Asset-Price Redistribution*

(PRELIMINARY DO NOT CITE)

Andreas Fagereng † Matthieu Gomez ‡ Émilien Gouin-Bonenfant‡
Martin Holm § Benjamin Moll ¶ Gisle Natvik †

First version: March 2022
[latest version]

Abstract

Over the past forty years, there has been a sharp increase in valuations across many asset classes. These rising valuations had important effects on the distribution of wealth. However, little is known regarding their effect on the distribution of *welfare*. To make progress on this question, we derive a sufficient statistic for the welfare effect of a rise in asset prices that depends on the present value of an individual's *net asset sales*. We then estimate this quantity using panel microdata covering the universe of Norwegian financial transactions from 1994 to 2015. We find that rising asset valuations had large redistributive effects: they redistributed welfare from the young towards the old, and from the poor towards the wealthy.

*We wish to thank Ian Martin and Clara Martinez Toledano for helpful discussions. Matthieu Gomez and Émilien Gouin-Bonenfant acknowledge support from by the National Science Foundation under grant number SES-2117398. Benjamin Moll acknowledges support from the Leverhulme Trust and the European Union's Horizon 2020 research and innovation programme (grant agreement No. 865227). Andreas Fagereng, Martin Holm, and Gisle Natvik acknowledge support from the ERC under the European Unions Horizon 2020 research and innovation programme (grant agreement No. 851891). Andreas Fagereng is also affiliated with Statistics Norway.

†BI Norwegian Business School
‡Columbia University
§University of Oslo
¶London School of Economics

1 Introduction

Over the last several decades, many advanced countries have seen large increases in aggregate wealth-to-income ratios and top wealth inequality. A large fraction of these trends is due to rising asset prices.[1] This raises the question: what are the welfare consequences of such asset price changes? Do they generate winners and losers? And if so, who?

As the following two polar viewpoints illustrate, the answer is not obvious. The first viewpoint is that rising asset prices and the resulting changes in wealth represent a large shift of resources toward the wealthy. A frequent next step in this line of argument is that this shift should be counteracted by redistributive taxation on wealth or unrealized capital gains (e.g., Piketty and Zucman, 2014; Saez et al., 2021).[2] In contrast, the second polar viewpoint argues that rising asset prices are just "paper gains" and therefore irrelevant for welfare (e.g., Cochrane, 2020). The argument is that a large chunk of rising asset prices are "revaluation gains" that do not come with rising cash-flows and therefore do not translate into a higher present-value of consumption.[3] Which (if any) of these two opposing views is correct is an open question.

To make progress on this question, we develop a sufficient statistic approach to quantify the welfare effect of rising asset prices at the individual level. We operationalize this approach using by using Norwegian administrative panel data on asset transactions from 1994 to 2015, and identify the winners and losers of asset price changes over this time period.

Consider the observed time paths of asset prices starting from some initial date, say the year 1994. The main use of our formula is to answer the following question: in retrospect, how much did a given individual win or lose (in terms of welfare) from the realized trajectory of asset prices relative to a baseline scenario starting from the same initial date? In practice, we empirically implement the following version of our formula (here for the case of one asset – the extension to multiple assets is straightforward):

$$\text{Welfare Gain}_i = \sum_{t=0}^{T} R^{-t} \left(\text{Sales}_{it} \times \text{Price Deviation}_t \right), \tag{1}$$

where i denotes the individual, T is the length of the sample period, $R > 1$ is a discount rate, Sales_{it} are the net sales of the asset by the individual in year t, and Price Deviation_t is the deviation of the asset price from the baseline scenario. The welfare gain is in dollar terms and has the interpretation of an equivalent variation (i.e., the willingness to pay to remove price deviations).[4] The formula follows from an application of the envelope theorem and thus holds

[1] See for example Kuhn et al. (2020) and Martínez-Toledano (2019)

[2] For example, Piketty and Zucman (2014) write: "Because wealth is always very concentrated [... a] high [wealth-to-income ratio] implies that the inequality of wealth, and potentially the inequality of inherited wealth, is likely to play a bigger role for the overall structure of inequality in the twenty-first century than it did in the postwar period. This evolution might reinforce the need for progressive capital taxation."

[3] Cochrane (2020) refers to "paper wealth" and writes "much of the increase in 'wealth inequality' [...] reflects higher market values of the same income flows, and indicates nothing about increases in consumption inequality". Also see the more nuanced version of this argument by Greenwald et al. (2021).

[4] See for example Mas-Colell et al. (1995). Our sufficient-statistics formula is a first-order approximation to the welfare gain and so the equivalent variation also equals the compensating variation, i.e. the net revenues of a

for small price deviations, a point we discuss in more detail below.

In all our results, we consider price deviations from a baseline scenario in which asset prices grow at the same rate as dividends (i.e., deviations from a world with constant price-dividend ratios). We thus compute the price deviation in (1) as the percentage change over time of the price-dividend ratio relative to a baseline level:

$$\text{Price Deviation}_t = \Delta\% \left(\frac{\text{Price}}{\text{Dividend}} \right)_t . \tag{2}$$

Formula 2 can be interpreted as a deviation of asset prices from the Gordon Growth model (i.e., a world in which dividends follow a random walk and discount rates are constant). In fact, under the random walk assumption for dividends, fluctuations in the price-dividend ratio of an asset are entirely due to changes in discount rates (Campbell and Shiller, 1988).[5] For our application, we use the 1991–1995 average price-dividend ratio as the baseline and find that price deviations in Norway have been particularly large for real estate (i.e., housing prices have grown much much faster than rent) and debt (i.e., real interest rates have declined sharply). Importantly, all of the variables in (1) and (2) are readily observable in our Norwegian data.

The welfare formula (1) generates two main insights. First, financial *transactions* matter for welfare, not holdings. Intuitively, rising asset prices is good news for prospective sellers (those with $\text{Sales}_{it} > 0$) and bad news for prospective buyers (those with $\text{Sales}_{it} < 0$). A particularly interesting case is an individual who owns assets but does not plan to buy or sell (i.e., $\text{Sales}_{it} = 0$). For such an individual, rising asset prices are merely "paper gains", with no corresponding welfare implications.

Second, asset price changes are *purely redistributive*. When asset prices rise, there is a redistribution of welfare from sellers to buyers. But since for every seller there is a buyer, summing formula (1) across all parties and counterparties of financial transactions in the economy implies that the aggregate welfare gain is zero.[6] However, since there are financial transactions between sectors of the economy (i.e., between households, the government, corporations, and foreigners), we can have that the household sector as a whole benefits, but necessarily at the expense of another sector. In practice, we find that the aggregate welfare gain of the Norwegian household sector is very close to zero.

It is useful to contrast these results with the two polar viewpoints described at the beginning of the introduction. The first viewpoint posited that rising asset prices redistribute toward existing asset holders. Our formula shows that, instead, it is *sellers* that benefit, not *holders*. If

planner who must compensate the individual for the asset price deviation, bringing her back to her welfare in the baseline scenario.

[5]While our main results compute welfare gains relative to a baseline scenario with constant price-dividend ratios, thereby capturing pure valuation effects, the formula (1) can also be used to compute welfare gains relative to different baseline scenarios. For example, instead of computing the welfare effects of asset-price changes due to valuation effects, we may be interested in computing the gains and losses of asset-price changes due to cash flow changes. In this case, our formula is still correct but we would also want to take into account the direct effect of cash-flow changes on individual welfare (which would manifest themselves in an additional additive term).

[6]Note that this result arises due to the fact that we define welfare in units of consumption. Whenever, sellers and buyers systematically have different marginal utility of consumption, then the aggregate welfare gain in terms of utils will not aggregate to zero.

an asset holder never sells, she does not benefit from the unrealized capital gains generated by the price deviation. In the data, some individuals with large asset positions buy and hence loose in welfare terms; conversely, others with small positions sell and hence win. The second viewpoint held that all (or at least most) of rising asset prices are irrelevant for welfare. As our formula shows, this is only true at the aggregate level. At the micro level, asset prices do matter for individual welfare, as households routinely buy and sell financial asset to bridge the gap between current income and desired consumption. In representative agent economies (where there is no trade), asset price deviations that leave income constant are indeed welfare irrelevant.

As we show in the main body of the paper, the formula easily extends to multiple assets including bonds and housing and asset transaction cost. The core of our paper is an empirical implementation of this extended welfare formula for the Norwegian economy to compute welfare gains and losses due to observed asset price changes for the time period 1994 to 2015 relative to a baseline scenario with constant price-dividend ratios. Our main findings are as follows. First, asset price changes have large redistributive effects. While the individual-level welfare gain in dollar terms (i.e., equivalent variation) is centered around zero, it is -35K at the 10th percentile and 80K at the 90th percentile (in 2015 dollars). As a fraction of total wealth (i.e., financial wealth plus human wealth), the welfare gains are -6% at the 10th percentile and 15% at the 90th percentile. Note that the distribution of welfare gains differs substantially from the distribution of wealth gains (defined as the discounted sum of initial holdings times price deviations), which is positive for almost everyone.

Second, we quantify the amount of redistribution *between cohorts*. Overall, we find a large amount of redistribution from young to old. Individuals who were less than 25 years old in 1994 experience large welfare losses. This is primarily due to the fact that the young are net buyers of housing. However, declining interest rates of mortgage debt partially offsets the rising cost of housing. On net, 20 year olds experience a welfare loss of around 25K$. The opposite is true for 60 year olds, who benefit from rising house prices but are hurt by declining interest rates on bank deposits. On net, 60 year olds gain gain 25K$.

Third, we quantify the amount of redistribution *between wealth percentiles*. We rank adults in 1994 according to their total wealth and find that welfare gains are concentrated at top of the wealth distribution. The top 1% experiences on average a 75K welfare gain, while the corresponding number is nearly zero at the 10th percentile. However, and perhaps surprisingly, this inequality in welfare gains tracks total wealth inequality almost one-for-one: the welfare gains as a fraction of total wealth is roughly 4% along the full wealth distribution.

Finally, we quantify the amount of redistribution *between sectors*. Overall, the household sector experiences a small, but positive, welfare gain of roughly 5K$ per individual. This is almost entirely due to a "welfare loss" for the consolidated government sector (i.e., government plus central bank and non-profit institutions). The key feature of the data that drives this result is that households are net debtors and the government holds a significant of those debt securities. As a result, declining interest rates benefit households at the expense of the government. Under some assumptions, we show that the household sector will eventually have to bear the cost of this "government welfare loss" through lower net transfers.

Literature Review. Our paper contributes to several strands of literature. A large literature has documented the rise in valuations across many asset classes (e.g., Piketty and Zucman, 2014, Farhi and Gourio, 2018, Greenwald et al., 2019). A growing literature examines the effect of rising asset prices on wealth inequality (e.g., Kuhn et al., 2020; Gomez, 2016; Catherine et al., 2020; Gomez and Gouin-Bonenfant, 2020; İmrohoroğlu and Zhao, 2022; Adam and Tzamourani, 2016; Greenwald et al., 2021). Relative to this literature, our contribution is to examine the effect of rising asset prices on *welfare* inequality.

Our focus on welfare connects this paper to Doepke and Schneider (2006), who examine the redistributive effect of inflation episodes using data from the Survery of Consumer Finances. Similarly, Glover et al. (2020) quantify the redistributive effect asset price fluctuations during the Great Depression across cohorts though a calibrated model. As in our paper, they stress the redistributive effect of valuation shocks between buyers and sellers of financial assets

Our result for the welfare effect of a deviation in asset prices is related to Auclert (2019), who examines the welfare effect of a deviation in the path of interest rates. It is also related to Dávila and Korinek (2018), who examines pecuniary externalities in a setup with incomplete markets and collateral constraints. Relative to these papers, our contribution is to bring this sufficient statistic approach to the data, thereby measuring the purely redistributive effect of asset price fluctuations.

More broadly, the paper also touches on a fundamental theme in asset pricing, which is the differential effect of cash-flow and discount rate shocks (i.e., valuation shocks) on households. A seminal paper is Campbell and Shiller (1988), who documented the importance of discount rate shocks in asset price fluctuations. Campbell and Vuolteenaho (2004) argue that households price cash-flow shocks and discount rate shocks differently. One way to take into account fluctuations in discount rate is to construct a measure of total wealth inclusive of human capital (e.g. Catherine et al., 2020; Greenwald et al., 2021). Because we focus on the *welfare* effect of this discount rate shocks, we sidestep this construction by measuring directly the role of valuations on financial transactions.

More broadly, we contribute to a growing literature using administrative micro data to study the heterogeneity of savings and portfolio choices across the life cycle (e.g., Feiveson and Sabelhaus, 2019, Calvet et al., 2021, Black et al., 2022) as well as the wealth distribution (e.g., Mian et al., 2020, Fagereng et al., 2019, Bach et al., 2020, Bach et al., 2017). Finally, our paper is related to Piketty et al. (2018), who propose a conceptual framework to allocate national income across households. In the spirit of this paper, we develop a methodology to allocate the effect of fluctuations in asset prices across households, which remains consistent with national accounting.

Roadmap. The remainder of this paper is organized as follows. In Section 2, we present our sufficient statistic for the welfare effect of a perturbation in asset prices. In Section 3, we present our actual implementation method on administrative data from Norway. We report our empirical results in Section 4, and we discuss robustness checks in Section 5.

2 Theory

This section presents our main theoretical result. We examine the effect of a sequence of small deviations in asset prices on individual welfare. To focus on the intuition, we first derive our main result in a two-period model with only one asset. We then generalize the result to an infinite horizon model with multiple assets and adjustment costs.

2.1 Two-period model

The economy is fully deterministic with two time periods $t \in \{0, 1\}$. Preferences are time separable preferences with a strictly concave utility function $U(\cdot)$ and a subjective discount factor $\beta < 1$. The agent receives labor income Y_0 at time 0 and Y_1 at time 1. There is one asset available for trading at time $t = 0$ with price P_0 which pays a dividend $D_1 > 0$ at time 1.

