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This paper proposes measures of panel data for returns to U.S. households' wealth and documents new facts on the heterogeneity in returns to wealth between households and across the wealth distribution. First, household leverage exhibits permanent heterogeneity and explains 58 percent of the permanent heterogeneity in returns to wealth. Second, returns to wealth decline as households become wealthier and exhibit declining returns to scale and specialization. Third, household-specific returns to wealth and assets are correlated with the persistent component of labor earnings. Fourth, housing and the regressivity of after-tax mortgage rates are critical to explain the permanent heterogeneity in returns.

Keywords: wealth inequality, returns to wealth, leverage, net worth, heterogeneity.
JEL classification: D14, D31, E21, G11

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1 Introduction

The causes and consequences of wealth inequality have long been topics of intense debate. More recently, permanent heterogeneity in returns to wealth has been implicated in explaining wealth inequality (Kesten, 1973; Benhabib et al., 2011; Quadrini, 2000; Piketty, 2014) and its evolution over recent decades (Gabaix et al., 2016; Khieu and Wälde, 2023). While persistent differences in returns to wealth have been posited in quantitative models, the degree and cause are just beginning to be empirically validated. The lack of evidence is driven by the scarcity of panel data at the level of the individual and the household, leaving key questions unanswered. For example, what is the degree of permanent heterogeneity in the returns to wealth in the United States? Which asset classes induce persistence in these returns? Are the persistent components in labor earnings and the returns to wealth correlated? And how and why do returns to wealth covary with household wealth?

This paper addresses these questions by proposing the first measures of household-level micro-panel data for returns to total household wealth and by asset class, in the United States, using the newly revised Panel Study of Income Dynamics (PSID) for the period 1999 to 2019. Household-specific returns to both wealth and assets are estimated by using fixed effects with empirical Bayes shrinkage. Household-specific returns to assets and wealth are compared in order to isolate the contribution of leverage and borrowing costs to the heterogeneity in the returns to wealth. Empirical evidence is presented on the degree of the persistent heterogeneity in returns and leverage–"type dependence"–and how average returns and leverage correlate with wealth–"scale dependence."

This paper is novel in key ways relative to the recent evidence of returns heterogeneity in Scandinavia (Bach et al., 2020; Fagereng et al., 2020). First, evidence is provided for the United States. This is particularly important given the differences in the economies, such as the higher wealth inequality in the U.S, and the generosity of social insurance and the presence of wealth taxes in Scandinavian countries. Second, this study examines returns to wealth, which allows an isolation of the role of leverage and borrowing cost heterogeneity. Permanent heterogeneity has only been observed for the returns to assets (Fagereng et al., 2020), but it is the returns to wealth that matter for understanding wealth inequality. Similarly, Bach et al. (2020) examines excess returns to wealth when examining scale dependence, whereas average returns to wealth are examined herein, and these have direct implications for redistributive taxation. Third, the analysis is not limited to a subset of wealth and asset income, such as core wealth (Cao and Luo, 2017), or taxable assets

(Bach et al., 2020; Fagereng et al., 2020). Returns measures include non-taxable assets (pension wealth, vacation properties), other debt (family debt), net investment, and rental income, which are not observed in the administrative data. Finally, to explore for potential correlations, persistence in labor earnings is considered jointly with permanent heterogeneity in returns.

There are the four main findings. They all show that household leverage is a first-order concern for returns to wealth heterogeneity.

First, the majority, 58 percent, of the permanent heterogeneity of the returns to wealth is determined by the degree and cost of borrowing. The standard deviation of the household-specific returns to total household assets in the United States is documented to be 3.8 percentage points. However, the standard deviation of the household-specific returns to wealth is much larger, at 9.3 percentage points. Moreover, leverage explains a high share of the permanent heterogeneity in returns to wealth for all leveraged asset classes: 76, 41, and 30 percent of the persistent heterogeneity in returns to primary and secondary housing, and private business assets, respectively. As such, the heterogeneity in returns to assets, for example in Fagereng et al. (2020) and Benhabib et al. (2019), understates the degree of the permanent heterogeneity in returns.

Homogeneity in household returns is rejected for returns to total assets and wealth and for every asset class. Thus, similar to the finding of Fagereng et al. (2020), portfolio allocation alone cannot explain heterogeneity in returns. Leverage itself exhibits permanent heterogeneity, is predictable, and is found to be related to the wealth of the household, the portfolio composition, and labor earnings. Leverage amplifies both the average return and the volatility of the returns to wealth. Household-specific leverage, as measured by the debt-to-assets ratio, is estimated to be 16.3 percentage points.

Second, returns to assets exhibit declining returns to scale and specialization. Returns to assets are found to peak at the 45th percentile of household wealth and then to decline thereafter. The declining returns for the wealthy are explained by the declining returns to scale to non-financial assets, especially to primary housing and private business assets. Moreover, the concentration of the portfolio allocation within an asset class is found to significantly reduce the return to that asset. While return variability, on average, increases within the public equity class, this is not found to translate to increased average returns within this asset class. Only the returns to low-risk assets increase consistently with household wealth, as households shift a higher share of their low-risk assets toward bonds and away from deposit accounts. The evidence of decreasing marginal returns and decreasing returns to specialization has important implications for optimal taxation, as increasing the wealth of the wealthiest households is unlikely to increase average efficiency when marginal returns are declining (Conesa et al., 2009; Guvenen et al., 2023).

Moreover, after the 30th percentile of wealth, returns to wealth are on average found to decline with total household wealth. This is due to the deleveraging that occurs as household wealth increases. On average, wealthier households consistently pay down housing debts and other borrowing. However, the exception is for private business assets, where the level of private business debt increases as average household wealth rises. The fact that returns to wealth, on average, are found to decline with total household wealth casts doubt on the mechanism of increasing returns to wealth as driving growth in wealth inequality across the entire wealth distribution, for example as proposed by Gabaix et al. (2016) and suggested by the scale dependence for returns on assets (Fagereng et al., 2020).

This evidence of scale dependence for average returns to wealth is important for capturing the degree of social mobility that arises from returns to wealth. However, this masks the potential contribution of household-specific heterogeneity in returns and leverage to wealth inequality (Kesten, 1973). Household-specific returns to both assets and wealth as well as household-specific leverage are found to be positively correlated with wealth. Such a correlation would rise endogenously as households with permanently higher returns are more likely to end up in the higher end of the wealth distribution. Thus, the underlying household-specific heterogeneity is critical to explaining the degree of wealth inequality and ignoring it would downplay the importance of the returns heterogeneity for the wealthiest households and the degree of social mobility for those households that deviate from the average return to wealth.

Third, apart from portfolio characteristics, housing and the regressivity of after-tax mortgage rates are critical to explaining the permanent heterogeneity in returns. Household-specific returns and leverage are partly explained by household and portfolio characteristics. Regarding the portfolio characteristics, higher returns to assets are associated with concentration in housing assets. However, accounting for the contribution of portfolio allocation and risk does little to reduce the estimates of the household-specific components, especially for leverage. Thus, a large portion of household-specific returns to assets is unexplained by portfolio characteristics.

Heterogeneity in returns that are not associated with risk arise from the regressivity of after-tax mortgage rates. The difference in the real after-tax mortgage rates between the bottom and top 10 percentiles of wealth is observed to be 4.7 percentage points. The contribution of borrowing costs and interest deductibility is unique as it shows a systematic component between household wealth and returns to wealth that is not associated with risk-taking. This alone contributes to a 0.43 percentage point difference in the returns to wealth between the top and bottom 10 percentiles of wealth. Hence, part of the relationship between returns and wealth is not explained by risk but, rather, by the regressivity of interest deductibility and the lower costs of borrowing for the wealthy.

Fourth, household-specific returns to wealth and assets are correlated with the explained component of labor earnings. Higher levels of education are significantly associated with higher asset returns, consistent with Fagereng et al. (2020), who document this as evidence of skill in investing. However, education is only found to contribute to higher returns for primary housing and low-risk asset classes. The importance of education is further exacerbated by higher-wage households maintaining higher leverage and thus earning higher returns to wealth, but again this arises only from primary-housing leverage.

However, while education may reflect investor skill, it could also reflect the ability of higher earnings to maintain higher leverage and take more risks. Higher earnings are found to be important to explaining both the returns to assets and the degree of leverage. Accounting for earnings reduces the importance of educational attainment and may reflect channels such as loan qualification, heterogeneity in risk preferences, or investor skill that is not associated with education. Whatever it reflects, the result is a positive correlation between the persistent component of labor earnings and household returns. The correlation coefficients of the explained component of wages with the household-specific returns to total assets, wealth, and leverage are 0.45, 0.52, and 0.30, respectively. These correlations have yet to be examined in models that quantify the contribution of scale dependence in returns to wealth inequality and mobility.

The above results highlight the advantages in the level of detail in the PSID household-level panel data. The potential disadvantage of the PSID include the potential for reporting bias and measurement errors in survey data. However, this is mitigated for in the estimation of the household-specific component, since the EB estimator removes the upward bias from transitory measurement errors that occurs in the fixed-effects estimates. The results are thus found to be very robust.

The measures offered for the U.S. by the PSID complement recent administrative panel datasets provided for Scandinavian countries (Bach et al., 2020; Fagereng et al., 2020), and have some comparative advantages. For example, as in Cao and Luo (2017), the PSID includes net investment in the measure of capital gains, which is not available in Scandinavian administrative data. Moreover, asset values for primary housing and private equity are observed in every wave of the PSID. This avoids imputing asset values, which could understate heterogeneity, and is potentially more inclusive than the book value of private equity reported for tax purposes. The dataset also comprises the entire household portfolio, including non-taxable assets (pension wealth, vacation properties) as well as other debts (such as family debts). Further, in the PSID samples, households are observed for 20 years, longer than the 12 years in Fagereng et al. (2020).

This analysis provides insights into the returns to wealth for the majority of households. Concerns that the wealthiest percentiles of households are underrepresented in the sample are partially mitigated by using the most recent waves, which have no incidences of top-coding. Pfeffer et al. (2016) find meaningful differences only for the one to two percent of the wealthiest households in more-recent waves, when comparing the Survey of Consumer Finances to the PSID. Bach et al. (2020) documents that the cross-sectional standard deviation of the realized returns to wealth begins to increase at the 90th wealth percentile, which is also found in the PSID. Hence, the PSID is representative up to at least the 98th percentile and is shown to capture the shifting risk appetite of the wealthy.

The empirical insights of this paper have important implications for the study of portfolio allocation, wealth inequality, social mobility, and corresponding policies.

The findings reject the homogeneity in returns on total assets and wealth and within each asset class in the United States. Household-specific returns are documented for financial assets and are associated with heterogeneity in the risk characteristics within financial assets. Moreover, risk-taking in public equity systematically increases with total household wealth. This suggests that the share of equities in a households' portfolio cannot identify the degree of risk-taking and calls into question the use of the share of the portfolio that is invested in stocks as a measure of the risk preferences, such as in Brunnermeier and Nagel (2008) or Chiappori and Paiella (2011). Instead, the degree of risk-taking within an asset class needs to be considered jointly with the share in that asset in order to identify how risk aversion changes with wealth.

The findings discipline the structure and calibration of the scale and type dependence in returns for models of asset income and wealth inequality (for example, Benhabib et al., 2011; Gabaix et al., 2016; Benhabib et al., 2019; Kaymak et al., 2022). Life-cycle leverage is needed to match the declining returns to wealth. It is critical to account for household-specific leverage and the role leverage plays in amplifying returns to wealth, to not underestimate the degree and risk in return heterogeneity. The evidence supports return heterogeneity arising from entrepreneurial skill (Quadrini, 2000; Cagetti and De Nardi, 2008, 2009; Nirei and Aoki, 2016; Benhabib et al., 2011) but concludes that it is not the only source of this heterogeneity. Returns to private business equity are found to exhibit declining returns to scale, but these are slightly offset by wealthier households maintaining higher leverage in business assets. Finally, the persistent component of returns and earnings are correlated, which amplifies mobility for high-return households.

Finally, the findings may have important implications for the design of taxation and redistribution. This paper provides a variance decomposition of the permanent and transitory components in returns that informs the degree of capital income taxation progressivity (Shourideh, 2013). For individuals, the permanent component's contribution to the variance of the idiosyncratic returns to total assets and wealth is found to be 15 and 14 percent, respectively, slightly lower than the estimate for the returns to assets of 28 percent in Fagereng et al. (2020) for Norway. The evidence also suggests that the permanent component differs by asset class, being particularly low for public equity. This may be used to inform targeted taxation of specific asset classes.

The paper is structured as follows. Section 2 introduces the measurement of leverage and returns to wealth, and summarizes the data. Section 3 introduces the model and the estimation of household-specific returns obtained by using empirical Bayes shrinkage. Section 4 reports the estimations of the scale and type dependence across households and examines robustness. Section 5 discusses the implications of the findings.

2 Data

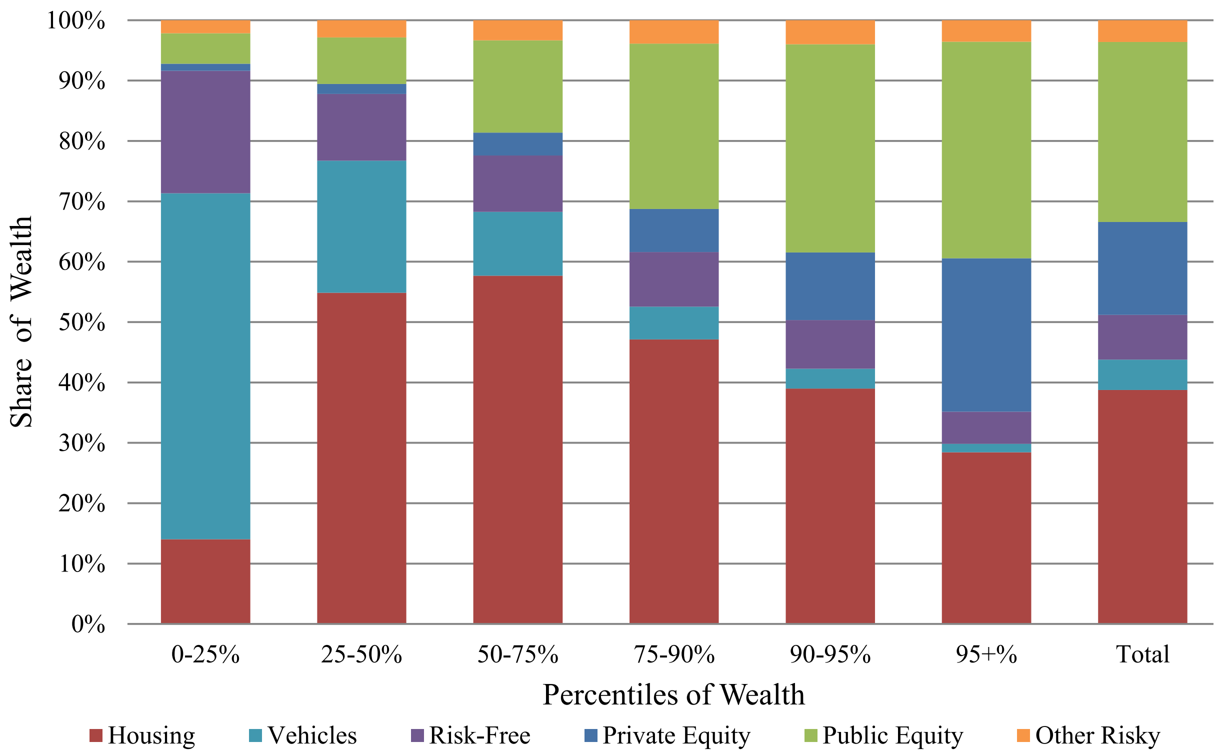
The redesigned Panel Study of Income and Dynamics (PSID) is the main dataset for the calculation of household-level pre-tax real rates of return. For this paper, the main innovation of the redesigned PSID was the regular and detailed collection of asset income, wealth, and net investment starting in the 1999 wave. Households were surveyed every two years for the period 1999 to 2019 (around March). Rates of return are annualized and available from 2001 to 2019.

