the earnings distribution most individuals have

[25]The details of our mapping between the highest degree observed in the ACS and the number of years spent at the different ISCED levels are presented in Table C.3 in the Appendix.

Figure 4: Highest Degree and Public Education Spending by Current Earnings, Individuals Aged 40–45



Notes: The figure shows the highest degree (left panel) and public education spending by current earnings (right panel) for individuals aged 40–45. Source: Own calculations based on the American Community Survey 2017. When calculating public education spending, we assume that a given degree implies that the individual has passed through all the stages below, and that everyone needed the same number of years to complete each stage (see Table C.3 in the Appendix for details). We also assume that all individuals have attended only public educational institutions. Each year in the education system is multiplied with the per-capita value of public education spending taken from the OECD (see Table 2). We use the 2017 values of per-capita spending although the individuals who were 40–45 years old in 2017 obtained their education in earlier years.

at most a high school diploma or attended college without obtaining a degree, the share of people with a bachelor's, master's, or professional and doctor's degree increases in the upper half of the earnings distribution.

When translating these differences in degrees into differences in public education spending received, there is—unlike in the cross-section—a positive income (or, more precisely, earnings) gradient. The 10% of individuals with the highest earnings have received average public education spending of \$335 K, about 1.4 times the amount of the bottom 50% (\$234 K). The allocation is still not proportional to earnings, however; proportionality would require a factor of about 14 (\$196 K vs. \$14 K).

Intergenerational Perspective The second argument invoked in the Dina literature for assigning public education spending proportionally to post-tax disposable income is the unequal access to education by parents' income or, more generally, socio-economic status (SES). Studies documenting this inequality are legion. Children from a more advantaged socio-economic background tend to go to better schools and are more likely to attend college. We show that these differences indeed produce a positive relationship between parents' SES and the public education expenditure that their children receive. Unfortunately, we do not observe parents' SES in the American Community Survey. We therefore make use of the Panel Study of Income Dynamics (PSID) instead, which we again combine with information from the OECD on current public expenditure per student.[26]

Like in the analysis based on lifetime earnings, we restrict the sample to individuals aged 40–45 in 2017. As we do not observe individual trajectories, we again assume that individuals followed a stylized path to their highest degree (no grade retentions etc.).

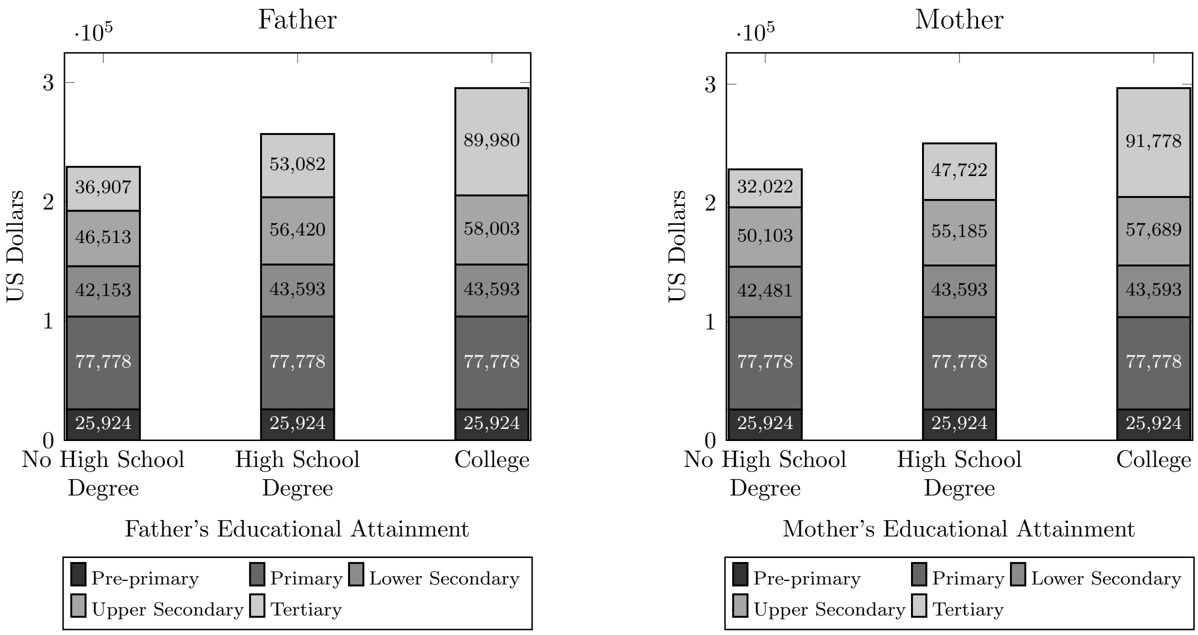
Figure 5 shows that individuals whose parents attended college received substantially more public education spending than children of parents with a high school degree or no degree at all. As almost all individuals attended school at least until grade 8, differences start to arise for upper secondary education (ISCED level 3). Individuals whose mother (father) did not complete high school received around \$50 K (\$46 K) in public spending for upper secondary education. If a parent attended college, public spending at the upper secondary level was higher by around \$7.5 K (mothers) and \$11.5 K (fathers). The differences at the tertiary level (ISCED levels 5–8) are more pronounced. Among individuals whose parents have no high school degree, only around 13% completed college (the share is about the same both for maternal and paternal education). This group therefore has a low (unconditional) average of public education spending at the tertiary level of \$32 K (mothers) and \$37 K (fathers). By contrast, individuals where one or both parents attended college received an average of around \$90 K in terms of public spending on tertiary education.

Total public spending on education was on average \$267 K for the cohort considered here. The difference between individuals from the most and the least privileged background with respect to parents' education is \$66 K on the father's side and \$68 K on the mother's side. This implies that going from the least to the most privileged parental background relates to around 30% additional education spending.

DINA as a Cross-Sectional Approach That children from already more privileged backgrounds receive almost \$70 K more in public education expenditure is more important for the distributional debate than the progressive pattern of public expenditure found in any given year, which, as seen above, is strongly driven by age effects. However, the positive association between public expenditure and parental SES or own lifetime earnings does not provide a justification for allocating public education expenditure proportionally to income in the Dina approach. So far, the approach has been exclusively cross-sectional, and departing from this cross-sectional perspective only for public education spending seems ad hoc. After all, age effects are also present in earnings or capital income, but

[26]The data are described in Section B in the Appendix.

Figure 5: Public Education Spending by Parents' Education. Individuals Aged 40–45



Notes: The figure depicts average public education spending by parents' education for individuals aged 40–45. The left panel distinguishes by the education of the father, the right panel by the education of the mother. Source: Own calculations using the Panel Study of Income Dynamics (PSID) 2017. When calculating public education spending, we assume that a given degree implies that the individual has passed through all the stages below, and that everyone needed the same number of years to complete each stage. We also assume that all individuals have attended only public educational institutions. Each year in the education system is multiplied with the per-capita value of public education spending taken from the OECD (see Table 2). We use the 2017 values of per-capita spending although the individuals who were 40–45 years old in 2017 obtained their education in earlier years.

are not adjusted for when measuring pre-tax income. Likewise, many cash transfers such as family benefits or in-kind transfers such as Medicare are also age-dependent (e.g., Auerbach, Kotlikoff, and Koehler 2023), but are assigned to current recipients in the Dina approach.

4 Conclusion

In the distributional national accounts (Dina) created by Piketty, Saez, and Zucman (2018) and others, government consumption (e.g., education, defense, infrastructure) is typically allocated proportionally to post-tax disposable income, which renders half of government expenditure distributionally neutral and implies large differences in the per-capita value of government consumption. The level of post-tax inequality is fairly sensitive to this assumption. When the expenditure is allocated on a lump-sum basis instead—an assumption that the recent version of the Dina Guidelines (Alvaredo et al. 2020) suggests as an alternative to the proportional allocation—the gap in post-tax income shares between the Top 10% and Bottom 50% is reduced by half. The trend in US post-tax income shares is hardly affected by the assumptions, however. Note, however, that this parallel shift is to some extent mechanical. The true question is whether the empirical relevance of the two approaches has changed over time. In the context of public education spending, changes in fiscal equalization (Hoxby 2001) or income-specific changes in enrollment (e.g., Cai and Heathcote 2022) could mean that an allocation proportional to income may work better or worse for different years. Likewise, there may have been changes in the income-specific use of public transportation or other items of government consumption over time.

The main contribution of our paper is to provide evidence on how an important part of government consumption is actually distributed. We find that, when adopting the cross-sectional perspective of the Dina approach, public education spending goes disproportionately to the bottom half of the income distribution. This pattern is strongly driven by age effects. There is indeed a positive relationship between public education spending and lifetime earnings or parents' socio-economic status, but even the relationship with earnings is far from being proportional. More importantly, the last two patterns do not provide an empirical basis for the cross-sectional Dina approach. Adjusting for age effects only for public education, but not for other items such as earnings, capital income, family cash transfers, or Medicare, would introduce an inconsistency into the framework.