Household problem. Denote C_t the consumption of the agent at time t and N_t the number of shares owned at the end of period t. The problem of the agent is to choose a sequence of consumption as to maximize welfare:

$$V = \max_{\{C_0, C_1\}} U(C_0) + \beta U(C_1), \tag{3}$$

subject to an initial holding N_{-1} and the following budget constraints:

$$\begin{aligned} (N_0 - N_{-1})P_0 &= Y_0 - C_0, \\ 0 &= N_0 D_1 + Y_1 - C_1. \end{aligned} \tag{4}$$

These budget constraints ensure that, at each period t, net asset purchases (the left hand side) must be equal to savings (the right hand side).

Comparative static with respect to prices. What is the effect of a small change in the price P_0 on welfare? Applying the envelope theorem, we immediately obtain the following comparative static:

$$\frac{\partial V}{\partial P_0} = U'(C_0)(N_{-1} - N_0). \tag{5}$$

In words, the effect of a rise in P_0 equals the marginal utility of consumption $U'(C_0)$ times the net sale of the asset $N_{-1} - N_0$. Intuitively, a rise in the price of the asset benefits agents who plan to sell the asset (i.e., $N_0 < N_{-1}$) and hurts agents who plan to buy the asset (ie, $N_0 > N_{-1}$). Note that a rise in the price of the asset does not affect agents who do not plan to trade (i.e. $N_0 = N_{-1}$): for those agents, the rise in the price of the asset is merely a "paper gain" with no effect on consumption and thus welfare.

Comparative static with respect to returns. The result in Equation 5 may be surprising at first: how can initial holders of the asset (i.e., $N_{-1} > 0$) not benefit from a rise in prices? The reason for this apparent paradox is that, even though a rise in P_0 increases the return on the asset at time $t = 0$, it also decreases the return of holding the asset at $t = 1$. To make this point formally, we now express the budget constraint in terms of financial wealth $A_t \equiv N_t P_t$:

$$\begin{aligned} A_0 &= R_0 A_{-1} + Y_0 - C_0, \\ 0 &= R_1 A_0 + Y_1 - C_1, \end{aligned} \tag{4'}$$

where R_t denotes the return of the asset at time t (i.e., $R_0 = P_0/P_{-1}$ and $R_1 = D_1/P_0$). Importantly, a rise in P_0 increases R_0 but *decreases* R_1.

Using the envelope theorem, the welfare effect of a rise in P_0 can be expressed as the sum of these two effects:

$$\begin{aligned} \frac{\partial V}{\partial P_0} &= U'(C_0) A_{-1} \frac{\partial R_0}{\partial P_0} + \beta U'(C_1) A_0 \frac{\partial R_1}{\partial P_0} \\ &= U'(C_0) \left(N_{-1} P_{-1} \frac{\partial (P_0/P_{-1})}{\partial P_0} + R_1^{-1} N_0 P_0 \frac{\partial (D_1/P_0)}{\partial P_0} \right) \\ &= U'(C_0)(N_{-1} - N_0). \end{aligned}$$

where the second line uses the Euler equation $U'(C_0) = R_1 \beta U'(C_1)$. This equation highlights the fact that sellers benefit from a rise in asset price because they benefit more from today's higher return than from tomorrow's lower return (as their holdings decrease over time). The effect is exactly the opposite for buyers.

As this example shows, while the two approaches give the exact same formulas, thinking about the deviation in prices, rather than deviation in returns, leads to more intuitive expressions for welfare.

2.2 Baseline model

For the sake of intuition, the previous section focused on the case of a two-period economy with only one asset. We now extend our formula to an infinite-horizon economy with multiple assets and adjustment costs (henceforth the "baseline model"), which is key to bringing the theory to the data.

Financial markets. Time periods are denoted by $t \geq 0$. There is a sequence of liquid one-period bonds B_t with a face value of one and price Q_t available for trading. Holding a one-period bond is equivalent to investing in a deposit account with an interest rate $R_{t+1} = 1/Q_t$ between t and $t+1$. Denote by $R_{0 \to t} = R_1 \cdot R_2 \cdots R_t$ the cumulative return of this deposit account between 0 and t.

There are also K long-lived assets available for trading. A share of asset k gives right to a dividend $D_{k,t} \geq 0$ at time t and has price $P_{k,t}$ at the end of period t. Following the heterogeneous-agent literature we assume that agent must pay adjustment costs to trade the long-lived assets (e.g., Kaplan and Violante, 2014 and Kaplan et al., 2018). These adjustment costs are particularly realistic when thinking about houses as well as private equity, which tend to be quite illiquid. In our deterministic setup, adjustment costs will allow different assets to have different returns without generating the possibility of infinite profits via arbitrage. Specifically, to buy a quantity of shares $N_{k,t} - N_{k,t-1}$ of asset k at time t, the agent will have to pay $\chi_k(N_{k,t} - N_{k,t-1})$ in adjustment costs, where $\chi_k(\cdot)$ is a stricly convex function. While the particular functional form does not matter for the effect of a asset prices changes on welfare at the first order (i.e., small price deviations), it will matter for higher-order effects, as discussed in Section 5.

Household problem. Households have time separable preferences with a strictly concave period utility $U(\cdot)$ and a subjective discount factor $\beta < 1$. and receives labor income Y_t at time t. Denote B_t the holdings of the one period bonds and $N_{k,t}$ the holdings of asset k at time t. The household problem is to choose a consumption path to maximize welfare:

$$V = \max_{\{C_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t U(C_t), \tag{6}$$

subject to initial holdings $(B_{-1}, N_{1,-1} \dots N_{K,-1})$ as well as a sequence of budget constraints

$$\sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) P_{k,t} + B_t Q_t = \sum_{k=1}^{K} N_{k,t-1} D_{k,t} + B_{t-1} + Y_t - C_t - \sum_{k=1}^{K} \chi_k(N_{k,t} - N_{k,t-1}), \tag{7}$$

and no-Ponzi conditions

$$\lim_{T\to\infty} B_T Q_T = 0 \quad \text{and} \quad \lim_{T\to\infty} R_{0\to T}^{-1} N_{k,T} P_{k,T} = 0 \quad \forall k. \tag{8}$$

As in the two-period model, the budget constraint simply says that the net purchase of financial assets (the left-hand side) must equal net savings (the right-hand side) at each period t. This net savings corresponds to the difference between total income (dividend income and labor income) net of adjustment costs and consumption.

Welfare gain. We are interested in the effect of a change in asset prices on welfare. Formally, we consider an exogenous "deviation" in the path of asset prices, denoted by $\{\mathrm{d}Q_t, \mathrm{d}P_{1t}, \dots, \mathrm{d}P_{K,t}\}_{t=0}^{\infty}$. We assume that each deviation satisfies a no-bubble condition; that is, $\lim_{T\to\infty} R_{0\to T}^{-1} \mathrm{d}P_{k,T} = 0$ for all $1 \leq k \leq K$. Intuitively, this no-bubble condition says that this deviation in prices cannot explode with time: higher prices today will lead to lower returns tomorrow.

Denote $\mathrm{d}V$ the effect of these deviations on welfare. We define the welfare *gain* as their effect of on welfare scaled by the marginal utility of consumption at time $t = 0$:

$$\text{Welfare Gain} \equiv \mathrm{d}V / U'(C_0). \tag{9}$$

This welfare gain is in units of consumption. It can be interpreted as the agent's willingness to pay for this particular deviation in asset prices. Totally differentiating the definition of welfare

(6) gives the following expression for the welfare gain:

$$\begin{aligned} \text{Welfare Gain} &= \sum_{t=0}^{\infty} \beta^t \frac{U'(C_t)}{U'(C_0)} \, \mathrm{d}C_t, \\ &= \sum_{t=0}^{\infty} R_{0\to t}^{-1} \, \mathrm{d}C_t, \end{aligned} \tag{10}$$

where the second line uses the Euler question; that is, $\beta^t R_{0\to t} U'(C_t)/U'(C_0) = 1$. Equation (10) says that our measure of welfare gain can be seen as the present value of the consumption changes due to the deviation in asset prices.

We can now express the welfare gain in terms of the deviation in the path of asset prices $\{\mathrm{d}Q_t, \mathrm{d}P_{1t}, \ldots, \mathrm{d}P_{K,t}\}_{t=0}^{\infty}$.

Proposition 1 (Welfare Gain)**.** *The welfare gain implied by an infinitesimal deviation in asset prices is given by*

$$\text{Welfare Gain} = -\sum_{t=0}^{\infty} \left(\sum_{k=1}^{K} R_{0\to t}^{-1} (N_{k,t} - N_{k,t-1}) \, \mathrm{d}P_{k,t} + B_t \, \mathrm{d}Q_t \right). \tag{11}$$

As in the two-period model, the welfare gain depends on whether the agent is a buyer or seller of assets. However, Equation 11 highlights the fact that portfolio choices (which asset is being purchased or sold) and the timing (when do these purchases or sales occur) also matter. The key insight is that the welfare gain associated with deviations in asset prices depend on financial *transactions* rather than *holdings*.

Our formula for the welfare gain of a household can be seen as the present value of the deviation of the cash flows generated by the household's trading strategy. For instance, for an agent that never plans to sell the asset, the cash flow of their trading strategy is simply the cash-flow of the assets held, which does not depend on asset prices. Finally, note that the adjustment cost function does not appear in the welfare formula. This is a direct implication of the envelope theorem, which says that the changes in adjustment costs are second-order for welfare.

Finally, our result is related to Auclert (2019), who derives the welfare gain corresponding to a perturbation in the path of interest rates. We show the equivalence between the two results in Appendix A.2. For our application, the key advantage of Proposition 1 is that it expresses the welfare gain in terms of deviations in asset prices and financial transactions, both of which we observe directly.

Aggregation. We now discuss how the welfare effect of a deviation in asset prices aggregate across households. Let i index a particular household and consider a set of households $\{1, 2, \ldots, I\}$.

Corollary 2 (Aggregation)**.** *Suppose that households only trade with each others. The welfare gain* *implied by an infinitesimal deviation in asset prices aggregates to zero.*

$$\left.\begin{array}{l}\sum_{i=1}^{I}(N_{ik,t}-N_{ik,t-1})=0 \quad \textit{for } 1\le k\le K\\ \sum_{i=1}^{I}B_{it}=0\end{array}\right| \implies \sum_{i=1}^{I}\text{Welfare Gain}_i=0$$

This corollary is quite intuitive. For instance, when asset prices rise, sellers benefit. But for every seller there is an offsetting buyer that is hurt, so the welfare gains must aggregate to zero over the full population. In fact, the assumption that households only trade with each other implies that that welfare gain aggregates to zero *for each asset class*. This result highlights a key difference between wealth gains and welfare gains: while a rise in asset prices increases aggregate wealth (as long as the asset is in positive net supply), it has no effect on aggregate welfare.

It is worth emphasizing that this aggregation results holds for our notion of welfare gain, which is in units of consumption, but not necessarily for welfare in units of utils. For instance, if asset prices rise and sellers systematically have a lower marginal utility of consumption than buyers, then the aggregate welfare effect in utils will be negative. The fact that welfare gains across agents sum up to zero does not necessarily mean that a utilitarian planner should not be concerned with the level of asset prices. Formally, denoting, λ_i the Pareto weight that a social planner assigns to household i, the effect of a deviation in prices on aggregate welfare is given by $\sum_{i=1}^{I}\lambda_i U'(C_{i0})\times\text{Welfare Gain}_i$, which is non-zero as long as $\lambda_i U'(C_{i0})$ covaries with welfare gains across the population. What our result does means is that a social planner could, in principle, undo the aggregate welfare effect of the price deviation via a purely redistributive policy (i.e., doing a net transfer of Welfare Gain$_i$ to all agents).

The assumption that household only trade with each other is key for the aggregation result in Corollary 2. In reality, however, households also trade with other entities such as the government and foreigners. In this case, the corollary can be modified to say that the aggregate welfare gain of the household, government, and foreign sectors is zero in aggregate. We discuss this point formally in the next section.

2.3 Discussion

We now discuss several extensions of the baseline model.

Stochastic environment. The experiment in the baseline model consists of a comparative static on the deterministic path of prices. The welfare gain answers question: how much would a household be willing to pay to live in an economy where the path of asset prices would differ by $\{dQ_t, dP_{1,t}, \ldots, dP_{Kt}\}_{t\ge 0}$. However, our formulas do not require that households actually have perfect foresight of these price deviations: Proposition 1 would remain the same if the price deviations were driven by a series of unexpected small shocks around a deterministic path.

Borrowing constraints. In the baseline model, agents can take unrestricted positions in any asset (i.e., long and short). In reality, there are limits on negative holdings, for instance on how much they can borrow. These additional constraints will impact our sufficient statistic channel through two channels. First, agents that expect this constraint to bind will discount the future at a higher rate than the interest rate. In this case, our welfare measure will tend to overestimate (in magnitude) the actual welfare effect of future deviations in asset prices, since agents will discount the associated cash flows at a higher rate.

Second, when the borrowing constraint depends on the price of an asset (e.g., collateral constraints), deviations in the price of the asset will directly affect the tightness of the borrowing constraint (e.g., Miao and Wang, 2012; Mian et al., 2013). In this case, higher asset prices are welfare-improving because they allow constrained households to increase their consumption today at the expense of tomorrow. In this case, our welfare measure will systematically underestimate the true welfare effect of a rise in asset prices.[7]

In both cases, our welfare gain formula fails because the welfare effect of the household differs from the actual discount rate in the market. This effect may be particularly important for cash-constrained households, who expect this borrowing constraint to bind in the near future.

Inheritance. In the baseline model, changes in asset holdings are only the result of saving. In reality, asset holdings may also increase due to inheritance. Formally, in the presence of bequest, the budget constraint (7) becomes

$$\sum_{k=1}^{K}(N_{k,t}-N_{k,t-1})P_{k,t}+B_tQ_t$$
$$=\sum_{k=1}^{K}\mathrm{I}_{k,t}P_{k,t}+\sum_{k=1}^{K}N_{k,t-1}D_t+B_{t-1}+Y_t-C_t-\sum_{k=1}^{K}\chi_k(N_{k,t}-N_{k,t-1}).$$

where $\mathrm{I}_{k,t}$ denotes the net number of shares of asset k received at time t as inheritance. With this modified budget constraint, the welfare gain becomes

$$\text{Welfare Gain}=-\sum_{t=0}^{\infty}R_{0\to t}^{-1}\left(\sum_{k=1}^{K}(N_{k,t}-N_{k,t-1}-\mathrm{I}_{k,t})\,\mathrm{d}P_{k,t}+B_t\,\mathrm{d}Q_t+\sum_{k=1}^{K}P_{k,t}\,\mathrm{d}\mathrm{I}_{k,t}\right).$$

Compared to the case without inheritance, the formula is modified in two ways. First, the effect of a price deviation on asset k only matters through the number of shares purchased $N_{k,t}-N_{k,t-1}-\mathrm{I}_{k,t}$, not the change in holdings $N_{k,t}-N_{k,t-1}$. Intuitively, if a household receives as an inheritance a house and plan to live in forever, higher valuations for housing are irrelevant for welfare. This distinction is not problematic for our application, since we measure transactions directly, rather than changes in holdings.