2.1 The Redesigned PSID

The PSID provides detailed socio-economic information on gender, age, marital status, education level, employment status, and geographic location. Data on labor and asset income are retrospective to the year prior, whereas wealth in assets and debt are reported at the time of the interview. The head of the household is defined as a person over age 15 with the most financial responsibility for the household.

The reported net worth of a household includes wealth in several asset classes less other debts held by the household. Wealth is defined as the amount the household would receive if they sold the asset and paid off all debts associated with the asset. This encompasses wealth in vehicles (including boats and motor homes), private equity in businesses and farms, the primary residence, secondary housing (rental properties or cottages), low-risk assets (checking or savings accounts, money market funds, certificates of deposits, government savings bonds, or Treasury bills), direct holdings in public stocks, private annuities, employer-based pensions or IRAs, and other assets (such as the cash value in life insurance policies, valuable collections, or rights in trusts or estates).

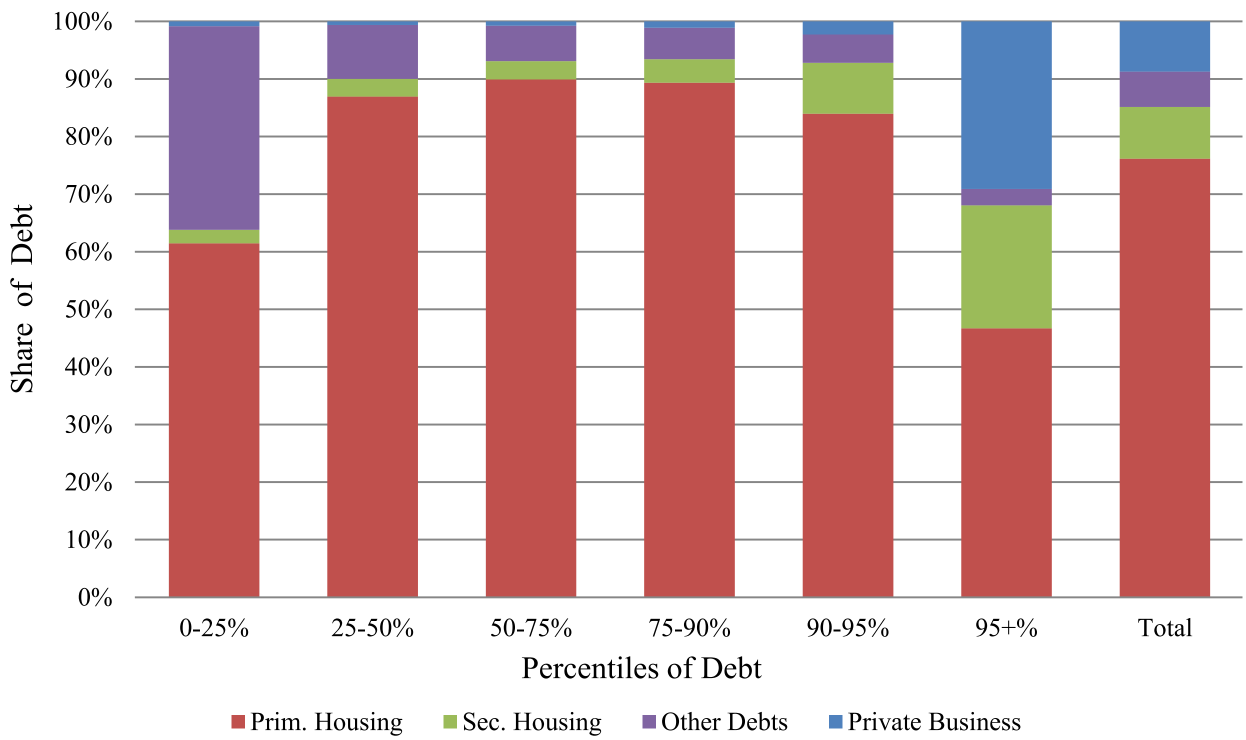
Figure 1. Components of Wealth



Note: For the years 1999-2019, conditional on two consecutive return observations. "Public Equity" is the value of stocks held in publicly held corporations, mutual funds, or investment trusts and IRA's. "Other Risky" wealth includes bond funds, cash value in a life insurance policy, a valuable collection for investment purposes, or rights in a trust or estate. "Low-risk" assets include checking or savings accounts, money market funds, certificates of deposits, government savings bonds, or Treasury bills. "Vehicles" includes wealth in cars, trucks, motor homes, trailers, or boats. All values are in real 2010 USD. Wealth excludes other debts: credit card, student, medical, legal and family debts.

The wealth held in specific asset classes is reported for percentiles of wealth in Figure 1. Immediately from the figure, we can see the importance of wealth in physical assets, with vehicles and housing representing over two-thirds of total household wealth for households below the 75th percentile of wealth. A comparative advantage of the PSID is the inclusion of non-taxable assets, such as vehicles and other wealth, which are missing from administrative tax datasets. Together, they represent 8.7 percent of total household wealth in the PSID. Financial and private business wealth represents over 50 percent of the wealth portfolio for households above the 90th percentile of wealth. Low-risk assets comprise only a small share of wealth for all households along the wealth distribution.

Figure 2. Components of Debt



Note: Share of debt types by percentile of debt for the years 1999-2019, conditional on two consecutive returns or wage observations after outliers are excluded. All values are in real 2010 USD. "Other Debts" include credit card, student, medical, legal, family and other reported debt.

In addition to the debt associated with housing and businesses, the PSID measures other debts which include credit card, medical, student, legal, and family. The share of debt types by percentile of total debt is presented in Figure 2. Mortgage debt for primary and secondary housing represents 76 percent of the total debt held by households. Although other debts represent only 6.1 percent of the total debt across all households, they represent 35 percent for households with debt levels below the 25th percentile. The sum of business and secondary-housing debt grows as a household becomes more indebted, representing 50.4 percent of debt held by households above the 95th percentile of debt holdings.

A comparative advantage of the PSID is that asset values for housing and private equity are reported in every period and reflect the amount expected to be received if the assets were sold. This eliminates the need for hedonic pricing measures for housing. Moreover, it provides an alternative measure to the balance sheet value of private equity in administrative tax data, which would exclude intangible capital and residual goodwill. Moreover, the dataset comprises the entire household portfolio, including non-taxable assets (private pension wealth, vacation properties) as well as other debts (such as family debts). The encompassing nature of the debt and asset information is a comparative advantage of the PSID and shown to be important in the analysis.

2.2 Measurement of Returns

Returns to assets and wealth are measured for primary housing, ph, secondary housing, oh, private businesses, b, public equity, s, low-risk assets, f, and other assets, o. Return measures build upon existing studies using the PSID (i.e. Quadrini, 2000; Flavin and Yamashita, 2002; Cao and Luo, 2017; Snudden, 2025). This section focuses on the measures of returns to wealth and leverage, and a detailed technical appendix is provided in appendix B. The nominal return to total household assets is

$$r_{it}^{n,a} = \frac{\sum_{j \in J} \{y_{j,it} + yg_{j,it}\}}{\sum_{j \in J} a_{j,it-1}}, \tag{1}$$

where $J = \{b, ph, oh, s, f, o\}$, $y_{j,it}$ and $yg_{j,it}$ are the dividends and capital gains, respectively, on asset j for household i between time *t-1* and t, and $a_{j,it-1}$ is the value of asset j for household i in time *t-1*. Similarly, the nominal return on assets in asset class j is given by

$$r_{j,it}^{n,a} = \frac{y_{j,it} + yg_{j,it}}{a_{j,it-1}}, \tag{2}$$

for $j \in \{b, ph, oh, s, f\}$.

In the PSID, asset values at the time of the survey are collected on private businesses, primary and secondary housing assets, and public equities (stocks). Moreover, net investment into the asset, such as net purchases of stocks and upgrades to housing, are reported in every wave. This enables the calculation of capital gains that account for net investment, consistent with Cao and Luo (2017). This is a relative advantage over administrative data, where net investment is not observed, which means that it is not possible to distinguish between capital appreciation or net investment when asset price changes are observed.

More generally, the panel dimension of the PSID data is important to measure the idiosyncratic component in capital gains. Return measures using the cross-sectional information in the Survey of Consumer Finances rely on imputing capital gains using aggregated indexes (e.g. Moskowitz and Vissing-Jørgensen, 2002; Kartashova, 2014; Xavier, 2021; Kartashova and Zhou, 2021). This could understate the idiosyncratic nature of returns through both the capital gains channel and for the estimate of the asset value used in the denominator. Furthermore, the panel dimension in both the PSID and administrative data is needed to observe returns at the household level. In contrast, cross-sectional data that examines granularity at a group level risks averaging out idiosyncratic differences in returns within the group.

For primary residences, capital gains are determined by the change in the reported value between survey years if the house was not sold, or by the difference between the selling price and the last reported value if the house was sold, minus the value of any renovations and upgrades. These capital gains are annualized to match asset income flows. The return on primary housing follows Flavin and Yamashita (2002) and includes capital gains, the value of housing services, and maintenance expenses, but differs in that it accounts for net investment in the calculation of capital gains and includes rental income, which were not available in their sample.

The flow of income from primary residences, excluding capital gains, combines housing services, ownership costs, and rental income. The imputed value of housing services is calculated using the real interest rate, depreciation rate, and property taxes. Households may rent out portions of their primary residence and report rental income, which is calculated as the rental income received minus the reduced flow consumption and additional utility costs. Rental income is attributed to the primary residence if no secondary property is owned; otherwise, it is attributed to the secondary residence. Ownership costs are determined by accounting for depreciation and adjusting property taxes for tax deductibility using marginal income tax rates, as calculated by the National Bureau of Economic Research tax simulator (Feenberg and Coutts, 1993).

Capital gains for stocks, private businesses, and secondary housing are defined as the annualized difference in asset values between the two waves less net investments:

$$rg_{j,it} = \frac{\Delta a_{j,it} - i_{j,it}}{2a_{j,it-1}}, \tag{3}$$

where $a_{j,it}$ is the value of asset j of household i in time t, and $i_{j,it}$ is the household's i net investment within asset class j at time t. Net investment reflects the money put into an asset minus the amount taken out. For instance, in the case of private businesses, net investment is the difference between the amount invested and the amount received from selling part or all of the asset. Returns are observed in cases of complete liquidation, such as in bankruptcy, as the asset value would be zero, and the net investment would equal the amount received from liquidation.

Asset values are reported for public equity holdings and primary residences in every wave, while values for private businesses and secondary housing are available starting from the 2011 wave. To impute values for these assets before 2011, we use the definition of the change in the asset value which is equal to the sum of the change in net worth less net investment, which assumes debt-financed net investments. This closely matches the relationship between debt and net investment from 2011 to 2019. The results remain robust using data post 2011 and to alternative investment financing assumptions.

Net investment is observed for housing, businesses, and equities, which together represent 85% of total household assets. For low-risk assets, changes in asset values are assumed to result from net purchases. Following Fagereng et al. (2020), net purchases are assumed to occur halfway through the period, so half of the change in asset value is included in the denominator for low-risk assets. For housing, business, and equities, net investment only enters the numerator, with the denominator being the lagged asset value, which assumes that net investment materializes at the end of the second year.

The PSID contains detailed information on mortgage rates for primary housing. A nominal mortgage interest rate, $r^{n,m}_{ph,it}$, is calculated as the debt weighted average of the first and second mortgage. The real after-tax mortgage rate, $r^{m}_{ph,it}$, is measured as

$$r^{m}_{ph,it} = \frac{1 + (1 - \tau_{it}) r^{n,m}_{ph,it}}{1 + \pi_t} - 1.$$

where π_t is the consumer price inflation over the sample period, using the annualized index provided by the Federal Reserve.

The calculation of the mortgage interest payments utilizes information on monthly mortgage payments, the current interest rate on the loan, the year the mortgage was obtained, and the years left to pay it out, following the TAXSIM recommendations to calculate mortgage deductibility. Interest payments for housing assets are net of tax deductions, since mortgage payments are deductible from labor income in the US.

In contrast, to the returns to assets, the returns to total wealth includes the households' endogenous leverage decisions by deducting interest payments in the yields and using net worth in the denominator. The nominal returns to total household wealth, inclusive of all debts is:

$$r_{it}^{n,w} = \frac{\sum_{j\in J} \{y_{j,it} + yg_{j,it} - int_{j,it}\}}{\sum_{j\in J} w_{j,it-1}}, \tag{4}$$

where $J = \{b, ph, oh, s, f, o\}$, $int_{j,it}$ is the interest paid on debts. Wealth is $w_{j,it-1} = a_{j,it-1} - d_{j,it-1}$, where $d_{j,it-1}$ is the debt associated with asset j by household i between time *t-1* and t. It is assumed that debt is not held for low-risk and public equities and, thus, the returns to wealth and assets are the same for these assets. A measure of returns to wealth is also provided that excludes other debts, $d_{o,it}$ (credit card, student, medical, legal and family debt). The nominal returns to wealth in asset class j is given by:

$$r_{j,it}^{n,w} = \frac{y_{j,it} + yg_{j,it} - int_{j,it}}{w_{j,it-1}}. \tag{5}$$

The total returns on assets used in this paper are most similar to the measure of the returns to individual "net worth" in Fagereng et al. (2020), who use the asset value in the denominator but net interest payments in the numerator.[2] In contrast to Fagereng et al. (2020), we explore the permanent heterogeneity in both returns on assets and returns on wealth to isolate the effects of endogenous leverage and debt serving.

