A Micro Perspective on r > g

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A MICRO PERSPECTIVE ON $r > g$ [*]

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Abstract

By exploiting large-scale administrative data on estimated gross and net personal wealth in Norway from 2010 to 2018, this paper establishes the first microlevel analysis of the difference between the real return on wealth and the real growth rate of total pretax income across the entire net wealth distribution. We show that for the top 40% of the distribution, aggregate $R - G$ underestimates its micro counterpart $r - g$, while the opposite happens for the bottom 60%, indicating that micro $r - g$ qualifies as a more precise measure to analyze the dynamics of income and wealth inequality thoroughly.

Keywords: Wealth inequality; Tax records; Norway.
JEL Classification: D30, D31, D33.

1 Introduction

The publication of "*Capital In The Twenty-First Century*" (Piketty, 2014) has sparked a surge of interest in the study of wealth inequality and the relation between the rate of return on capital and the growth rate of income. The main conclusion in Piketty (2014) and Piketty and Zucman (2014) is that if the rate of return on wealth overcomes that of on income ($r > g$), wealth-rich individuals, the so-called *rentiers*, would accumulate wealth faster than individuals typically holding low or negative values of wealth and mainly relying on income, thus fostering wealth disparities in the longer run. The necessary assumptions for this prediction to hold and the relation to economic theory have been analyzed by Hiraguchi (2019); Jones (2015), Mankiw (2015) and Stiglitz (2016). The author himself returns to the debate in Piketty (2015a), clarifying that he does not consider "*r > g as the only or even as the primary tool [...] for forecasting the path of inequality in the twenty-first century. Institutional changes and political shocks [...] have played a major role in the past, and it will probably be the same in the future*".

In our view, a thorough understanding of $r > g$, its predictive power, relevance, and eventual limitations in the short run and the long run hinges crucially on the variety of analyses carried out upon it. Several studies have recently attempted to decompose the rate of return on wealth to allow heterogeneity of returns across the wealth distribution. Jordà, Knoll, Kuvshinov, Schularick, and Taylor (2019) use granular asset price data and find that the relation $r > g$ is a constant feature of their data in peacetime for every country and period under analysis.[1] Focusing on r, Fagereng, Guiso, Malacrino, and Pistaferri (2020) exploits the high quality of Norwegian individual-level data on wealth holdings to document the persistent heterogeneity of real rates of return on net worth across the distribution, even within asset classes. Furthermore, they show that scale dependence matters since rates of return on net worth are positively correlated with individuals' position in the wealth distribution. Bach, Calvet, and Sodini (2020) use Swedish data and confirm that the expected return on (household) net worth is strongly persistent and increases with net wealth holdings.

Proceeding along these lines, we intend to fill a gap in the literature by providing the first microlevel empirical assessment of the difference between r and g across the net wealth distribution comparing it to its macroeconomic counterpart, which we will refer to as $R - G$. By exploiting large-scale administrative data on personal wealth in Norway from 2010 to 2018, we show that the aggregate $R - G$ (with an average of 1.8% throughout the period) underestimates its micro counterpart $r - g$ for the top 40% of the wealth distribution, while the opposite happens for the bottom 60%. This implies as well that micro $r - g$ predicts a higher level of wealth inequality in comparison to $R - G$. This result is illustrated through a simple simulation exercise in the paper. In other words, although formally the macro $R - G$ can be expressed in terms of its micro counterpart $r - g$ through a difference between two unweighted averages, our empirical evidence indicates that the

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[1]For Norway in the period $1980 - 2015$, they estimate that on average the real return on wealth is 6.55% higher than the real growth of GDP.

distribution of $r - g$ provides insights on the dynamics of wealth inequality that do not arise by exclusively focusing on mean variables. We also analyze whether our evidence on the micro $r - g$ can be explained only by persistent heterogeneity across the net wealth distribution or if we can attribute some of its variation to scale dependence. The results show that at least half of the variation in $r - g$ when moving up from the bottom to the top decile of the net wealth distribution is associated with scale dependence, implying that the scale of wealth can indeed be inserted among the determinants of micro $r - g$. Finally, we decompose personal wealth into its main components (housing and financial) to show that the share of financial wealth is positively correlated with real rates of return, while the opposite is true for housing wealth.

The paper is structured as follows. Section 2 presents the data and outlines our definitions of personal income and wealth. Section 3 presents the main results, followed by the discussion section 4, before section 5 concludes the paper.

2 Data and descriptive statistics

Our analysis is based on Norwegian administrative tax records on income and wealth.[2] Norwegian administrative tax records represent a particularly reliable source of information since most components of income and wealth are reported by third parties, such as banks and employers, mitigating the risk of measurement errors and underreporting deriving from self-reported income and wealth in surveys. Our baseline sample consists of the entire population of residents in Norway with age 20 years and above (although our results are not affected by considering a younger sample), in between 2010 and 2018. For each resident individual i, the following definitions of personal wealth, capital income and total fiscal income (all pretax) are considered. All variables are measured on the last day of the year and are at the level of individuals, not households.

Gross wealth [$gw_{i,t}$]: estimated personal gross wealth, including estimated market values of real and financial capital. Real capital includes the estimated market value of the primary dwellings, secondary dwellings, land, and buildings related to business activity (business assets). Financial capital includes cash, domestic deposits, foreign deposits, government and corporate bonds, bond funds and money market funds, shares in stock funds, other taxable capital abroad and outstanding claims and receivables. Note that as entrepreneurs report private business wealth to the tax authorities as an assessed valuation of their shares, our variable, therefore, includes a portion of unrealized capital gains on financial wealth.

Private debt [$d_{i,t}$]: private debt to Norwegian and foreign creditors (consumer debt, student debt, and long-term debt), including debt related to shares in real estate companies.

Capital income [$k_{i,t}$]: taxable property income includes share dividends, interest income on bank deposits and on domestic and foreign assets, interest on loans to compa-

nies, realized capital gains, imputed rents, and unrealized capital gains on housing wealth. From this, we subtract realized capital losses and interest expenditures. We compute imputed rents as a constant fraction of the percentile estimated value of housing wealth by employing a nominal interest rate of 3%, as done in Bø (2020). We follow Fagereng et al. (2020) and compute unrealized capital gains on housing as the yearly difference in housing wealth of the previous year.[3]

Total fiscal income [$y_{i,t}$]: fiscal pre-tax income includes employee income and net income from self-employment[4], taxable and tax-free transfers and capital income.

The full sample (before any trimming) varies from approximately 3.67 million individuals in 2010 to 4.12 million in 2018, and it sums up to 35.09 millions throughout the period.[5] All variables are subsequently adjusted for inflation based on CPI and expressed from here onward in real terms.[6]

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[3]We do not exclude transactions from capital gains in housing wealth, due to data limitations.

[4]Net self-employment income is the sum of self-employment income in agriculture, forestry and fishing and self-employment income from other industries received during the calendar year, less any losses. It also includes sickness benefits paid to the self-employed.

[5]For more information on the full sample, see Table 4 in the Online Appendix **A**, showing summary descriptive statistics describing our sample.

[6]In each year, the totals for our series of estimated net wealth fully match those from the national accounts household sector wealth statistics provided by Statistics Norway (Table 10315 - Property account for households $2010 - 2018$).