Second, welfare gains also depend on how the number of shares received as inheritance reacts to the deviation in valuations. In our empirical results, we will assume perfectly inelastic

[7] Conversely, the same channel may make agents with hyperbolic discounting worse off, since higher prices make it easier for them to deviate from their pre-planned consumption paths Laibson (1997).

bequests (i.e., $\mathrm{dI}_{k,t} = 0$).

Joy of asset ownership. In the baseline model, agents only get utility from consumption. In reality, households may also care about asset ownership per se (e.g., owning a house rather than renting it). If only the quantity of assets enters the utility function, this "joy of ownership" does not affect our results. However, our results would change if agents directly cared about valuations, say, due to social status (Bakshi and Chen, 1996; Roussanov, 2010) or political power (Piketty et al., 2013). In this case, rising asset prices would have an indirect and heterogeneous effect on welfare via the "joy of asset ownership" and our measure of welfare gain should be interpreted as the effect of asset prices on welfare that operates through changes in consumption.

Government sector. We now extend our measure of welfare gain in the presence of a government sector. Consider the baseline model with the only difference being that every household receives a net transfer T_{it} from the government. For simplicity, consider a special case where there is asset (i.e., a one-period bond B_t with price Q_t). In the presence of government transfers, the sequence of budget constraints for individual i becomes:

$$B_{it}Q_t = B_{it-1} + Y_{it} - C_{it} + T_{it}.$$

In this case, the welfare gain for individual i becomes

$$\text{Welfare Gain} = -\sum_{t=0}^{\infty} R_{0\to t}^{-1} B_{it}\, \mathrm{d}Q_t + \sum_{t=0}^{\infty} R_{0\to t}^{-1}\, \mathrm{d}T_{it}. \tag{12}$$

Compared to the baseline model, this measure of welfare gain takes into account how the net government transfers to individual i react to asset prices (i.e., $\mathrm{d}T_{it} \neq 0$). To understand how net government transfers react to prices, consider the sequence of the budget constraints for the government:

$$B_{gt}Q_t = B_{gt-1} - \sum_{i=1}^{I} T_{it}$$

Totally differentiating and solving forward gives:

$$\sum_{t=0}^{\infty} R_{0\to t}^{-1} \sum_{i=1}^{I} \mathrm{d}T_{it} = -\sum_{t=0}^{\infty} R_{0\to t}^{-1} B_{gt}\, \mathrm{d}Q_t. \tag{13}$$

This equation highlights that the deviation in the present value of aggregate government net transfers must equal the deviation in the government financial cash flows. In particular, this equation implies that the welfare gains of all individuals in the economy, inclusive of government transfers, aggregate to zero as long as $\sum_{i=1}^{I} B_{it} + B_{gt} = 0$ (a form of Ricardian equivalence).

In our empirical exercise, we will not take a stance on how a deviation in asset prices affects government transfers household per household. As a result, we will construct a measure of individual welfare gains gross of government transfers; that is, $-\sum_{t=0}^{\infty} R_{0\to t}^{-1} B_{it}\, \mathrm{d}Q_t$. To maintain balance, we will construct a measure of government "welfare gain" as a separate entity; that is, $-\sum_{t=0}^{\infty} R_{0\to t}^{-1} B_{gt}\, \mathrm{d}Q_t$. With these definitions, the welfare gains of the household sector and of the government sector still aggregate to zero.

3 Implementation

We now discuss how we bring the theory to the data in order to estimate the distribution of welfare gains across households.

Non-infinitesimal asset price changes. Proposition 1 gives a formula for the welfare gain associated with an infinitesimal deviation in prices. We can use this formula to obtain a first-order approximation for a non-infinitesimal deviation on asset prices $\{\Delta Q_t, \Delta P_{1,t}, \ldots, \Delta P_{K,t}\}_{t\geq 0}$ on welfare:

$$\text{Welfare Gain} = -\sum_{t=0}^{\infty} R_{0\to t}^{-1} \left(\sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) \Delta P_{k,t} + B_t \Delta Q_t \right) \tag{14}$$

The path of asset price deviations that we are interested in is the deviation from a world in which prices grow at the same rate as dividend; that is, a world with a constant price-dividend ratio. This corresponds to a deviation deviation of asset prices from the Gordon Growth model (i.e., a world in which dividends follow a random walk and discount rates are constant). In fact, under the random walk assumption for dividends, fluctuations in the price-dividend ratio of an asset are entirely due to changes in discount rates (Campbell and Shiller, 1988).

Formally, for a given baseline value of the price-dividend ratio for asset k, $\overline{PD}_k$, we consider the price deviation $\Delta P_{k,t} = P_{k,t} - \overline{PD}_k \times D_{k,t}$. As a motivating example, Figure 1 plots the price index of houses in Norway together with the price index for rents. Starting from 1994, the price of housing starts to grow faster than rents. In this case, our methodology quantifies the welfare gain associated with a deviation of realized prices P_{Ht} from the counterfactual price path had the price-to-rent ratio remained constant over time (i.e., $\overline{PD}_H \times D_{Ht}$). Similarly, we will consider a deviation of the price of one-period bonds away from a baseline value $\overline{Q}$ (i.e., $\Delta Q_t = Q_t - \overline{Q}$).

Plugging these price deviation formulas into (14) and re-arranging, we obtain a sufficient statistic for the individual-level welfare effect of price deviations:

$$\text{Welfare Gain} = -\sum_{t=0}^{\infty} R_{0\to t}^{-1} \left(\sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) P_{k,t} \times \frac{PD_k - \overline{PD}_k}{PD_{k,t}} + B_t Q_t \times \frac{Q_t - \overline{Q}}{Q_t} \right) \tag{15}$$

Notice that we quantify this formula using only data on financial transactions (i.e., $(N_{k,t} - N_{k,t-1}) P_{k,t}$ and $B_t Q_t$) and asset valuation ratios (i.e., PD_{kt} and Q_t).

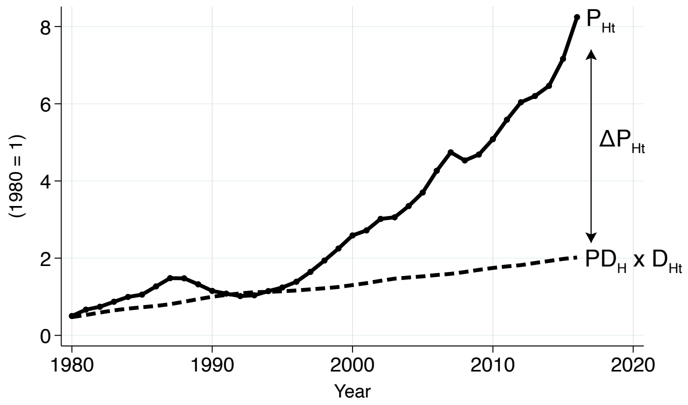


Figure 1: Graphical representation of the price deviation ΔP_{Ht}

Notes. Figure 1 plots the housing price index in Norway from Norges Bank's project on Historical Monetary Statistics (solid line) as well as the rental price index from *Statistics Norway* (dashed line). Both are normalized to one in 1980. The difference between the two can be interpreted as a deviation ΔP_{Ht} between the realized price path P_{Ht} and a counterfactual price path with constant price-to-rent ratio $\overline{PD}_h \times D_{Ht}$.

Time sample and asset classes. We consider four asset classes: housing, debt, deposits, and equity, which correspond to the four main asset classes traded by Norwegian households. Note that we do not need to account for illiquid forms of wealth such as human wealth and defined-benefit pensions since they are not tradable.

We implement Equation (15) starting from 1994. We calibrate the discount rate to 5% (i.e., $R = 1.05$), which roughly corresponds to the average of the deposit and mortgage rate over 1991–1995. Note that, while the formula depends on an infinite sum of transactions, we only observe financial transactions up to 2015. The quantitative effect of this truncation depends on how fast prices grow relative to the discount rate. In Section 5, we will extrapolate the observed financial transactions after 2015 to account for this truncation. In any case, even with finite sample, our results can still be interpreted as the welfare gain of a price deviation that stops in 2015 (i.e., the price deviation reverts to zero after 2015).

Taking stock, we will estimate our final measure of welfare gain for each household as follows:

$$\begin{aligned}
\text{Welfare Gain} &= \sum_{a \in \{\text{housing,debt,deposit,equity}\}} \text{Welfare Gain}_{\text{a}}, \\
\text{Welfare Gain}_{\text{housing}} &= -\sum_{t=0}^{20} R^{-t}(N_{H,t} - N_{H,t-1})P_{H,t} \times \frac{PD_{H,t} - \overline{PD}_H}{PD_{H,t}}, \\
\text{Welfare Gain}_{\text{debt}} &= -\sum_{t=0}^{20} R^{-t} B_{M,t} Q_{M,t} \times \frac{Q_{M,t} - \overline{Q}_M}{Q_{M,t}}, \\
\text{Welfare Gain}_{\text{deposit}} &= -\sum_{t=0}^{20} R^{-t} B_{D,t} Q_{D,t} \times \frac{Q_{D,t} - \overline{Q}_D}{Q_{D,t}}, \\
\text{Welfare Gain}_{\text{equity}} &= -\sum_{t=0}^{20} R^{-t}(N_{E,t} - N_{E,t-1})P_{E,t} \times \frac{PD_{E,t} - \overline{PD}_E}{\overline{PD}_{E,t}},
\end{aligned} \tag{16}$$

where $\overline{PD}_H, \overline{Q}_M, \overline{Q}_D$, and $\overline{PD}_E$ represent the average valuation of housing, mortgage debt, deposits, and equity (respectively) over 1991–1995 (i.e., at the start of our sample).

Computing these welfare gains requires only two types of data on (i) valuation ratios (to compare the actual valuations to a baseline) (ii) market value of financial transactions (at the individual level). We now discuss each data source successively.

3.1 Data on valuations

We rely on publicly available data sources for asset prices. For interests rates on household debt and deposits (i.e., price of one-period bond Q in the theory), we use *Statistics Norway*'s database on interest rates on loans and deposits offered by banks and mortgage companies.[8] Note that above 90 percent of Norwegian mortgage debt has adjustable interest rates in our sample period, so that the year-to-year variation in bank-level interest rates immediately affects households' interest costs.[9]

For the price-dividend-ratio in the Norwegian housing market, we combine data from different sources. The best existing data stems from *Eiendomsverdi* (EV), a private company that collects data on the housing market. Their data in turn stems from registries of housing transactions, rental brokers and the main Norwegian housing rental market place, `Finn.no`. However, EV's price-dividend ratio exists only from 2012 and onward. We therefore combine two other indices, one for house prices and one for housing rents, to obtain our price-dividend series in the years before 2012. The rental index comes from *Statistics Norway*, and is part of the official Consumer Price Index. The house price series stems from Norges Bank's project on Historical Monetary Statistics Eitrheim and Erlandsen (2005).[10] As these two series are indices, the ratio between them alone has no interpretation. We therefore scale their ratio so that in 2012, it equals the EV measure of the price-dividend ratio.[11] In the results that follow, we use our constructed series for the years prior to 2012, and EV's series from 2012 and onward.[12]

For equity valuation, we use the total cash flow over total market capitalization of Norwegian firms, using data from *Worldscope*. Indeed, in the micro-data, most Norwegians own Norwegian stocks, rather than foreign stocks. The series is similar to other series for price-to-earnings series ratio, such as Global Financial Data.

[8]The interest rate data are available on *Statistics Norway*'s web site `https://www.ssb.no/en/statbank/table/08175/`.

[9]Mortgage contracts in Norway typically are annuity loans with 25-year repayment schedules. When interest rates change, the payment schedule adjusts so that the sum of monthly debt repayment and interest costs remains constant at a new level throughout the remaining period of the contract. Such adjustments happen frequently, normally whenever the Central Bank policy rate changes.

[10]This house price index is in turn obtained from combining data by the Norwegian Real Estate Broker's Association, the private consulting firm Econ Poyry, and listings at the main platform for house transactions Finn.no. Norges Bank updates these data regularly and provides them online, currently at https://www.norges-bank.no/en/topics/Statistics/Historical-monetary-statistics/House-price-indices/.

[11]Importantly, because all these three data series exist after 2012, we can use this most recent period to validate that the our constructed price-dividend series for the years before 2012, tracks the high-quality EV series after 2012. Indeed, we find no substantial difference between using EV's price-dividend ratio or using our constructed alternative based on publicly available data, for the years after 2012.

[12]Note that, to be precise, the true cash-flow from owning property is the rent *net of maintenance cost*. However, as long as maintenance cost are a constant fraction of rents, this adjustment does not matter when comparing the growth of valuations between two time periods.

Figure 2 plots the yield of each asset class over time (i.e., dividend-to-price ratios). All yields, except equity yields, decline substantially over time. The yield of housing decreases by 7pp, the yield of mortgage debt decreases by 4pp while the yields on deposits decreases by 3pp. The fact that equity valuations have remained stable in Norway over time is consistent with the rest of Europe, and contrasts with the decline in equity yields in the U.S. (Greenwald et al., 2021). To compute the welfare gains of deviations in valuations, Equation (16) requires a measure of the relative difference between valuations at time t and their average baseline value (i.e., their averages in 1991-1995). To visualize these price deviations, see Figure 14 in the Appendix.