The distinction between return on assets and wealth is critical; substantial differences in the two return measures are shown throughout this paper. The return to wealth is paramount, since it most succinctly summarizes how asset income contributes to wealth inequality. We also examine the components of returns to wealth separately (borrowing costs, return on assets, and leverage) as it comes with the advantage that they are observable even if the household has negative wealth.

Nominal returns to assets and wealth for all asset classes and for total household returns are converted to real returns by using consumer price inflation. For example, the real return to wealth is thus calculated as

$$r_{j,it}^{w} = \frac{1 + r_{j,it}^{n,w}}{1 + \pi_t} - 1.$$

Leverage is measured for the total household portfolio and for each asset class using the debt-to-assets ratio:

$$lev_{it}^{a} = \frac{\sum_{j\in J} d_{j,it}}{\sum_{j\in J} a_{j,it}}, \tag{6}$$

where $d_{j,it}$ is debt in asset class $J = \{b, ph, oh, s, f, o\}$. A measure of total household leverage

[2]Similarly, the return measure of Cox (2020), who also uses the PSID, is more closely related to the return on assets measure since it excludes housing and other debts in the denominator and includes interest payments in the numerator. Cox (2020) also calculates capital gains as the change in wealth and does account for net investment.

excluding other debts is also provided.

For the leverage in an asset class, the debts associated with the asset are attributed to that asset class:

$$lev_{j,it} = \frac{d_{j,it}}{a_{j,it}}, \tag{7}$$

where $j \in \{b, ph, oh\}$. The alignment of debt with its corresponding asset is consistent with established accounting and lending practices. This approach is also consistent with the measurement of net worth for tax purposes, and previous studies using the PSID which attributed mortgage debt to housing returns (Flavin and Yamashita, 2002; Palia et al., 2014).[3]

2.3 Sample Selection

The baseline sample follows Blundell et al. (2008) and includes households with a continuous marital status, and excludes observations if there is a change in the head or spouse. Observations are biennial from 1999 to 2019, consistent with the survey frequency. The sample excludes households from the Survey of Economic Opportunity and those with heads born before 1920. Households are included only if the head is aged between 20 and 70 years.

Outliers in wages and returns are managed similarly to Blundell et al. (2008) and Fagereng et al. (2020), respectively. Wages are not observed for households with total labor income below \$100, and returns are omitted if the value of the asset or net worth in the denominator of the returns calculation is less than \$500. An exception is made for private business assets, where the threshold is set at \$5000 to filter for businesses with sufficient capital rather than sole proprietorship without assets. Robustness to alternative minimum wealth and asset value levels are explored in section 4.8.

For direct holdings of stocks and private businesses, observations where the household reported ownership in the previous period but reported zero asset value in the current period without indicating a sale are treated as reporting error and the return to that asset class is dropped. This does not occur for any housing assets, and applies to only 13 return observations for private equity. It primarily affects returns to public equities, where it occurs for 11.5% of the return observations.[4] As explored in section 4.8, this assumption does not significantly affect the estimates.

Observations are dropped if any demographic data is missing, unknown, or not reported. Re-

[3]Section 4.5 explores the relationship between leverage in specific asset classes and holdings of other assets.

[4]For public equities, the number of occurrences is incredible. This rate is an order of magnitude higher than the default rate reported by S&P global markets over this time period

turns are calculated provided all components of asset income, net investment, debt, and wealth are reported. To mitigate the influence of extreme values, the top and bottom five returns observations are excluded. Additionally, returns and wage observations are omitted if the change or level of returns to assets exceeds the studentized 99% confidence interval. None of the variables used in this study were found to be top-coded or truncated at high values. Observations are included only if there are three consecutive waves of available data on asset income and wealth, requiring at least two consecutive returns observations. The Bayesian shrinkage method employed is robust to noise from transitory idiosyncratic errors, ensuring the robustness of the main results to these assumptions, as detailed in section 4.8.

2.4 Data Summary

The summary statistics for the measures of returns and leverage are summarized in Table 1. The total returns to total household assets, r^a_{it}, are described as *"Total Assets"* and have a mean of 3.5 percent and a standard deviation of 10.6 percentage points. The leverage on wealth amplifies the mean and standard deviations for returns to total household wealth, r^w_{it} or *"Total Wealth"*, which are 8.2 and 28.2 percentage points, respectively. The average household total debt-to-assets ratio is 40.2 percent. For all return measures, the standard deviation within households is larger than the standard deviation between households, but the opposite is true for the leverage measures.

Returns are skewed right and display more kurtosis than a normal distribution, especially for business and financial assets. Skewness and kurtosis are amplified when leverage is accounted for in the returns to wealth. The right skewness reflects the limited downside risk that arises from the natural limit of zero asset values and the option to default or sell the asset.

The return to primary-housing assets has a mean of 5.2 percentage points and a standard deviation of 10.4 percentage points. The standard deviation is lower than the 14 percentage points for the period 1968 to 1992 calculated by Flavin and Yamashita (2002). Apart from the sample period, this reflects the inclusion of individualized tax rates, net investment, and rental income in the calculation of the returns to primary housing. The finding in Flavin and Yamashita (2002) that housing indexes underestimate the household returns risk on housing is confirmed in this paper for the later sample period. The Case and Shiller index, to which Flavin and Yamashita (2002) compare their primary-housing returns, has a standard deviation of 7.7 percentage points for the period between 1998 and 2014. Similarly, the standard deviation of the Freddie Housing index for 1998 to 2014 is 6.4 percent. This highlights a major advantage of the PSID in which asset values

Table 1. Returns for all Asset Classes are Heterogeneous Within and Across Households

	Obs	House-holds	Mean	Std. Dev. Total	Std. Dev. Within	Std. Dev. Between	25p	75p	Skew-ness	Kurt-osis
Total Assets	15223	3271	3.5	10.6	9.4	5.7	-1.8	7.0	1.3	8.4
Private Business	859	235	38.0	99.3	85.7	53.5	-14.9	46.5	3.1	15.8
Primary Hous.	16111	3144	5.2	10.4	9.5	5.3	0.2	10.0	0.4	5.3
Secondary Hous.	1766	420	9.7	33.1	30.1	16.0	-6.5	17.9	2.3	11.4
Risk-Free	23923	4594	-1.7	1.0	0.8	0.6	-2.2	-1.5	1.3	6.1
Public Equity	8901	1918	8.6	36.8	32.4	19.4	-2.41	4.5	3.7	22.0
Total Wealth	15223	3271	8.2	28.2	24.4	16.8	-2.1	12.9	2.1	19.8
Private Business	859	235	53.1	152.1	128.0	81.4	-18.6	59.7	5.3	47.7
Primary Hous.	16111	3144	14.5	39.1	33.8	23.9	-0.8	21.6	2.0	16.8
Secondary Hous.	1766	420	13.6	53.7	47.9	28.5	-12.3	25.0	2.5	15.3
Wealth ex. O. Debt	15177	3265	6.4	21.1	18.5	11.9	-2.1	11.3	1.7	15.9
Total Leverage	18672	3795	40.2	40.9	16.1	27.1	4.5	65.6	3.3	36.6
Private Business	1122	308	23.1	23.7	83.9	62.0	0.0	19.0	1.7	4.8
Primary Hous.	17738	3467	13.5	35.0	11.4	20.0	16.9	79.6	-0.1	1.8
Secondary Hous.	2140	514	50.4	30.4	15.9	20.0	0.0	48.0	1.0	2.5
Total Lev. ex. O. Debt	17943	3680	31.0	30.3	8.4	7.1	0.0	55.9	0.5	2.0

Note: Annualized rates of return for households, in percentage points, excluding outliers, 1999-2019. 25p and 75p refer to the percentiles of returns. "ex. O. Debt" refers to measures that exclude other debts.

are reported in every wave.

The mean return to business assets is the highest at 38 percentage points, followed by the return to secondary-housing assets at 9.7 percentage points. Like housing, realized household returns to stocks exhibit more variation compared to their aggregate counterparts. The return to public equity has a mean of 8.6 and a standard deviation of 36.8. In contrast, the real returns and standard deviations on the Standard and Poor's (S&P) 500 index, including dividends, over the same period are smaller with a mean return of 4.6 and a standard deviation of 11.6 percentage points. The mean real return to low-risk assets is -1.7 percentage points, reflecting the fact that most low-risk assets are held in checking and savings accounts that earn little interest, especially during the second half of the period when the U.S. Treasury rate was close to zero.

3 Empirical Model

This section proposes a model to estimate household-specific returns to wealth. The returns to wealth are regressed on a set of controls to remove the year and age effects. The year effects are removed to account for the aggregate effects in the unbalanced panel data, and the age effects are removed to isolate the age-invariant differences in the returns (see robustness in section 4.8).

Specifically, the returns to wealth are regressed on a set of year and age indicators, $z'_{j,it}$:

$$r^w_{j,it} = \mathbf{z_{j,it}}\beta^z_j + \tilde{r}^w_{j,it}. \tag{8}$$

The residuals $\tilde{r}^w_{j,it}$ represent the returns excluding the age and year effects. These returns are then regressed on a set of household-observable and portfolio characteristics:

$$\tilde{r}^w_{j,it} = \mathbf{x_{j,it}}\beta^x_j + e^w_{j,it}. \tag{9}$$

The controls measure predictable variations in returns and include lagged portfolio shares (interacted with year fixed effects). The portfolio shares are between 0 and 1 and rates of return are represented in percent, so the coefficients are interpreted as percentage points. The controls for the observable household characteristics include indicators for family size, marital status, number of children, region interacted with year fixed effects, outside dependents, and income from a family member other than the head or spouse. The controls also include separate indicators if the household reported having sold any primary or secondary housing, private businesses, and/or public equities since the last wave. Indicators for the percentile of wealth for household i in the previous wave are also included in the set of controls. The lagged value of wealth is used to avoid spurious correlation of returns and household wealth.

The unexplained component, $e^w_{j,it}$, is represented as the sum of a household-specific return, $\epsilon^w_{j,i}$, and the idiosyncratic error term, $u^w_{j,it}$.

$$e^w_{j,it} = \epsilon^w_{j,i} + u^w_{j,it}. \tag{10}$$

The standard deviation of $\hat{\epsilon}^w_{j,i}$ is denoted $\hat{\sigma}(\epsilon_j; w)$. The same framework is used to estimate the returns to assets, $r^a_{j,it}$, to estimate $\hat{\epsilon}^a_{j,i}$ and yield $\hat{\sigma}(\epsilon_j; a)$. This is done for the total household portfolio as well as for each asset class j. This structure is motivated by the absence of permanent shocks to household-specific returns documented by Snudden (2025) which implies that household-specific returns are initial conditions that persist over the life of the household.

The household-specific returns absorb persistent differences in financial knowledge, risk preferences (including portfolio allocation), investment skill (potentially including entrepreneurial ability), persistent differences in borrowing costs, location, and gains or losses from the asset scale. It also subsumes permanent characteristics, such as race, educational level, and gender. The contribution of these observable characteristics to the measures of the returns is examined in more detail in later sections. The transitory idiosyncratic error, $u^w_{j,it}$, can be interpreted as the sum of the measurement error and the risk of both good and bad luck in household i's investments.

The household-specific returns, $\hat{\epsilon}^w_{j,i}$, are estimated by using fixed effects with empirical Bayes (EB) shrinkage. The EB procedure adjusts the fixed-effects estimates by shrinking them toward the mean of the true underlying distribution of household-specific returns. This ensures that any measurement error or transitory shocks in the term $u^w_{j,it}$ does not introduce bias. This procedure is based on Morris (1983) as operationalized by Chandra et al. (2016). A key innovation is that the use of the unconditional variance during shrinkage avoids overshrinking the conditional household-specific returns when the covariates are correlated with the household-specific returns (Guarino et al., 2015). A detailed description of this procedure along with Monte Carlo experiments verifying this approach can be found in appendix A.

By comparing the household-specific returns to assets and wealth, a measure of the contribution of the standard deviation in the household-specific returns to wealth due to differences in borrowing and the cost of borrowing, γ_j, can be calculated as

$$\gamma_j = \frac{\hat{\sigma}(\epsilon_j; w) - \hat{\sigma}(\epsilon_j; a)}{\hat{\sigma}(\epsilon_j; w)}, \tag{11}$$

where $\gamma_j = 0$ if $\hat{\sigma}(\epsilon_j; w) = \hat{\sigma}(\epsilon_j; a)$ and $\gamma_j = 1$ if $\hat{\sigma}(\epsilon_j; a) = 0$. Bounds $\gamma_j \in [0, 1]$ are guaranteed by the requirements of positive wealth and that the rates of return to both assets and wealth are observed. The requirement of positive wealth is needed only for the estimate of γ_j, but is not needed to measure the permanent heterogeneity in returns on assets and leverage. Section 4.8 reports the robustness of permanent heterogeneity in returns on assets and leverage for households with negative wealth.

4 Results

4.1 Type Dependence in Returns

Homogeneous returns to assets and wealth are rejected for all measures of returns at the 0.1 percent significance level and at the 5 percent level for secondary-housing returns, Table 2. The standard deviations for the household-specific returns to total household assets and to wealth are 3.83 and 9.34 percentage points, respectively. A key finding is that the majority, 58 percent, of the type dependence in returns to wealth arises from the heterogeneity in the degree and cost of borrowing, γ.

Table 2. Leverage Explains 58 Percent of Household-specific Returns to Wealth

	$\hat{\sigma}_\epsilon$	$\hat{\sigma}_\epsilon^2 / \hat{\sigma}_e^2$	γ
Total Assets	3.83 (0.369)	0.13	
Primary Hous.	3.14 (0.402)	0.09	
Secondary Hous.	3.36 (1.328)	0.01	
Private Business	41.44 (9.351)	0.16	
Risk Free	0.35 (0.017)	0.19	
Public Equity	4.21 (1.313)	0.01	
Total Wealth	9.18 (0.728)	0.11	58%
Primary Hous.	13.20 (1.531)	0.12	76%
Seconday Hous.	5.739 (2.912)	0.01	41%
Private Business	58.91 (17.61)	0.16	30%
Wealth ex. O. Debt	7.79 (0.589)	0.14	51%

Note: Estimates are of the household-specific returns, in percentage points, using fixed effects with empirical Baynes shrinkage. They include the standard deviation with standard errors in brackets, variance decomposition, and the share of household-specific returns to wealth due to leverage. "Wealth ex. O. Debt" refers to returns to total household wealth excluding other debts.