Figure 1: Gross and net wealth, capital and total income: $2011 - 2018$.
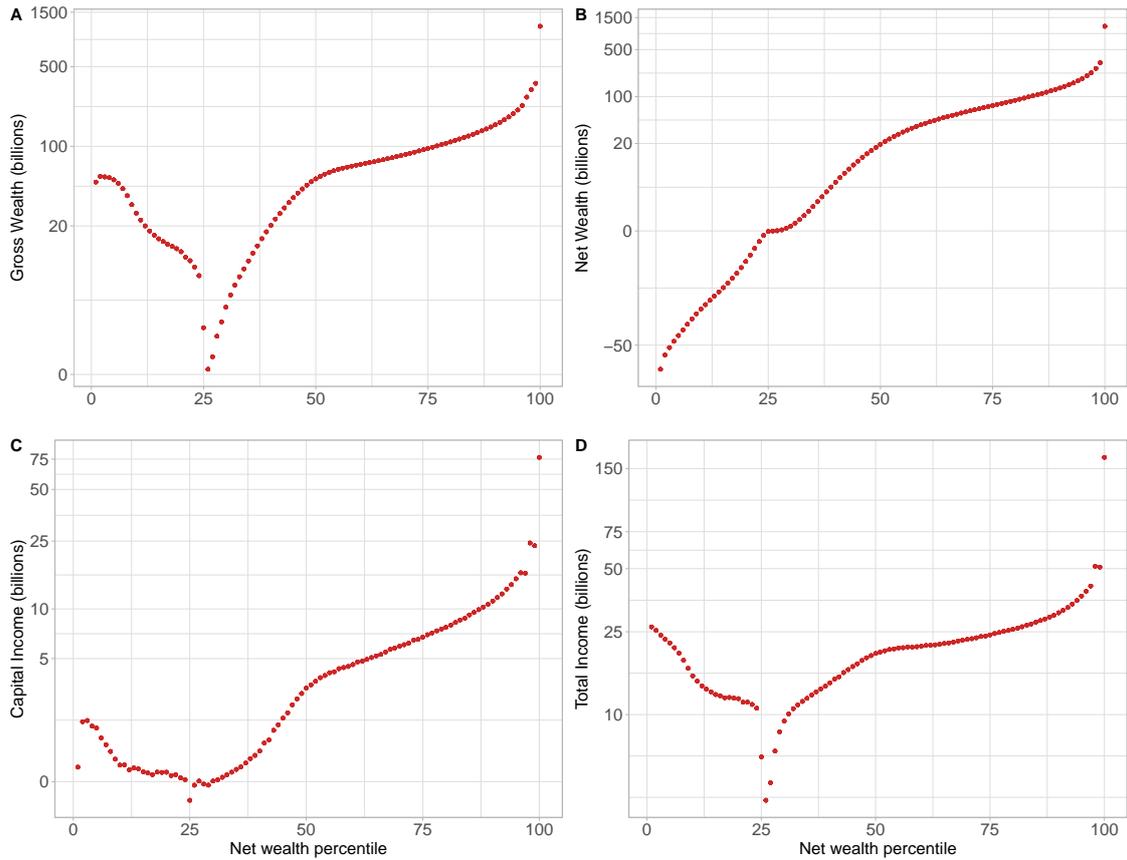
Note: Panel **A** shows the series of gross wealth; Panel **B** shows the series of net wealth; Panel **C** depicts capital incomes and in Panel **D** total incomes are drawn. All variables are given in billions of Norwegian kroner, constant prices, 2015 CPI, pseudolog scale, ranked across the net wealth distribution and pooled across the years $2011 - 2018$. The bottom part of the gross wealth distribution appears to be decreasing since individuals are ranked according to their net wealth holdings.

Figure 1 plots our main variables of interest in the period $2011 - 2018$: gross (gw_t) and net ($w_t = gw_t - d_t$) wealth, capital (k_t) and total income (y_t) (pooled across the years $2011 - 2018$, billions Norwegian kroner, constant prices, 2015 CPI), all ranked across the net wealth distribution. The first year of our baseline sample 2010 is not included because a series of capital gains in housing wealth are computed as yearly differences starting from 2011. Note that, due to indebtedness in the lower deciles (mostly long-term debt), the net wealth turns positive only around the 25th percentile.

Regarding conventional inequality measures, the gross wealth distribution exhibits a Gini coefficient of 0.52 across the period ($2011 - 2018$), while the Gini coefficient for the net wealth distribution, rises to 0.61. The Gini coefficient for the distribution of pretax capital incomes exhibits a level of 0.58, while it drops to 0.28 for the series of pretax total income (this value is slightly higher than estimations of the Gini coefficient of total income for Norway by Statistics Norway, which lies between 0.237 in 2011 and 0.251 in 2018).[7] The

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[7]Statistics Norway Table 09114: Measures of income dispersion. Household equivalent income (EU-scale) between persons (M) (UD) $2004 - 2018$.

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discrepancy between our estimates of the Gini and those of Statistics Norway might be due to our capital income definition, which is net of interest expenditure including imputed rents and unrealized capital gains in housing wealth. Proceeding with measures of wealth concentration, the top 10% receives a slightly increasing share, in between 50% and 55% of the total net wealth in our sample. The same is true for the top 1%, increasing its share from approximately 20% to 24% in the final year. A top 1% share of slightly above 20% is in line with previous estimates of top wealth shares in Norway, documented in Epland and Kirkeberg (2012).[8] Regarding the composition of wealth, the wealthy own higher shares of financial and business assets with respect to the rest of the distribution. At the same time, liabilities are substantially high throughout the distribution, highlighting the high level of households' indebtedness in the Norwegian economy.[9]

A due precisation is to be made about our definition of wealth. In the unified framework developed by Piketty and Zucman (2014) and Alvaredo et al. (2016), national wealth is the sum of public and private wealth, where private wealth consists of the net wealth of private households (personal wealth) and of nonprofit institutions serving households (NPISH). In this work, we focus purely on personal wealth, hence abstracting from the net wealth of the NPISH and public wealth. This choice allows, however, a more precise mapping between the aggregate and micro variables.

3   Results

Results from our main analysis are presented below. Since capital gains in housing wealth begin in 2011, growth rates in income across the net wealth distribution will be available from 2012 to 2018. Therefore, we restrict our analysis to this range of years.

3.1   Wealth-income ratios

We start by estimating the household sector's aggregate wealth-income ratio β for each t:

$$\beta_t = \frac{GW_t}{Y_t} = \frac{\sum_{p=1}^{P} gw_{p,t}}{\sum_{p=1}^{P} y_{p,t}}, \tag{1}$$

where gw_p and y_p are the percentile sums of individual-level real gross wealth and total income, respectively, and with $P = 100$ since we focus on percentiles, in addition, we derive the micro βs for the pooledsample given by $\beta_p = \frac{gw_p}{y_p}$ to analyze how the wealth-income ratio evolves across the net wealth distribution.

For the aggregate wealth-income ratio, we measure an average from the period of 371%, growing non-monotonically from 320% in 2012 to slightly below 440% in 2018.[10] The micro wealth-income ratio varies quite significantly across the distribution of net wealth.

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[8]For more details, see Figure 3 in Online Appendix B.

[9]More details are provided in Figure 4 in Online Appendix B.

[10]For a comparison, Fagereng, Holm, Moll, and Natvik (2019) show that in between 2012 and 2015 Norway's aggregate wealth-to-income ratio (they label this series as *"No saving by holding"*) ranged from around 450% to around 480%.

For the top 30%, the wealth-income ratio lies above the aggregate average of 371%, while the opposite is true for the bottom 70%. The top 1% of the net wealth distribution exhibits a wealth-income ratio of approximately 700%, indicating a high degree of heterogeneity across the distribution, especially at the very top.[11]

3.2 The aggregate R and G

We define the aggregate real rate of return R as the yearly ratio between end-of-period total capital income at time t (net of interest expenditure, the cost of capital), K_t, and end-of-period total gross wealth at $t - 1$, GW_{t-1}. Following Fagereng et al. (2020), we express the rate of return as a share of gross wealth to avoid negative values for individuals with negative net wealth and to avoid measurement errors from attributing infinite returns to individuals with very low values of net wealth.

$$R_t = \frac{K_t}{GW_{t-1}} = \frac{\sum_{p=1}^{P} k_{p,t}}{\sum_{p=1}^{P} gw_{p,t-1}}. \tag{2}$$

Our estimate of the rate of return in Norway, pooled across the years $2012 - 2018$, exhibits an average of 4.6%. Furthermore, we define the aggregate growth rate G of total fiscal income as follows:

$$G_t = \frac{Y_t - Y_{t-1}}{Y_{t-1}} = \frac{\sum_{p=1}^{P} y_{p,t} - \sum_{p=1}^{P} y_{p,t-1}}{\sum_{p=1}^{P} y_{p,t-1}}. \tag{3}$$

Our estimate of the growth rate G of the total fiscal income in Norway gives an average of 2.8%. Taken together, this implies that our estimate for the aggregate $R - G$ in Norway over the considered time period amounts to 1.8%.

3.3 A micro-level perspective on *r* and *g*

The main contribution of this paper is to present the first microlevel-based empirical estimates of the difference between the real rate of return and the growth rate of total fiscal pretax income across the entire net wealth distribution. To this end, we define *r* as the percentile average (for each $p = 1, \dots P$) of the ratio between individual capital income and gross wealth:

$$r_{p,t} = \frac{1}{N_p} \sum_{i=1}^{N_p} \frac{k_{i,t}}{gw_{i,t-1}}, \tag{4}$$

with N_p being the total number of individuals in each percentile p. The standard deviation of the micro r_p is 27.8%, slightly higher than the standard deviation of 22.1% estimated for unweighted returns to wealth in Fagereng et al. (2020) (although their analysis is based on the years $2004 - 2015$, hence it overlaps with our empirical exercise only for a few years).

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[11]To see these results graphically, refer to Figure 5 in Online Appendix B.

Regarding g, we define it as follows:

$$g_{p,t+1} = \frac{y_{p,t+1} - y_{p,t}}{y_{p,t}} = \frac{\sum_{i=1}^{N_p} y_{i,t+1} - \sum_{i=1}^{N_p} y_{i,t}}{\sum_{i=1}^{N_p} y_{i,t}}, \tag{5}$$

with N_p being the total number of individuals in each percentile p of the net wealth distribution. At this point, we trim the full sample by excluding percentiles of r and g lying outside the accepted range of $[-30\%; +30\%]$.[12] Volatility in the rates of return across the net wealth distribution is especially high for percentiles exhibiting low levels of gross wealth, while high volatility in growth rates of income is mostly due to capital gains on housing wealth. These corrections are conservative and, if anything, they reduce the extent of heterogeneity of r and g across the net wealth distribution.