Based on our findings, we conclude that public education expenditure should not be allocated proportionally to post-tax disposable income as recommended in the Dina Guidelines. As microdata on education is widely available, an allocation based on actual enrollment can improve the distributional analysis of post-tax income at little extra cost. This recommendation is in line with the OECD–Eurostat Expert Group on Disparities in a National Accounts framework (EG DNA), which also argues for an allocation based on actual use (Zwijnenburg 2019). An even easier improvement is to allocate public education spending as a lump-sum transfer, which—at least in the US context of 2017—provides a good approximation of the actual distribution. In line with this approach, Auten and Splinter (2024) run a robustness check in which they allocate all government consumption on a per-capita basis. Compared to their main specification (in which half is allocated on a per-capita basis and the other half proportionally to post-tax income), they find that the Top 1% income share is reduced by three-quarters of a percentage point.

Given that a proportional allocation implies very high per-capita values for individuals with high incomes, we believe that a lump-sum allocation is the preferable benchmark for the remaining parts of government consumption (defense, infrastructure) as well. A recent study by Glaeser, Gorback, and Poterba (2022) shows, for instance, that the share of gasoline expenditure declines with both annual expenditure and, more strongly, annual income. If gasoline expenditure is taken as an—admittedly rough—measure of road use, this suggests that public per-capita spending on roads is not proportional to income either. The same holds for public transportation: Glaeser, Gorback, and Poterba show that bus use is clearly progressive, while the use of subways and commuter rail tends to increase with income, but much less than the proportionality assumption would imply. Finally, national defense, as a classic example of a public good, is arguably best assigned on a lump-sum basis as well. However, there is clearly need for further research on these issues. In the meantime, and given the inherent difficulty of assigning some of these public in-kind expenditure items to households and individuals, reporting results for both a lump-sum and a proportional allocation is probably a reasonable compromise.

Another option is to resort to an income concept such as disposable personal income that takes only money transfers and certain in-kind transfers such as Medicare and Medicaid into account while avoiding the assignment of government consumption altogether (Gindelsky 2022). Whether this or the more comprehensive Dina income concept is more useful depends on the question at hand.

In our analysis, differences in public education spending result from differences in enrollment and in the choice of public or private institutions. In a robustness check, we also exploit differences in average spending across states. We do *not* capture any remaining variation in per-capita spending. As this remaining variation is likely positively related to income, this means that we do not capture one component that would work toward the proportionality assumption used as the benchmark in the Dina approach. However, we find such a strong departure from proportionality that the within-state differences in per-capita spending would have to be implausibly high in order to justify the assumption. Moreover, at least at the level of school districts, the difference by income is less pronounced than one might think, and is characterized by a U-shape instead of a monotonous increase with income. Still, incorporating more fine-grained information on per-capita spending would further increase the precision of the DINA approach and is a useful direction for future research.

References

Aaberge, Rolf, Manudeep Bhuller, Audun Langørgen, and Magne Mogstad (2010). "The Distributional Impact of Public Services When Needs Differ". In: *Journal of Public Economics* 94, pp. 549–562.

Aaberge, Rolf, Lasse Eika, Audun Langørgen, and Magne Mogstad (2019). "Local Governments, In-kind Transfers, and Economic Inequality". In: *Journal of Public Economics* 180, p. 103996.

Aaberge, Rolf, Audun Langørgen, and Petter Lindgren (2013). "The Distributional Impact of Public Services in European Countries". Statistics Norway Research Department Discussion Paper No. 746.

Alvaredo, Facundo, Anthony B. Atkinson, Thomas Blanchet, Lucas Chancel, Luis Bauluz, Matthew Fisher-Post, Ignacio Flores, Bertrand Garbinti, Jonathan Goupille-Lebret, Clara Martínez-Toledano, Marc Morgan, Theresa Neef, Thomas Piketty, Anne-Sophie Robilliard, Emmanuel Saez, Li Yang, and Gabriel Zucman (2020). "Distributional National Accounts Guidelines: Methods and Concepts Used in the World Inequality Database". Paris. World Inequality Lab.

Auerbach, Alan J., Laurence J. Kotlikoff, and Darryl Koehler (2023). "US Inequality and Fiscal Progressivity: An Intragenerational Accounting". In: *Journal of Political Economy* 131, pp. 1249–1293.

Auten, Gerald and David Splinter (2024). "Income Inequality in the United States: Using Tax Data to Measure Long-term Trends". In: *Journal of Political Economy*. Forthcoming.

Bach, Stefan, Charlotte Bartels, and Theresa Neef (2021). "Distributional National Accounts: A Macro-Micro Approach to Inequality in Germany". DIW and Freie Universität Berlin.

Blanchet, Thomas, Lucas Chancel, and Amory Gethin (2022). "Why is Europe More Equal than the United States?" In: *American Economic Journal: Applied Economics* 14 (4), pp. 450–518.

Bönke, Timm, Giacomo Corneo, and Holger Lüthen (2015). "Lifetime Earnings Inequality in Germany". In: *Journal of Labor Economics* 33 (1), pp. 171–208.

Bozio, Antoine, Bertrand Garbinti, Jonathan Goupille-Lebret, Malka Guillot, and Thomas Piketty (2022). "Predistribution vs. Redistribution: Evidence from France and the U.S." World Inequality Lab, Paris.

Bricker, Jesse, Alice Henriques, Jacob Krimmel, and John Sabelhaus (2016). "Measuring Income and Wealth at the Top Using Administrative and Survey Data". In: *Brookings Papers on Economic Activity* Spring, pp. 261–312.

Bruil, Arjan, Céline van Essen, Wouter Leenders, Arjan Lejour, Jan Möhlmann, and Simon Rabaté (2022). "Inequality and Redistribution in the Netherlands". Working Paper.

Cai, Zhifeng and Jonathan Heathcote (2022). "Tuition and Income Inequality". In: *American Economic Review* 112 (1), pp. 81–121.

Callan, Tim, Timothy Smeeding, and Panos Tsakloglou (2008). "Short-run Distributional Effects of Public Education Tranfers to Tertiary Education Students in Seven European Countries". In: *Education Economics* 16 (3), pp. 275–288.

Chatterjee, Aroop, Léo Czajka, and Amory Gethin (2023). "Redistribution without Inclusion? Inequality in South Africa since the End of Apartheid". Working Paper, Paris School of Economics.

Congressional Budget Office, ed. (2023). *The Distribution of Household Income in 2020*. URL: http://www.cbo.gov/publication/59509 (visited on 12/11/2023).

De Brey, Cristobal, Thomas D. Snyder, Anlan Zhang, and Sally A. Dillow (2021). "Digest of Education Statistics 2019 (NCES 2021-009)". Washington, DC. National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

De Rosa, Mauricio, Ignacio Flores, and Marc Morgan (2022). "More Unequal or Not as Rich? Revisiting the Latin American Exception". Working Paper, Paris School of Economics.

Feenberg, Daniel and Elisabeth Coutts (1993). "An Introduction to the TAXSIM Model". In: *Journal of Policy Analysis and Management* 12 (1), pp. 189–194.

Garbinti, Bertrand, Jonathan Goupille-Lebret, and Thomas Piketty (2018). "Income Inequality in France, 1900–2014: Evidence from Distributional National Accounts". In: *Journal of Public Economics* 162, pp. 63–77.

Garfinkel, Irwin, Lee Rainwater, and Timothy Smeeding (2006). "A Re-examination of Welfare States and Inequality in Rich Nations: How In-kind Transfers and Indirect Taxes Change the Story". In: *Journal of Policy Analysis and Management* 25 (4), pp. 897–919.

Gillespie, W. Irwin (1965). "Effect of Public Expenditures on the Distribution of Income". In: *Essays in Fiscal Federalism*. Ed. by Richard A. Musgrave. Washington, DC: Brookings Institution, pp. 122–186.

Gindelsky, Marina (2022). "Do Transfers Lower Inequality Between Households? Demographic Evidence from Distributional National Accounts". In: *Economic Inquiry*, pp. 1–25.

Glaeser, Edward L., Caitlin S. Gorback, and James M. Poterba (2022). "How Regressive Are Mobility-Related User Fees and Gasoline Taxes". NBER Working Paper No. 30746.

Haider, Steven and Gary Solon (2006). "Life-Cycle Variation in the Association between Current and Lifetime Earnings". In: *American Economic Review* 96 (4), pp. 1308–1320.

Hammar, Olle, Paula Roth, Daniel Waldenström, and Gabriel Zucman (2020). "Distributional National Accounts in the Welfare State: Sweden, 1930–2016". In progress.

Hansen, W. Lee and Burton Weisbrod (1969). "The Distribution of Costs and Direct Benefits of Public Higher Education: The Case of California". In: *Journal of Human Resources* 4 (2), pp. 176–191.

Higgins, Sean, Nora Lustig, Whitney Ruble, and Timothy M. Smeeding (2016). "Comparing the Incidence of Taxes and Social Spending in Brazil and the United States". In: *Review of Income and Wealth* 62 (S1), S22–S46.

Horton, Tim and Howard Reed (2010). *Where the Money Goes: How We Benefit from Public Services*. Trade Unions Congress.

Hoxby, Caroline M. (2001). "All School Finance Equalizations Are Not Created Equal". In: *Quarterly Journal of Economics* 116 (4), pp. 1189–1231.

Insee (2021). "Expert Group Report on the Measurement of Inequality and Redistribution". Paris. Insee Methods.

Jestl, Stefan and Emanuel List (2020). "Distributional National Accounts (DINA) for Austria, 2004–2016". World Inequality Lab Working Paper, 2020/23.