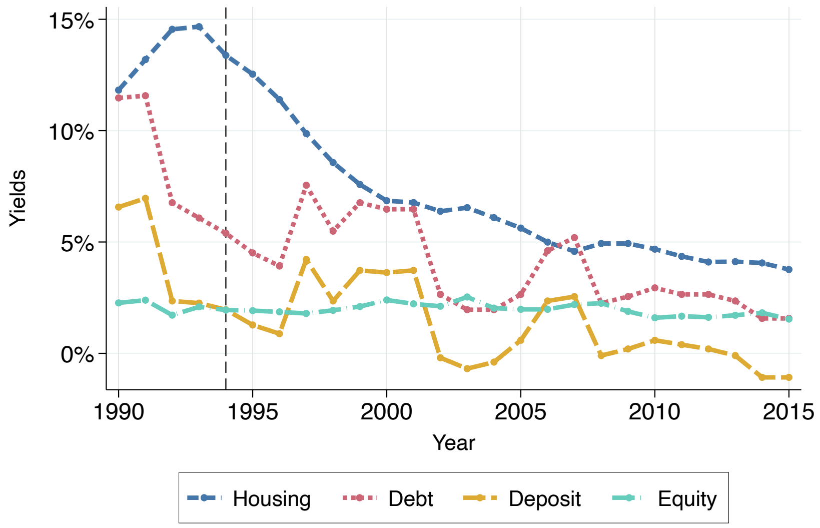


Figure 2: Evolution of yields in Norway

Notes. Figure 2 contains the yields of each asset class over time. The yields of debt and deposit correspond to the average real interet rate on mortgage and debt, respectively, from *Statistics Norway*. The growth of the housing yield is computed as the growth of the rental index from *Statistics Norway* relative to the growth of the price index from Norges Bank's project on Historical Monetary Statistics (note that the initial normalization does not matter for the construction of welfare gains (16)). The equity yield is the ratio between the total cash flows and the total valuation of Norwegian firms from *Worldscope*.

3.2 Data on holdings and transactions

We combine data from a variety of Norwegian administrative registries that cover the universe of Norwegian households from 1993 to 2015. These data come with identifiers at the individual, household, and firm level, as well as information on parent-children links We use the registries for individual tax payments, holdings of equity shares (listed and unlisted corporations), firm balance sheets (listed and unlisted corporations), and transactions of equity shares and housing. Flow variables are measured annually, whereas assets and liabilities are valued at the end of the year. The data are uncensored (i.e., no top coding), and the only sources of attrition are mortality and emigration. The income and wealth data are largely third-party reported by employers and financial intermediaries, and scrutinized by the tax authority as they are used for tax purposes.

Holdings. On household balance sheets, we separately observe bank deposits, cash flows, bond holdings (corporate, sovereign, mutual and money market funds), vehicles (cars and boats), stock funds, listed stocks, private businesses, housing and other forms of estate holdings, and outstanding debt. With the stockholder registry we observe individual ownership shares in every corporation. In principle, we observe each individual's wealth, yet we aggregate the wealth data to the household level because this is the unit subject to wealth taxation in Norway.[13]

Because we observe firms' ownership structure as well as balance sheets, we are able to unpack each firm's assets and liabilities and allocate them to the owners' household balance sheets in proportion to their ownership shares. We do this for all non-listed companies. For listed companies, we allocate the financial assets using publicly-available data from the *Financial Accounts* (see Appendix B). We thus construct variables called "debt" (mortgages, student loans, and unsecured credit), "deposits" (bank deposits), and housing (principal residence, secondary homes and recreational estates), and "public equity" (listed stocks and stock funds), which includes both assets directly held by households, as well as indirectly held through their ownership of firms. For indirectly held housing, we use book values on the firm balance sheet. For directly-held housing, we use a valuation approach that combines transaction data and registered housing characteristics to estimate a value for each house over our sample period (see Fagereng et al., 2020).

To obtain the value of the equity in private businesses held by households, we proceed as follows. Every year, firms must report their assessed total value to the tax authority. As documented in Appendix B, the sum of assessed values across firms aligns closely with the one reported in the *Financial Accounts*. We take the assessed value of each firm and subtract the value of its debts, real estate, and public equity share holdings that we have allocated to the owner's household balance sheet. Then, we allocate this residual (henceforth "private equity") to each owner according to their ownership shares.

Our notion of welfare gain can be interpreted as the present value of the deviation in consumption due to the deviation in asset prices (see Equation 10). It is therefore natural to scale it by the present value of consumption. However, we do not observe consumption in our sample. Instead, in some exercises, we will scale by "total wealth", which incorporates not only financial wealth but also human wealth (i.e., the present value of future labor income plus net government transfers earned between 1994 and 2015, discounted at 5 pp. annually). Table 1 summarizes the balance sheet data.

Transactions. Equation 16 highlights the fact that we need data on holdings for debt and deposits (which are modeled as one period bonds), but net transactions for housing and equity (which are modeled as long-lived assets). For housing, we directly observe the annual value of market transactions in the housing market at the individual-level. Net transactions in year t are defined as all housing purchases minus all housing sells within a year. The observed dollar

[13]While wealth is *registered* at the individual level, it is *taxed* at the household level. The latter in turn means that couples have strong incentives to transfer assets within the household so as to minimize their total tax burden. Hence the reported wealth allocation between individuals *within* the household is likely to be misleading.

Table 1: Descriptive statistics in 2005 (values in thousands of USD)

	Mean	S.D.	P10	P50	P90	P99
Housing	352.46	563.55	0.00	270.21	768.59	1,846.52
Debt	83.96	283.24	0.00	41.29	206.98	504.81
Deposits	40.67	257.17	0.42	10.85	88.62	402.22
Public equity	9.19	512.88	0.00	0.00	11.66	124.09
Private equity	13.87	823.36	0.00	0.00	0.00	155.15

Notes. The total number of observations is 3,535,162. Values are reported in thousands of 2011 US dollars.

amount of net housing transactions can be transformed into real housing units by dividing by a house price index.

We do not directly observe market transactions for equity and impute net transactions. The imputation approach is similar for all assets within equities. We observe wealth at the beginning and end of the year and a price index (either asset or asset class). We then compute a measure of unrealized capital gains by assuming that all transactions are in the same direction and uniformly distributed within a year. Net transactions within each asset are the change in nominal wealth minus imputed nominal capital gains, divided by a price index.

The price index used for imputation differs between assets. For listed stocks, the method differs depending on the available information. Starting in 2005, we have information on individual stock ownership and use market prices from the stock exchange to compute capital gains for each stock. Before 2005, we lack information on individual stock ownership and use capital gains from the financial accounts to impute capital gains on listed stocks at the individual level. We also use capital gains from the financial accounts to impute individual capital gains for stock funds. For private businesses, we assume that there are no capital gains such that all changes in private business wealth are net transactions.

4 Empirical Findings

In this section, we estimate our sufficient statistic (16), which measures the welfare gains associated with the realized deviation in asset prices, for all Norwegian that was at least 18 years old at some point between 1994 and 2015. We describe the heterogeneity across individuals in Section 4.1. We then describe the heterogeneity across observable characteristics such as age (Section 4.2) and wealth (Section 4.3). Finally, we discuss the heterogeneity of welfare gains across sectors (i.e. households, government and foreigners) in Section 4.4.

4.1 Redistribution across individuals

Welfare gains. We start by documenting the heterogeneity in welfare gains in the full population. Figure 3 reports the histogram of welfare gains, as well as its decomposition between the effect of each asset class. As predicted by Section 2, the average welfare gain is close to zero. However, there is a substantial heterogeneity of welfare gains across individuals: the welfare gain is −35K at the 10th percentile and 80K the the 90th percentile, with a standard deviation around 60K.

Note that there is a large mass at zero, reflecting the fact that a substantial part of the population neither benefits or is hurt by changing asset prices, consistent with the idea that a large fraction of households are "hand-to-mouth" (i.e., they consume their income). The decomposition of the welfare gain by asset class indicates that welfare gains due to equity are very small, reflecting the fact that there is very little fluctuations in equity prices.

Normalized welfare gains. This dispersion in welfare gains across individuals may reflect dispersion in initial wealth as opposed to dispersion in welfare gains *normalized* by initial wealth. To disentangle between the two, we scale welfare gains by total wealth, defined as the sum of financial and human wealth (see Section 3.2).

Recall that welfare gains can be interpreted as the present value of the change in consumption due to the deviation in asset prices (see Equation 10). As as consequence, this *normalized* version of welfare gains is a proxy for to the change in consumption as a fraction of the present value of consumption.

Figure 3 shows significant heterogeneity in welfare gains, even after normalizing by initial wealth. Welfare gain is -6% at the 10th percentile and 15% at the 90th percentile, with a standard deviation around 11%. The skewness is positive, at around 0.45: while the median individual neither benefits or is hurt by the rise in asset prices, some individuals disproportionately benefit from the rise in asset prices.

Comparing welfare and wealth gains. How do *welfare* gains differ from *wealth* gains? To answer this question, we plot together the histogram of welfare and wealth gains across individuals. We define wealth gains as the effect of the rise in prices on the terminal value of wealth:[14]

$$\text{Wealth Gain} = \sum_{t=0}^{T} R_{0\to t-1}^{-1} \sum_{k=1}^{K} N_{k,t-1} \left(R_{0,t}^{-1} \Delta P_{k,t} - \Delta P_{k,t-1} \right) - \sum_{t=0}^{T} R_{0\to t}^{-1} B_t \Delta Q_t \tag{18}$$

Wealth gains equal welfare gains for one period bonds. However, they differ for long duration assets. This is because wealth gains only capture the positive effect of rising valuations on returns today, without taking into account their negative effect on returns tomorrow.[15] This suggests that wealth gains tend to overestimate welfare gains.

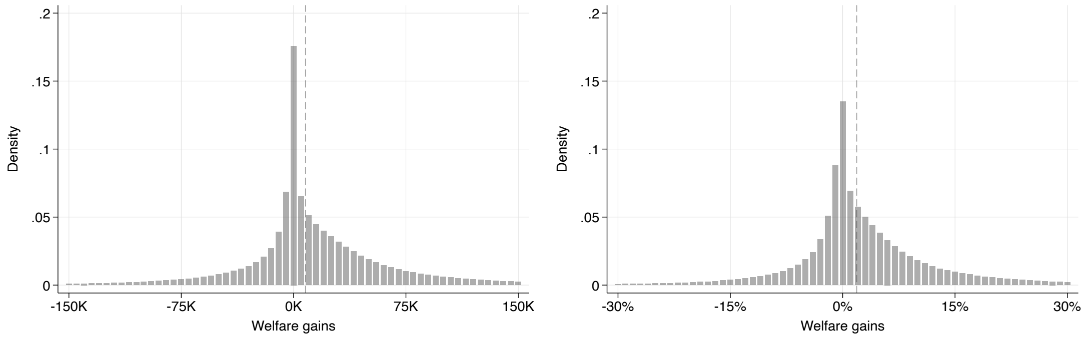
To test this intuition, Figure 4 compares the histograms of welfare and wealth gains. The main observation is that, while welfare gains are centered around zero, wealth gains are centered about a positive value (10% of wealth in average). This reflects the fact that wealth gains

[14]In the particular case in which individuals do not change their holdings over time, this simplifies to:

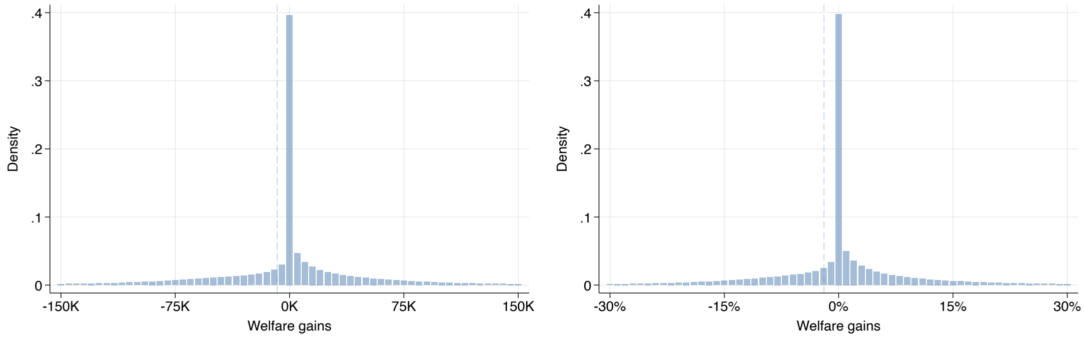
$$\text{Wealth Gain} = R_{0\to T}^{-1} \sum_{k=1}^{K} N_{k,-1} \Delta P_{k,T} \tag{17}$$

which is simply the discounted value of the deviation in terminal wealth.

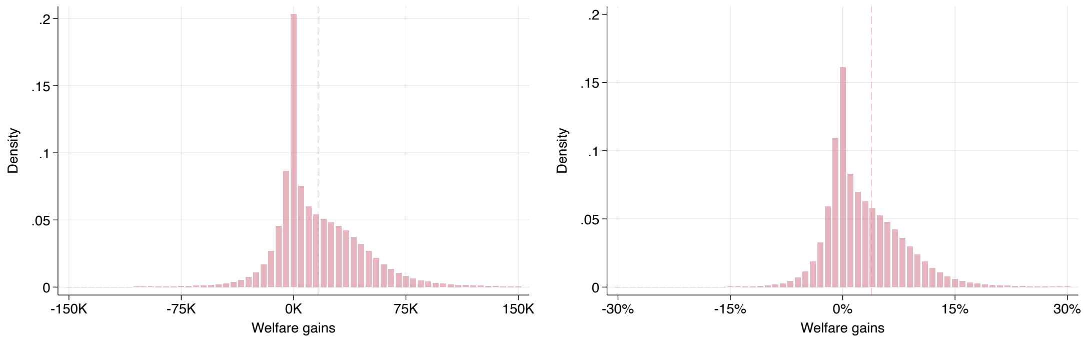
[15]See Appendix A.3 for a formal expression for the difference between welfare and wealth gains.