Before we move on to present the result of the micro $r - g$, let us highlight, for the sake of clarity, the analytical expression linking the macro $R - G$ to its micro counterpart. Recall the definition of the aggregate R in Equation 2, which can be expressed as a function of the micro r_p as follows:

$$R_t(r_{p,t}) = \frac{1}{P} \sum_{p=1}^{P} \left(\frac{1}{N_p} \sum_{i=1}^{N_p} \frac{k_{i,t}}{gw_{i,t-1}} \right) = r_{1,t}S_1 + \ldots + r_{p,t}S_p, \tag{6}$$

with $S_p = w_p/W$ being the share of net wealth within percentile p (hence $\sum_{p=1}^{P} S_p = 1$). In other words, the aggregate rate of return R can be decomposed into the unweighted average of the micro rates at the percentile level. A similar decomposition can be applied to the growth rate of total income G of Equation 3, yielding the following result for the functional form of the difference between the macro $R - G$ and its micro counterpart:

$$\begin{aligned} R_t(r_{p,t}) - G_t(g_{p,t}) &= (r_{1,t}S_1 + \ldots + r_{p,t}S_p) - (g_{1,t}\lambda_1 + \ldots + g_{p,t}\lambda_p), \\ &= (r_{1,t}S_1 - g_{1,t}\lambda_1) + \ldots + (r_{p,t}S_p - g_{p,t}\lambda_p). \end{aligned} \tag{7}$$

with $\lambda_p = y_p/Y$ being the share of total income within percentile p (hence $\sum_{p=1}^{P} \lambda_p = 1$).

3.4 The distribution of $r - g$

We now present the main finding of our study, namely, the full distribution of $r - g$.

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[12]Trimming is performed in a conservative spirit. This ensures that our findings are not driven by a few outliers or measurement errors. Our baseline trimming results in excluding 9% of the full sample, the results are robust to significantly milder trimming or even to no trimming. Robustness checks on trimming are provided in Online Appendix C.

Figure 2: The distribution of $r - g$
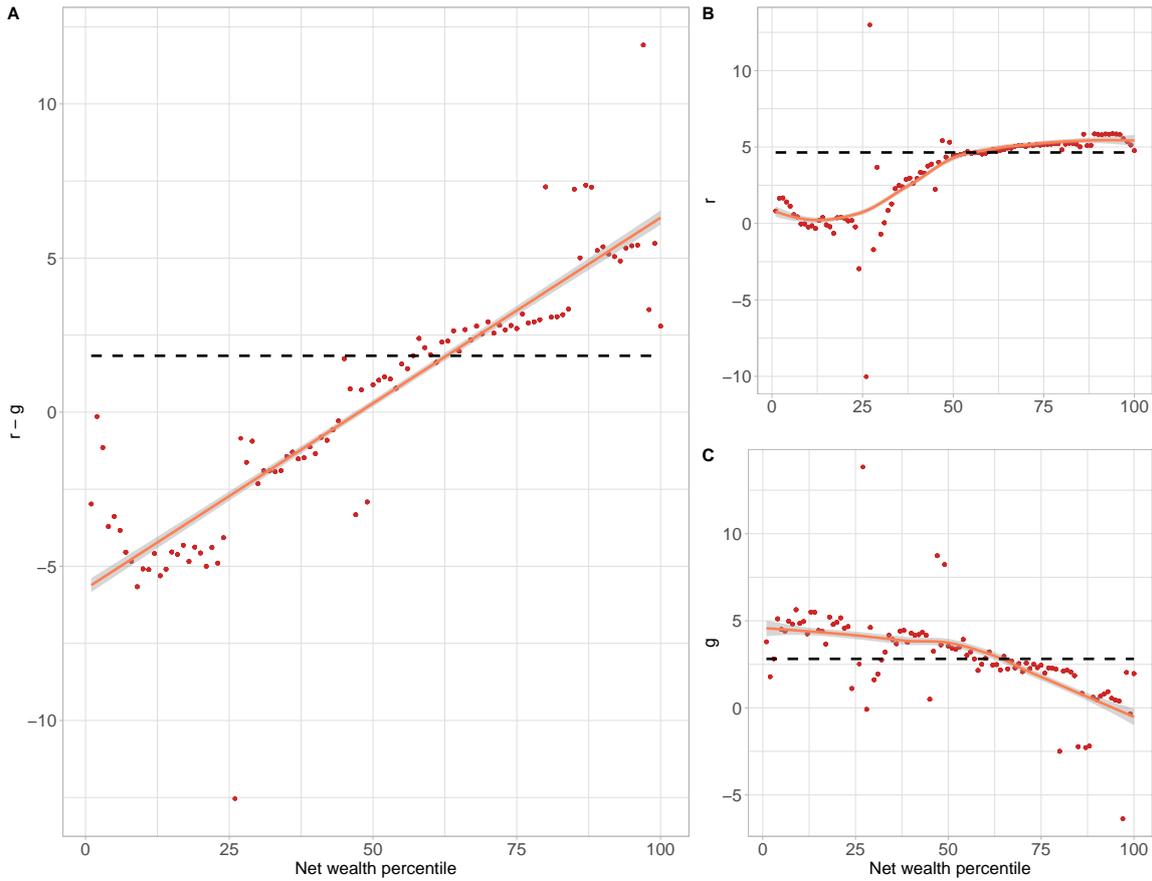
Note: Panel **A** shows the difference between the rate of return r and the growth rate of personal total fiscal income g, across the net wealth distribution, in percentage terms (%), averaged over the years $2012 - 2018$. The horizontal dashed line represents the aggregate $R - G$ with an average of 1.8% throughout the period. A linear fit is drawn for illustrative purposes throughout the distribution of $r - g$. Panels **B** and **C** respectively show how r and g evolve across the net wealth distribution over the period considered. The dashed horizontal lines represent the aggregate levels for R (panel B) and G (panel C). A local polynomial nonparametric fit for each of the two distributions is drawn.

Panel A in Figure 2 shows the difference between the *micro* rates of return on wealth r and the *micro* growth rate of personal total fiscal income g, across the net wealth distribution. The horizontal dashed line represents the aggregate $R - G$ with an average of 1.8% throughout the period, as shown in subsection 3.2. The aggregate $R - G$ of 1.8% overestimates its micro counterpart $r - g$ for approximately the bottom 60% of the net wealth distribution, while the opposite happens for the top 40%. We claim that this evidence demonstrates that an assessment of how the difference between the real rate of return on wealth minus the real income growth is distributed delivers more insights than just focusing on mean variables. Therefore, micro $r - g$ qualifies as a more informative measure to highlight distributional aspects.

Panels B and C in Figure 2 respectively, show how r and g evolve across the net wealth distribution, pooled across the years $(2012 - 2018)$. The dashed horizontal lines in panels B and C represent the G and R levels, respectively. In panel C, it is shown that micro g

fluctuates around its aggregate counterpart G for the whole distribution of net wealth. Interestingly, income growth seems to be slightly negatively correlated with wealth, as the bottom 30% in the net wealth distribution tends to have moderately higher growth rates than the rest of the distribution. In fact, in Norway, the bottom net wealth owners are typically highly indebted, but do not necessarily earn low incomes. In our data, the degree of correlation between income and wealth is negative for the bottom 30% in the net wealth distribution, while it is positive and close to 1 for the rest. In contrast, Panel B in Figure 2 shows that r exhibits higher heterogeneity and a positive degree of covariation with the position in the net wealth distribution, in line with Fagereng et al. (2020). Overall, the extent to which the covariation between $r - g$ and net wealth holdings is due to heterogeneity or scale effects (or both) shall be further analyzed in the paper's discussion section.

4 Discussion

4.1 A simulation exercise

Does micro $r - g$ lead to higher or lower wealth inequality compared to its aggregate counterpart $R - G$? This subsection sheds light on this aspect related to the dynamics of wealth inequality. Berman, Ben-Jacob, and Shapira (2016) study the dynamics of wealth inequality through a theoretical exercise based on realistic modeling of the wealth distribution. In a subsequent related study, Berman and Shapira (2017) analyze the asymptotic properties of the wealth distribution, concluding that for $r > g$, the wealth distribution constantly becomes increasingly inegalitarian.