Johnson, William R. (2006). "Are Public Subsidies to Higher Education Regressive?" In: *Education Finance and Policy* 1 (3), pp. 288–315.

Larrimore, Jeff, Richard V. Burkhauser, Gerald Auten, and Philip Armour (2021). "Recent Trends in US Income Distributions in Tax Record Data Using More Comprehensive Measures of Income Including Real Accrued Capital Gains". In: *Journal of Political Economy* 129 (5), pp. 1319–60.

Larrimore, Jeff, Jacob Mortenson, and David Splinter (2021). "Household Incomes in Tax Data: Using Addresses to Move from Tax-Unit to Household Income Distributions". In: *Journal of Human Resources* 56 (2), pp. 600–631.

Marical, Francois, Marco Mira d'Ercole, Maria Vaalavou, and Gerlinde Verbist (2006). "Publicly-provided Services and the Distribution of Resources". In: *OECD Social, Employment and Migration Working Papers* 45.

McGonagle, Katherine A., Robert F. Schoeni, Narayan Sastry, and Vicki A. Freedman (2012). "The Panel Study of Income Dynamics: Overview, Recent Innovations, and Potential for Life Course Research". In: *Longitudinal and Life Course Studies* 3 (2), pp. 268–284.

Musgrave, Richard A., Karl E. Case, and Herman Leonard (1974). "The Distribution of Fiscal Burdens and Benefits". In: *Public Finance Quarterly* 2 (3), pp. 259–311.

O'Dea, Cormac and Ian Preston (2012). "The Distributional Impact of Public Spending in the UK". London. IFS Working Paper W12/06.

O'Higgins, Michael and Patricia Ruggles (1981). "The Distribution of Public Expenditures and Taxes among Households in the United Kingdom". In: *Review of Income and Wealth* 27 (3), pp. 298–326.

OECD Statistics (2020). *Education at a Glance – Dataset "Educational finance indicators"*. URL: https://stats.oecd.org (visited on 09/23/2021).

Paulus, Alari, Holly Sutherland, and Panos Tsakloglou (2010). "The Distributional Impact of In-Kind Public Benefits in European Countries". In: *Journal of Policy Analysis and Management* 29 (2), pp. 243–266.

Piketty, Thomas, Emmanuel Saez, and Gabriel Zucman (2017). *Distributional National Accounts: Methods and Estimates for the United States. Data Appendix.* URL: http://gabriel-zucman.eu/usdina/ (visited on 09/23/2021).

— (2018). "Distributional National Accounts: Methods and Estimates for the United States". In: *Quarterly Journal of Economics* 133 (2), pp. 553–609.

Piketty, Thomas, Li Yang, and Gabriel Zucman (2019). "Capital Accumulation, Private Property, and Rising Inequality in China, 1978–2015". In: *American Economic Review* 109 (7), pp. 2469–2496.

Reynolds, Morgan and Eugene Smolensky (1977). *Public Expenditures, Taxes, and the Distribution of Income: The United States, 1950, 1961, 1970.* Institute for Research on Poverty monograph series. New York: Academic Press.

Ruggles, Patricia and Michael O'Higgins (1981). "The Distribution of Public Expenditure among Households in the United States". In: *Review of Income and Wealth* 27 (2), pp. 137–164.

Ruggles, Steven, Sarah Flood, Ronald Goeken, Josiah Grover, Erin Meyer, Jose Pacas, and Matthew Sobek (2020). *IPUMS USA: Version 10.0 [dataset].* Minneapolis, MN: IPUMS. URL: https://doi.org/10.18128/D010.V10.0.

Saez, Emmanuel and Gabriel Zucman (2016). "Wealth Inequality in the United States since 1913: Evidence from Capitalized Income Tax Data". In: *Quarterly Journal of Economics* 131 (2), pp. 519–578.

— (2020). "Trends in US Income and Wealth Inequality: Revising After the Revisionists". NBER Working Paper No. 27921.

Samwick, Andrew A. (2013). "Donating the Voucher: An Alternative Tax Treatment of Private School Enrollment". In: *Tax Policy and the Economy* 27 (1), pp. 125–160.

Smeeding, Timothy (1977). "The Antipoverty Effectiveness of In-Kind Tranfers". In: *The Journal of Human Resources* 12 (3), pp. 360–378.

Smeeding, Timothy, Peter Saunders, John Coder, Stephen Jenkins, Johan Fritzell, Aldi J. M. Hagenaars, Richard Hauser, and Michael Wolfson (1993). "Poverty, Inequality, and Family Living Standards Impacts across Seven Nations: The Effect of Noncash Subsidies for Health, Education and Housing". In: *Review of Income and Wealth* 39 (3), pp. 229–256.

Smith, Matthew, Danny Yagan, Owen Zidar, and Eric Zwick (2019). "Capitalists in the Twenty-first Century". In: *Quarterly Journal of Economics* 134 (4), pp. 1675–1745.

Splinter, David (2020). "Reply: Trends in US Income and Wealth Inequality: Revising After the Revisionists". Working Paper.

Survey Research Center, ed. (2022). *Panel Study of Income Dynamics, Public Use Dataset.* Ann Arbor, MI: Institute for Social Research, University of Michigan.

Verbist, Gerlinde, Michael Förster, and Maria Vaalavou (2012). "The Impact of Publicly Provided Services on the Distribution of Resources: Review of New Results and Methods." In: *OECD Social, Employment and Migration Working Papers* 130.

Wilson, Kathryn, Kristina Lambright, and Timothy Smeeding (2006). "School Finance, Equivalent Educational Expenditure, and Income Distribution: Equal Dollars or Equal Chances for Success?" In: *Education Finance and Policy* 1 (4), pp. 396–424.

Zwijnenburg, Jorrit (2019). "Unequal Distributions: EG DNA versus DINA Approach". In: *AEA Papers and Proceedings* 109, pp. 296–301.

Zwijnenburg, Jorrit, Sophie Bournot, and Federico Giovannelli (2017). "OECD Expert Group on Disparities in a National Accounts Framework – Results from the 2015 Exercise". Paris. OECD Statistics Directorate Working Paper No. 76.

Appendix

A Revisiting Piketty, Saez, and Zucman (2018)

A.1 Overview

In an important methodological contribution, Piketty, Saez, and Zucman (2018) create distributional national accounts that make income measures from tax and survey data consistent with the macro totals published in national accounts. They study pre-tax and post-tax income inequality in the United States for the years 1913–2014 and document a massive increase for both types of inequality since 1980.

In this section of the Appendix, we show that their findings regarding the *level* of post-tax inequality are sensitive to their assumption regarding the allocation of government consumption expenditure. Based on their publicly available data, we show that with a different assumption—a lump-sum allocation of government consumption instead of an allocation proportional to post-tax disposable income—, the gap in the shares of post-tax national income accruing to the Bottom 50% and the Top 10% is reduced by half in recent years, from 20 to 10 percentage points.[27] The effect of the allocation rule on post-tax income shares is of the same order of magnitude as in the study by Blanchet, Chancel, and Gethin (2022) for a number of European countries.

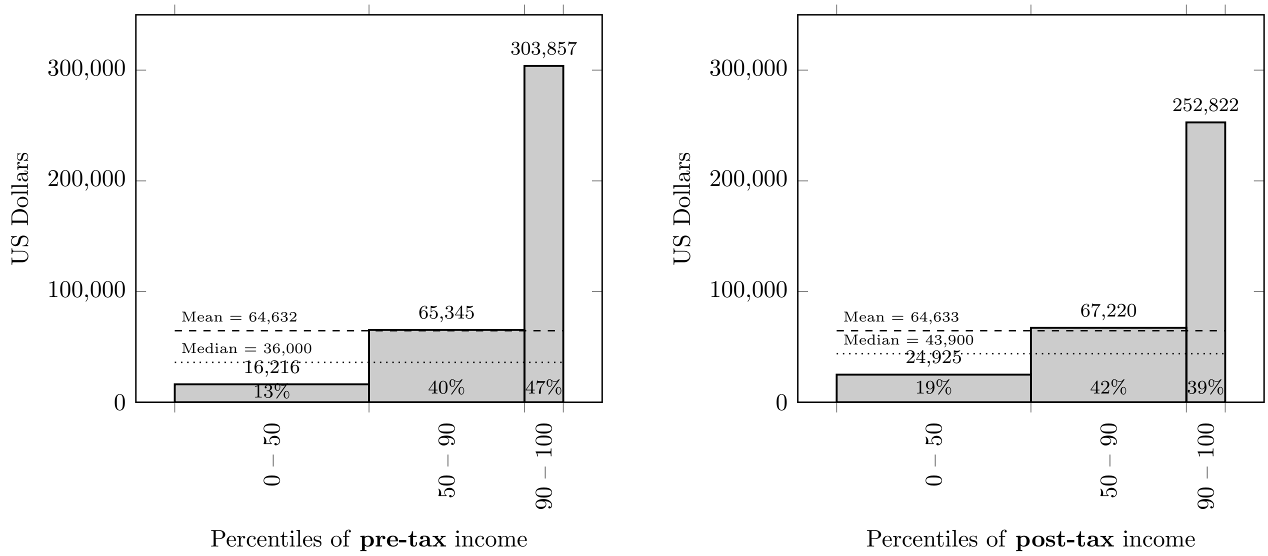
A.2 Post-tax Income Inequality and Government Expenditure

Figure A.1 summarizes the distribution of U.S. national income in 2014, the most recent year in their study. Piketty, Saez, and Zucman allocate all items of national income to adults age 20 and above. In couples, the income is assumed to be split equally. The mean value of national income by adult in 2014 is \$65 K. By construction, the mean is the same for pre-tax and post-tax income, which are alternative ways of allocating the same total national income.[28] Pre-tax income is distributed very unequally: the 10% of adults with the highest pre-tax income receive 47% of the total, while the Bottom 50% receive only 13%. This translates into an average pre-tax income of about \$300 K among the Top 10% (47/10 times the mean income of \$65 K), compared with \$16 K for the bottom half of the pre-tax income distribution. The Middle 40% receive almost exactly their population share of 40%, and accordingly have an average pre-tax income close to the overall mean.