The importance of leverage for household-specific returns arises due to its importance for primary housing, which explains 76 percent of the 13.2 percentage point standard deviation for the returns to wealth in primary housing. Leverage is also important for household-specific returns to private business wealth and secondary-housing assets, accounting for 41 and 30 percent of household-specific returns to wealth, respectively.

The presence of other debts further amplifies the dispersion of the returns to total household wealth. Ignoring other household liabilities, such as family and credit card debt, would underestimate households' leverage and total returns to wealth. The other debts increase the share of the fixed effects that are explained by leverage from 51 percent to 58 percent.

The variance decomposition of the relative importance of household-specific returns, $\mathrm{Var}(\epsilon_j^x)/\,\mathrm{Var}(e_j^x)$, in $x \in \{a, w\}$ has been shown by Shourideh (2013) to inform the degree of the progressivity of the optimal capital income taxation. The variance decomposition is estimated to be 13 and 11 percent of the variance in the returns to assets and wealth, respectively. The permanent component is higher for primary housing, private business and low-risk assets, and low at 0.01 for private equity and secondary-housing assets.

4.2 Deconstructing Type Dependence

The household-specific returns capture permanent differences in returns across households, which may reflect differences in wealth, portfolio shares, and investment skill. To isolate these influences, modified versions of equation (8) and (9) are estimated. Specifically, portfolio composition, relative portfolio volatility, and wealth are successively included in the first stage regression, presented as equation (8). Households' relative portfolio volatility is defined as $\mathrm{sd}(r^a_{j,it})/\,\mathrm{sd}(r^a_{jm})$, where $\mathrm{sd}(r^a_{j,it})$ is the standard deviation of household $i's$ returns to asset j and $\mathrm{sd}(r^a_{jm})$ is the within-household cross-sectional standard deviation of the returns to asset j.[5] Then, equation 9 is re-estimated with those controls excluded. This isolates the respective contribution to the household-specific component and these are summarized in Table 3.

Table 3. Portfolio Allocation and Risk have Minimal Impact on Household-specific Returns

	Year	Year, Age	+Portfolio	+Port. & Risk	+Port., Risk & Wealth
Total Assets	4.15	3.83	3.34	3.22	0.99
	(0.379)	(0.369)	(0.362)	(0.350)	(0.456)
Total Wealth	9.73	9.18	9.30	8.85	3.23
	(0.913)	(0.728)	(0.721)	(0.712)	(0.831)

Note: Standard deviation of household-specific returns, in percentage points, excluding the contributions of portfolio shares, the relative portfolio risk, and household wealth. For example, "+Port., Wealth, & Risk" removes the contribution of year, age, portfolio shares, wealth, and relative volatility. Standard errors are in parentheses.

Perhaps surprisingly, persistent differences in portfolio allocation contribute only partially to household-specific returns. When the contribution of both portfolio allocation and relative volatility are excluded from household-specific returns to assets, the standard deviation only falls from 3.83 to 3.22 percentage points. This provides evidence of the presence of household-specific heterogeneity in returns that could be attributed to investor skill. When the wealth ventile is accounted for, the standard deviation of household-specific returns to assets falls to 0.93 and 3.23 percentage points, respectively. While absorbing much of the scale dependence, homogeneity is still rejected at the 5 and 0.1 percent level for the returns to assets and wealth, respectively. As explored in detail in section 4.2, wealth and its covariates are highly correlated with household-specific returns.

These insights contribute to the debate on how household-specific returns should be understood and modeled arising from the seemingly different results that are documented in the Scandinavian

[5]This measure is used for ease of interpretation as the variation of the within-household returns exceeds those of the aggregate. The results are robust to the use of the households' financial $\beta_i = Cov(r^a_{j,i}, r^a_j)/Var(r^a_j)$ as in Fagereng et al. (2020).

administrative tax data set (Bach et al., 2020; Fagereng et al., 2020). Fagereng et al. (2020) document fixed effects for returns to assets across individuals, but this partly reflects the persistent differences in portfolio risk characteristics across households. That said, even though persistent differences in risk characteristics drive some of the heterogeneity in the returns to wealth, as in Bach et al. (2020), the risk and portfolio characteristics cannot explain all of the heterogeneity in household-specific returns.

4.3 Explaining Returns

Household-specific returns subsume permanent household characteristics such as race, education level, and gender. As found in the last section, these returns also subsume permanent differences in wealth, portfolio shares, and relative volatility. This section examines how these observable characteristics are related to average returns to assets and wealth.

Specifically, returns to assets are modeled by using linear panel regressions:

$$r^a_{j,it} = \mathbf{X_{j,it}}\beta^X_j + \zeta^a_{j,it} \tag{12}$$

where $j \in \{a, b, ph, oh, s\}$ for household i in year t, and $\mathbf{X_{j,it}}$ is a vector of controls. These controls include those in equations (8) and (9) as well as permanent household characteristics such as race, education level, and gender.

Four variations in these controls are examined for total returns to household assets and are reported in Table 4. The first specification does not interact portfolio shares with time fixed effects, so the contribution of portfolio shares can be reported. A second specification controls for households' relative volatility. The third specification interacts portfolio shares with time fixed effects. The final specification examines the correlation with labor earnings. Households' relative labor earnings are defined as $mean_i(W_{it})/mean(W_{it})$, where $mean_i(W_{it})$ is the mean wage of household i, and $mean(W_{it})$ is the average wage of all households.

When accounting for relative portfolio variability, only the share of the asset portfolio in primary-housing assets is found to significantly increase the returns to total household assets at the one percent level. The share of the asset portfolio in secondary-housing assets is only significant when the relative variability is not accounted for. The relative volatility of the assets returns portfolio increases the fit of the model, and a doubling of the within-household returns variability, compared to the average household, increases the average returns to total household assets by over

Table 4. Asset Returns are Related to Households' Permanent Characteristics

	(1)	(2)	(3)	(4)
Private business share	2.42	-2.26		
	(1.86)	(1.88)		
Primary housing share	5.36	4.12		
	(0.30)	(0.30)		
Secondary hous. share	4.74	2.27		
	(1.44)	(1.48)		
Public equity share	1.20	0.22		
	(0.62)	(0.60)		
Advanced degree	1.51	2.47	2.54	1.95
	(0.42)	(0.42)	(0.41)	(0.45)
Single	-0.09	-0.34	-0.35	-0.71
	(0.48)	(0.47)	(0.47)	(0.49)
African-American	-0.86	-0.93	-0.90	-0.88
	(0.33)	(0.32)	(0.32)	(0.33)
Male	0.15	-0.01	-0.10	-0.33
	(0.36)	(0.35)	(0.35)	(0.37)
Relative volatility		3.21	3.26	3.29
		(0.25)	(0.25)	(0.25)
Relative earnings				0.97
				(0.22)
N	15223	15223	15223	14510
Adj. R^2	0.088	0.124	0.144	0.147

Note: Returns to total household assets are in percentage points. All regressions exclude fixed effects and control for the year fixed effects interacted with the region, lagged wealth, age, observable household characteristics, and indicators of whether assets were sold in that period. Column 3 includes interactions between the time effects and the lagged portfolio shares. Asset shares are in values from 0 to 1. HAC-robust standard errors are in parentheses.

three percentage points. This provides further evidence of the heterogeneity within asset classes and the inability of portfolio allocation alone to explain the permanent variation in returns.

Permanent household demographics variables are also significantly associated with returns to assets. The presence of an advanced education degree increases the total returns to assets across specifications at the one percent level. A household head who identifies as African-American is associated with a negative and slightly less than one percentage point reduction in returns to total household assets. In contrast, marital status and gender of the head of household have statistically insignificant coefficients. As in Fagereng et al. (2020), we find that the year fixed effects are significant (although not reported here) in explaining the returns to total household assets and wealth and closely follow the movement in aggregate indexes.

The attainment of a post-secondary degree or above proxies for financial sophistication and is commonly associated with investor skill (Campbell, 2006; Fagereng et al., 2020). The coefficient on higher educational attainment falls when relative earnings are included but is still significant. Relative earnings are significant and positively associated with average returns to assets. The significance of earnings may reflect the opportunity arising from higher income, such as the ability to purchase fixed assets and the innate abilities that are not captured by educational attainment alone. These findings for the U.S. confirm those by Fagereng et al. (2020), who note that differences in returns to assets are not merely accounted for by portfolio characteristics but are also associated with household characteristics, particularly for variables that may reflect investor ability.

Table 5. Persistent Returns to Wealth can be Partly Explained

	(1)	(2)	(3)	(4)	(5)
Private business share	14.18	7.58	3.94		
	(2.34)	(2.37)	(2.34)		
Primary housing share	15.70	13.14	11.62		
	(1.38)	(1.37)	(1.35)		
Other housing share	13.45	9.14	7.51		
	(2.61)	(2.64)	(2.62)		
Public equity share	8.03	6.22	4.44		
	(1.36)	(1.34)	(1.35)		
Advanced degree	8.39	9.78	8.84	8.84	6.93
	(1.14)	(1.15)	(1.14)	(1.14)	(0.00)
Single	-4.72	-4.98	-3.71	-3.73	-4.86
	(1.16)	(1.15)	(1.14)	(1.13)	(1.16)
African-American	-1.98	-2.12	-2.61	-2.26	-2.66
	(0.99)	(0.98)	(1.09)	(0.96)	(1.02)
Male	-0.76	-1.01	-0.61	-0.82	-1.58
	(0.80)	(0.79)	(0.78)	(0.78)	(0.80)
Relative volatility		5.28	5.31	5.32	5.50
		(0.47)	(0.47)	(0.47)	(0.48)
Leverage: business debt			15.95	16.33	16.75
			(5.45)	(5.44)	(5.57)
Leverage: housing debt			6.24	6.20	5.64
			(0.84)	(0.85)	(0.87)
Relative earnings					4.21
					(0.52)
N	15013	15013	15013	15013	14306
Adj. R^2	0.083	0.097	0.104	0.115	0.120

Note: OLS regressions for the returns to total household wealth excluding fixed effects. Returns are in percentage points. All regressions control for dummies for the year, lagged wealth, age, region, observable household characteristics, and indicators of whether assets were sold in that period. Regressions 3 and 4 include lagged debt-to-assets leverage ratios. Regression 4 includes interactions between the time effects and the lagged portfolio wealth shares. Wealth shares are in values from 0 to 1. HAC-robust standard errors are in parentheses.

Table 5 reports the exercise repeated for the returns to total household wealth. The returns to wealth are influenced by both the underlying portfolio and the leverage decisions of the household.

As such, educational attainment, race, and relative variability continue to be important drivers of the returns process, but their effect is amplified by leverage. Now, however, the non-housing portfolio shares are also significant, even when accounting for the relative variability. That said, once the leverage in housing and private business are both accounted for, the private business share is no longer significant at the five percent level. This suggests that ignoring the role of leverage in returns to wealth omits an important explanatory variable and overstates the importance of asset allocation.

This insight is particularly important for comparisons of returns to private and public equity. While returns for the two asset classes are found to be comparable by Moskowitz and Vissing-Jørgensen (2002), Kartashova (2014) documents a positive difference in average private and public equity returns, using the Survey of Consumer Finances. For the returns to total household assets, the coefficient on the private business portfolio share was not found to be significantly higher than the public equity portfolio share. In contrast, for the returns to total household wealth, the portfolio allocation in private business assets was found to contribute more to the total returns to assets, compared to the public equity portfolio allocation. However, this is true only when the leverage of private business assets is excluded. Thus, it is the leverage in business assets that generates higher returns to wealth, compared to public equities.

This exercise is now repeated for the returns to assets within each asset class and is presented in Table 6. The portfolio shares are not interacted with the time fixed effects, so the coefficients for the portfolio shares can be reported. All estimates include an indicator of whether that asset had been sold since the last wave. This may help capture reporting bias, underestimated commissions and costs from selling, or address the timing of liquidation. Selling primary- and secondary-housing assets is found to significantly reduce the returns to primary-housing assets by 5.1 and 12.8 percentage points, respectively. Interestingly, selling private business assets or public equities is not found to be significant.

The ability to examine each asset class enables an understanding of which asset classes contribute to the effects observed in the returns to total household assets. For example, an African-American head of household is found to have a significantly negative effect only for low-risk assets. An advanced degree is found to have a significant positive effect only for returns to primary housing and low-risk assets.

In contrast, asset specialization, represented by the portfolio share of assets in total assets, is consistently an important, negative, and significant factor in explaining the returns to assets for

Table 6. Decreasing Returns to Assets from Specialization

	Business	Prim. Housing	Otr. Housing	Public Equity	Risk Free
If sold	-26.85	-5.14	-12.80	0.98	
	(22.7)	(0.44)	(3.15)	(1.52)	
Private business share	-114.60	-0.42	-3.61	-5.25	-0.04
	(26.4)	(1.05)	(11.23)	(4.90)	(0.046)
Primary hous. share	-20.06	-5.68	-3.80	-9.12	-0.01
	(28.4)	(0.82)	(10.97)	(2.43)	(0.018)
Other hous. share	-36.73	-3.98	-48.09	-11.91	-0.13
	(31.8)	(1.01)	(9.60)	(3.52)	(0.035)
Public equity share	-49.47	-0.33	-12.40	-31.29	0.21
	(36.3)	(0.80)	(10.27)	(2.99)	(0.036)
Advanced degree	-5.22	2.12	-0.46	3.20	0.16
	(31.1)	(0.51)	(6.56)	(3.41)	(0.027)
Single	-3.04	0.30	2.20	0.03	-0.13
	(18.2)	(0.54)	(7.67)	(2.39)	(0.028)
African-American	-13.56	-0.41	9.54	-0.42	-0.12
	(19.1)	(0.43)	(4.95)	(2.43)	(0.016)
Male	-13.28	-0.23	-2.67	-1.10	-0.01
	(13.2)	(0.47)	(6.26)	(1.79)	(0.022)
Relative volatility	42.98	1.30	11.88	16.97	-0.42
	(8.7)	(0.24)	(2.19)	(1.07)	(0.020)
N	859	14795	1574	8097	22093
Adj. R^2	0.347	0.143	0.195	0.201	0.354

Note: OLS regressions excluding fixed effects for returns to assets, in percentage points, for each asset class. All regressions control for the year, lagged wealth and portfolio shares, age, region, observable household characteristics, and indicators of whether assets were sold in that period. Asset shares are in values from 0 to 1. HAC-robust standard errors are in parentheses.

each asset class. As households increase their portfolio shares of an asset class, the returns to that asset class decline. This provides evidence against increasing returns to asset specialization arising from, say, knowledge acquisition, as hypothesized by the theoretical contributions of Lusardi et al. (2017) or Kacperczyk et al. (2018).