The scope of our paper is to highlight the main findings of our empirical analysis, conveyed synthetically. To this end, we carry out a simulation calibrated on our data[13], and we draw a counterfactual comparison between two scenarios. Assume that the dynamics of income and wealth accumulation at time t can be summarized as follows:

$$
\begin{cases}
W_{p,t} = W_{p,t-1} + s_p Y_{p,t}, \\
Y_{p,t} = r_p W_{p,t-1} + Y_{p,t}^L, \\
Y_{p,t} = (1 + g_p) Y_{p,t-1}.
\end{cases}
\tag{8}
$$

where the wealth stock for percentile p at time t is equal to wealth at time $t-1$ plus a savings component $s_p Y_{p,t}$.[14] We assume a gross saving rate, s_p that monotonically increases with net wealth percentiles from 0% to 35%, in line with recent estimates of saving rates across the wealth distribution in Norway (Fagereng et al., 2019). Income $Y_{p,t}$ is defined as the sum of capital income (including capital gains), $r_p W_{p,t-1}$, and labour income, $Y_{p,t}^L$. Furthermore, we assume that income grows at the percentile-specific rate g_p. We assume, for simplicity, a fixed rank for both income and wealth distributions. Rearranging equation 8, we obtain

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[13]Each percentile is initialized with the average percentile-specific value over the period $2012 - 2018$ for the different variables considered in this exercise.

[14]In other words, we take into account that a part of income (both stemming from capital and other sources), i.e., $(1 - s_p)Y_{p,t}$, is consumed.

the following system of equations to conduct our simulation:

$$\begin{cases} Y_{p,t-1} = (1 + g_p)Y_{p,t-2}, \\ W_{p,t} = W_{p,t-1}(1 + s_p r_p) + s_p(1 + g_p)Y_{p,t-1} - s_p r_p W_{p,t-1}. \end{cases} \quad (9)$$

Let us draw two scenarios from here onward. In Scenario A, we let the income of each percentile of the wealth distribution y_p grow in every period at the average growth rate estimated in our main results section ($G = 2.8\%$). We assume that each percentile of the wealth distribution w_p is characterized by a rate of return equal to the aggregate rate of return ($R = 4.6\%$). Scenario A thus depicts a situation in which $R - G = 1.8\%$ is constant across the wealth distribution, as shown by the horizontal line drawn in Figure 2. In Scenario B instead, we introduce heterogeneity by allowing income across different percentiles to grow at the percentile level income growth rates (i.e., $g = g_p$). We apply the micro rates of return ($r = r_p$) to the percentiles of the wealth distribution.

Table 1: Simulating wealth inequality dynamics

| | | **Long-run** | |
	Initial	Scenario **A**	Scenario **B**
Gini Net Wealth	0.70	0.57	0.99
(% change)		(-19%)	(41%)
Gini Net Wealth (no joint distribution effect)	0.70	0.75	0.96
(% change)		(7%)	(37%)

Note: Scenario A applies average growth rates to all percentiles (G and R), Scenario B applies percentile-specific growth rates ($g = g_p$ and $r = r_p$). Gini coefficients across net wealth percentiles are calculated at time $t = 1$ (on average for the years $2012 - 2018$) and time $t = 150$ for net wealth. % changes in parenthesis. We show results at time $t = 150$ in order to avoid considering transitory adjustments effects of the simulation. For simplicity, we assume no wealth mobility. See Figure 7 in Appendix for evolution over time of Gini coefficients for the different cases.

The results of the simulation exercise are presented in Table 1. The univariate Gini co-efficient for net wealth decreases after 150 time periods under Scenario A (the one in which aggregate $R - G$ is employed). On the other hand, introducing heterogeneity by allowing percentiles of income and wealth distribution to grow at different rates, as in Scenario B, delivers a different outcome. In fact, the Gini coefficient of net wealth increases by 41%, therefore stabilizing at higher levels than for Scenario A. In our view, the gap between the two scenarios highlighted by this simulation exercise underlines the importance of consid-ering heterogeneity for wealth inequality dynamics. Although the result of a decreasing Gini coefficient in Scenario A might appear counterintuitive, this is mostly due to the in-teracting joint distribution of income and wealth in our data, which we use to initialize the simulation exercise. In particular, although the correlation between average income and net wealth over the period $2012 - 2018$ is positive and high for most parts of the net wealth distribution as expected, income and wealth happen to be negatively correlated for per-

centiles in the bottom 30% of the net wealth distribution. This is because individuals in the bottom portion of the net wealth distribution often have high levels of indebtedness that they sustain through high levels of income (as shown in Panel B of Figure 1). When considering a single homogeneous $R-G$, the effect of saving out of increased income for the bottom 30% predominates over the effect of increased capital income for the wealth rich due to higher returns, resulting therefore in an overall reduction of wealth inequality. Under Scenario B instead, the effect of return heterogeneity implies higher rates of return on wealth for the wealthy rich, which overcome the counteracting saving effect at the bottom of the net wealth distribution. For clarity, we therefore conducted an additional exercise in which we assume an initial income level that is proportional to wealth (hence avoiding joint distributional effects). This yields a slight increase (7%) in the Gini coefficient for net wealth in Scenario A. The gap between Scenarios A and B is also reduced; however, it remains positive and significant. Overall, the main message of this thought experiment is that considering a homogeneous $R-G$ underestimates the magnitude of wealth inequality with respect to taking into account heterogeneity by employing $r-g$.[15]

In our view, this result is in line with the theoretical insights in Stiglitz (2016), extending the Solow model by introducing variable returns to capital to explain the emergence of income and wealth inequality, and with Gabaix, Lasry, Lions, and Moll (2016) studying the importance of scale dependence in growth dynamics for understanding inequality. Piketty (2015b) clarifies how $R-G$ does not work as a direct determinant of inequality but instead as an amplifier of other kinds of shocks, increasing inequality in the steadystate and making disparities more persistent. Our findings suggest that the heterogeneity of $r-g$ across the distribution should be added to the list of determinants of increasing wealth inequality.

4.2 Persistent heterogeneity or scale dependence?

To what extent is the main finding shown in Figure 2 caused by persistent heterogeneity in returns across the net wealth distribution, and to what extent is it instead determined by wealth scale effects? By persistent heterogeneity, we mean idiosyncracies in returns, which may, for instance, be attributed to differences in risk preferences, or the ability to catch entrepreneurial opportunities. A high degree of persistent heterogeneity in returns implies that the aggregate $R-G$ fails to predict each and any single realization of the micro $r-g$. In addition, there would be a low degree of covariation between the micro $r-g$ and position in the net wealth distribution. By scale dependence, we mean a positive effect of the scale of net wealth on returns. If scale dependence also causes variation in $r-g$, then we might observe an increasing monotonic trend in $r-g$, as is indeed the case in Figure 2. The implications of the above question are decisive for the study of wealth inequality. As argued by Piketty (2014), *"It is perfectly possible that wealthier people obtain higher average returns than less wealthy people... It is easy to see that such a mechanism can automatically lead*

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[15]Simulations for the top 1% shares are perfectly in line with results related to Gini coefficients and can be provided upon request.

to a radical divergence in the distribution of capital." To investigate the relative importance of scale effects, we follow both Fagereng et al. (2020) and Gabaix et al. (2016) and estimate the following simple model:

$$(r - g)_{p,t} = \theta D(w_{p,t}) + \omega_p + f_t + \phi_p + \epsilon_{p,t}, \tag{10}$$

where $(r - g)_{p,t}$ denotes the micro $r - g$ for percentile p at time t, $D(w_{p,t})$ represents the decile of the net wealth distribution (capturing scale effects), ω_p and f_t are the percentile (capturing persistent heterogeneity) and time fixed effects (capturing time dependent co-variation in $r - g$ and net wealth), respectively, ϕ_p is the age (standardized) and $\epsilon_{p,t}$ is the error term. In other words, the coefficient θ represents the scale dependence parameter. Note that we choose to perform the following estimations at the percentile level due to the limited flexibility in econometric modeling (motivated by privacy concerns) provided by the interface microdata.no administered by Statistics Norway. Table 2 shows the results.

Table 2: Explaining heterogeneity in the distribution of $r - g$

	(1)	(2)	(3)	(4)
	$r - g$	$r - g$	$r - g$	$r - g$
Decile	1.206***	1.138***	0.525***	0.524***
	(21.15)	(19.49)	(13.51)	(12.24)
Time FE	NO	YES	YES	YES
Percentile FE	NO	NO	YES	YES
Age (standardized)	NO	NO	NO	YES
Observations	638	638	638	638

Note: The table shows regression estimates of the micro r as in model specification given by equation 10. The amount of observations is reduced to 638 from 700 due to trimming of the dataset, mentioned in subsection 3.3. t-statistics in parentheses.

We know from our database that a move from the lowest to the highest decile of the net wealth distribution would increase $r - g$ by approximately 8 percent. Again, this is an average magnitude and not a precise accounting of the dispersion of this measure. Which portion of this increase can be explained by scale dependence? According to the scale dependence coefficient θ in column 4 and after persistent heterogeneity is controlled for, each decile shift leads to an increase in $r - g$ of 0.524 percent, implying that jumping from the lowest to the highest decile (8 times θ) corresponds on average to a higher $r - g$ of approximately 4.19 percent. This amounts to half of the entire variation in $r - g$, indicating that scale dependence counts at least as much as the degree of heterogeneity. The coexistence of persistent heterogeneity and scale dependence results as well from the analysis in Fagereng et al. (2020), although they focus exclusively on rates of return and not on $r - g$.