[27] The results, code, and most of the micro data are available at `http://gabriel-zucman.eu/usdina/`. We use the November 2017 vintage, which corresponds to the published version (Piketty, Saez, and Zucman 2018). The series have since been updated to more recent years, improved, and revised (to incorporate changes in the underlying National Accounts data). These changes are documented in `https://gabriel-zucman.eu/files/PSZUpdates.pdf`. The part of the analysis that we focus on in this article—the allocation of government consumption—has not been affected by the updates.

[28] The small difference in Figure A.1—63,632 vs. 64.633—is due to rounding.

Figure A.1: Distribution of Pre-tax and Post-tax National Income



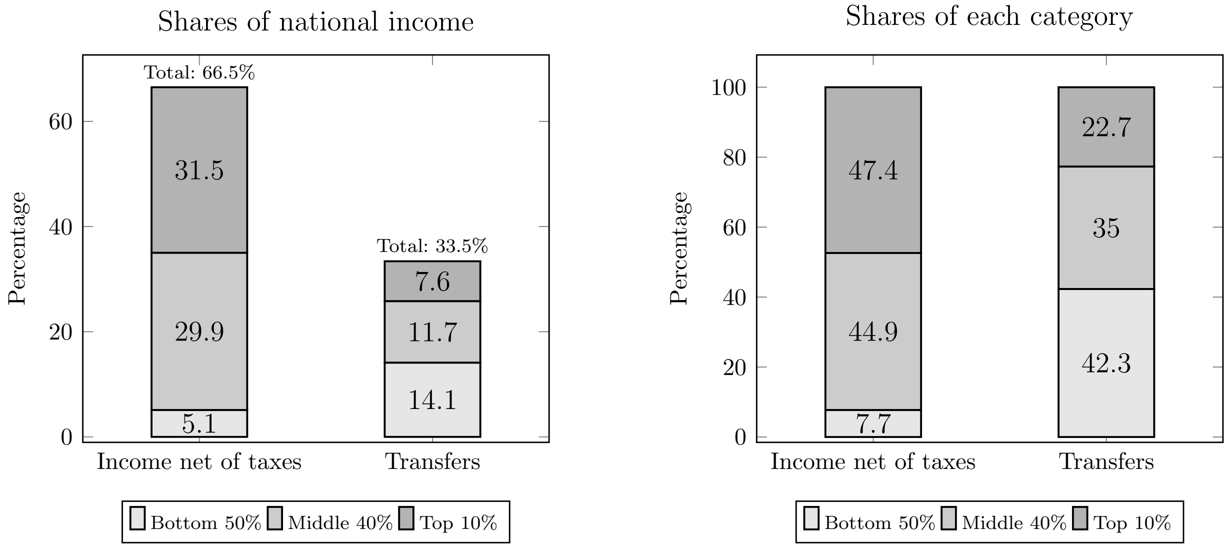
Notes: The figure shows how national income is distributed among adults aged 20 and above in the United States in 2014. The figure depicts the income shares of the Bottom 50%, Middle 40%, and Top 10%, both for total pre-tax income (left panel) and for post-tax income (right panel), as well as the overall mean and median and the mean within each group. Source: Own calculations based on Piketty, Saez, and Zucman (2018). Pre-tax income: Appendix Tables II-B1, II-B3, II-B13. Post-tax income: Appendix Tables II-C1, II-C3, II-C13.

Income after taxes and transfers is less unequally distributed. The share of the Top 10% decreases from 47% to 39%, while the shares of the Middle 40% and the Bottom 50% increase by 2 and 6 percentage points, respectively.

Figure A.2 shows how post-tax income is divided between two broad categories—income net of taxes on the one hand and transfers on the other—and how each is divided among the Top 10%, Middle 40%, and Bottom 50%. Overall, 66.5% of U.S. national income in 2014 corresponds to income net of taxes, while the remaining 33.5% are transfers. The share of national income that goes to the Bottom 50% is made up of 5.1% of income net of taxes and 14.1% of transfers, yielding a total of 19%. For the two other groups, post-tax income is mostly income net of taxes, but transfers play a role as well. In fact, the Top 10% receive more than twice their population share in terms of transfers (22.7%), while the Bottom 50% receive less than half of all transfers (42.1%).

This surprising result is explained by the way in which government spending is allocated to individuals in Piketty, Saez, and Zucman (2018)'s analysis. Figure A.3 breaks down this spending into several underlying categories. Overall, government spending amounts to \$5.072 B or 33.5% of total national income (\$15.154 B) in 2014. Piketty, Saez, and Zucman treat about half of this amount (\$2.515 B) as individualized. This category in turn can be divided into cash transfers and in-kind transfers. The cash transfers are Social Security pension and non-pension (disability insurance, unemployment insurance), social assistance benefits in cash (refundable tax credits, veterans' benefits,

Figure A.2: Decomposition of Post-tax Income



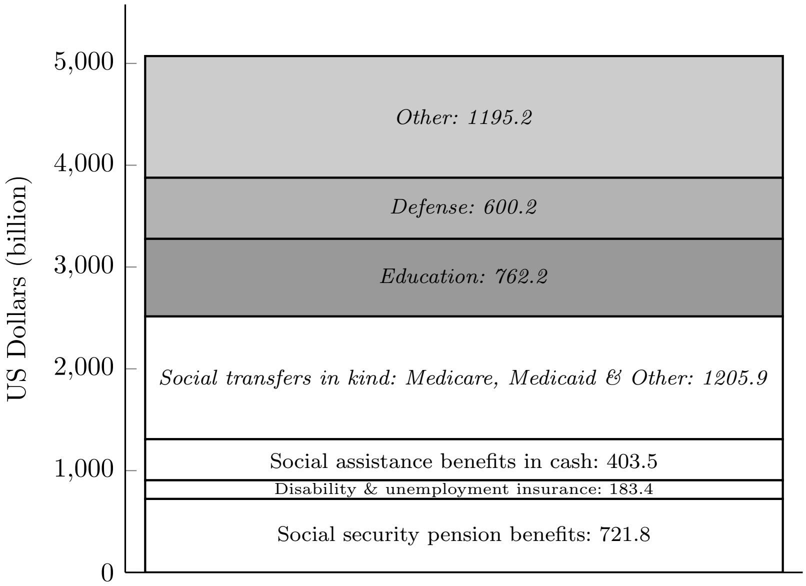
Notes: The figure shows a decomposition of post-tax income into income net of taxes and transfers. The left panel shows that income net of taxes makes up 66.5% of national income, while transfers make up the remaining 33.5%. The right panel decomposes both categories of national income. The figure shows, for example, that the transfers that accrue to the Bottom 50% represent 14.1% of national income and 42.3% of all transfers. Source: Own calculations for the United States in 2014 based on Piketty, Saez, and Zucman (2018), Appendix Table II-C2.

workers' compensation, food stamps, supplemental security income, TANF/AFDC, and some smaller programs). These are assigned based on rules and on the recipient status observed in the Current Population Survey (CPS). Individualized in-kind transfers are mostly Medicare (assigned based on rules: age or receipt of disability insurance) and Medicaid (assigned based on the CPS). Note that some of these transfers (pension benefits, disability, and unemployment insurance) are already included in pre-tax income and are thus not counted towards as government redistribution in the definition of Piketty, Saez, and Zucman, which is limited to the difference between pre-tax and post-tax income.

The other half of government expenditure ($2.558 B) falls into three domains: education, defense, and a catch-all other category, which includes roads, public transportation and more generally the physical as well as legal and administrative infrastructure. These are items of government consumption expenditure. They represent goods and services and not a cash flow from the government to individuals. In accordance with the practice of national accounting, they are valued at the monetary cost of providing them (net of fees for their use), as opposed to the monetary equivalent of the benefit that individuals attach to them, which is much more difficult to measure. Citing the difficulty of observing who receives these goods and services, Piketty, Saez, and Zucman opt to allocate all of them proportionally to post-tax disposable income, which is pre-tax income minus taxes plus individualized monetary transfers.