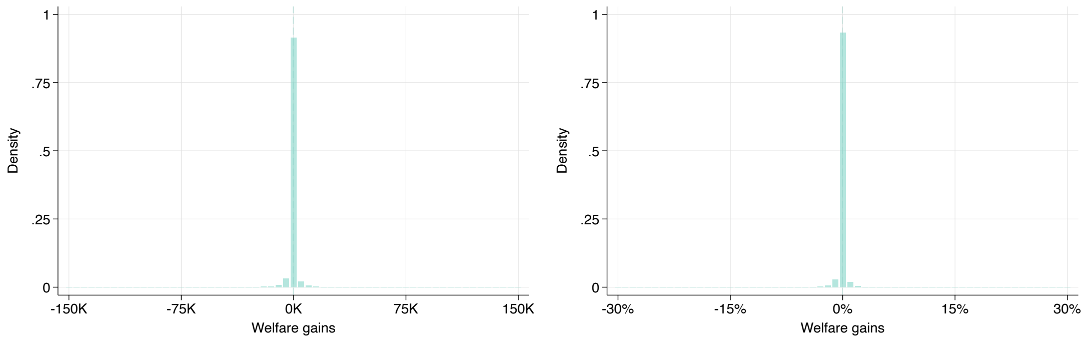
(a) Total



(b) Housing



(c) Deposit and debt

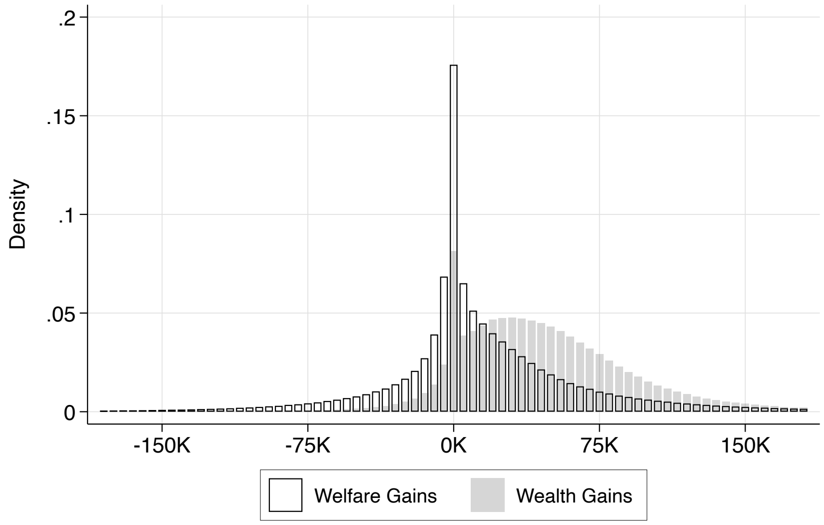


(d) Equity

Figure 3: Heterogeneity of welfare gains across individuals

Notes. Notes. Figure 3 plots the density of individual welfare gains, as define in (16), across individuals in Norway. Figures in the left column plot welfare gains in level (in 2015 US dollars) while figures in the right column plot welfare gains normalized by initial wealth, where initial wealth is defined as the sum of financial wealth and human capital (e.g. the present value of labor income earned and government benefits received from 1994 to 2015) in 1994. Data from Statistics Norway.

accrue to all asset holders while welfare gains only accrue to asset sellers. Also, the distribution of wealth gains tends to be less dispersed than the distribution of welfare gain (standard deviation, skewness, and kurtosis are all lower). In sample, the correlation between (normalized) welfare and wealth gains is only 30%, which indicates that wealth gains are a poor proxy for the actual welfare gains.



(a) Level

(b) Normalized by initial wealth

Figure 4: Comparing welfare and wealth gains across individuals

Notes. Figure 4a plots the density of welfare gains defined in (16), in black lines, and the density of wealth gains defined in (18), in grey shading, across individuals in Norway. Units are 2015 US dollars. Figure 4b plots the same quantities normalized by initial wealth, where initial wealth is defined as the sum of financial wealth and human capital (e.g. the present value of labor income earned and government benefits received from 1994 to 2015) in 1994. Data from Statistics Norway.

4.2 Redistribution across cohorts

Welfare gains. The previous section documented a large heterogeneity in welfare gains between individuals. We now focus on documenting the heterogeneity in welfare gains along observable characteristics.

One natural characteristic is age. Indeed, the existing literature on household finance has documented large differences in portfolio holdings over the life cycle (e.g., Flavin and Yamashita, 2011; Cocco et al., 2005). This heterogeneity may naturally generate heterogeneity in trading, and, therefore, in welfare gains.

Figure 5 contains the average welfare gains for different cohorts, indexed by the age of individuals in the cohort in 1994. The main pattern is that welfare gains are negative for the young and positive for the old: rising asset prices redistribute welfare from the young to the old. This is consistent with the life cycle model of savings: the young use their net savings to buy financial assets, while the old sell their financial assets to consume.

Quantitatively, the average welfare gain is approximately -20K for individuals below 15 years old in 1994 (Millennial), and around 25K for individuals above 50 years old in 1994 (Baby boomers). Decomposing the welfare gains into the contribution of each asset class reveals interesting patterns. On the one hand, consistent with the fact that the young tends to buy houses from the old, higher house prices redistribute welfare from the young toward the old. On the other hand, consistent with the fact that the young tends to borrow from the old, lower mortgage rate redistribute welfare from the old toward the young.

Overall, the effect of higher housing prices dominates the effect of lower mortgage rates for two reasons. First, as one can see from Figure 2, the yields of house prices decreased more than the interest rate on debt. Second, as young people build equity in their houses, they decrease their mortgage balances over time, which means that they benefit relatively less from the decrease in mortgage rates as they age.

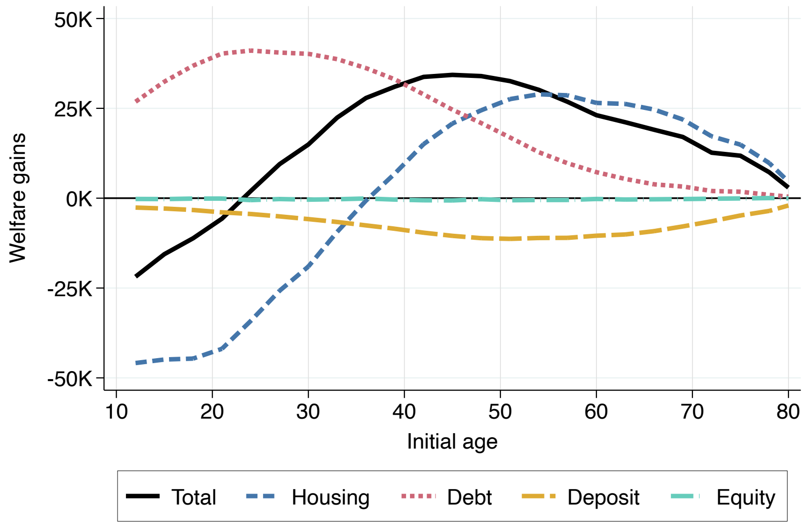


Figure 5: Welfare across cohorts

Notes. Figure 5 plots the average welfare gain (16) for individuals in each cohort. Cohorts are indexed by the age of individuals in 1994. All quantities in 2015 US dollars. Data from Statistics Norway.

Comparing welfare and wealth gains. As in the previous section, we now compare welfare and wealth gains across cohorts. Figure 6 plots the average wealth gain and the average wel-

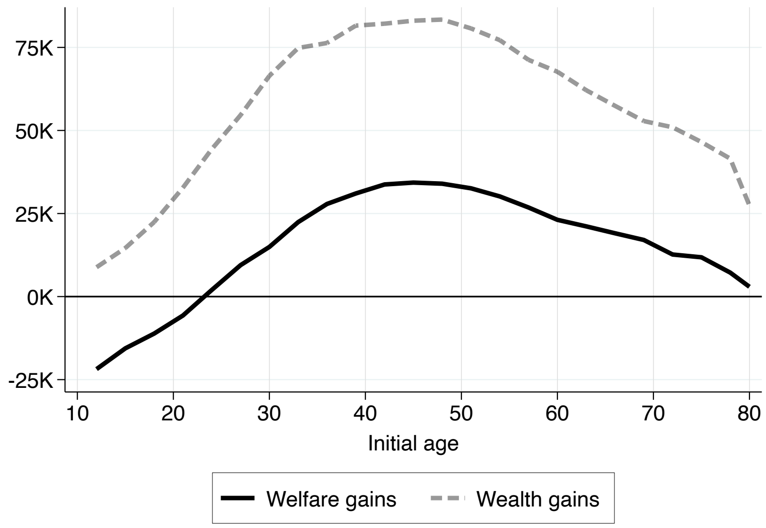


Figure 6: Welfare versus welfare gains across cohorts

Notes. Figure 6 plots the average wealth gain, as defined in (16), and the average wealth gain, as defined in (18), for each cohort in Norway. Cohorts are indexed by the age of individuals in 1994. Units are 2015 US dollars. Data from Statistics Norway.

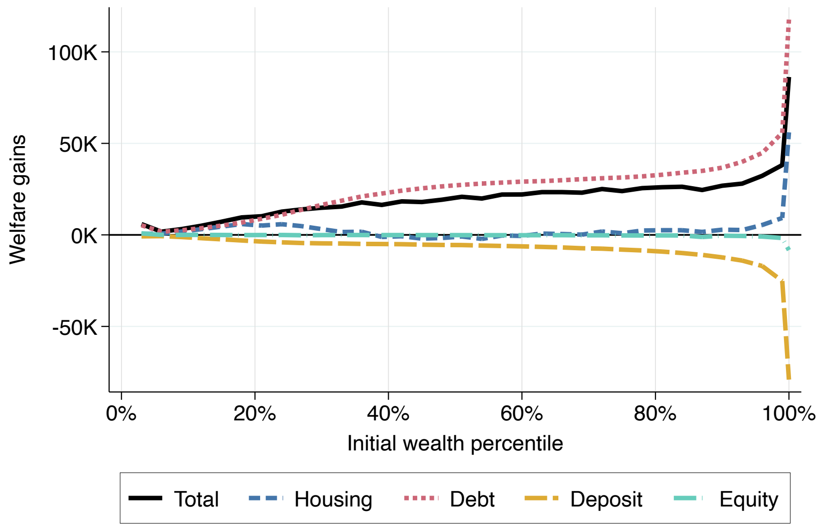
fare gain for each cohort in our sample. There are two main observations. First, in contrast with welfare gains, wealth gains are positive for everyone, reflecting the overall rise in valuations during the time period. Second, while welfare gains converge to zero as age increases, wealth gains remain large for 80 years olds. This reflects the fact that, while assets held by these individuals increased in value, these wealth gains did not correspond to any welfare gains as these assets were simply passed to their children.

4.3 Redistribution across wealth percentiles

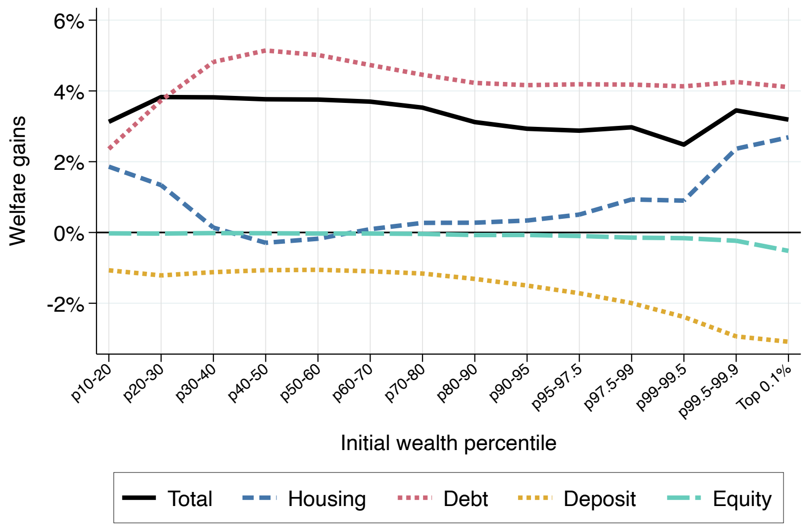
A growing literature has emphasized the effect of higher valuations on the wealth distribution (e.g., Kuhn et al., 2020; Gomez, 2016; Greenwald et al., 2021). One natural question is: are these wealth gains actually welfare gains? To answer this question, we compare wealth and welfare gains across the wealth distribution.

Figure 7a contains the average welfare gain for each wealth percentile, computed using the initial distribution of wealth in 1994. The main pattern is that wealthier individuals do benefit more from higher asset prices. However, Figure 7b, shows that as a fraction of total wealth, the welfare effect of higher asset prices is relatively constant throughout the wealth distribution at around 3.5%. Focusing on the contribution of different asset classes reveals interesting patterns. On the one hand, as a proportion of wealth, wealthy individuals benefited more from the rise in house prices. On the other hand, these individual tend to be net lenders, rather than net borrowers, which means that they were hurt by lower interest rates. Finally, the contribution of lower interest rates on debt is the main contributor throughout at all wealth percentiles, a fact that we will discuss in Section 4.4.

Figure 8a contrasts welfare gains to wealth gains across the wealth distribution. The main finding is that wealth gains are an order of magnitude larger than the actual welfare gains. This is especially striking for the top 1%, which has relatively little welfare gains but large wealth



(a) Level



(b) Normalized by initial wealth

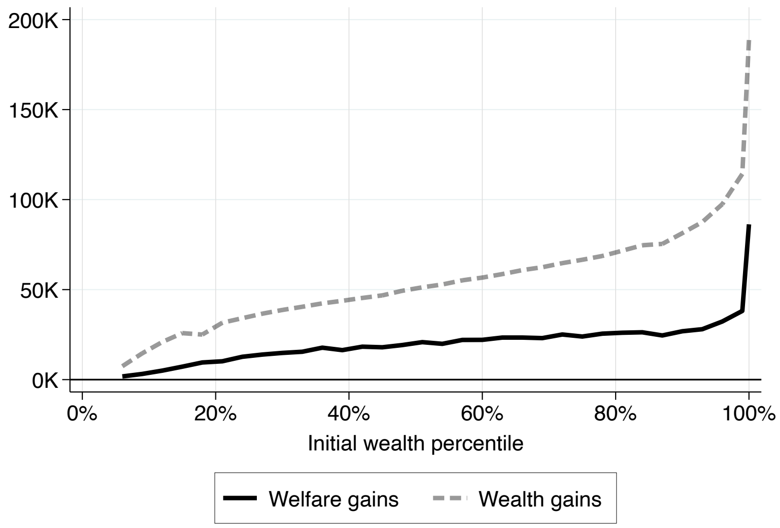
Figure 7: Welfare gains across wealth percentiles

Notes. Figure 7a plots the average welfare gain, as defined in (16), for each wealth percentile in Norway. Wealth is defined as the sum of financial wealth and human capital (e.g. the present value of labor income earned in our sample) in 1994. Figure 7b plots the same quantities normalized by wealth. Units are in 2015 US dollars. Data from Statistics Norway.