4.3 Do the types of wealth and rate of return correlate?

This subsection focuses on a decomposition of our wealth series. Not all wealth owners are equal, and the type of wealth substantially impacts rates of return. Focusing now only on the rate of return r, do we gain additional insights by separating between the types of wealth owners? We compute for all years the shares of housing (including the estimated market value of first and secondary dwellings) and financial wealth on personal gross wealth, with individuals ranked by their position in the net wealth distribution. Housing represents the main wealth component for the middle class $50 - 90\%$, since it accounts for approximately $75 - 80\%$ of middle class gross wealth. Focusing on the top 10%, the picture changes slightly. Housing remains the biggest component of gross wealth for the $90 - 99$ percentiles, although with a lower share before it drops to approximately 20% of total gross wealth for the top 1%.[16] We specify a baseline linear fixed-effects model to synthesize the information on types of wealth and rates of return:

$$r_{p,t} = \omega_p + f_t + \rho_{p,t} + \mu_{p,t} + \gamma X_{p,t} + \epsilon_{p,t}, \tag{11}$$

where $r_{p,t}$ denotes the rate of return r for percentile p at time t. ω_p and f_t are the fixed percentile and time effects, respectively. $\rho_{p,t}$ is the lagged share of financial wealth on gross wealth for each percentile, while $\mu_{p,t}$ is the lagged share of housing. $X_{p,t}$ represents a set of control variables (lagged levels of housing and financial wealth), and $\epsilon_{p,t}$ is the error term.

Table 3: Explaining rates of return in relation to type of wealth owners

	(1)	(2)	(3)	(4)	(5)	(6)
	r	r	r	r	r	r
Financial (%)	0.871**	0.950*	1.069*			
	(2.12)	(1.92)	(1.83)			
Housing (%)				-1.129***	-0.917**	-0.902*
				(-4.13)	(-2.40)	(-1.87)
Percentile FE	YES	YES	YES	YES	YES	YES
Time FE	NO	YES	YES	NO	YES	YES
Housing (level)	NO	NO	NO	NO	NO	YES
Financial (level)	NO	NO	YES	NO	NO	NO
Observations	518	518	518	518	518	518

Note: The table shows regression estimates of the micro r as in model specification given by equation 11. All regressions include a full set of dummy variables for net wealth percentiles computed on 1-year lagged housing wealth (both in levels and as a share of gross wealth), financial wealth (both in levels and as a share of gross wealth). YES implies that the regressor is included, NO implies that it is not. The amount of observations is reduced to 518 since approximately 120 missing values are generated when creating lags. t statistics in parentheses.

Results are shown in Table 3. In model specifications $[1 - 3]$, the lagged share of financial wealth is included as the main regressor, in addition to control variables such as

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[16]For additional details on ownership of different types of wealth, see Figure 6 in Online Appendix B.

percentile and time fixed effects and lagged levels of financial wealth. A 1 percentage point increase in the lagged share of financial wealth owned within the percentile leads to a 1.069 percentage point increase in r (column 3), implying that the type of wealth matters and that an increasing share of financial wealth leads to higher returns for large owners of financial wealth. In model specifications $[4 - 6]$, we include the lagged share of housing wealth as the main regressor, in addition to control variables such as percentile and time fixed effects and lagged levels of housing wealth. As expected, a 1 percentage point higher share of housing wealth is expected to lead to a 0.902 percentage point lower r (column 6), contrary to what we observed for financial wealth.

5   Concluding remarks

This paper analyzes for which portions of net wealth distribution returns to wealth happen to be higher than growth rates of income, by utilizing Norwegian tax records on income and wealth. The implication of this analysis for the study of the dynamics of income and wealth inequality is that the full distribution of $r - g$, qualifies as a more precise measure than simply focusing on the aggregate $R - G$, by allowing for covariation between the difference between real rates of return and income growth rates and position in the net wealth distribution.

Our main contribution is to show that, for the top 40% of the distribution, the aggregate $R - G$ underestimates its micro counterpart $r - g$, while the opposite is true for the bottom 60%. We investigate the determinants of this variability and show that, after controlling for persistent heterogeneity, a large part of the variation in $r - g$ when moving up from the bottom to the top decile of the net wealth distribution is explained by scale dependence.

In our view, this empirical exercise confirms the relevance of taking into account substantial heterogeneity when modeling inequality in relation to macroeconomic phenomena. We also believe that this study enhances our understanding of the relevance of the measure $r - g$ for the study of inequality. However, it leaves aside important aspects such as the role of public wealth and retained earnings. If anything, we presume that allocating undistributed profits would imply even stronger heterogeneity of $r - g$ across the wealth distribution, reinforcing this work's main message.

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Online Appendix A: Descriptive statistics

Table 4: Descriptive statistics of the baseline sample.

| Variables	Categories	Unit	Obs	Mean	St. Dev.	Min	Max
Personal Gross Wealth - (gw)	2010	NOK	3 672 154	1463380.1028	1685698.0736	0	9329716
	2011	NOK	3 736 564	1554668.584	1788062.487	0	9829390
	2012	NOK	3 796 370	1683743.0032	1907787.5646	0	10462519
	2013	NOK	3 850 558	1757966.1676	2011619.0821	0	11067254
	2014	NOK	3 904 534	1814654.1231	2066818.6761	0	11455698.33
	2015	NOK	3 951 412	1942130.2156	2217501.5086	0	12424534
	2016	NOK	3 995 151	2079815.851	2399362.3057	0	13564935
	2017	NOK	4 061 631	2206908.234	2592048.4519	0	14868726.56
	2018	NOK	4 126 767	2234013.351	2641582.311	0	15340798
	2010-2018		35 095 141				
Private Debt - (d)	2010	NOK	3 672 154	572006.9409	887600.6338	0	4796267
	2011	NOK	3 736 564	604197.2627	938542.5002	0	5038880
	2012	NOK	3 796 370	640141.8714	992279.3503	0	5301895
	2013	NOK	3 850 558	675494.5575	1046485.1423	0	5601334
	2014	NOK	3 904 534	705418.2386	1090841.0443	0	5817836
	2015	NOK	3 951 412	738784.8513	1143644.2329	0	6070201
	2016	NOK	3 995 151	774263.3705	1201549.8505	0	6367489
	2017	NOK	4 061 631	807733.4229	1260241.406	0	6684241
	2018	NOK	4 126 767	837090.6793	1309206.2736	0	6941879
	2010-2018		35 095 141				
Personal Net Wealth - (w)	2010	NOK	3 672 154	891373.1619	1581126.2314	-4796267	9329716
	2011	NOK	3 736 564	950471.3213	1670687.3286	-5038880	9829390
	2012	NOK	3 796 370	1043601.1318	1768568.4121	-5301895	10462519
	2013	NOK	3 850 558	1082471.61	1871589.4863	-5601334	11067254
	2014	NOK	3 904 534	1109235.8845	1926933.7456	-5817836	11455698.33
	2015	NOK	3 951 412	1203345.3643	2065344.3123	-6070201	12424534
	2016	NOK	3 995 151	1305515.2237	2231434.3546	-6367489	13564935
	2017	NOK	4 061 631	1399136.5817	2402849.0841	-6684241	14868726.56
	2018	NOK	4 126 767	1396883.9111	2452349.2445	-6941879	15340798
	2010-2018		35 095 141				
Capital income - (k)	2010	NOK	3 672 154	10388.7938	36130.7456	-6255	287378
	2011	NOK	3 736 564	11671.6094	39172.2868	-12011	307958
	2012	NOK	3 796 370	12574.3758	41266.2958	-3030	324819
	2013	NOK	3 850 558	14212.711	46434.3561	0	364900
	2014	NOK	3 904 534	15133.9046	50644.2364	-4918	400050
	2015	NOK	3 951 412	15467.0957	62335.6454	-14240	510809
	2016	NOK	3 995 151	12690.2313	54444.6483	-16499	446348
	2017	NOK	4 061 631	13521.0656	57585.0475	-16063	473962
	2018	NOK	4 126 767	13531.2799	56577.9826	-6494	468565
	2010-2018		35 095 141				
Total fiscal income - (y)	2010	NOK	3 672 154	370486.8579	241542.426	0	1441504
	2011	NOK	3 736 564	387346.7956	255816.7936	0	1525017
	2012	NOK	3 796 370	403894.1623	268705.8449	0	1593909
	2013	NOK	3 850 558	419618.4645	281579.7698	0	1665686
	2014	NOK	3 904 534	432801.0258	292761.3459	0	1737556
	2015	NOK	3 951 412	445533.6917	307390.4366	0	1888036
	2016	NOK	3 995 151	449121.896	302836.0827	0	1821027
	2017	NOK	4 061 631	454857.311	311373.0565	0	1859382
	2018	NOK	4 126 767	463823.6129	323328.2209	0	1913067
	2010-2018		35 095 141				

Note: This Table presents the summary statistics of our baseline sample. Our sample is constructed by considering the entire population of residents with age 20 years and above, in between $2010 - 2018$. All variables are pre-tax and are considered at the last day of the year.