This choice makes half of government spending distributionally neutral by assump-

Figure A.3: Categories of Government Expenditure



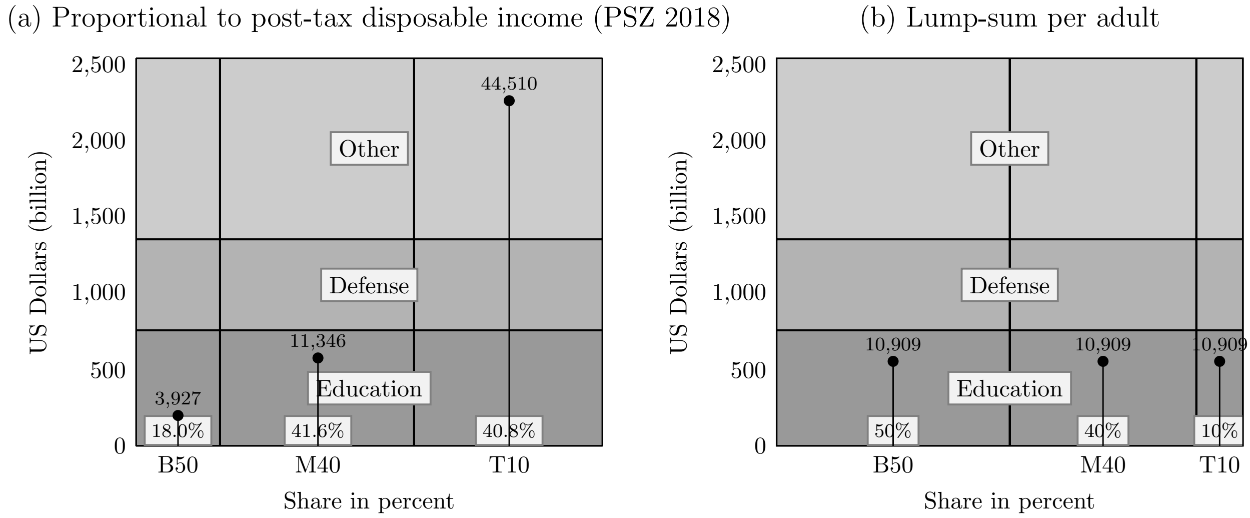
Notes: The figures shows the different categories that make up total government expenditure. Individualized transfers are shown in against a white background, government consumption in gray. Transfers in kind are italicized, the remaining items are cash transfers. Social assistance in cash comprises refundable tax credits, SNAP, SSI, TANF/AFDC, and various smaller programs. Source: Own calculations for the United States in 2014 based on Piketty, Saez, and Zucman (2018), Appendix Table I-SA11.

tion, and implies extremely unequal amounts of government consumption per capita (Figure A.4a). As the 50% of adults with the lowest post-tax disposable income receive 18.0% of the total, they get assigned the same share of government consumption, which corresponds to less than \$4 K per person and year. By contrast, each adult in the Top 10% is assumed to receive \$45 K per year in terms of public spending on education, defense, public transportation, roads, and other infrastructure, despite more frequently using private-sector alternatives, at least for education and transportation. At the very top, per capita values are even higher. The 0.01% of individuals with the highest incomes each receive more than \$4 M per year.

A.3 Consequences for Post-tax Income Shares

Levels With a lump-sum allocation, each adult gets assigned the same value of government consumption, which amounts to \$11 K per year (see Figure A.4b). This assumption leads to a substantial change in the level of post-tax inequality. With a lump-sum allocation, the gap in the post-tax income shares between the Bottom 50% and the Top 10% is reduced by half in 2014. When each adult is allocated the same amount of government consumption, the share of the Bottom 50% is higher by about 5 percentage points, and the share of the Top 10% is reduced by about the same magnitude compared with an allocation that is proportional to post-tax disposable income (see Figure C.6). As a result, the gap in the income shares of the two groups is reduced from about 20 to 10 percentage

Figure A.4: Comparison of Assumptions About Collective Expenditure



Notes: The figure contrasts Piketty, Saez, and Zucman (2018)'s assumption regarding the allocation of government consumption with the alternative of a lump-sum allocation. Piketty, Saez, and Zucman allocate government consumption proportionally to post-tax disposable income (left panel). With this assumption, the Bottom 50% of the post-tax income distribution receive 18.0% of government consumption, while the Middle 40% receive 41.6%, and the Top 10% 40.8%. This implies a per-capita value of $3,927 in the bottom half of the distribution, compared with $44,510 among the Top 10%. The right panel shows an alternative assumption in which each adult receives the same share of government consumption, which corresponds to a per-capita value of $10,909. With this assumption, the share of government consumption that goes to the three groups is equal to their population share. Source: Own calculations for the United States in 2014 based on Piketty, Saez, and Zucman (2018), Appendix Tables I-SA11, II-C1b.

points. The share of the Middle 40% is almost unaffected. The effect of the allocation rule on the income shares is of the same order of magnitude as in the study by Blanchet, Chancel, and Gethin (2022) for a number of European countries.

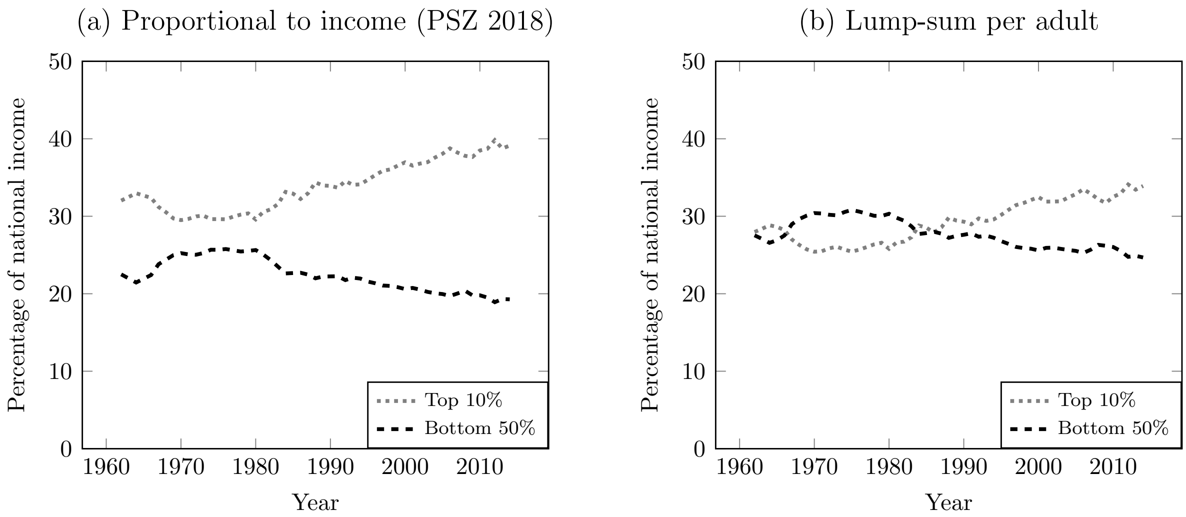
Trends The sensitivity of the level of post-tax income inequality to the assumptions regarding the allocation of government consumption has not always been highlighted enough in the Dina literature[29] and motivates our analysis of how this expenditure (or parts thereof) is actually distributed. However, the key finding of Piketty, Saez, and Zucman, namely the sharp increase not only in pre-tax, but also post-tax inequality over the past four decades or so, also holds with a lump-sum allocation of government consumption.

As Figure A.5 shows, replacing the proportional allocation with a lump-sum allocaton leads to a parallel shift in the series for the national income shares of the Bottom 50% and the Top 10%. With the lump-sum allocation, the series intersect both in the mid-1960s and the mid-1980s. However, given that the population shares of the two groups differ, an identical share of national income means that the average post-tax income of the Top 10% is five times larger than for the Bottom 50%. In 2014, the ratio of average incomes is 10.1 with a proportional allocation and 6.9 with a lump-sum allocation (Figure C.7).

There are two reasons for the parallel shift. First, the share of government consumption in national income has been fairly stable between 15 and 20% over the period considered here. Second, while the income shares based on a proportional allocation merely reflect the trends observed for post-tax disposable income, the series for the lump-sum allocation is based on population shares that are time-constant by construction (Top 10%, Middle 40%, Bottom 50%) and thus cannot capture any real movements in the allocation of government consumption either. The finding of a parallel shift is therefore somewhat mechanical, while the true question is whether the empirical relevance of the two approaches has changed over time. In the context of public education spending, changes in fiscal equalization (Hoxby 2001) or income-specific changes in enrollment (e.g., Cai and Heathcote 2022) could mean that an allocation proportional to income may work better or worse for different years. Likewise, there may have been changes in the income-specific use of public transportation or other items of government consumption over time.

[29] Piketty, Saez, and Zucman (2018) do run a robustness check in which they assign public education spending not proportionally to post-tax income, but as a function of the number of children in the tax unit. This check does not take into account the differences in per-capita expenditure by level of education (tertiary education is much more expensive per capita than primary and secondary education, at least in the United States) and, importantly, it allocates tertiary education spending to the tax units of the parents and not to the students themselves, thus making the allocation more regressive. In our view, this choice makes sense when studying educational inequality, but constitutes a departure from the purely cross-sectional, separate tax-unit approach that is adopted elsewhere in their paper. Finally, the robustness check only reports the consequences for the average income of the Bottom 50% and not the change in the income shares of all three groups.

Figure A.5: Effect of the Assumptions on Post-tax Income Shares, 1962–2014



Notes: The figure shows how the assumption regarding the allocation of government consumption affects the distribution of post-tax income in the United States over the years 1962–2014. Each panel shows the share of the Bottom 50% and the Top 10%. The left panel is for the assumption adopted by Piketty, Saez, and Zucman (2018), i.e. an allocation of government consumption that is proportional to post-tax disposable income. The right panel shows the income shares that result from assuming a lump-sum allocation. Source: Own calculations based on Piketty, Saez, and Zucman (2018), Appendix Tables I-SA11, II-C1b, II-C2, II-C3b.