The background risk from holding housing assets has a negative effect on the level of returns to public equity. Holding a share of a portfolio of housing assets is associated with a significant and negative effect on the level of returns of public equities. Flavin and Yamashita (2002) posit that background risk from primary housing would reduce the *share* of that households' portfolio in stocks compared to bonds, which was empirically confirmed in the PSID sample by Cocco (2005) and Palia et al. (2014). The results from this analysis suggest that background risk from primary housing also reduces the average returns to public equities.

4.4 Scale Dependence in Returns

Attention is now turned to "scale dependence"; i.e., how returns covary with household wealth. A positive correlation of returns with wealth was proposed by Gabaix et al. (2016) to explain the speed of the change in inequality observed in the U.S. data. A positive correlation was documented for returns on assets by Fagereng et al. (2020) for Norway, and for excess returns by Bach et al. (2020) for Sweden. We thus test for the scale dependence in the U.S. for both returns to assets and to wealth and dissect the asset classes that are responsible. The returns relation to wealth is estimated using

$$x_{j,it} = \mathbf{W_{it-1}}\beta_j^x + f_i^x + f_t^x + e_{j,it}^x. \tag{13}$$

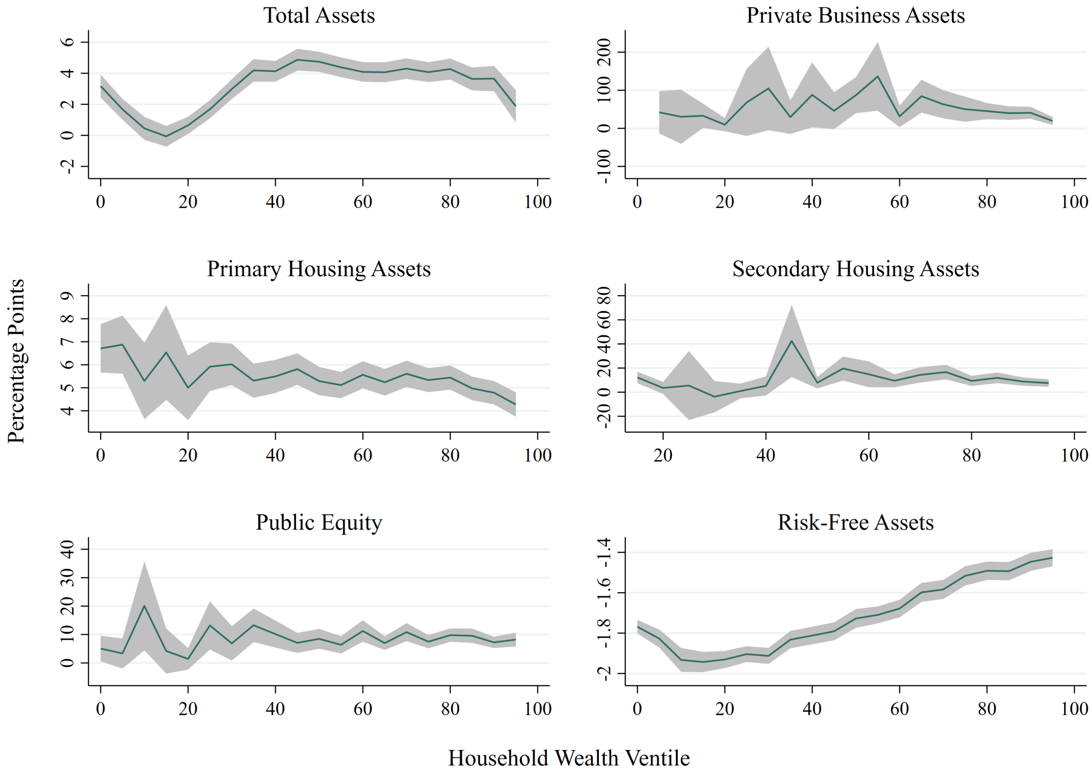
where $x_{j,it}$ is the measure of interest such as the returns, mortgage rates or leverage, W_{it-1} is an indicator of the lagged wealth ventile, f_i is the household fixed effects, f_t is the time fixed effects, and $e_{j,it}^w$ is the error. The sample also does not drop returns to assets if a returns-to-wealth measure is not available so that the returns to assets can be reported for the entire wealth distribution.

The predicted margins for the returns to total household assets and the five asset classes for each ventile of household wealth are illustrated in Figure 3. Notably, only low-risk assets display a robust positive relation with total household wealth. This is consistent with the findings for financial returns in Bach et al. (2020) and Fagereng et al. (2020). However, by disaggregating public equity from low-risk assets, we see that this is primarily driven by low-risk assets. In contrast, returns to primary housing and business assets decrease for the wealthiest ventile of households.

On average, returns to assets fall until the 15th percentiles of wealth. This occurs since these percentiles have negative wealth due to housing and educational debt but are also likely to hold public equities and other fixed assets. In contrast, households close to the 15th percentile tend to have little wealth and to hold only checking and savings deposits. The returns to total household assets increase until the 45th percentile of household wealth and then are relatively stable until the very top ventile of total household wealth. The decline in the returns for the wealthiest ventile is due to the decreasing returns to private business and private housing assets that are concentrated in the portfolios of the wealthiest households. For the returns to total assets, the declining returns to non-financial assets counterbalance the increasing returns to financial assets. Thus, for the U.S. and household-level measures of housing assets, we find evidence of positive scale dependence only at the low but positive wealth levels and decreasing scale dependence for the wealthiest households.

For scale dependence to explain the change in the wealth distribution over time, as suggested

Figure 3. Only Average Returns to Low-Risk Assets Increase with Household Wealth



Note: Predictive margins for returns to assets by household wealth ventile. Controls for lagged wealth ventile as well as household and time fixed effects. 95 % confidence intervals.

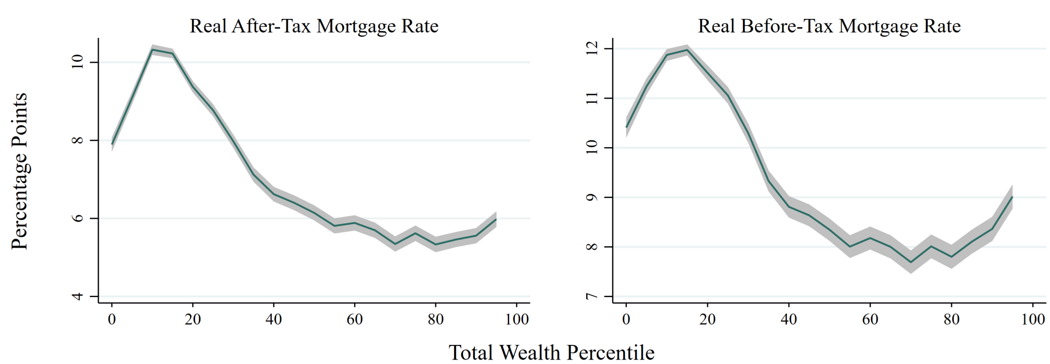
by Gabaix et al. (2016), the returns to wealth, not assets, would need to be positively correlated with wealth. Figure 3 reports the predicted margins for the returns to total household wealth and the three leveraged asset classes. The returns to wealth do increase up until the 30 percentile of the wealth distribution. Over this part of the wealth distribution, households are steadily increasing their investments in housing, which amplifies their leverage and returns to wealth. However, after the 30th percentile of wealth, there exists a strong negative correlation between returns to wealth and total household wealth. The declining returns to wealth are due to the combined effect of the declining marginal returns to non-financial assets and the reduced leverage as wealth increases. Deleveraging for total returns to wealth is driven predominately from primary-housing debt, which is by far the most important debt held by households across the wealth distribution. This result is novel, as the increasing scale was documented for returns on assets in Fagereng et al. (2020) and for excess returns in Bach et al. (2020) but not for returns on wealth.

For primary-housing assets, the role of borrowing constraints and the progressivity of mortgage payment tax deductibility can be shown. The predicted margins from equation (13) for the real

Figure 4. Total Rates of Return to Wealth Decline with Wealth

Note: Predictive margins for the returns to wealth by household wealth ventile. Controls for the lagged wealth ventile as well as the household and time fixed effects. 95% confidence intervals.

Figure 5. Tax Deductions Reduce Borrowing Costs for the Wealthy



Note: Predictive margins for the primary-housing real mortgage rate by household wealth ventile. Controls for the lagged wealth ventile as well as the household and time fixed effects. 95% confidence intervals.

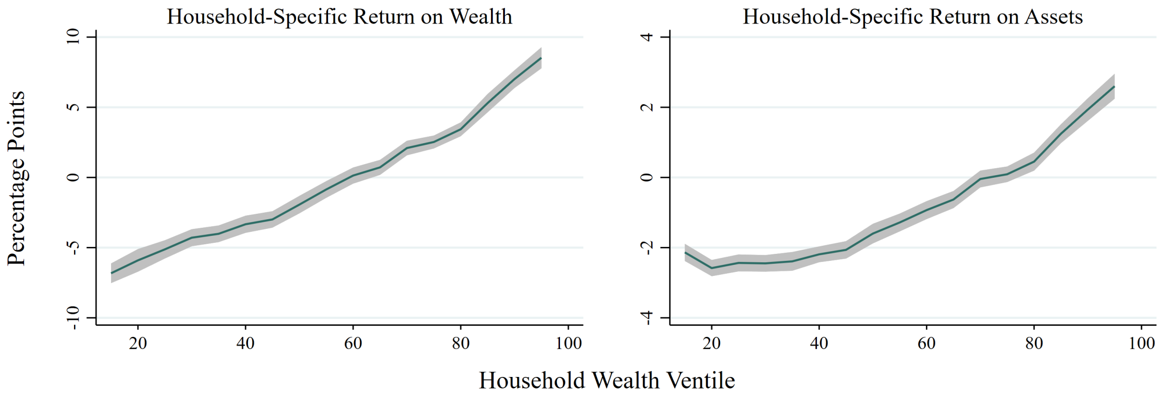
after-tax mortgage rate and the real mortgage rate on primary housing are illustrated in Figure 5. Real before-tax mortgage rates are highest for the 15th percentile of household wealth and then increase again at the 85th percentile of wealth. In contrast, real after-tax mortgage rates are lower than the before-tax mortgage rates across the distribution and the wealthiest households see the largest benefit with close to a three percentage point reduction in borrowing costs. The difference in the real after-tax mortgage rates between the bottom and top 10 percentiles of wealth is 4.7 percentage points. Assuming the average tax rate for all households reduces the differences in the average returns to wealth between the bottom and top 10 percentiles of wealth by 0.43 percentage points. Wealthier households benefit from lower borrowing costs and the regressivity of mortgage payment tax deductibility. The contribution of borrowing costs and interest deductibility is unique as it shows a systematic component between household wealth and returns to wealth that is not associated with risk-taking.

Figure 6. High Returns Variability are Primarily Due to Public Equity

Note: Predictive margins for the relative variability of returns to assets by household wealth ventile. Controls for the lagged wealth ventile as well as the household and time fixed effects. 95% confidence intervals.

With asset shares not fully capturing the risk exposure and portfolio return volatility being a strong predictor for all measures of returns, the degree of the return variability is examined over the wealth distribution. Figure 6 reports the predicted margins for the measure of relative variability following equation 12. Consistent with private equity returns declining with wealth, the variability of the returns for private equity also declines. However, public equity returns variability consistently increases as households' wealth increases. The changing variability of asset returns across the wealth distribution for the asset classes further shows the inadequacy of using the portfolio composition alone to capture risk-taking to explain the level of the returns.

Figure 7. Household-specific Returns are Closely Associated with Wealth



Note: Predictive margins for household-specific returns to assets and wealth by household wealth ventile. Controls for the initial wealth ventile as well as the time fixed effects. 95% confidence intervals.

To illustrate how wealth correlates with household-specific returns, the predicted margin between household-specific returns to assets, $\epsilon^a_{j,i}$, and total household wealth, $\epsilon^w_{j,i}$, by wealth ventile are presented in Figure 9. This estimate uses the baseline measure of household-specific returns. Scale dependence is measured using equation 13, but to avoid double counting, it only uses the initial observation of household wealth. Household-specific returns to assets and wealth strongly and positively covary with total household wealth. It is important to note that this relationship is endogenous as households with permanently higher returns are more likely to be wealthier. Analysis of how much of this arises endogenously would require a structural model, is beyond the scope of this study, and is left for future research. However, credible studies of return variability should be able to match that returns on wealth on average exhibit negative scale dependence but that type-dependence endogenously results in a positive correlation with wealth.

4.5 Heterogeneity in Leverage

Given the importance of leverage for the returns to wealth, this section asks how much of the leverage is household-specific. The leverage in asset j of household i at time t, $\text{lev}_{j,it}$, is modeled by using linear panel regressions similar to the returns to assets and wealth shown in equations 8 and 9. The unexplained component of leverage, $e^l_{j,it}$, from the second stage regression is represented as the sum of the household-specific leverage, $\epsilon^l_{j,i}$, and the idiosyncratic error term, $u^l_{j,it}$:

$$e^l_{it} = \epsilon^l_i + u^l_{it} \tag{14}$$

The standard deviation of $\hat{\epsilon}^l_{j,i}$ is denoted $\hat{\sigma}(\epsilon^l_j)$. The household-specific leverage, ϵ^l_i is estimated by using fixed effects with EB shrinkage.

Table 7. Estimates of Household-specific Leverage

	$\hat{\sigma}_{\epsilon^l}$	$\hat{\sigma}^2_{\epsilon^l}$ / $\hat{\sigma}^2_{e^l}$
Total	16.33 (0.785)	0.25
Private Business	19.10 (4.426)	0.68
Primary Housing	24.22 (0.357)	0.71
Secondary Housing	26.24 (0.914)	0.81
Total ex. O. Debt	15.34 (0.285)	0.59

Note: Estimates of household-specific leverage, with standard errors in parentheses and variance decomposition. Leverage is measured as the debt-to-assets ratio in percent. "Total ex. O. Debt" refers to total household leverage excluding other debts.