Online Appendix B: Additional figures

Measures of wealth concentration. Figure 3 plots the shares for the top 10% and top 1% of the net wealth distribution from 2010 to 2018.

The top 10% receives a slightly increasing share, between 50% and 55% of the total net wealth in our sample. The same is true for the top 1%, increasing its share from approximately 20% to 24% in the final year. A top 1% share of slightly above 20% is in line with previous estimates of top wealth shares in Norway, documented in Epland and Kirkeberg (2012).

Figure 3: Shares of net wealth for the top 1% and top 10%, 2010 − 2018.
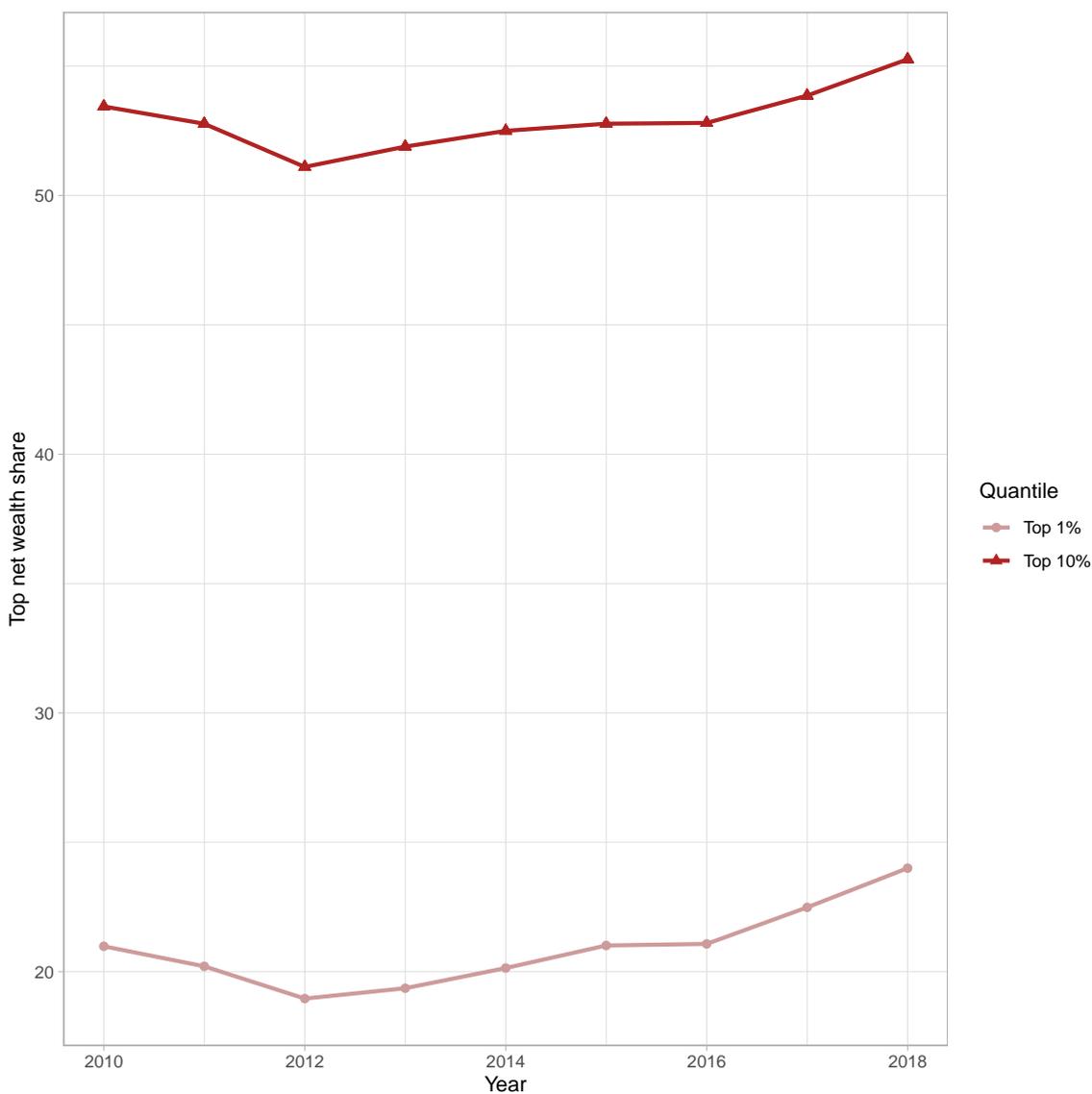
Note: this figure plots the 2010 − 2018 time series for the shares for the top 10% and top 1% of the net wealth distribution.

Wealth composition. Figure 4 shows the different components of personal wealth in Norway across the net wealth distribution. Notably, the wealthy own higher shares of financial and business assets with respect to the rest of the distribution. At the same time, liabilities are substantially high throughout the distribution, highlighting the high level of households' indebtedness in the Norwegian economy.

Figure 4: The composition of wealth, 2010 − 2018.
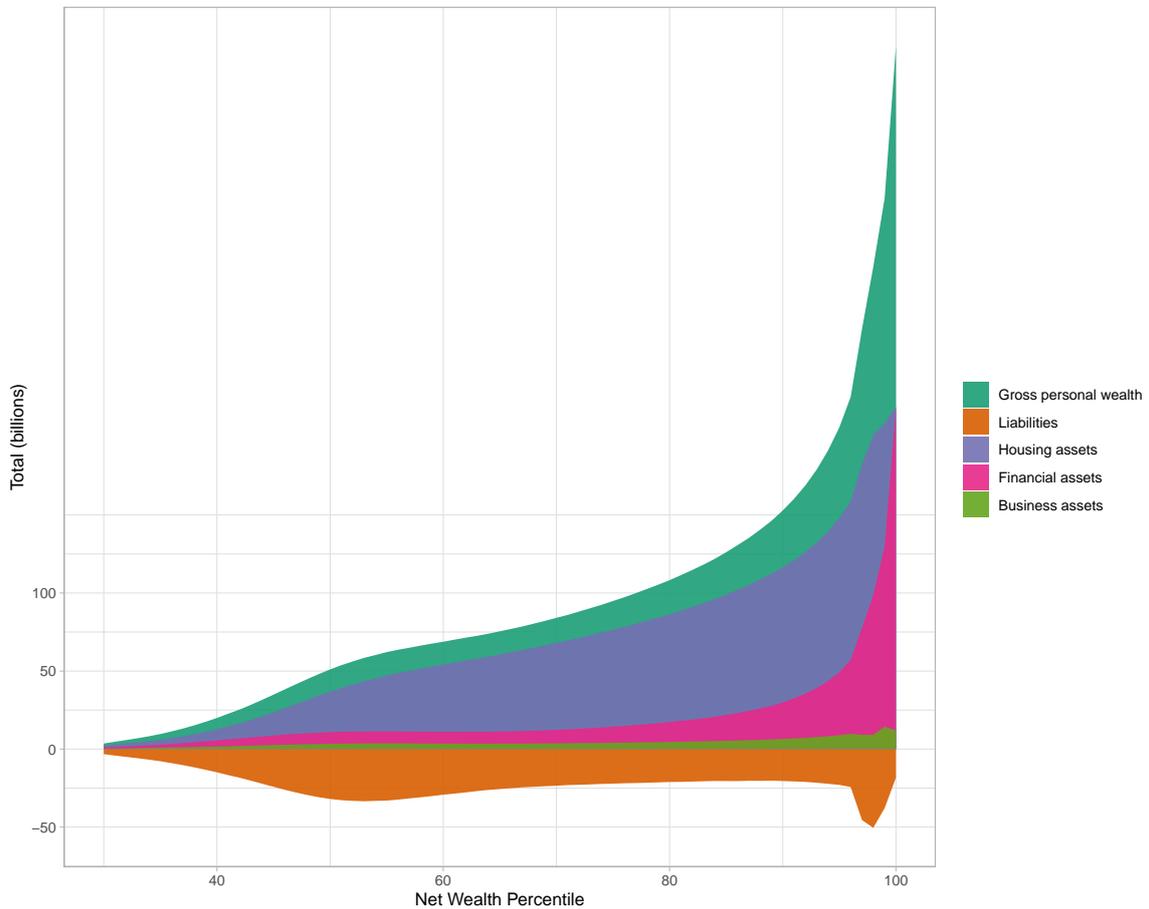
Note: The composition of wealth in Norway across the net wealth distribution. Averages (pooled across the years, 2010 − 2018) per percentile, nominal values.

Wealth-income ratios. The upper part of Figure 5 (Panel A) shows how the aggregate wealth-income ratio in our sample evolves over the period considered. The average through-out the period is 371% (marked by a horizontal dashed line in both the upper and lower parts of the figure). Our aggregate wealth-income ratio grows nonmonotonically from 320% in 2012 to slightly below 440% in 2018.