B Supplementary Analyses: PSID Data Linking Parents and Children

For some of the supplementary analyses, we draw on additional data from the Panel Study of Income Dynamics (PSID), a well-established panel study that began to survey 5,000 families in 1968 (McGonagle et al. 2012). As with the ACS, we use the 2017 wave. The PSID is much smaller than the ACS, but tracks individuals after they leave their original household, which allows us to link parents' and children's educational attainment in many cases.

The PSID provides information on the highest grade or year of school someone has completed and, if applicable, on the type of college degree (associate's, bachelor's, master's, PhD). Like the ACS, the PSID does not record complete educational histories. We therefore assume that a given degree implies that the individual has passed through all the stages below, that everyone needed the same number of years to complete each stage (see Table C.3 in the Appendix for details), and that all education was received in the United States.

We use the PSID only for the intergenerational analysis in Section 3.2, where we focus on individuals aged 40–45 in 2017. As a check on the data, we compare summary statistics between the PSID and individuals from the same age group in the ACS (Table B.1). The check is important because we can link information on education between parents and children for only about half of individuals in our age group. Reassuringly, the table shows that summary statistics for both samples are very close, which suggests that selection is not a major issue.

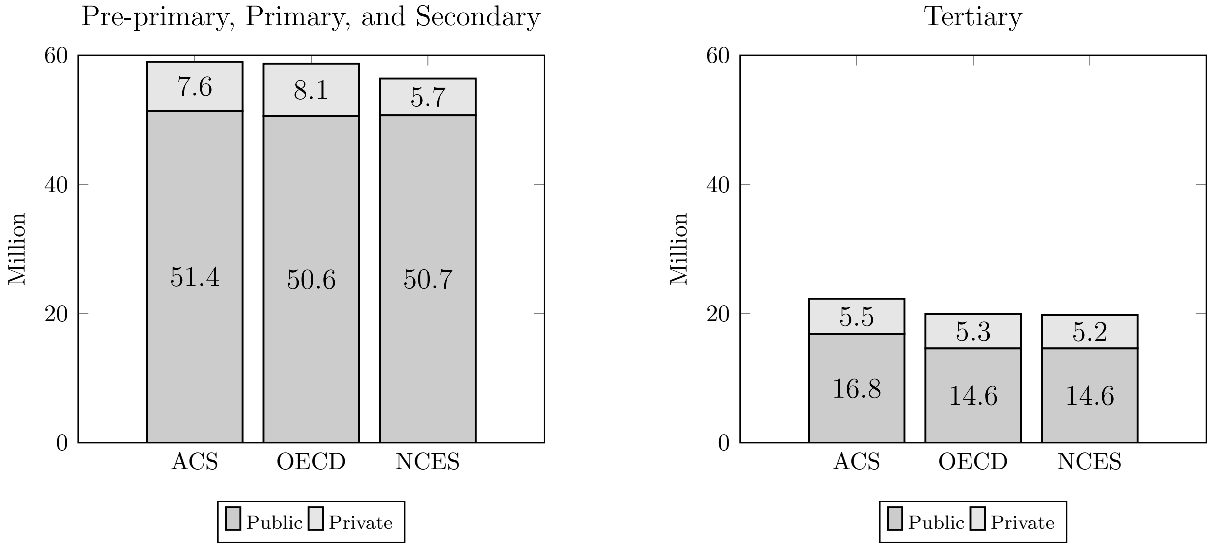
Table B.1: Summary Statistics: Comparison of ACS and PSID, Individuals Aged 40–45

	ACS		PSID	
Age	42.5	(0.004)	42.5	(0.059)
Share Female (%)	50.9	(0.001)	48.1	(0.016)
Annual Labor Income ($)	51,143	(143)	51,007	(1,889)
High School Education (%)	23.8	(0.001)	26.5	(0.015)
Associate's Degree (%)	9.3	(0.001)	9.7	(0.010)
Bsc. Degree (%)	21.4	(0.001)	20.5	(0.013)
Msc. Degree (%)	10.5	(0.001)	10.3	(0.010)
Total Education Transfers ($)	261,440	(172)	269,224	(2,055)
N	216,278		925	
N, weighted	23.787 M		11.962 M	

Notes: The table compares means (and standard errors in parentheses) of some key variables for individuals aged 40–45 across the ACS and the PSID data. The ACS data are used in Figure 4, the PSID data are used in Figure 5. The difference in the number of weighted observations is due to missing values for parental education in the PSID. Without conditioning on education information for at least one parent being present, the PSID has 1,770 observations and 23.858 M weighted observations, very close to the ACS number.

C Additional Tables and Figures

Figure C.1: Enrollment in Educational Institutions, United States 2017



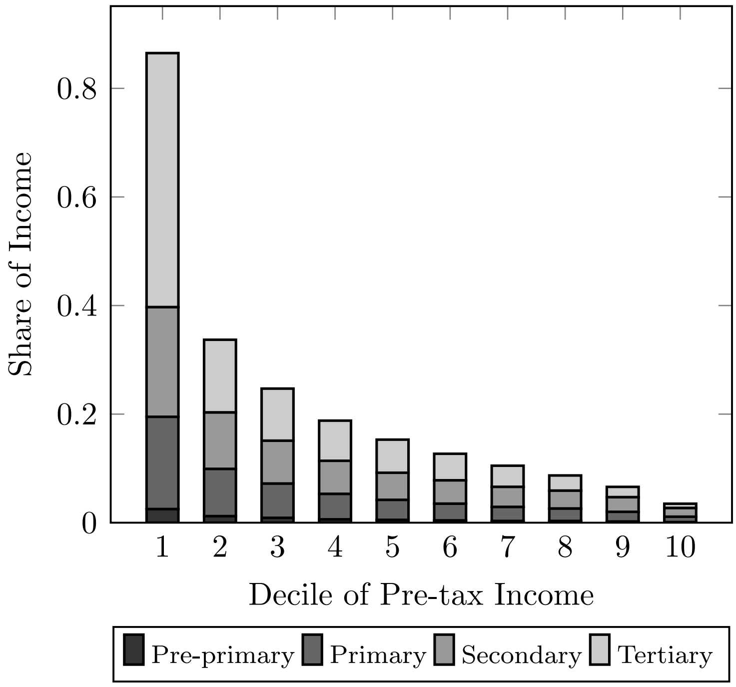
Notes: The figure compares our ACS-based numbers for the enrollment in educational institutions in the United States in 2017 with statistics published by the OECD and the National Center for Education Statistics (NCES). The left panel shows the number of students enrolled in pre-primary, primary, or secondary education, the right panel is for tertiary education. A distinction is made between public and private institutions. Source: Own calculations based on the American Community Survey 2017. OECD: Education at a Glance 2020 (OECD Statistics 2020), Table: Enrollment data adjusted to the financial year. Sum of students in full-time and part-time education. Part-time is only non-zero at the pre-primary and the tertiary levels. Students in post-secondary non-tertiary education not included (110 K are enrolled in public institutions, 273 K in private institutions). NCES: National Center for Education Statistics, Digest of Education Statistics 2019 (De Brey et al. 2021), Table 105.30: Enrollment in elementary, secondary, and degree-granting postsecondary institutions, by level and control of institution: Selected years, 1869-70 through fall 2029.

Table C.1: Public Education Spending by Income: Detailed Results

	Income Decile									
	1	2	3	4	5	6	7	8	9	10
A. Pre-tax Income (Adults)										
Pre-primary	179	165	169	153	146	141	144	152	136	114
Primary	1,209	1,214	1,230	1,144	1,098	1,118	1,165	1,218	1,245	1,237
Secondary	1,386	1,447	1,514	1,505	1,504	1,542	1,635	1,758	1,920	1,913
Tertiary	3,253	1,927	1,852	1,821	1,817	1,812	1,716	1,534	1,379	992
Total	6,027	4,752	4,765	4,623	4,564	4,613	4,660	4,661	4,680	4,256
B. Post-tax Cash Income (Adults)										
Pre-primary	138	141	162	174	164	157	153	163	138	110
Primary	935	978	1,189	1,277	1,217	1,231	1,254	1,294	1,293	1,209
Secondary	1,102	1,248	1,430	1,604	1,591	1,678	1,709	1,877	1,953	1,926
Tertiary	3,402	2,046	1,889	1,834	1,798	1,742	1,652	1,468	1,312	976
Total	5,577	4,413	4,670	4,888	4,769	4,808	4,768	4,802	4,696	4,221
C. Equivalized Pre-tax Income (Households)										
Pre-primary	379	409	378	333	306	271	241	189	154	124
Primary	2,701	3,074	2,874	2,627	2,222	2,176	1,923	1,716	1,481	1,290
Secondary	3,254	3,890	3,890	3,495	3,275	3,152	2,691	2,428	2,049	1,723
Tertiary	6,771	3,447	3,476	3,524	3,455	3,462	3,147	2,953	2,566	1,686
Total	13,106	10,820	10,618	9,978	9,258	9,061	8,002	7,286	6,250	4,822