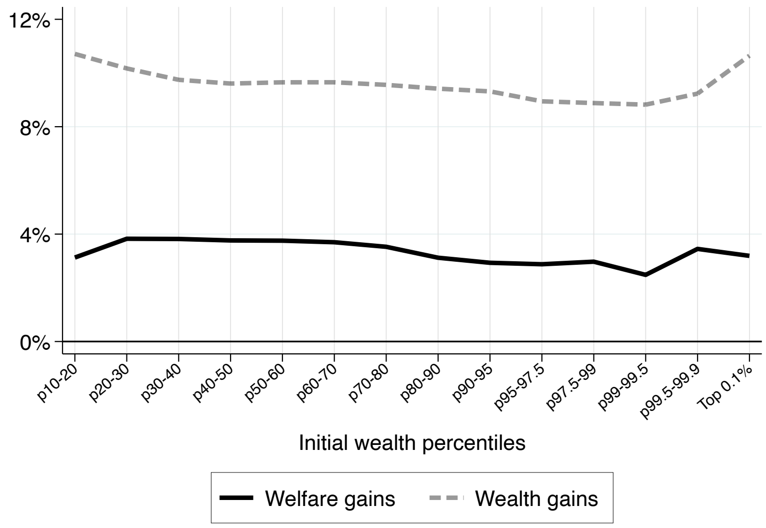
gains. Overall, our results indicate that welfare gains in the right tail of the wealth distribution have been much smaller than the wealth gains.

4.4 Redistribution across sectors

When households only trade with each other, the aggregate household welfare gain is zero (see Corollary 2). The logic is that for every household selling an asset, there is an offsetting household purchasing it. In practice, however, households routinely trade asset with other non-household entities. For instance, domestic households have mortgage loans originated by domestic banks but ultimately held by the government or foreigners. We now conduct



(a) Level



(b) Normalized by initial wealth

Figure 8: Welfare versus wealth gains across wealth percentiles

Notes. Figure 8a plots the average individual welfare gain, defined in (16), and the average wealth gain, defined in (18), for each wealth percentile in Norway. Wealth is defined as the sum of financial wealth and human capital (e.g. the present value of labor income earned in our sample) in 1994. Units are 2015 US dollars. Figure 8b plots the same quantities normalized by wealth. Data from Statistics Norway.

a systematic sectoral investigation of the redistributive effect of asset price changes. To do so, we group all entities in the economy into three sectors: households, the government, and foreigners.

The key accounting identity that we leverage is that every financial asset is liability for one sector and an asset for another sector. With this in mind, it is immediate that in a multisector economy, Corollary 2 becomes

$$\text{Welfare Gain}_{\text{households}} = -\left(\text{Welfare Gain}_{\text{government}} + \text{Welfare Gain}_{\text{foreigners}}\right), \tag{19}$$

where WG is the aggregate household welfare gain defined in (16). In words, a positive welfare gain for the household sector must be exactly offset by a welfare loss in another sectors. We now describe how we measure and interpret the welfare gains across sectors.

Data and definitions. We use publicly available data from the Norwegian *Financial Accounts*, which covers all holdings and transactions of financial assets. Traditionally, housing is not considered a financial asset and thus not included in the Financial Accounts. Therefore, we augment the publicly available data by aggregating our administrative housing transaction registry described in Section 3. For our analysis, we combine the government sector with the central bank and the non-profit sector. Hence, we use the term "government" liberally to include all entities that serve the household sector. We then consolidate the business sector with its ultimate owners. (see Appendix B for a detailed description of all data manipulations.)

Our resulting dataset covers the total amount holdings and transactions between sectors (i.e., household, government, and foreigners) for five broad asset classes (i.e., deposits, debt, private equity shares, public equity shares, mutual fund shares) over the 1996–2015 period . As we show in Appendix B Figure 15, the match between aggregated household micro data and sectoral aggregate data is almost perfect, with a small and volative residual for public equity and mutual fund shares).

Results. Figure 9 presents the welfare gain across sectors, where all numbers are scaled by the number of individuals in Norway. Notice that the household sector as a whole has a positive welfare gain of roughly $+4K$, with negative contributions from deposits and housing as well as a large positive contribution from debt +14K.

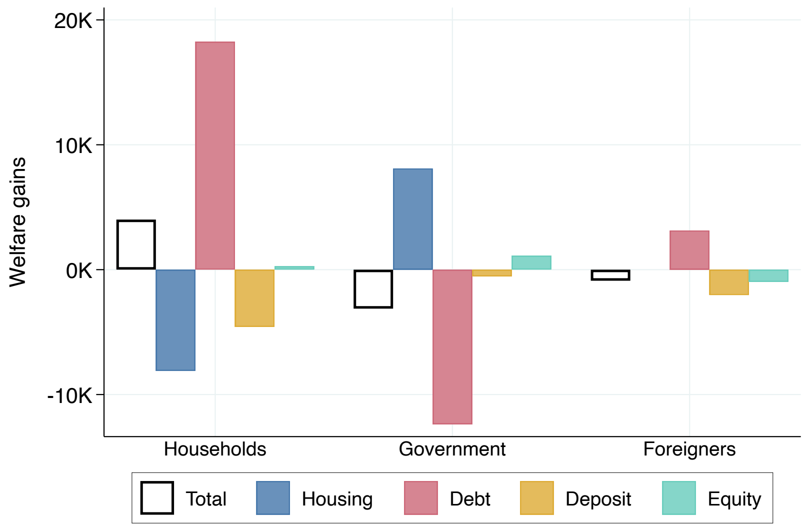


Figure 9: Welfare gains across sectors

Notes. Figure 9 contains the welfare gain for each sector of the economy, as well as the contribution of each asset class. To make it comparable to the other figures in our paper, the aggregate welfare gains of each sector is divided by the number of individuals in Norway. Units are 2015 US dollars.

Declining interest rates have benefited the household sector as a whole due to the fact that households are a net debtors. Who is the counterparty that was hurt? For the most part, it was the government. While the government does not lend directly to households, it holds debt securities originated by the banking sector on its balance sheet, presumably in order to finance some of its long-term liabilities, such as defined-benefit pensions. On the other hand, the household sector as a whole was hurt by rising house prices. The reason is that households were net buyers of housing, and the main entities that build new housing in Norway are non-profit institutions, who benefit from rising house prices.

Overall, there is very little redistribution between domestic sectors and foreigners, leading to a negligible negative welfare effect for foreigners of less than 1K. What is noteworthy is the fact that Norways sovereign wealth fund made large purchases of foreign equity during the great financial crisis when prices were temporarily low (it "bought the dip"), leading to a positive welfare gain for the government at the expense of foreigners. On the other hand, the government held foreign debt securities throughout the sample period, leading to a negative welfare gain for the government and a positive welfare gain for foreigners.

The key takeaway of the sectoral analysis is that existing households in Norway appear to have benefited *on average* from changes in asset prices. However, following the logic presented in Section 2.3, the Norwegian government was hurt, which means that it had to (or will have to) decrease its net transfers to the household sector. While tt is beyond the scope of this paper to estimate the contribution of changes in asset prices on the government's spending, it is entirely possible that the households who experienced negative welfare gains (i.e., the young) will also be the one that will bear the brunt of future reductions in government net transfers such as pension benefit.

5 Robustness

Our sufficient statistic approach is valid under two important assumptions: first, that first-order effects are a good approximation of the overall welfare effect, and, second, that working with a sample of transactions up to 2015 captures most of the welfare gains. We now discuss each of these assumptions in Section 5.1 and Section 5.2, respectively.

5.1 Welfare gains at the second-order

Our measure of welfare gains defined in Proposition 1 is only valid for an infinitesimal deviation in asset prices. For a non-infinitesimal price deviation, it only corresponds to a first-order approximation of the full welfare effect. However, the price deviations we observe in the data are quite large. Are these higher-order effects important?

To answer this question, we now formally model a non-infinitesimal deviation in asset prices. The deviation is now indexed by $\theta \in [0, 1]$; that is, $P_t(0)$ corresponds to the non-perturbated prices and $P_t(1)$ corresponds to the fully perturbated price.

Using Proposition 1, we can still write the welfare gains between $\theta = 0$ and $\theta = 1$ as the integral of the welfare effect of infinitesimal deviations in prices:[16]

$$\text{Welfare Gain} = \int_0^1 \sum_{t=0}^{\infty} R_{0\to t}(\theta)^{-1} \left(\sum_{k=1}^{K} (N_{kt}(\theta) - N_{kt-1}(\theta))\, \mathrm{d}P_{kt}(\theta) + B_t(\theta)\, \mathrm{d}Q_t(\theta) \right)$$

For a variable x, denote $\Delta x = x(1) - x(0)$ the difference between the value of the variable in the perturbated path and in the baseline path. A trapezoid approximation gives us the following second-order approximation for welfare:

$$\begin{aligned} \text{Welfare Gain} \approx & \sum_{t=0}^{\infty} \left(R_{0\to t} + \frac{\Delta R_{0\to t}}{2} \right)^{-1} \\ & \times \left(\sum_{k=1}^{K} \left(N_{kt} - N_{kt-1} + \frac{\Delta N_{kt} - \Delta N_{kt-1}}{2} \right) \Delta P_{kt} + \left(B_t + \frac{\Delta B_t}{2} \right) \Delta Q_t \right) \end{aligned} \tag{20}$$

In contrast with our first-order approximation (14), this second-order approximation requires to know how transactions would change if valuations were at their 1994 level. Put differently, our first-order approximation is valid at the second-order only if transactions do not react to deviation in prices; that is, $\Delta N_{kt} = \Delta B_t = 0$.

One alternative assumption is that, if valuations were at the same as in 1994, individuals within the same age and wealth percentile would trade as much as they do in 1994; that is

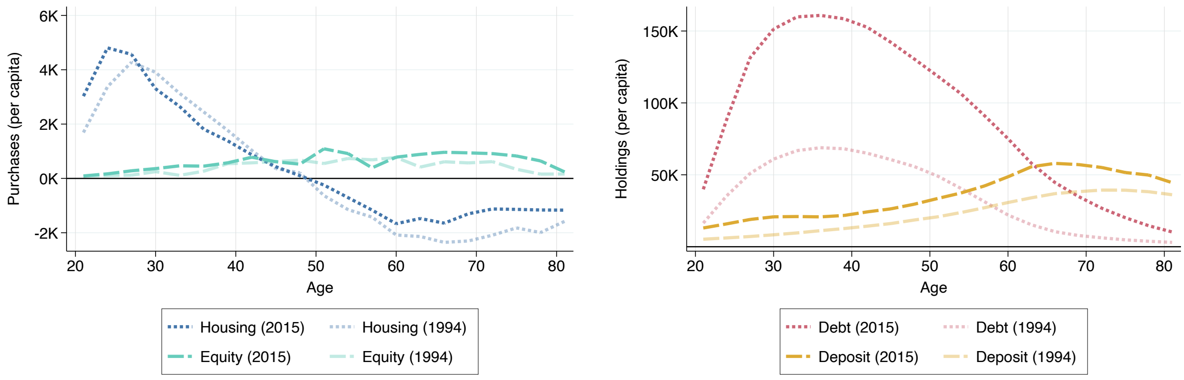
$$\begin{aligned} N_{kt} + \Delta N_{kt} &= G^t N_{k0}, \\ B_t + \Delta B_t &= G^t B_0, \end{aligned} \tag{21}$$

where $G = 1.01$ denotes the gross growth rate of the economy in our sample (per capita). To examine the effect of this assumption, Figure 10 compares $N_{k,t} - N_{k,t-1}$ with $G^t\,(N_{k,0} - N_{k,-1})$. One striking result is that the number of houses traded per cohort remains roughly similar over time, despite the rise in housing prices during the time period.

Figure 10 compares B_t with $G^t B_0$. Deposits mortgage balances have increased much more rapidly than one could expect from the growth of the economy. Intuitively, this reflects the fact that, to buy the same quantity of houses as before, the young must now borrow a much larger amount.

Figure 11 uses these numbers to compute the welfare effect at the second order, under assumption (21). The main effect of the second-order adjustment is to decrease the welfare gain due to mortgage rates: intuitively, this reflects the fact that, if house prices were closer to their 1994 valuations, agents would have lower mortgage balance, and, therefore, they would benefit less from low mortgage rates. Still, this adjustment is small: results are quantitatively very similar to our first-order approximation.

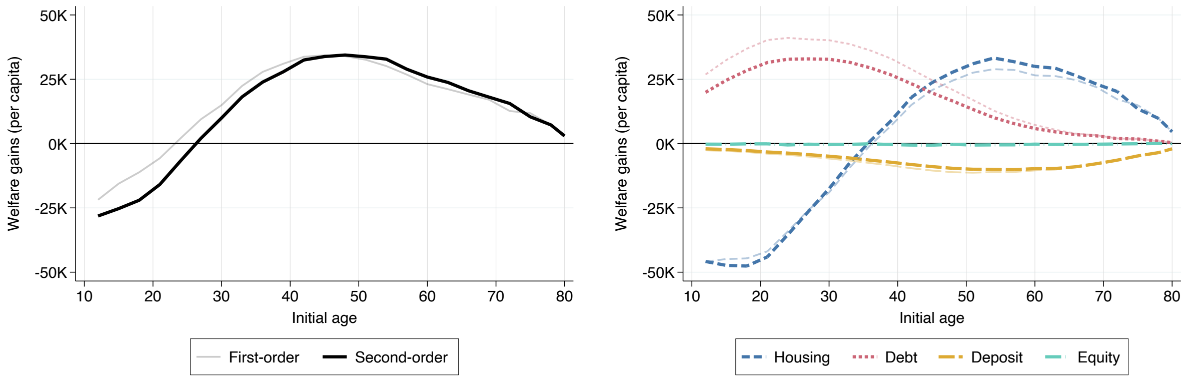
[16] Formally, this non-infinitesimal welfare gain corresponds to the difference in consumer surplus.