The lower part of Figure 5 (Panel B) instead shows how the wealth-income ratio varies across the distribution of net wealth throughout the period. For the top 30%, the wealth-income ratio lies above the aggregate average of 371%, while the opposite is true for the bottom 70%. The top 1% of the net wealth distribution exhibits a wealth-income ratio of approximately 700%, indicating a high degree of heterogeneity across the distribution, especially at the very top.

Figure 5: Wealth-income ratio: aggregate and by percentile
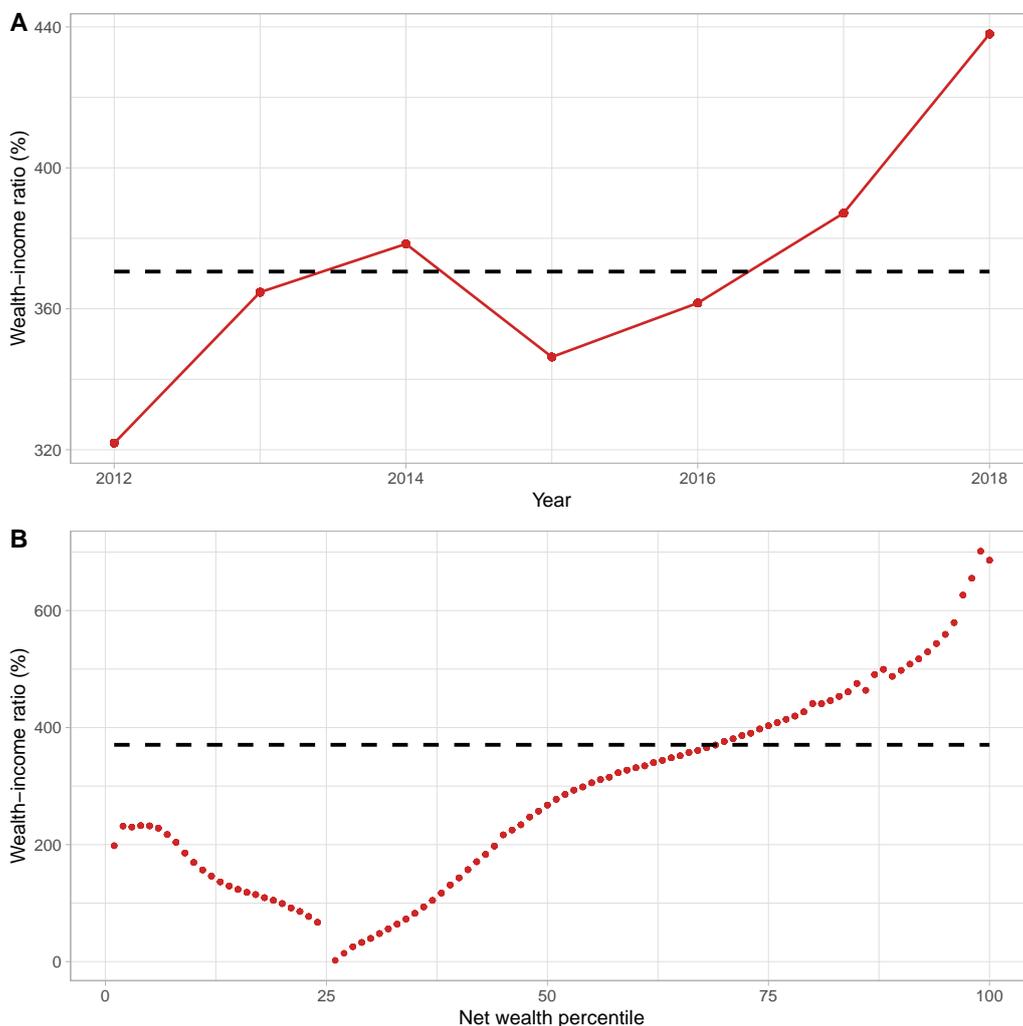
Note: the upper part of this figure shows the aggregate wealth-income ratio across the years $2012-2018$, while the lower part shows the micro wealth-income ratio across the distribution of net wealth. The average is 371% and is marked by a horizontal dashed line in both the upper and lower parts of the figure.

Housing and financial wealth. From Figure 6, which shows the percentile share of housing in Panel A and of financial wealth in Panel B respectively, it is clear how housing represents the main wealth component for the middle class $50 - 90\%$, since it stands for approximately $75-80\%$ of their gross wealth. Focusing on the top 10%, the picture changes slightly. Housing remains the largest component of gross wealth, although with a lower share. In fact, as visible from Panel B, financial wealth represents a large share of top 10% wealth in our data.

Figure 6: Financial wealth and housing shares of gross wealth
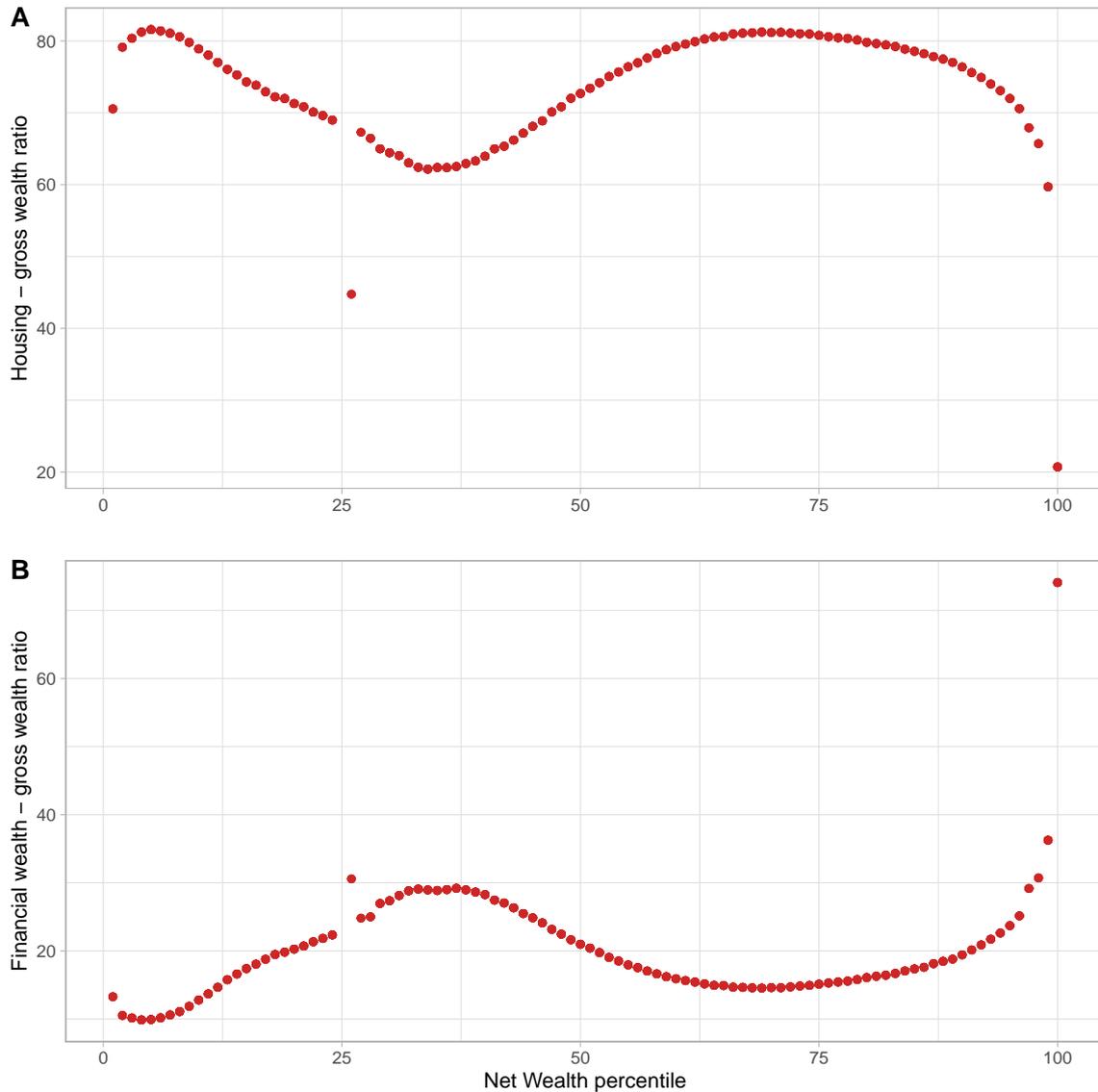
Note: this figure shows the shares of housing (including estimated market value of first and secondary dwellings) and financial wealth on personal gross wealth, with individuals ranked by their position in the net wealth distribution. Averages across $2012 - 2018$ time period.

Simulation analysis

Panel A displays the evolution over time of the Gini coefficient for net wealth in our simulation (scenarios A and B) when calibrating on our average (over the period $2012 - 2018$) percentile-level data. Panel B assumes instead that the rank correlation between income and net wealth is equal to 1. In other words, we hypothetically assume an initial level income directly proportional to net wealth for each percentile. Alternative assumptions oninitial income, provided that it isproportional to percentile wealth, yield the same results.