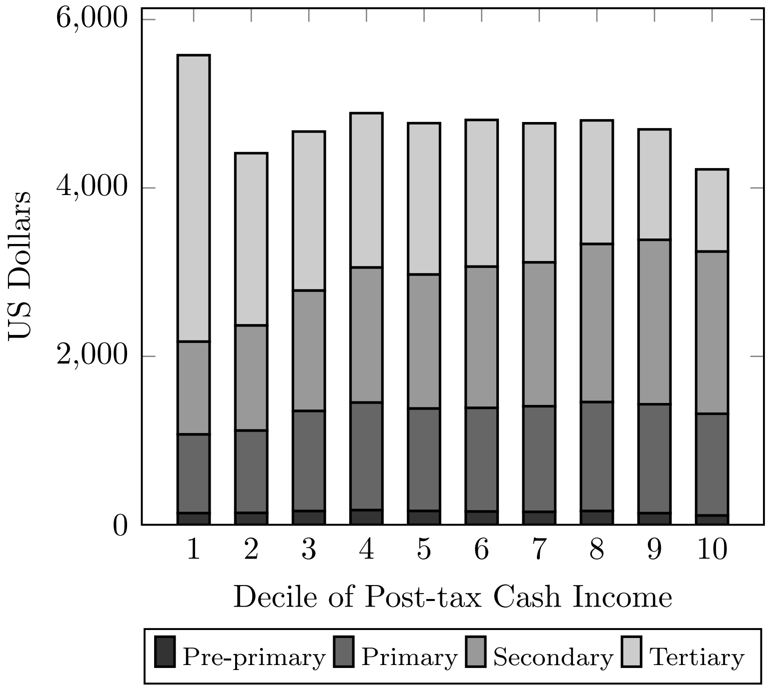
Notes: The table shows how public education spending in the United States in 2017 is distributed among the deciles of the income distribution. All values in 2017 US Dollars. For the sake of presentation and given the large sample size, standard errors are omitted. The deciles are based on pre-tax income (panel A), post-tax disposable income (panel B), and equivalized pre-tax household income (panel C). The same information is presented in graphical form in Figure 1 in the main text and Figures C.3 and C.5 in the Appendix. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level. In panels A and B, the resulting sum is split equally among adults aged 20 and above in the household, and household income is likewise split equally among all adults. Panel C reports public education spending at the household level instead, and deciles are based on equivalized pre-tax household income, using the modified OECD equivalence scale, which assigns a value of 1 to the first adult in the household, of 0.5 to each additional household member aged 14 and above, and of 0.3 to each child below the age of 14. Pre-tax income is directly taken from the American Community Survey, while post-tax disposable income is simulated using TAXSIM v32.

Figure C.2: Public Education Spending as Share of Pre-Tax Income by Deciles of Pre-Tax Income



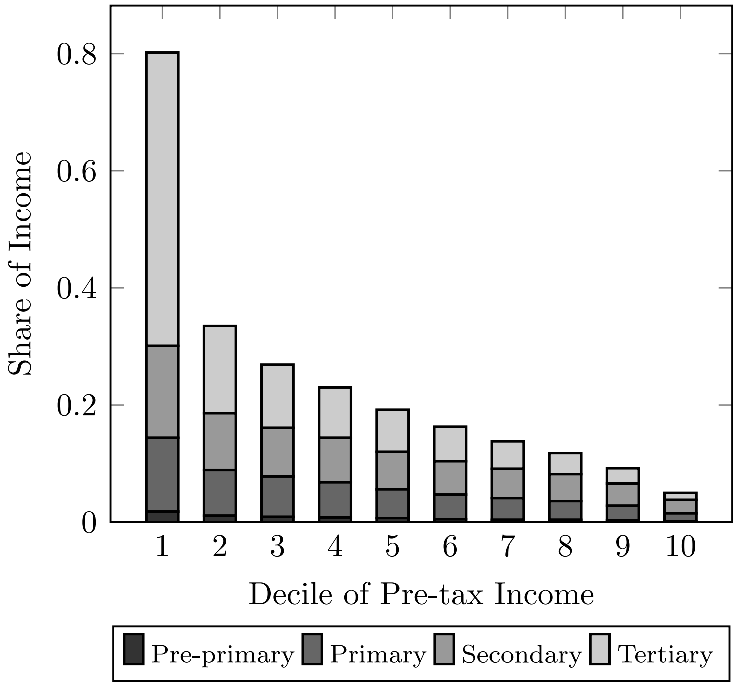
Notes: The figure shows how public education spending in the United States in 2017 is distributed among the deciles of the pre-tax income distribution. For each decile, the bars show the average of annual public education spending expressed as shares of average pre-tax income for the pre-primary, primary, secondary, and tertiary levels of education. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Household income is likewise split equally among all adults. Observations with income below the 2.5th percentile are dropped.

Figure C.3: Public Education Spending by Post-tax Cash Income, Allocated Based on Actual Enrollment



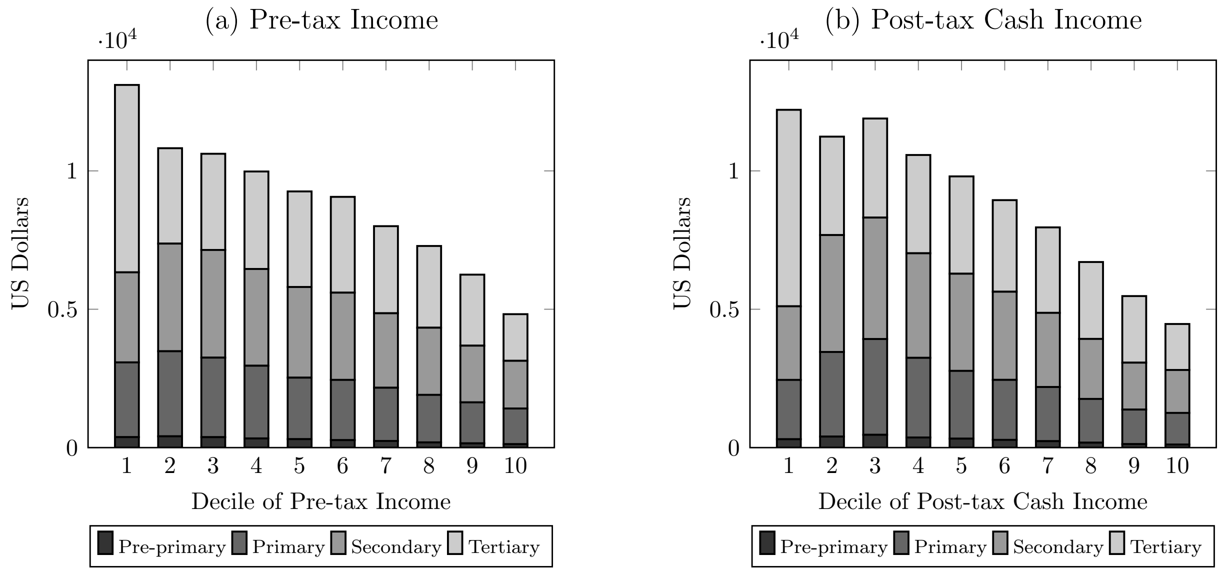
Notes: The figure shows how public education spending in the United States in 2017 is distributed among the deciles of the post-tax disposable income distribution. For each decile, the bars show the average values of annual public education spending (in 2017 US Dollars) at the pre-primary, primary, secondary, and tertiary levels of education. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Household post-tax disposable income is simulated using TAXSIM v32, and is likewise split equally among all adults.

Figure C.4: Public Education Spending as Share of Post-Tax Income by Deciles of Post-Tax Income



Notes: The figure shows how public education spending in the United States in 2017 is distributed among the deciles of the post-tax income distribution. For each decile, the bars show the average of annual public education spending expressed as shares of average post-tax income for the pre-primary, primary, secondary, and tertiary levels of education. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Household income is likewise split equally among all adults. Household post-tax disposable income is simulated using TAXSIM v32, and is likewise split equally among all adults. Observations with post-tax income below the 2.5th percentile are dropped.

Figure C.5: Public Education Spending by Equivalized Household Income, Allocated Based on Actual Enrollment



Notes: The figure shows how public education spending in the United States in 2017 is distributed among households over deciles of the equivalized household income distribution. Left panel: deciles based on pre-tax income. Right panel: deciles based on post-tax disposable income simulated using TAXSIM v32. For each decile, the bars show the average values of annual public education spending (in 2017 US Dollars) at the pre-primary, primary, secondary, and tertiary levels of education. Source: Enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is then summed up at the household level. Household income is equivalized using the modified OECD equivalence scale, which assigns a value of 1 to the first adult in the household, of 0.5 to each additional household member aged 14 and above, and of 0.3 to each child below the age of 14.