(a) (b)

Figure 10: Transactions in 1994 versus 2015 (adjusted for economic growth)

Notes. Figure 10 plots transactions in 1994 versus 2015, after adjusting them for economy growth. Formally, Figure 10a plots $(N_{k,T} - N_{k,T-1})P_T$ and $(G^T P_T / P_0)\,(N_{k,0} - N_{k,-1})P_0$ while Figure 10b plots $B_T Q_T$ and $(G^T Q_T / Q_0)\,B_0 Q_0$. Units are 2015 US dollars. Data from Statistics Norway.



(a) Total (b) Detail by asset class

Figure 11: Welfare gains at the second-order

Notes. Figure 11 plots the average welfare gain at the first-order and at the second-order (using Equation (20)) for individuals in each cohort. The second-order approximation is constructed using Assumption (21), which says that, if valuations were back to their level of 1994, households would trade the same quantity of assets as in 1994. Units are 2015 US dollars. Data from Statistics Norway.

5.2 Welfare gains with permanent valuation changes

Our measure of welfare gains in Proposition 1 expresses the gains as the present value of all future transactions, interacted with the deviation in prices. However, as discussed in Section 3, we only apply our formula on a finite sample, since we only observe financial transactions up to 2015. Therefore, our formula should be interpreted as the welfare gain of fluctuations in prices up to 2015, which mean revert afterwards.

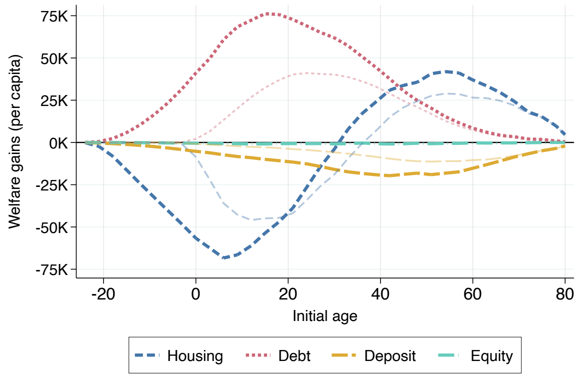
One alternative exercise would be to compute the welfare gains of valuations remaining permanently at their 2015 level. To do this exercise, we need to impute the transactions in future years. To do so, we simply assume that future transactions in each cohort will equal the transaction of the cohort with the same age in 2015, after adjusting for economic growth.

Formally, we assume that, for $t \geq T$, we have:

$$N_{kt}P_{kt} = G^{t-T}N_T P_T$$
$$B_t Q_t = G^{t-T}B_T Q_T \qquad (22)$$

Figure 12 plots the average welfare gain in each cohort after doing these imputations. The main effect of a permanent rise in valuations is to shift the graph of welfare gains to the left; that is, to redistribute welfare to existing generations at the expense of unborn generations.

(a) Total



(b) Detail by asset classes

Figure 12: Welfare gains with permanent price deviations

Notes. Figure 12 plots the average welfare gain in each cohort for a transitory versus a permanent change in asset prices. Units are 2015 US dollars. Data from Statistics Norway.

Appendix

A Additional results

A.1 Proofs

Proof of Proposition 1. The Lagrangian is

$$\mathcal{L} = \sum_{t=0}^{\infty} \beta^t U(C_t)$$
$$+ \sum_{t=0}^{\infty} \lambda_t \left(\sum_{k=1}^{K} N_{k,t-1} D_t + B_{t-1} + Y_t - C_t - \sum_{k=1}^{K} \chi(N_{k,t} - N_{k,t-1}) - \sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) P_{k,t} - B_t Q_t \right)$$

The first order conditions give:

$$\begin{aligned} \beta^t U'(C_t) &= \lambda_t && (\partial\mathcal{L}/\partial C_t) \\ \lambda_t(D_t + P_t - \chi'(N_{k,t+1} - N_{k,t})) &= \lambda_{t-1}\left(P_{t-1} + \chi'\left(N_{k,t} - N_{k,t-1}\right)\right) && (\partial\mathcal{L}/\partial N_{k,t-1}) \\ \lambda_t &= \lambda_{t-1} Q_{t-1} && (\partial\mathcal{L}/\partial B_{t-1}) \end{aligned}$$

The infinitesimal change in welfare is given by the infinitesimal change in the Lagrangian:

$$\begin{aligned} \mathrm{d}V &= \sum_{t=0}^{\infty} \left(\sum_{k=1}^{K} \frac{\partial \mathcal{L}}{\partial P_{k,t}} \mathrm{d}P_{k,t} + \frac{\partial \mathcal{L}}{\partial Q_t} \mathrm{d}Q_t \right) \\ &= \sum_{t=0}^{\infty} \lambda_t \left(- \sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) \mathrm{d}P_{k,t} - B_t \mathrm{d}Q_t \right) \\ &= -U'(C_0) \sum_{t=0}^{\infty} R_{0\to t}^{-1} \left(\sum_{k=1}^{K} (N_{k,t} - N_{k,t-1}) \mathrm{d}P_{k,t} + B_t \mathrm{d}Q_t \right) \end{aligned}$$

□

A.2 Duration mismatch

Auclert (2019) examines the effect of a perturbation in the path of interest rates on welfare. We now discuss that his result relates to our Proposition 1.

Consider an economy where, at time $t = 0$, the agent can trade bonds of all maturities. Denote Q_h the price of the bond with maturity $h \geq 1$. That is, the long-term interest rate between 0 and h is $R_{0\to h} = 1/Q_h$.

As in the baseline model, the agent receives labor income Y_t at time t and they initially own N_{-1} shares of a long lived asset that yield a sequence of dividends $(D_t)_{t\geq 0}$. The agent chooses consumption to maximize utility:

$$V = \max_{\{C_t\}_{t\geq 0}} \sum_{t=0}^{\infty} \beta^t U(C_t)$$

with the following sequence of budget constraints

$$\sum_{h=1}^{\infty} B_h Q_{h0} = N_{-1}D_0 + Y_0 - C_0 \qquad \text{for } t = 0,$$
$$0 = N_{-1}D_t + B_h + Y_t - C_t \qquad \text{for } t \geq 1$$

where B_h denotes the number of bonds with maturity h bought at time $t = 0$. As given by Proposition 1, the welfare effect of a perturbation in the price of bonds with different maturities depends on the number of transactions:

$$\begin{aligned}\text{Welfare Gain} &= -\sum_{h=1}^{\infty} B_h \,\mathrm{d}Q_{h0} \\ &= \sum_{h=1}^{\infty} (N_{-1}D_h + Y_h - C_h)\,\mathrm{d}Q_{h0} \\ &= \sum_{h=1}^{\infty} R_{0\to h}^{-1}(C_h - Y_h - N_{-1}D_h)\,\mathrm{d}\log R_{0\to h}\end{aligned}$$

In the special case in which the perturbation is a level shift in the yield curve; that is, $\mathrm{d}\log R_{0\to h} = h\,\mathrm{d}\log R$, this becomes:

$$\text{Welfare Gain} = \left(\sum_{h=1}^{\infty} R_{0\to h}^{-1}(C_h - Y_h - N_{-1}D_h)h\right)\mathrm{d}\log R.$$

In particular, the welfare gain of a permanent rise in interest rate on welfare, relative to the value of initial wealth, depends on the difference between the duration of income and the duration of consumption.

A.3 Welfare and wealth gains

We now discus the relationship between welfare gains, as defined in (11), and wealth gains, as defined in (18).

Proposition 3. *For an asset k, welfare gains equals wealth gains adjusted for the effect of valuations on future returns*

$$\underbrace{-\sum_{t=0}^{T} R_{0\to t}^{-1}\left(N_{k,t} - N_{k,t-1}\right)\mathrm{d}P_{k,t}}_{\text{Welfare gain}} = \underbrace{\sum_{t=0}^{T} R_{0\to t-1}^{-1} N_{k,t-1}P_{k,t-1}\,\mathrm{d}\ln R_{k,t}}_{\text{Wealth gain}} + \underbrace{\sum_{t=T+1}^{\infty} R_{0\to t-1}^{-1} N_{k,T-1}P_{k,t-1}\,\mathrm{d}\ln R_{k,t}}_{\text{Effect on future returns}}.$$

where $\mathrm{d}\ln R_{kt} = \left(R_t^{-1}\,\mathrm{d}P_{k,t} - \mathrm{d}P_{k,t-1}\right)/P_{kt-1}$ *denotes the effect of valuation changes on returns*

This proposition highlights that wealth gains due to higher valuations overestimate welfare gains because they do not take into account that these higher valuations imply lower returns on wealth going forward. This is the same intuition as the one discussed in the two-period

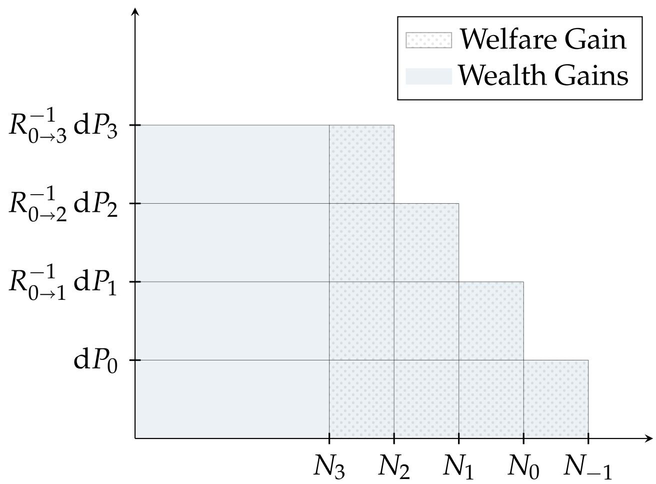


Figure 13: Geometric representation of welfare gains and wealth gains

Notes. Figure 13 plots the set of points $(N_t, R_{0\to t}^{-1}\,\mathrm{d}P_t)$ where $\{N_t\}_{t\geq 0}$ denotes the individual holdings and $\{R^{-t}\,\mathrm{d}P_t\}_{t\geq 0}$ denotes the discounted value of price deviations, for $0 \leq t \leq 3$. Welfare gains correspond to the area between the x-axis and the curve $(N_t, R_{0\to t}^{-1}\,\mathrm{d}P_t)$ while wealth gains correspond to the area between the y-axis and the curve $(N_t, R_{0\to t}^{-1}\,\mathrm{d}P_t)$. Formally:

$$\text{Welfare Gains} = \sum_{t=0}^{T} R_{0\to t}^{-1}\,\mathrm{d}P_t \times (N_t - N_{t-1}),$$
$$\text{Wealth Gains} = \sum_{t=0}^{T} N_{t-1} \times \left(R_{0\to t}^{-1}\,\mathrm{d}P_t - R_{0\to t-1}^{-1}\,\mathrm{d}P_{t-1}\right).$$

model in Section 2.[17]

Proof of Proposition 3. Using summation by part, welfare gains for asset k can be rewritten as:

$$-\sum_{t=0}^{T} R_{0\to t}^{-1}\,(N_{k,t} - N_{k,t-1})\,\mathrm{d}P_{k,t} = -R_{0\to T}^{-1} N_{k,T}\,\mathrm{d}P_{k,T} + \sum_{t=0}^{T} R_{0\to t-1}^{-1} N_{k,t-1}\left(R_t^{-1}\,\mathrm{d}P_{k,t} - \mathrm{d}P_{k,t-1}\right).$$

This equality is represented geometrically in Figure 13. To conclude, note that the assumption of no-bubble (that is, $\lim_{T\to\infty} R_{0,\to T}^{-1}\,\mathrm{d}P_T = 0$) implies that higher valuations today are associated with lower returns in the future; that is,

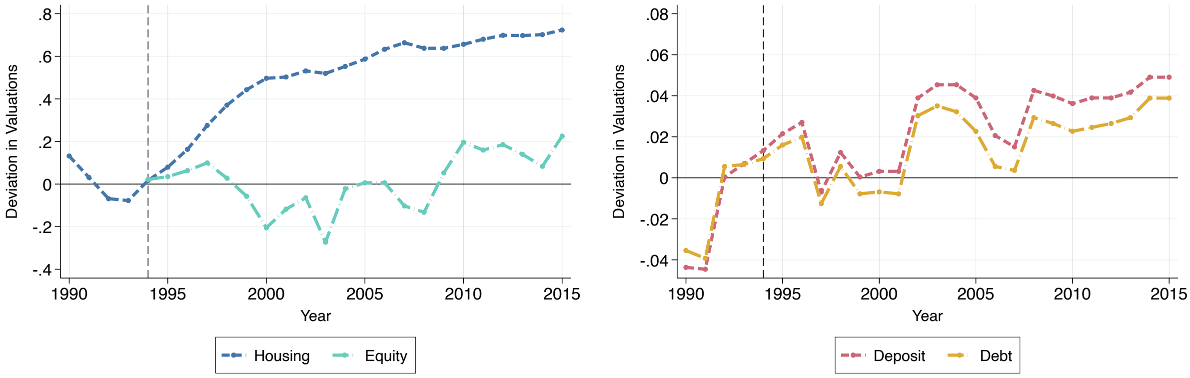
$$\begin{aligned} R_{0\to T}^{-1}\,\mathrm{d}P_{k,T} &= -\sum_{T+1}^{\infty} R_{0\to t-1}^{-1}\left(R_t^{-1}\,\mathrm{d}P_{k,t} - \mathrm{d}P_{k,t-1}\right), \\ &= -\sum_{T+1}^{\infty} R_{0\to t-1}^{-1} P_{t,k}\,\mathrm{d}\ln R_{t,k} \end{aligned}$$

□

[17]This linearization is similar in spirit to Campbell-Shiller decomposition (see also Knox and Vissing-Jorgensen (2021)).

A.4 Additional figures

Figure 14: Deviation in valuations



References

Adam, Klaus and Panagiota Tzamourani, "Distributional consequences of asset price inflation in the euro area," *European Economic Review*, 2016, *89*, 172–192.

Auclert, Adrien, "Monetary policy and the redistribution channel," *American Economic Review*, 2019, *109* (6), 2333–67.

Bach, Laurent, Laurent E Calvet, and Paolo Sodini, "From saving comes having? disentangling the impact of saving on wealth inequality," *Disentangling the Impact of Saving on Wealth Inequality (December 16, 2017). Swedish House of Finance Research Paper*, 2017, (18-8).