Table 7 displays the estimates of the household-specific leverage for the measure of total household leverage, total household leverage excluding other debts, and each leveraged asset class. The main finding is that household-specific leverage is sizable. Household-specific leverage represents a particularity high share of the overall heterogeneity in leverage for housing assets. This confirms that much of household-specific returns to wealth can be explained by household-specific differences in leverage. The variance decomposition for total leverage excluding other debts suggests that 59 percent of the heterogeneity in leverage is household-specific.

Similar to the estimates of the household-specific returns, to isolate the role of portfolio composition and wealth to household-specific leverage, a modified version of equations 8 and 9 is estimated. Specifically, portfolio composition, the lagged household wealth percentile, and then both portfolio composition and lagged wealth are successively included in the first stage regression in equation 8. Then equation 9 is re-estimated with those controls excluded. The purpose is to isolate the contribution of the portfolio characteristics in the household-specific component. These results are summarized in Table 8.

The results suggest that persistent differences in the asset allocation and relative volatility contribute very little to household-specific leverage. Even when accounting for the portfolio characteristics and wealth ventile, the household-specific component of leverage is sizable. These results motivate substantial household-specific heterogeneity in leverage for the determination of heterogeneity in returns to wealth in studies of wealth inequality.

To examine how observable characteristics are related to leverage, the exercise in section 4.3 is now repeated for the measures of leverage as in equation 12 and summarized in Table 9. As

Table 8. Total Household-specific Leverage Excluding Contributors

	Year	Year, Age	+Portfolio	+Port. & Risk	+Port., Risk & Wealth
Total	16.3	16.3	18.0	17.7	14.6
	(1.327)	(0.785)	(0.714)	(0.849)	(1.020)
Total ex. O. Debt	16.7	15.3	15.8	15.4	14.2
	(0.395)	(0.285)	(0.294)	(0.331)	(0.295)

Note: Standard deviation of household-specific leverage excluding the contributions of the year, age, portfolio shares, degree of risk, and household wealth. Leverage is measured as the debt-to-assets ratio in percent. "+Port., Wealth & Risk" removes the additional contribution of the portfolio shares, the wealth percentile, and the relative volatility of the household portfolio.

Table 9. Leverage Heterogeneity Characteristics are Partly Observable

	(1)	(2)	(3)	(4)
Private business share	54.27	59.15		
	(2.46)	(2.80)		
Primary housing share	62.21	63.45		
	(1.34)	(1.42)		
Other housing share	60.26	63.55		
	(2.02)	(2.17)		
Public equity share	33.63	36.38		
	(2.15)	(2.25)		
Advanced degree	20.47	20.72	20.63	14.41
	(1.12)	(1.17)	(1.17)	(1.26)
Single	-11.00	-12.41	-12.43	-13.28
	(1.59)	(1.67)	(1.68)	(1.71)
African-American	0.88	1.24	1.21	0.83
	(1.29)	(1.33)	(1.33)	(1.39)
Male	-1.82	-1.88	-1.84	-2.98
	(1.37)	(1.43)	(1.43)	(1.48)
Relative volatility		-2.24	-2.22	-2.03
		(0.49)	(0.49)	(0.48)
Relative earnings				12.42
				(0.52)
N	18672	17216	17216	16563
Adj. R^2	0.401	0.402	0.404	0.419

Note: OLS regressions of the debt-to-assets ratio in percent excluding the fixed effects. All regressions control for the year, lagged wealth and portfolio shares, observable household characteristics, and indicators of whether assets were sold in that period. Asset shares are in values from 0 to 1. HAC-robust standard errors are in parentheses.

leverage defines the differences in returns to assets versus wealth, the differences in the importance of observable household characteristics are reflected in the leverage.

The asset portfolio allocation has a sizable and highly significant correlation with households' leverage, especially for asset concentration in private businesses and housing asset classes. Perhaps most interesting is that the concentration of the portfolio share in public equities is also associated with higher household leverage. This provides some evidence that debt held by households is used to finance public equity investment.

Interestingly, educational attainment continues to be positively associated with leverage, even when accounting for relative earnings. One possible explanation is that since debt is widely held, an advanced education may help a household choose cheaper debt, as suggested by Campbell (2006). Leverage could also arise from a higher willingness to lend to more-educated households if they are seen as less-risky borrowers. Another possible explanation is that more-educated households maintain higher debt levels so as to achieve higher returns to wealth. For example, during the latter half of the sample when borrowing rates were low, a household that used savings to invest in risky assets rather than pay off their primary mortgages would have reaped much larger returns to wealth. More education may have contributed to the financial knowledge to make such an allocation decision.

Table 10. Leverage Characteristics Vary by Asset Type

	Private Business	Prim. Housing	Second. Housing
Private business share	48.89	57.26	44.52
	(5.55)	(2.85)	(6.68)
Primary housing share	30.55	32.82	16.87
	(5.63)	(2.10)	(6.32)
Seconday housing share	28.01	53.47	59.71
	(5.91)	(2.72)	(5.71)
Public equity share	28.13	49.45	33.39
	(7.40)	(2.27)	(6.27)
Advanced degree	-4.34	22.94	0.30
	(4.65)	(1.20)	(6.78)
Single	-18.73	-13.08	-9.78
	(3.74)	(1.54)	(4.85)
African-American	-7.37	7.46	9.85
	(3.92)	(1.01)	(3.38)
Male	-9.10	0.20	-3.70
	(4.08)	(1.25)	(3.38)
Relative volatility	-5.46	-7.04	-11.18
	(0.90)	(0.43)	(0.84)
N	968	15498	1715
R^2-Adj.	0.277	0.468	0.309

Note: OLS regressions excluding fixed effects for the debt-to-assets ratio in percent. All regressions control for the dummies for the year, two-year lagged wealth, observable household characteristics, and indicators of whether assets were sold in that period. Asset shares are values from 0 to 1. HAC-robust standard errors are in parentheses.

Along a similar vein, a single household is found to hold significantly less leverage compared to a married household. A possible explanation includes a lower willingness to lend to single households if they are seen as more-risky borrowers. It could also reflect lower risk tolerance of single households or less ability to smooth income due to the absence of a secondary income earner. Male heads of households are not found to hold significantly less debt except when accounting for relative earnings, which again points to earnings ability to sustain debt. Finally, the relative volatility of the household portfolio is found to be significantly and negatively correlated with total household leverage, suggesting that risk-taking in asset classes is partly offset by leverage for the returns to wealth.

To examine whether these characteristics hold only for specific asset classes, this exercise is repeated for the debt-to-assets ratio for each asset class and is presented in Table 10. Importantly, advanced degree holders are found to only hold significantly more debt in primary housing. This presents an interesting puzzle as lower debt costs or higher willingness to lend to advanced degree holders should have a similar effect on secondary-housing leverage.

Portfolio specialization as measured by the share of the asset portfolio within each asset class significantly contributes to higher debt for all asset classes. Holding a higher portfolio share in stocks is associated with leverage for all asset classes, suggesting households may be using all forms of debt to finance public equity investment.

4.6 Scale Dependence in Leverage

Attention is now turned to "scale dependence" in leverage; that is, how leverage and household-specific leverage covary with household wealth. Leverage and the cost of borrowing drive the differences in the scale dependence between the returns on assets and wealth. The scale dependence of leverage is isolated by using equation 13, which controls for the lagged wealth ventile and year fixed effects. Figure 8 illustrates the predicted margins for the measures of the leverage across the household wealth ventile.

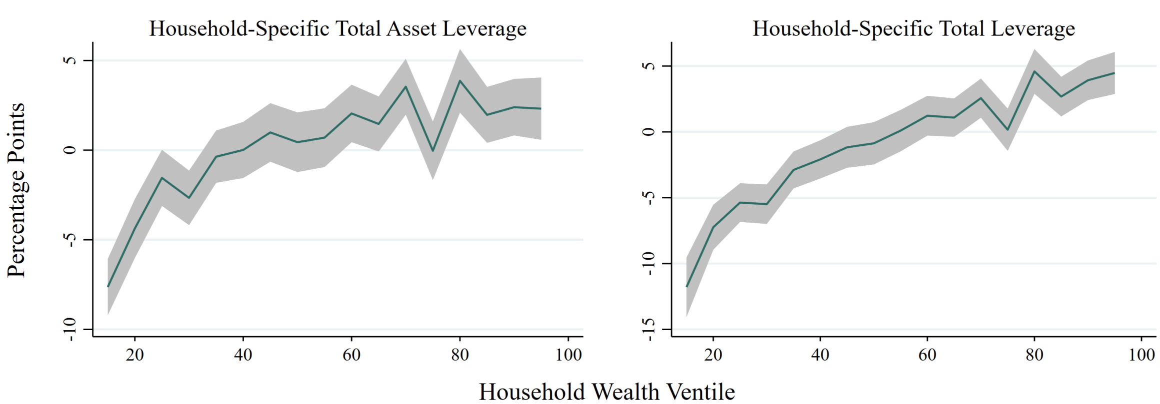
Consistent with the differences in the scale dependence for returns on total household wealth and assets, leverage on average exhibits strong negative scale dependence. As households become wealthier, they on average consistently reduce their overall total leverage. This arises primarily from reductions in primary- and secondary-housing leverage. In contrast, for primary business assets, the wealthiest households are offsetting declining returns by increasing their degree of private business leverage. As was seen for the declining scale dependence for the returns to wealth, wealthier households significantly reduce their leverage, which is of first-order importance for explaining the

Figure 8. Wealthy Aggressively Pay Down Housing Debt

Note: Predictive margins for leverage by household wealth ventile. Controls for lagged wealth ventile as well as household and time fixed effects. 95% confidence intervals. Leverage is measured as the debt-to-assets ratio for the household, in percent.

returns to wealth.

Figure 9. Household-specific Leverage is Positively Associated with Wealth



Note: Predictive margins for household-specific leverage by household wealth ventile. "Total Asset Leverage" is the measure of the debt-to-assets ratio excluding other debts. Controls for initial wealth ventile as well as time fixed effects. 95% confidence intervals.

To illustrate how wealth correlates with household-specific leverage, the predicted margin between household-specific leverage excluding other debts and total household leverage are presented by the wealth ventile in Figure 9. The scale dependence is measured using equation 13, but to avoid double counting, it only uses the initial observation of household wealth. Household-specific returns to assets and wealth strongly and positively covary with total household wealth. Again, this relationship is endogenous as households with permanently higher returns are more likely to be wealthier. Credible studies of returns variability should be able to match that returns on wealth exhibit negative scale dependence but that type-dependence endogenously results in a positive correlation with wealth.

4.7 Correlation of Persistent Returns and Wages

Education and relative wages have been documented to be important factors in explaining returns to assets and leverage. Together, these suggest that household-specific returns and leverage should be correlated with the persistent component of wages. To estimate the correlation, the real wage is modeled by using a linear panel regression:

$$w_{it} = \mathbf{X_{j,it}} \Gamma^X + \zeta_{it}, \tag{15}$$

where $\mathbf{X_{j,it}}$ controls for all of the observable household characteristics, as in equation 12, such as race, education level, and gender, as well as the year interacted with the region. The explained component of wages is denoted $\hat{w}_{it}$. The pairwise correlation coefficients of the explained component of earnings, $\hat{w}_{it}$, with household-specific returns to assets, $\epsilon^a_{j,i}$, wealth, $\epsilon^w_{j,i}$, and leverage, $\epsilon^w_{j,i}$, are reported in Table 11.

Table 11. Correlation of Household-specific Returns and Leverage with Explained Wages

	Return to Assets	Return to Wealth	Leverage
Total	0.45 (0.000)	0.51 (0.000)	0.30 (0.000)
Primary Housing	0.21 (0.000)	0.36 (0.000)	0.18 (0.000)
Secondary Housing	0.03 (0.174)	-0.03 (0.224)	0.01 (0.810)
Private Business	0.49 (0.000)	0.49 (0.000)	0.24 (0.000)
Risk-Free	0.31 (0.000)	-	-
Public Equity	0.40 (0.000)	-	-

Note: Pairwise correlation of household-specific returns to assets, returns to wealth and the debt-to-assets ratio with the explained component of wages. P-values are in parentheses.

The pairwise correlation of the explained component of earnings with household-specific returns to assets and wealth is highly significant, with correlation coefficients of 0.45, 0.51, respectively.

Moreover, the correlation with household-specific total leverage is 0.30. Across asset classes, the correlations are largest for private business, followed by financial assets. Only for secondary-housing assets are the correlations insignificant.

The correlation of earnings with returns has not been accounted for in previous studies that examine the importance of returns heterogeneity for models of social mobility and wealth inequality (for example, Benhabib et al., 2011; Gabaix et al., 2016; Benhabib et al., 2019; Gabaix et al., 2016). However, in this paper, the correlation of the persistent component may partly account for the strong relationship between household-specific returns and wealth. The correlation will amplify upward mobility and further drive concentration in the wealth distribution for high-return households.

4.8 Robustness

The estimates of household-specific returns, the variance decomposition, and the finding that leverage explains the majority of returns-to-wealth heterogeneity are robust to the underlying data and estimation assumptions, as shown in Table 12. This is due to the use of the EB procedure, which makes the estimates immune to transitory measurement error and return variability. The estimates are also consistent to alternative minimum consequence panel observations. The largest difference occurs when only one returns measure is observed (minimum four years or two waves) due to the inability to calculate an adequate standard deviation for EB shrinkage. This is consistent with evidence from Monte Carlo simulations, as can be seen in appendix A.

The row denoted "Individuals" reports estimates for individual-specific returns instead of household-specific returns. This is done as in Fagereng et al. (2020) by counting married households twice. In this case, the estimate of household-specific returns to assets increases slightly to 4.06 percentage points. The baseline specification requires a measure of returns to wealth as well as returns to assets to calculate a measure of $\hat{\gamma}$. One reason Fagereng et al. (2020) examine returns to assets is to not exclude those with negative wealth who are at bottom 15 percentiles of the wealth distribution. When households' returns-to-assets measure is not dropped in the case of negative total household wealth, the estimate of the standard deviation of household-specific returns to assets is reduced insignificantly to 3.59. In all cases, the null of the homogeneous household-specific returns continues to be rejected.