Table C.2: Robustness Checks

	Decile of Pre-tax Income									
	1	2	3	4	5	6	7	8	9	10
Main specification	6.0	4.8	4.8	4.6	4.6	4.6	4.7	4.7	4.7	4.3
Drop if > 50% of income imputed	5.9	4.7	4.8	4.6	4.5	4.6	4.7	4.7	4.6	4.2
Drop if income negative	6.0	4.7	4.8	4.6	4.6	4.6	4.7	4.7	4.7	4.3
Drop if income < 1%	6.0	4.7	4.8	4.6	4.6	4.6	4.7	4.7	4.7	4.3
Drop if income < 2.5%	5.4	4.7	4.8	4.6	4.6	4.6	4.7	4.7	4.7	4.3
Drop if income > 99.5%	6.0	4.8	4.8	4.6	4.6	4.6	4.6	4.7	4.7	4.3
Enrollment as in NCES	5.5	4.4	4.4	4.3	4.2	4.3	4.3	4.4	4.4	4.0
Variation across states	5.6	4.4	4.5	4.4	4.3	4.3	4.4	4.5	4.6	4.4
Full-time equivalents	4.6	3.8	3.8	3.7	3.7	3.7	3.8	3.8	3.9	3.6
2/4-year college	6.8	5.2	5.2	5.1	5.0	5.1	5.1	5.1	5.1	4.6
Current expenditure	5.5	4.3	4.3	4.2	4.1	4.2	4.2	4.2	4.2	3.9
All expenditure	7.2	5.5	5.5	5.4	5.3	5.3	5.4	5.3	5.3	4.8

Notes: The table summarizes the results of our robustness checks. For comparison, results for the main specification are shown in the first row as well. The amounts reported in the table are annual public education transfers in thousand US Dollars. Source: In the main specification, enrollment in public educational institutions is taken from the American Community Survey 2017. Each pupil or student is assigned the per-capita value of public education spending taken from the OECD (see Table 2). Public education expenditure is summed up at the household level, and the resulting sum is split equally among adults aged 20 and above in the household. Household income is likewise split equally among all adults. The robustness checks modify the measurement of enrollment, of per-capita expenditure, or of the household income that enters the computation of the deciles. For details, see Section 3.2.

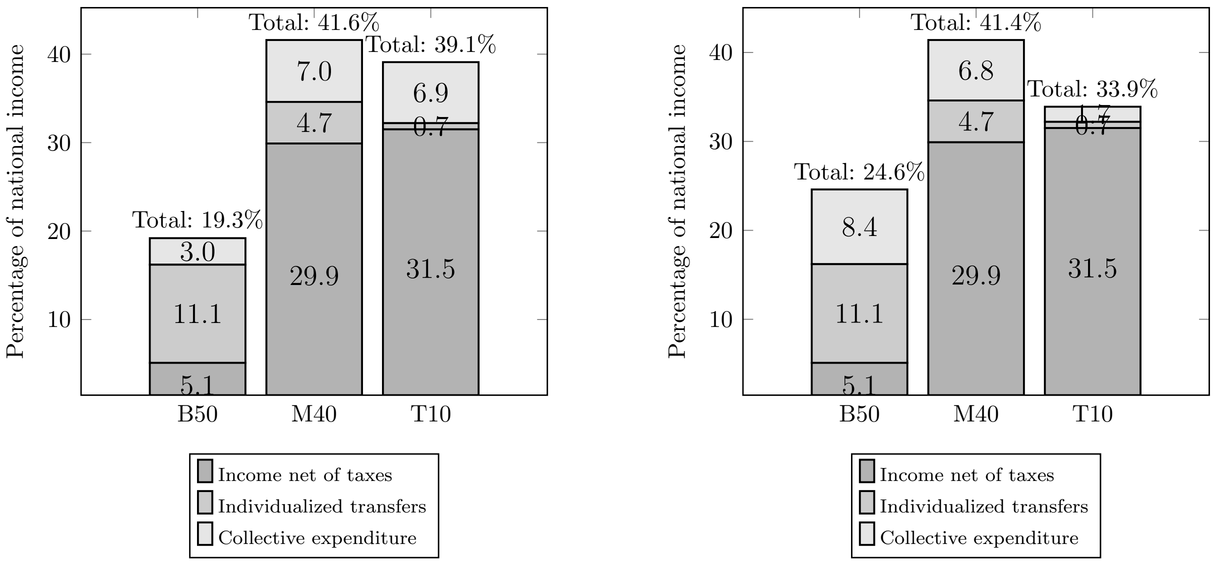
Table C.3: Construction of Educational Trajectories

	Years Spent at ISCED Level									
Highest Degree (ACS)	0	1	2	3	4	5	6	7	8	Total
No schooling completed	0	0	0	0	0	0	0	0	0	0
ISCED 0										
Nursery school, preschool	2	0	0	0	0	0	0	0	0	2
ISCED 1										
Kindergarten	2	1	0	0	0	0	0	0	0	3
Grade 1	2	2	0	0	0	0	0	0	0	4
Grade 2	2	3	0	0	0	0	0	0	0	5
Grade 3	2	4	0	0	0	0	0	0	0	6
Grade 4	2	5	0	0	0	0	0	0	0	7
Grade 5	2	6	0	0	0	0	0	0	0	8
ISCED 2										
Grade 6	2	6	1	0	0	0	0	0	0	9
Grade 7	2	6	2	0	0	0	0	0	0	10
Grade 8	2	6	3	0	0	0	0	0	0	11
ISCED 3										
Grade 9	2	6	3	1	0	0	0	0	0	12
Grade 10	2	6	3	2	0	0	0	0	0	13
Grade 11	2	6	3	3	0	0	0	0	0	14
12th grade, no diploma	2	6	3	3	0	0	0	0	0	14
Regular high school diploma	2	6	3	4	0	0	0	0	0	15
GED or alternative credential	2	6	3	4	0	0	0	0	0	15
Some college, but less than 1 year	2	6	3	5	0	0	0	0	0	16
ISCED 4										
Associate's degree, type not specified	2	6	3	4	2	0	0	0	0	17
ISCED 5										
1 or more years of college credit, no degree	2	6	3	4	0	2	0	0	0	17
ISCED 6										
Bachelor's degree	2	6	3	4	0	0	4	0	0	19
ISCED 7										
Master's degree	2	6	3	4	0	0	4	2	0	21
Professional degree beyond a bachelor's degree	2	6	3	4	0	0	4	2	0	21
ISCED 8										
Doctoral degree	2	6	3	4	0	0	4	2	4	25

Notes: The table documents how we map the information on the highest degree in the American Community Survey (ACS) 2017 into educational trajectories. The rows correspond to the values of the variable "Highest degree" (educd) in the ACS. The question reads: "What is the highest degree or level of school this person has completed?". As our method is retrospective and we do not have information on grade repetition or, more generally, the individual pathways to a given degree, we assign the same number of years to all individuals with the same degree. For instance, individuals with a regular high school diploma are assumed to have spent two years at ISCED level 0, six years at ISCED level 1, three years at ISCED level 2, and four years at ISCED level 2. Individuals with a bachelor's degree are assigned the same trajectory plus four years at ISCED level 6, and a master's degree would add two years at ISCED level 7. The last column of the table gives the total number of years thus obtained. The number is meant as a summary measure only. When computing the public expenditure for each degree, we multiply the number of years *at each ISCED level* with the corresponding OECD per-student expenditure from Table 2.

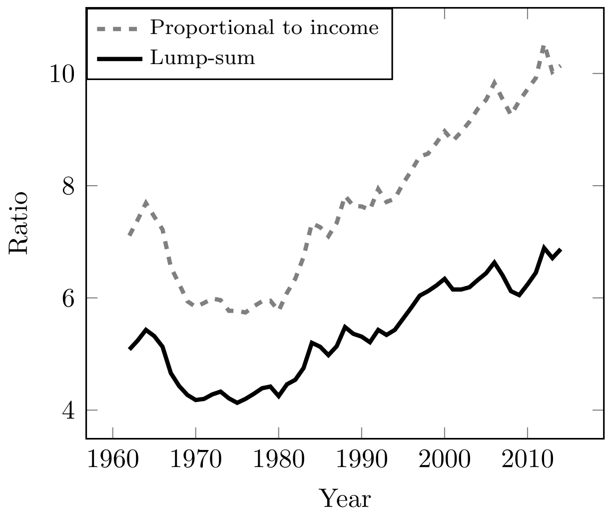
Figure C.6: Effects of the Assumptions on the Distribution of Post-tax Income

(a) Proportional to disposable income (PSZ 2018) | (b) Lump-sum per adult



Notes: The figure shows how the assumption regarding the allocation of government consumption affects the distribution of post-tax income. When government consumption is allocated based on post-tax disposable income as in Piketty, Saez, and Zucman (2018), the Bottom 50% receive 19.3% of national post-tax income, while the Middle 40% receive 41.6%, and the Top 10% receive 39.1% (left panel). Under the alternative assumption in which each adult receives the same amount of government consumption, the shares are 24.6%, 41.4%, and 33.9% instead (right panel). Source: Own calculations for the United States in 2014 based on Piketty, Saez, and Zucman (2018), Appendix Tables I-SA11, II-C1b, II-C2, II-C3b.

Figure C.7: Effect of the Allocation Rules on the Ratio of Average Incomes of the Top 10% to Bottom 50%, 1962–2014



Notes: The figure shows how the assumption regarding the allocation of government consumption affects the ratio of average post-tax incomes of the Bottom Top 10% and the Bottom 50% in the United States over the years 1962–2014. The dashed gray line represents the assumption adopted by Piketty, Saez, and Zucman (2018), i.e. an allocation of government consumption that is proportional to post-tax disposable income. The black line shows the ratio that results from assuming a lump-sum allocation. Source: Own calculations based on Piketty, Saez, and Zucman (2018): Appendix Tables I-SA11, II-C1b, II-C2, II-C3b.