_ , _ , and _ , "Rich pickings? risk, return, and skill in household wealth," *American Economic Review*, 2020, *110* (9), 2703–47.

Bakshi, Gurdip S and Zhiwu Chen, "The spirit of capitalism and stock-market prices," *The American Economic Review*, 1996, pp. 133–157.

Black, Sandra E, Paul J Devereux, Fanny Landaud, and Kjell G Salvanes, "The (Un) Importance of Inheritance," 2022.

Calvet, Laurent E, John Y Campbell, Francisco Gomes, and Paolo Sodini, "The cross-section of household preferences," Technical Report, National Bureau of Economic Research 2021.

Campbell, John Y and Robert J Shiller, "The dividend-price ratio and expectations of future dividends and discount factors," *The Review of Financial Studies*, 1988, *1* (3), 195–228.

_ and Tuomo Vuolteenaho, "Bad beta, good beta," *American Economic Review*, 2004, *94* (5), 1249–1275.

Catherine, Sylvain, Max Miller, and Natasha Sarin, "Social security and trends in inequality," *Available at SSRN*, 2020.

Cocco, Joao, Francisco Gomes, and Pascal Maenhout, "Consumption and portfolio choice over the life cycle," *The Review of Financial Studies*, 2005, *18* (2), 491–533.

Cochrane, John, "Wealth and Taxes, part II," Blog post, available at `https://johnhcochrane.blogspot.com/2020/01/wealth-and-taxes-part-ii.html` 2020.

Dávila, Eduardo and Anton Korinek, "Pecuniary externalities in economies with financial frictions," *The Review of Economic Studies*, 2018, *85* (1), 352–395.

Doepke, Matthias and Martin Schneider, "Inflation and the redistribution of nominal wealth," *Journal of Political Economy*, 2006, *114* (6), 1069–1097.

Eitrheim, Øyvind and Solveig Erlandsen, "House price indices for Norway 1819-1989," *Scandinavian Economic History Review*, 2005, *53*, 7–33.

Fagereng, Andreas, Martin Blomhoff Holm, and Kjersti N. Torstensen, "Housing Wealth in Norway, 1993–2015," *Journal of Economic and Social Measurement*, 2020, *45* (1), 65–81.

_ , _ , Benjamin Moll, and Gisle Natvik, "Saving behavior across the wealth distribution: The importance of capital gains," Technical Report, National Bureau of Economic Research 2019.

Farhi, Emmanuel and François Gourio, "Accounting for macro-finance trends: Market power, intangibles, and risk premia," Technical Report, National Bureau of Economic Research 2018.

Feiveson, Laura and John Sabelhaus, "Lifecycle patterns of saving and wealth accumulation," 2019.

Flavin, Marjorie and Takashi Yamashita, "Owner-occupied housing: life-cycle implications for the household portfolio," *American Economic Review*, 2011, *101* (3), 609–14.

Glover, Andrew, Jonathan Heathcote, Dirk Krueger, and José-Víctor Ríos-Rull, "Intergenerational redistribution in the great recession," *Journal of Political Economy*, 2020, *128* (10), 3730–3778.

Gomez, Matthieu, "Asset prices and wealth inequality," Technical Report 2016.

_ and Emilien Gouin-Bonenfant, "A q-theory of inequality," *Working paper*, 2020.

Greenwald, Daniel L, Martin Lettau, and Sydney C Ludvigson, "How the wealth was won: Factors shares as market fundamentals," Technical Report, National Bureau of Economic Research 2019.

_ , Matteo Leombroni, Hanno Lustig, and Stijn Van Nieuwerburgh, "Financial and total wealth inequality with declining interest rates," Technical Report, National Bureau of Economic Research 2021.

İmrohoroğlu, Ayşe and Kai Zhao, "Rising wealth inequality: Intergenerational links, entrepreneurship, and the decline in interest rate," *Journal of Monetary Economics*, 2022.

Kaplan, Greg and Giovanni L Violante, "A model of the consumption response to fiscal stimulus payments," *Econometrica*, 2014, *82* (4), 1199–1239.

— , **Benjamin Moll, and Giovanni L Violante**, "Monetary policy according to HANK," *American Economic Review*, 2018, *108* (3), 697–743.

Knox, Benjamin and Annette Vissing-Jorgensen, "A stock return decomposition using observables," Technical Report, working paper 2021.

Kuhn, Moritz, Moritz Schularick, and Ulrike I Steins, "Income and wealth inequality in America, 1949–2016," *Journal of Political Economy*, 2020, *128* (9), 3469–3519.

Laibson, David, "Golden eggs and hyperbolic discounting," *The Quarterly Journal of Economics*, 1997, *112* (2), 443–478.

Martínez-Toledano, Clara, "Housing Bubbles and Wealth Inequality," Working Paper, Paris School of Economics 2019.

Mas-Colell, Andreu, Michael D. Whinston, and Jerry R. Green, *Microeconomic Theory*, New York: Oxford University Press, 1995.

Mian, Atif, Kamalesh Rao, and Amir Sufi, "Household balance sheets, consumption, and the economic slump," *The Quarterly Journal of Economics*, 2013, *128* (4), 1687–1726.

Mian, Atif R, Ludwig Straub, and Amir Sufi, "The saving glut of the rich," Technical Report, National Bureau of Economic Research 2020.

Miao, Jianjun and Pengfei Wang, "Bubbles and total factor productivity," *American Economic Review*, 2012, *102* (3), 82–87.

Piketty, Thomas and Gabriel Zucman, "Capital is back: Wealth-income ratios in rich countries 1700–2010," *The Quarterly Journal of Economics*, 2014, *129* (3), 1255–1310.

— , **Emmanuel Saez, and Gabriel Zucman**, "Rethinking capital and wealth taxation," *Paris School of Economics Working Paper*, 2013.

— , — , **and** — , "Distributional national accounts: methods and estimates for the United States," *The Quarterly Journal of Economics*, 2018, *133* (2), 553–609.

Roussanov, Nikolai, "Diversification and its discontents: Idiosyncratic and entrepreneurial risk in the quest for social status," *The Journal of Finance*, 2010, *65* (5), 1755–1788.

Saez, Emmanuel, Danny Yagan, and Gabriel Zucman, "Capital Gains Withholding," Technical Report, University of California, Berkeley 2021.

Online Appendix (not for publication)

B Financial accounts

Definitions. The *Financial Accounts* are produced by Statistics Norway provides and provide consistent measures of stocks and flows in financial markets. We use Table 10788, which provides annual data on (i) financial assets and liabilities by sector and (ii) financial transactions between sectors. We consider the following asset categories:

1. Deposits (22);
2. Loans and debt securities (30, 40);
3. Public equity shares (511);
4. Private equity shares (512);
5. Fund equity shares (520);
6. Other (10, 21, 519, 610–800).

The numbers in parantheses denote the line items from the Financial Accounts that we sum. The category "other" contains assets that are either quantitatively unimportant or illiquid). We consider the following sectors of the economy:

1. Government (121, 13, 15);
2. Households (14);
3. Non-financial corporations (11);
4. Financial corporations (122–129);
5. Foreigners (2).

The numbers in parantheses denote the sector codes from the Financial Accounts that we consolidate together. Our definition of "Government" includes the central bank as well as the non-profit sector.

Housing transactions. Traditionally, housing is not considered as a financial asset and thus not included in the Financial Accounts. To be consistent with the microdata, we augment the Financial Accounts by aggregating our administrative housing transaction registry data. Due to data limitation, whenever a party in a housing transaction is not a household, we assume that it is the government.

Sectoral accounting identity. The subscript $j \in \{1, \ldots, J\}$ denote a "sector", $k \in \{1, \ldots, J\}$ denotes a "counterparty sector", and $s \in \{1, \ldots, S\}$ denotes an asset class. Let A_{jks} denote the value of securities in asset class s held by sector j and issued by sector k. Similarly, let L_{jks} denote the value of securities in asset class s issued by sector k and held by sector j. The following identity holds:

$$A_{jks} = L_{kjs}. \tag{23}$$

In words, it means that every security is an asset for one sector and a liability for another sector. For instance, when a household holds an equity share issued by a business, it represents an asset for the household and a liability for the business. An implication of (23) is that aggregate net worth is zero

$$\sum_{j \in \{G,H,F,Bnf,Bf\}} \sum_{k \in \{G,H,F,Bnf,Bf\}} (A_{jks} - L_{jks}) = 0.$$

Consolidating the business sector. We now describe how we consolidate the business sector with its ultimate owner. Denote by $j \in \{G, H, Bnf, Bf, F\}$ the government, household, non-financial corporation, financial corporation, and foreign sectors. The consolidation process consists of adjusting measures of stocks and flows held by the sectors $\{G, H, F\}$ to accounts for their indirect holdings/transactions through their ownership of the sectors $\{Bnf, Bf\}$. Denote by $x_{js} \in \{A_{jks}, L_{jks}\}$ the adjusted value of assets/liabilities securities in asset class s held by sector j. We adjust the data according to

$$\widetilde{x}_{js} = \underbrace{x_{js}}_{\text{Directly held}} + \underbrace{\sum_{k \in \{Bnf,Bf\}} \omega_{jk} x_{ks}}_{\text{Indirectly held}}.$$

where $\omega_{jk} \in [0, 1]$ denotes the share of the equity issued by sector k that is held by sector j.

Holdings and transactions of financial assets by the corporate sector. The table below reports the holdings and transactions of financial assets by the corporate sector. The results are expressed as a share of total equity outstanding and average over the 1996–2015 period. The corporate sector has a net negative holding of deposits (i.e., −29%), owing to the fact that bank deposits are a liability for private banks. Overall, there is a moderate level of leverage and net equity purchases (i.e., 25% and 0.7% respectively). Table 2 reports the data for the non-financial and financial corporate sectors separately.

Validation. Figure 15 plots the aggregate value of household net assets for each asset category implied by both the Financial Accounts and the aggregate microdata.

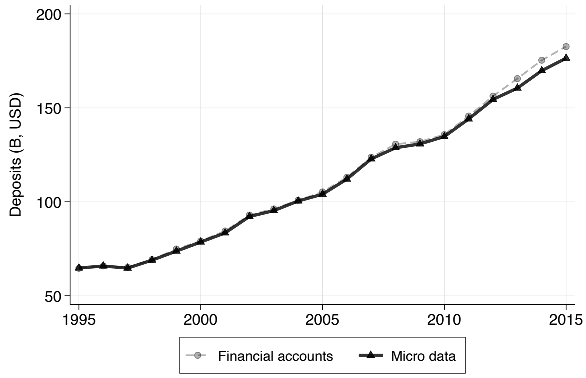
Table 2: Financial transactions of corporates as share of equity outstanding (1996–2015 average)

Sector	Deposits	Debt	Equity
Non-financial corporations	0.165	-0.542	0.008
Financial corporations	-2.430	3.967	0.001
Corporate sector	-0.286	0.245	0.007

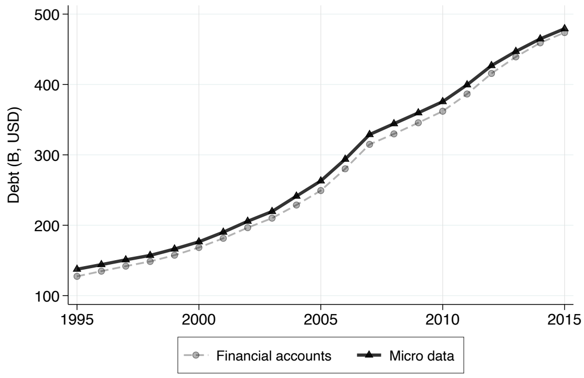
Notes. "Deposits" denotes the net holdings of deposits as a fraction of equity outstanding; "Debt" denotes the net debt issued as a fraction of equity outstanding; "Equity" denotes the net purchase of equity shares as a fraction of equity outstanding.

Figure 15: Comparing Microdata Aggregates to Financial Accounts

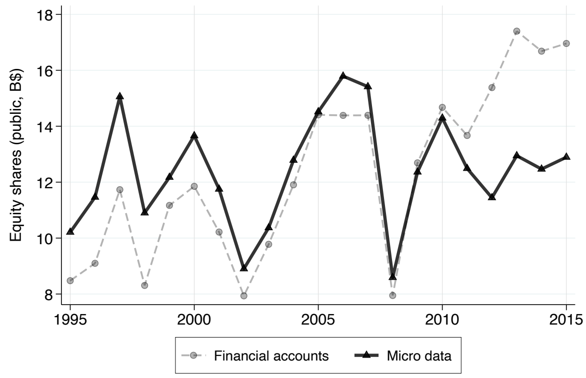
(a) Deposits



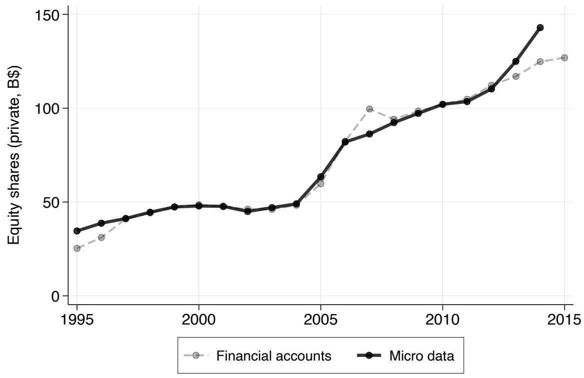
(b) Debt



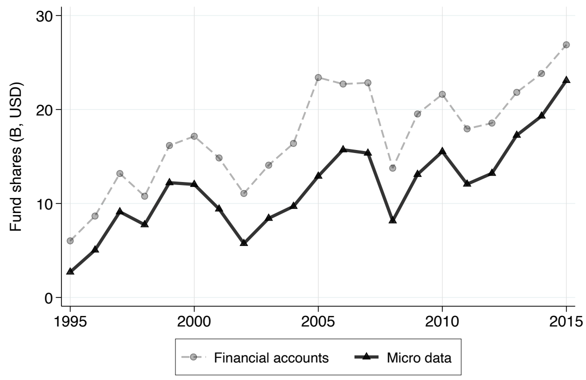
(c) Equity shares (public)



(d) Equity shares (private)



(e) Equity shares (fund)



(f) Other