A consistent measure of the permanent heterogeneity in the returns to assets in Fagereng et al. (2020) assumes individuals, does not require a measure for returns to wealth, and does not control

Table 12. Robustness of Household-specific Returns

	$\hat{\sigma}_\epsilon$	$\hat{\gamma}$	$\hat{\sigma}_\epsilon^2$ / $\hat{\sigma}_e^2$	N
Min. 4 years	5.26 (0.280)	0.60	0.21	17011
Min. 6 years (Baseline)	3.83 (0.369)	0.58	0.13	15223
Min. 8 years	3.45 (0.530)	0.55	0.11	11993
Min. 10 years	3.27 (0.811)	0.52	0.11	8861
Min. 12 years	3.94 (1.134)	0.45	0.15	6293
Individuals	4.06 (0.223)	0.58	0.14	26807
$r_{a,it}^w$ not required	3.59 (0.292)	-	0.11	17831
Fagereng et al. measure	4.20 (0.212)	-	0.15	30975
No min. asset value	4.20 (0.391)	0.55	0.13	15436
\$5000 min. assets	3.66 (0.351)	0.57	0.13	14096
Ex. Public Equity Owners	3.18 (0.271)	0.62	0.11	11632
Exclude Homeowners	1.24 (1.247)	0.31	0.03	2236
Exclude Bus. Owners	3.39 (0.373)	0.60	0.11	13833

Note: Standard deviation of household-specific returns, in percentage points with standard errors in brackets, using fixed effects with empirical Baynes shrinkage under various sample restriction assumptions. The Fagereng et al. measure assumes that observations of individuals' returns and returns to wealth are not required and excludes age covariates in the first stage. Columns refer the standard deviations of the household-specific returns to assets, $\hat{\sigma}_\epsilon$, the share of the returns to wealth due to leverage, $\hat{\gamma}$, the variance decomposition $\hat{\sigma}_\epsilon^2/\hat{\sigma}_e^2$, and the number of household-year observations, N.

for age/ life-cycle factors. In this case, the standard deviation of permanent heterogeneity in the returns to assets is estimated to be 4.2, still lower than the corrected estimate of 5.21 by Fagereng et al. (2020). Correspondingly, the permanent component share of the variance is 15 percent, lower than the 27 percent found by Fagereng et al. (2020). The differences may reflect several factors, including the country, the more-encompassing measure of the household portfolio, and the use of EB shrinkage.

To explore whether only specific asset classes contribute to household-specific returns, estimates are provided when primary homeowners, public equity owners, and private business owners are dropped from the sample. The null of homogeneous household-specific returns is rejected when private business or public equity owners are excluded. This suggests that these asset classes alone are inadequate at explaining permanent returns heterogeneity. However, when primary homeowners are excluded, the estimate of household-specific returns to assets falls to 1.24 and the null of homogeneous returns cannot be rejected. This is fascinating as public equity and private business ownership constitute two-thirds of the original sample. This is, however, consistent with the evidence of Table 4 that only the portfolio share in primary housing has explanatory power for the returns to assets.

5 Conclusion

This paper proposes household-level panel-data measures for returns to wealth in the United States, using the newly available information in the revised PSID. Using these returns measures, several theories are tested regarding scale- and type dependence in returns to wealth among households in the United States.

The presence of household-specific returns to assets in the United States provides further evidence of the rejection of the homogenous returns that have been observed for Norway by Fagereng et al. (2020) and used in quantitative models that explain wealth heterogeneity (e.g. Benhabib et al., 2019; Kaymak et al., 2022). However, it is the returns to wealth, not assets, that are of primary importance for explaining wealth inequality. The homogeneity in the returns to wealth is substantially larger, and the majority is explained by the amplifying role of leverage. Leverage exhibits a sizable household-specific component that is evident within all leveraged asset classes.

Leverage is also of first-order importance for how returns to wealth vary along the wealth distribution. For returns to wealth, declining leverage dominates any increasing scale dependence in the return on assets. The declining scale dependence for returns to wealth is driven primarily by deleveraging in housing and is slightly offset by the increase in leverage from private business assets.

The first application of the results regards the study of asset-income inequality in explaining wealth inequality and social mobility. Household-specific leverage, and its role in amplifying type dependence in returns, needs to be considered so as to not understate the degree of returns heterogeneity for wealth inequality. Leverage is also critical to explaining the declining returns to wealth, on average, which is needed to capture the degree of social mobility along the wealth distribution.

The positive correlation of the explained component of labor earnings and household-specific returns to assets and wealth suggest that the social mobility of households with high returns are party amplified by labor earnings through the leverage channel. The importance of earnings for higher leverage, even when controlling for education, also points to channels such as loan qualification, heterogeneity in risk preferences (Krusell and Smith, 1998; Hendricks, 2007; De Nardi, 2004), or investor skill that is not associated with education.

The evidence on leverage heterogeneity also informs other mechanisms that have been proposed to understand returns and wealth inequality. Household-specific entrepreneurial returns (Quadrini, 2000; Cagetti and De Nardi, 2008, 2009; Benhabib et al., 2011) are shown to account for some but not all of the heterogeneity in returns. Moreover, leverage heterogeneity amplifies returns and risk in private business and secondary-housing asset classes which would have implications for portfolio allocation, consistent with primary housing leverage as noted by Chetty et al. (2017). Capturing declining returns to scale and specialization are features that need to be incorporated in the study of housing and entrepreneurial activity.

The second applicability of the results is for the study of portfolio choice and risk preferences. The evidence in Fagereng et al. (2020) and this paper demonstrates that returns are heterogeneous even within asset classes. As such, the share of public equities in a portfolio is insufficient to identify the degree of portfolio risk. This highlights a pitfall of using the portfolio share invested in stocks to identify preferences related to risk aversion, such as in Brunnermeier and Nagel (2008) or Chiappori and Paiella (2011). Instead, the degree of risk within an asset class needs to be considered jointly with the portfolio share in that asset to identify relative risk aversion, such as in Palia et al. (2014).

The third applicability of the results regards the redistribution and taxation of wealth and capital income. The variance decomposition of the permanent component in returns, 0.13 percent, can be used to inform the progressivity of capital income taxation (Shourideh, 2013). The permanent component in idiosyncratic returns is particularly high for primary housing assets and low for public equity and secondary housing, offering potential efficiency gains by targeting the progressivity of capital income taxation for specific asset classes. Moreover, the degree of optimal wealth redistribution hinges on marginal returns across the wealth distribution (Conesa et al., 2009; Guvenen et al., 2023). Decreasing marginal returns to scale and specialization suggests that previous studies have overplayed the costs of redistribution.

References

Bach, L., L. E. Calvet, and P. Sodini (2020). Rich pickings? Risk, return, and skill in household wealth. *American Economic Review 110*(9), 2703–47.

Benhabib, J., A. Bisin, and M. Luo (2019). Wealth distribution and social mobility in the US: A quantitative approach. *American Economic Review 109*(5), 1623–47.

Benhabib, J., A. Bisin, and S. Zhu (2011). The distribution of wealth and fiscal policy in economies with finitely lived agents. *Econometrica 79*(1), 123–157.

Blundell, R., L. Pistaferri, and I. Preston (2008). Consumption inequality and partial insurance. *American Economic Review 98*(5), 1887–1921.

Brunnermeier, M. K. and S. Nagel (2008). Do wealth fluctuations generate time-varying risk aversion? Micro-evidence on individuals. *American Economic Review 98*(3), 713–36.

Cagetti, M. and M. De Nardi (2008). Wealth inequality: Data and models. *Macroeconomic Dynamics 12*(S2), 285–313.

Cagetti, M. and M. De Nardi (2009). Estate taxation, entrepreneurship, and wealth. *American Economic Review 99*(1), 85–111.

Campbell, J. Y. (2006). Household finance. *The Journal of Finance 61*(4), 1553–1604.

Cao, D. and W. Luo (2017). Persistent heterogeneous returns and top end wealth inequality. *Review of Economic Dynamics 26*, 301–326.

Chandra, A., A. Finkelstein, A. Sacarny, and C. Syverson (2016). Health care exceptionalism? Performance and allocation in the US health care sector. *American Economic Review 106*(8), 2110–44.

Chetty, R., L. Sándor, and A. Szeidl (2017). The effect of housing on portfolio choice. *The Journal of Finance 72*(3), 1171–1212.

Chiappori, P.-A. and M. Paiella (2011). Relative risk aversion is constant: Evidence from panel data. *Journal of the European Economic Association 9*(6), 1021–1052.

Cocco, J. F. (2005). Portfolio choice in the presence of housing. *The Review of Financial Studies 18*(2), 535–567.

Conesa, J. C., S. Kitao, and D. Krueger (2009). Taxing capital? Not a bad idea after all! *American Economic Review 99*(1), 25–48.

Cox, J. (2020). Return heterogeneity, information frictions, and economic shocks. *mimeo*.

De Nardi, M. (2004). Wealth inequality and intergenerational links. *The Review of Economic Studies 71*(3), 743–768.

Eika, L., M. Mogstad, and O. L. Vestad (2020). What can we learn about household consumption expenditure from data on income and assets? *Journal of Public Economics 189*, 104163.

Fagereng, A., L. Guiso, D. Malacrino, and L. Pistaferri (2020). Heterogeneity and persistence in returns to wealth. *Econometrica 88*(1), 115–170.

Feenberg, D. and E. Coutts (1993). An introduction to the TAXSIM model. *Journal of Policy Analysis and Management 12*(1), 189–194.

Flavin, M. and T. Yamashita (2002). Owner-occupied housing and the composition of the household portfolio. *American Economic Review 92*(1), 345–362.

Gabaix, X., J.-M. Lasry, P.-L. Lions, and B. Moll (2016). The dynamics of inequality. *Econometrica 84*(6), 2071–2111.

Guarino, C. M., M. Maxfield, M. D. Reckase, P. N. Thompson, and J. M. Wooldridge (2015). An evaluation of empirical Bayes's estimation of value-added teacher performance measures. *Journal of Educational and Behavioral Statistics 40*(2), 190–222.

Guvenen, F., G. Kambourov, B. Kuruscu, S. Ocampo, and D. Chen (2023). Use it or lose it: Efficiency and redistributional effects of wealth taxation. *The Quarterly Journal of Economics 138*(2), 835–894.

Hendricks, L. (2007). How important is discount rate heterogeneity for wealth inequality? *Journal of Economic Dynamics and Control 31*(9), 3042–3068.

Kacperczyk, M., J. Nosal, and L. Stevens (2018). Investor sophistication and capital income inequality. *Journal of Monetary Economics 107*, 18–31.

Kartashova, K. (2014). Private equity premium puzzle revisited. *American Economic Review 104*(10), 3297–3334.

Kartashova, K. and X. Zhou (2021). Wealth inequality and return heterogeneity during the COVID-19 pandemic. *FRB of Dallas Working Paper 2114*.

Kaymak, B., D. Leung, and M. Poschke (2022). Accounting for wealth concentration in the United States. *Federal Reserve Bank of Cleveland Working Paper, 2022, 22-28*.

Kesten, H. (1973). Random difference equations and renewal theory for products of random matrices. *Acta Mathematica 131*(1), 207–248.

Khieu, H. and K. Wälde (2023). Capital income risk and the dynamics of the wealth distribution. *Economic Modelling 122*, 106243.

Krusell, P. and A. A. Smith, Jr (1998). Income and wealth heterogeneity in the macroeconomy. *Journal of Political Economy 106*(5), 867–896.

Lusardi, A., P.-C. Michaud, and O. S. Mitchell (2017). Optimal financial knowledge and wealth inequality. *Journal of Political Economy 125*(2), 431–477.

Morris, C. N. (1983). Parametric empirical Bayes inference: theory and applications. *Journal of the American Statistical Association 78*(381), 47–55.

Moskowitz, T. J. and A. Vissing-Jørgensen (2002). The returns to entrepreneurial investment: A private equity premium puzzle? *American Economic Review 92*(4), 745–778.

Nirei, M. and S. Aoki (2016). Pareto distribution of income in neoclassical growth models. *Review of Economic Dynamics 20*, 25–42.

Palia, D., Y. Qi, and Y. Wu (2014). Heterogeneous background risks and portfolio choice: Evidence from micro-level data. *Journal of Money, Credit and Banking 46*(8), 1687–1720.

Pfeffer, F. T., R. F. Schoeni, A. Kennickell, and P. Andreski (2016). Measuring wealth and wealth inequality: Comparing two us surveys. *Journal of Economic and Social Measurement 41*(2), 103–120.

Piketty, T. (2014). *Capital in the Twenty-First Century.* Harvard University Press.

Quadrini, V. (2000). Entrepreneurship, saving, and social mobility. *Review of Economic Dynamics 3*(1), 1–40.

Shourideh, A. (2013). Optimal taxation of wealthy individuals. *Society for Economic Dynamics, Meeting Papers, Mimeo*.

Snudden, S. (2025). Idiosyncratic asset return and wage risk of US households. *Economic Inquiry (forthcoming)*.

Xavier, I. (2021). Wealth inequality in the us: the role of heterogeneous returns. *mimeo, Available at SSRN 3915439*.

Online Appendices (For Online Publication Only)

A Empirical Bayes

This appendix describes the empirical Bayes shrinkage of the fixed-effects estimates that are used to estimate household-specific returns. It also explores the estimator by using Monte Carlo simulation. The empirical Bayes shrinkage procedure is based on Morris (1983) as operationalized by Chandra et al. (2016).

The household-specific returns of household i are given by ϵ_i. Let $\hat{e}_i$ be the observed returns, which are equal to the household-specific returns plus measurement error η_i:

$$\hat{e}_{it} = \epsilon_i + \eta_{it}.$$

The empirical Bayes procedure adjusts the estimate of household-specific returns so that the transitory term does not introduce bias into the estimates. This is accomplished by shrinking the estimate of household-specific returns towards the true underlying household-specific returns distribution. True household-specific returns are not observable, but the distribution can be estimated.

A.1 Implementation

Equation (10) produces the estimated household-specific returns $\hat{\epsilon}_i$ and the corresponding standard error $\hat{\pi}_i$. Heteroskedastic-robust standard errors are used to estimate the noise to shrink the fixed effects. Then, following Morris (1983), $\bar{R}$ and $\hat{\sigma}^2_\epsilon$ are simultaneously determined when iterating over the following procedure. Begin by fixing $W_i = 1\ \forall i$, then iterate the following to convergence:

1. Compute $\bar{R}$ and then a new estimate $\hat{\sigma}^2_\epsilon$, where

$$\hat{\sigma}^2_\epsilon = \max\left\{0, \frac{\sum_{i=1}^{N_i} W_i \left\{ \left(\frac{N_i}{N_i - 1}\right) \left(\hat{\epsilon}_i - \bar{R}\right)^2 - \hat{\pi}_i^2 \right\}}{\Sigma_i W_i}\right\},$$

$$\bar{R} = \frac{\Sigma_i W_i \hat{\epsilon}_i}{\Sigma_i W_i}.$$

2. If $\hat{\sigma}^2_\epsilon$ has converged, exit. Otherwise, fix new weights W_i and return to step 1

$$W_i = \frac{1}{\hat{\pi}_i^2 + \hat{\sigma}^2_\epsilon}$$

where W is a diagonal matrix of W_i and N_i is the number of households. $\hat{\sigma}_\epsilon^2$ is the weighted average of the squared deviations of $\hat{\epsilon}_i$ from $\bar{R}$ less the weighted average of $\hat{\pi}_i^2$. The variance of household-specific returns unconditional on the covariates, consistent with Chandra et al. (2016), is necessary for shrinkage to avoid over shrinking when the covariates are correlated with the household-specific returns (see also Guarino et al., 2015). The weights, W_i, give more weight to observations with less measurement error. The max operator ensures that $\hat{\sigma}_\epsilon^2$ is always nonnegative in finite samples.