Figure 7: Simulated Gini coefficient of net wealth
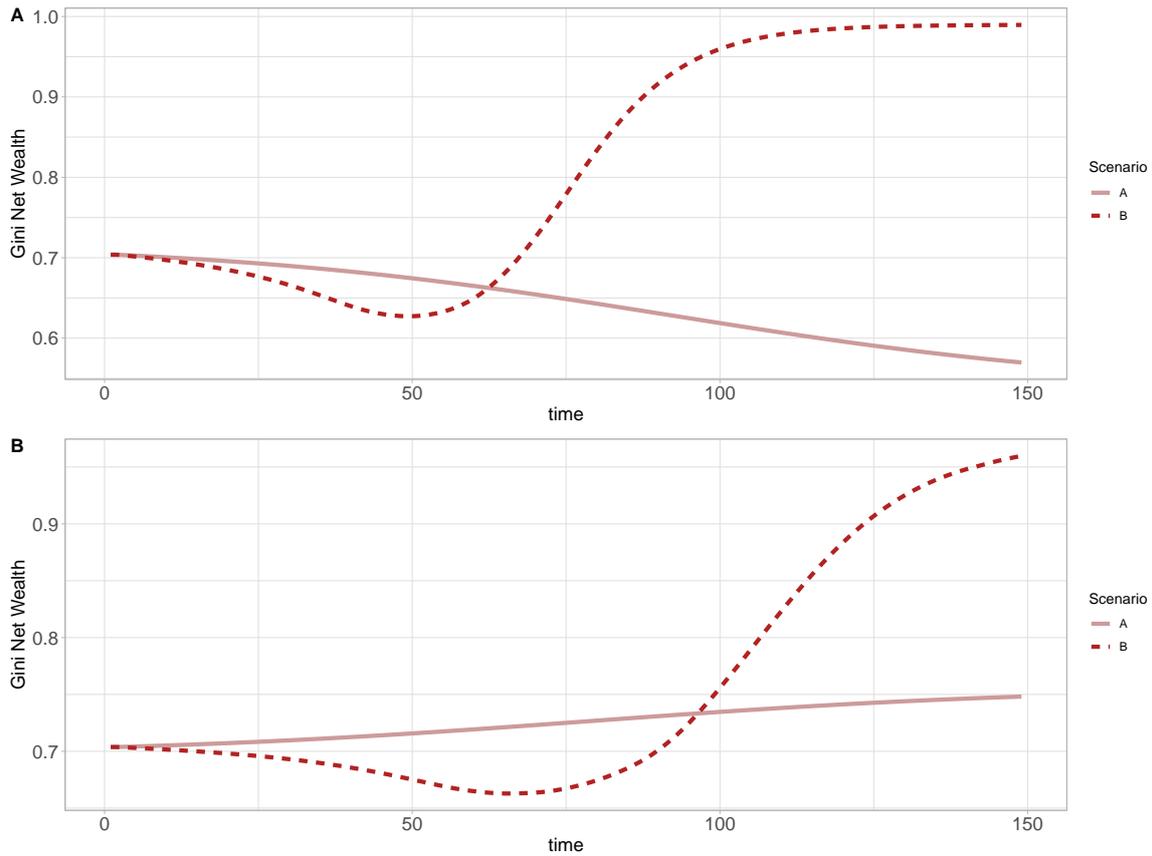
Note: Panel A displays the evolution of the Gini coefficient for net wealth over time (Scenarios A and B) when calibrating on our average (over the period $2012 - 2018$) percentile-level data. Panel B assumes instead that the rank correlation between income and net wealth is equal to 1. In other words, we hypothetically assume an initial level income directly proportional to net wealth for each percentile.

Online Appendix C: Alternative trimming strategies

In Figure 8 we have restricted the sample according to the following rules. First, we leave out percentiles 24-27, as these have close to zero net and gross wealth. Second, we leave out income growth rates which are greater than 0.41 (4 observations), as we suspect these large numbers are driven by our imputation procedure for housing capital gains. This trimming strategy excludes 5% of the total sample.

In Figure 9 we have restricted the sample according to the following rules. For percentiles with wealth close to zero we exclude observations for which rates of return are extreme (values larger than 100%), as we suspect these are artificially inflated by low denominators. Furthermore, we exclude extreme values for income growth rates, as these are due to our imputation procedure for housing capital gains. This trimming strategy excludes 2% of the total sample.

Finally, in Figure 10 we trim 2% of the tails of the variable $r - g$.

Our main finding on the shape of $r - g$ along the net wealth distribution is generally confirmed, even if, in the two cases explained in this section, further heterogeneity and some outliers are present with respect to our baseline sample.

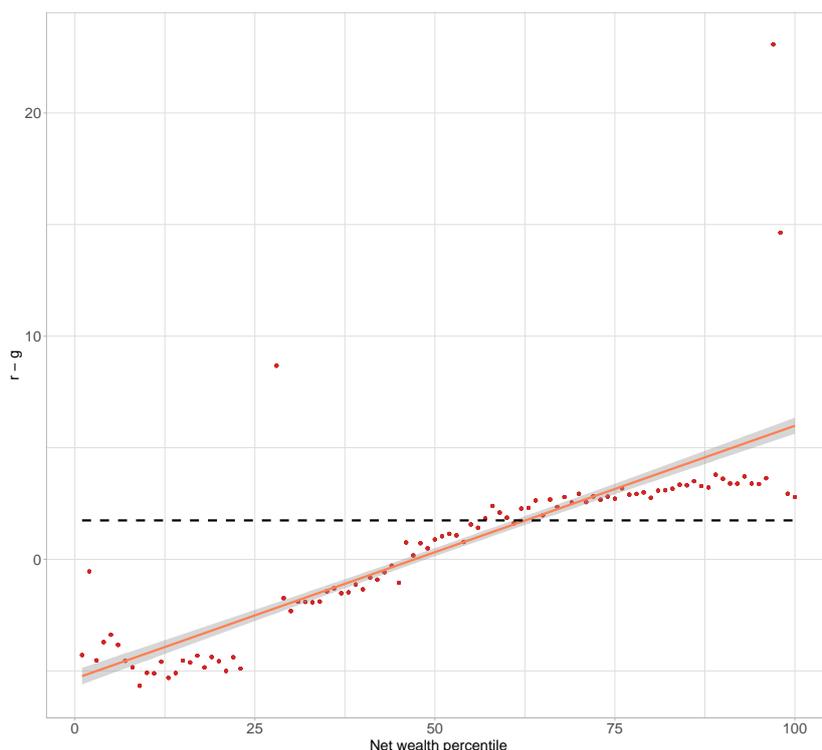Figure 8: $r - g$ with alternative trimming procedure (1)

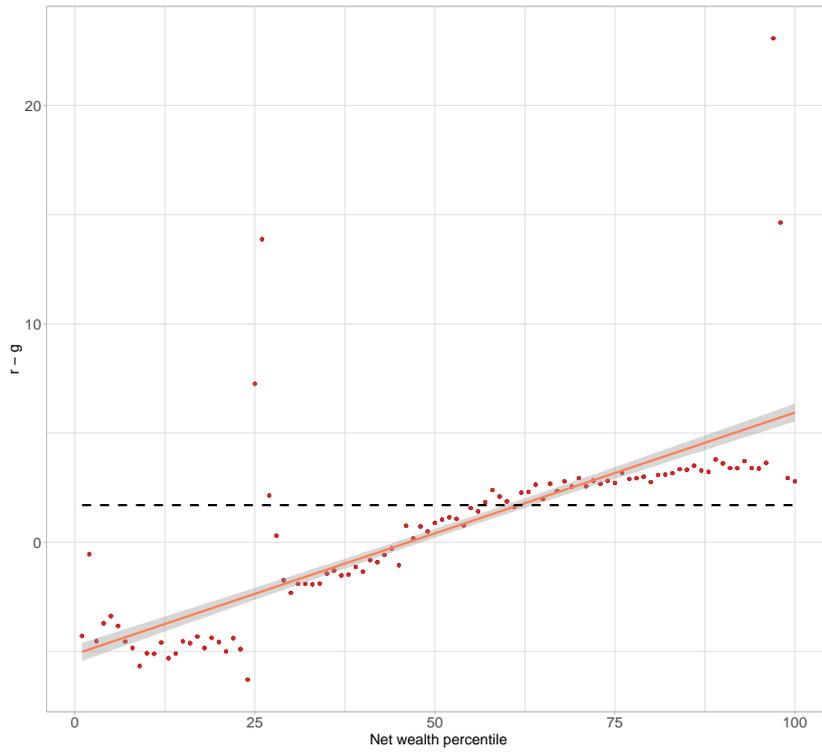Figure 9: $r - g$ with alternative trimming procedure (2)

Figure 10: $r - g$ with alternative trimming procedure (3)