The feasible best estimate of the posterior mean ϵ_i^f is

$$\epsilon_i^f = \left(1 - \hat{B}_i\right) \hat{e}_i + \hat{B}_i \bar{R}$$

$$\hat{B}_i = \left(\frac{N_i - 3}{N_i - 1}\right) \left(\frac{\hat{\pi}_i^2}{\hat{\pi}_i^2 + \hat{\sigma}_\epsilon^2}\right)$$

The empirical Bayes procedure produces the feasible empirical Bayes household-specific returns ϵ_i^f and the unconditional estimated variance of the household-specific returns $\hat{\sigma}_\epsilon^2$. The root of $\hat{\sigma}_\epsilon^2$ provides the standard deviation of household-specific returns.

A.2 Monte Carlo Simulations

The properties of the empirical Bayes procedure are now illustrated by using a Monte Carlo exercise. Let the simulated returns for household i in time t, r_{it}, be the sum of household-specific return $\epsilon_i \sim N(0, \sigma_\epsilon^2)$ and a transitory idiosyncratic component $u_{it} \sim N(0, \sigma_u^2)$, $r_{it} = \epsilon_i + u_{it}$. The relative value of the household-specific return and the idiosyncratic transitory error is set similar to that found in the data: $\sigma_\epsilon = 5$ and $\sigma_u = 10$.

A random variable is simulated, $s_i \sim U[0, 1]$, to construct an observable, x_{it}, that is either unrelated to ϵ_i or is linearly correlated:

$$x_{it} = \begin{cases} s_i, & \text{if no correlation} \\ |\alpha + \epsilon_i| s_i, & \text{if linear correlation} \end{cases} \tag{16}$$

The simulations are run with $\alpha = 0.3$ to produce a noisy correlated x_{it} with ϵ_i. Then the household-specific return is estimated with

$$r_{it} = \beta x_{it} + \epsilon_i + u_{it}.$$

Table 13. Monte Carlo Simulations

Periods	N	FE	RE	BS	FE	RE	BS
9	350	6.13	5.02	5.03	6.13	3.06	5.04
		(0.45)	(0.45)	(0.45)	(0.45)	(0.41)	(0.45)
9	4000	6.10	4.99	5.03	6.10	3.04	5.03
		(0.14)	(0.14)	(0.14)	(0.14)	(0.12)	(0.14)
9 (Unabl.)	350	6.68	4.93	5.07	6.68	2.99	5.09
		(0.53)	(0.54)	(0.54)	(0.53)	(0.45)	(0.54)
9 (Unabl.)	4000	6.67	4.99	5.13	6.67	3.03	5.13
		(0.15)	(0.15)	(0.16)	(0.15)	(0.13)	(0.16)

Note: Monte Carlo estimates of the standard deviation of the household-specific return with a true value of 5. Estimators include fixed effects (FE), random effects (RE), and fixed effects with empirical Baynes shrinkage (BS). There are 500 simulations. "No Correlation" refers to orthogonal household-specific returns and the independent variable. Unbalanced data (Unbal.) refers to the households (N) that are missing half of their observations (Periods). Standard deviations are reported in brackets.

Table 13 summarizes the estimated standard deviations of the household-specific returns $\hat{\sigma}_\epsilon$, using fixed effects (FE), random effects (RE), and fixed effects with empirical Bayes shrinkage (BS). There are 500 simulations of $N \in [350, 4000]$ households. The number of time periods, T, is either $T = 9$ or unbalanced with $N/2$ households missing the last half of their observations.

As can be seen in Table 13, lacking a correlation between the regressor and the household-specific return, the random effects and the empirical Bayes estimates are quite similar and close to their true values. In contrast, the fixed-effects estimate is upward biased. When there is a linear correlation of the regressor with household-specific returns, the fixed-effects estimator remains upward biased but the random-effects estimates become downward biased. The empirical Bayes estimates do not display downward bias and are close to their true values.

B Data Description and Selection

The redesigned Panel Study of Income and Dynamics data is the main dataset for the calculation of household-level real rates of return. For this paper, the main innovation of the PSID was the regular and detailed collection of asset income, wealth, and net investment. Households were surveyed every two years for the period 1999 to 2019. Rates of return are annualized and available for 2000 to 2020. The year 1998, or the initial household observation, is lost due to the calculation of the returns.

B.1 Assets and Wealth

The PSID provides detailed socio-economic information on gender, age, marital status, education level, employment status, and geographic location. Data on labor and asset income are retrospective to the year prior, whereas wealth in assets and debt are reported at the time of the interview. Interviews are conducted early in the year (around March). The head of the household is defined as a person over age 15 with the most financial responsibility for the household.

The reported total net worth of household i at time t, w_{it}, includes wealth in several asset classes less other debts held by the household. The wealth in asset classes refers to the amount the household would receive if they sold the asset and paid off all debts associated with the asset. This includes the wealth in all vehicles $w_{v,it}$ (including boats and motor homes), private equity in businesses and farms $w_{b,it}$ (almost all businesses, so henceforth private businesses), and the wealth in the primary residence, $w_{ph,it}$, as well as any secondary-housing equity such as rental properties or cottages, $w_{oh,it}$. Wealth in low-risk assets, $w_{f,it}$, that are not in employer-based pensions or individual retirement accounts (IRAs) is also reported and includes checking or savings accounts, money market funds, certificates of deposits, government savings bonds, or Treasury bills. The value of direct holdings in public stocks (that are not in employer-based pensions or IRAs), $w_{s,it}$, is also reported and includes direct holdings in publicly held corporations, mutual funds, or investment trusts. Households' wealth in private annuities and employer-based pensions or IRAs, $w_{ira,it}$, are reported. Finally, all other assets, $w_{o,it}$, are reported, including any other savings or assets, such as the cash value in a life insurance policy, a valuable collection for investment purposes, or rights in a trust or estate. The total of other debt, $d_{o,it}$, held by the household and not associated with any specific asset class is reported and includes credit card, student, medical, legal and family debt. The total wealth of a household, w_{it}, is thus defined as follows:

$$w_{it} = w_{b,it} + w_{ph,it} + w_{oh,it} + w_{f,it} + w_{s,it} + w_{v,it} + w_{o,it} + w_{ira,it} - d_{o,it}. \tag{17}$$

B.2 Imputation of Capital Gains

A difficulty previous studies incurred in calculating returns is that asset income is reported as a total for a year, whereas wealth is observed at a point in time. Wealth can be put into or removed from a particular asset category; for example, through the accumulation of capital gains in wealth. In the Scandinavian tax database used by Bach et al. (2020) and Fagereng et al. (2020), wealth is reported at the end of the year, income is reported for the year, and capital gains are reported when realized. However, in the PSID asset values, the net investment and flow income that took place during the period between the two surveys are reported in every wave for the asset classes other than low-risk assets. Thus, unlike previous studies, capital gains can be observed for these assets in every period. All capital gains are annualized.

For each asset class, the wealth in the asset is defined as the value of the asset less the debt associated with the asset. The asset value and wealth are net of fees and commissions. For example, the wealth in the primary residence, $w_{ph,it}$, is defined as the reported value of the primary residence, $a_{ph,it}$, less the primary mortgage debt, $d_{ph,it}$: $w_{ph,it} = a_{ph,it} - d_{ph,it}$.

For the primary residence, capital gains are defined as the change in the reported value of the primary residence, $a_{ph,it} - a_{ph,it-1}$, between the two years if the house was not sold, or the difference from the selling price, $a^*_{ph,it}$, on the last reported value if the primary residence was sold, $a^*_{ph,it} - a_{ph,it-1}$, less the value of renovations and upgrades, $i_{ph,it}$. Capital gains are measured between the waves and then are annualized to match the asset income flows. Capital gains on primary housing, $yg_{ph,it}$ are

$$yg_{ph,it} = (\mathbb{1}_{\{sold=1\}} a^*_{ph,it} + \mathbb{1}_{\{sold=0\}} a_{ph,it} - a_{ph,it-1} - i_{ph,it})/2. \tag{18}$$

Capital gains to stocks, $yg_{s,it}$, private businesses, $yg_{b,it}$, and secondary-housing wealth, $yg_{oh,it}$ are defined as the difference in asset values, $\Delta a_{j,it}$, less the net amount invested, $i_{j,it}$:

$$yg_{j,it} = (\Delta a_{j,it} - i_{j,it})/2, \tag{19}$$

for $j \in \{s, b, oh\}$.

Net investment is the amount of money put into an asset, less the amount of money taken out of that asset class. For example, for private businesses, a household's net investment is the difference between how much money the household put into the business and how much money the household got from selling all or part of the business. In the case of complete liquidation (say in the case of bankruptcy), the asset value, $a_{j,it}$, would equal zero and the net investment would equal the amount received from the liquidation, $i_{j,it}$. Thus, returns are observed in cases of total liquidation.

Asset values are available for every period for holdings of public equities and for primary residences. Asset values are available for private businesses and secondary housing, starting in the 2011 wave. Prior to 2011, net worth is reported for secondary-housing and private business assets but not for asset values. Fortunately, however, net worth and net investment are reported. Thus, the asset values for secondary housing and private businesses can be imputed prior to 2011 by using simple accounting. The asset value, $a_{j,it}$, can be imputed by using the change in net wealth, $\Delta w_{j,it+1}$, and net investment, $i_{j,it+1}$, as follows:

$$a_{j,it} = a_{j,it+1} - \Delta w_{j,it+1} - i_{j,it+1}. \tag{20}$$

for $j \in \{b, oh\}$. This inference implies that the wealth accumulation from principal payments is included in net investment. This is confirmed for 2012–2020, when asset values, net investment, and change in net worth are all observed. The imputed private business and secondary-housing asset values are used in the calculation of the returns for the survey waves prior to 2011.

B.3 A New Measure of Returns

The returns proposed in this study are pre-tax real returns to assets and wealth. In addition to returns to total household assets and wealth, returns are analyzed for five asset categories: low-risk assets, primary and secondary housing, private businesses, and public equity. Observing and comparing returns to assets versus wealth allows one to parse the role of borrowing costs and leverage in the heterogeneity of the returns to wealth. Merely focusing on the returns to assets ignores that leverage is a household's endogenous decision.

The returns to primary housing include capital gains, the value of housing services, and rental income, net of maintenance costs. Let the imputed value of flow services from a housing residence be denoted by DIV_{it}, where

$$DIV_{it} = (rr + \delta)a_{ph,it-1} + ptax_{ph,it}, \tag{21}$$

and rr is the real interest rate, δ is the depreciation rate, and $ptax_{ph,it}$ is the value of property taxes. Following Flavin and Yamashita (2002), it is assumed that $rr = 0.05$.[6] The cost of ownership is given by

$$COST_{it} = \delta a_{ph,it-1} - (1 - \tau_{it})ptax_{ph,it} \tag{22}$$

, where τ_{it} is the marginal income tax rate. It is assumed that the cost of maintenance and repairs from depreciation are equal for both landlords and homeowners, which implies that a house has a

[6] The estimates reported herein are very similar for alternative assumptions of the imputed rental value. For example, using the imputed rental value estimate of 0.0288 from Eika et al. (2020) that was used in Fagereng et al. (2020) changes the estimates of the household-specific returns to total assets and primary housing from 3.83 and 3.14 to 3.86 and 3.10, respectively.

constant physical condition. Finally, households can rent out a fraction of their primary residence, RNT_{it}, and accrue rental income, $y_{ph,it}$, less reduced flow consumption and the additional cost of utilities, $utils_{ph,it}$:

$$RNT_{it} = y_{ph,it} - \kappa_{ph,i}(a_{ph,it-1}rr + utils_{ph,it}) \tag{23}$$

where $\kappa_{ph,i}$ is the share of the primary residence rented out. Rental income is reported for all housing assets. Rental income is attributed to the primary residence, $y_{ph,it}$, if the household does not own a secondary property, and to secondary income, $y_{oh,it}$, if the household owns a secondary property. Absent direct observations of the share of the primary residence rented out, it is assumed that $\kappa_{ph,i} = 0.5$ if rental income is accrued and $\kappa_{ph,i} = 0$ if no rental income is accrued.

For ease of exposition, let the net income from primary and secondary residences, the numerators of $r^a_{ph,it}$, and $r^a_{oh,it}$, excluding capital gains, be denoted by $yt_{ph,it}$ and $yt_{oh,it}$, respectively. The total return to the primary residence is thus

$$\begin{aligned} r^{n,a}_{ph,it} &= \frac{yg_{ph,it} + DIV_{it} - COST_{it} + RNT_{it}}{a_{ph,it-1}} \\ &= \frac{a_{ph,it-1}rr(1-\kappa_{ph,it}) + y_{ph,it} + \tau_{it}ptax_{ph,it} - \kappa_{ph,it}utils_{ph,it} + yg_{ph,it}}{a_{ph,it-1}} \\ &= \frac{yt_{ph,it} + yg_{ph,it}}{a_{ph,it-1}}. \end{aligned} \tag{24}$$

As housing constitutes the largest share of household portfolios, on average, accurate measures of the returns are important for the measure of the returns to total assets. The returns to the primary-housing asset improves on the measure in Flavin and Yamashita (2002) in three ways. First, the tax rate is household- and year-specific and is calculated using the National Bureau of Economic Research tax simulator (Feenberg and Coutts, 1993). Second, capital gains are net of investment, which includes major improvements and upgrades. This data was not available for the earlier PSID sample of Flavin and Yamashita (2002). Third, rental income is acknowledged as a source of income. Failure to acknowledge rental income can understate the return to housing. The inclusion of rental income and capital gains also improves on the measure of returns to housing in Fagereng et al. (2020). Moreover, Fagereng et al. (2020) impute housing values from aggregate price indexes based on a hedonic model, but price indexes are known to understate the degree of idiosyncratic housing price variation as shown by Flavin and Yamashita (2002).

The return to secondary housing is modeled to allow for the property to be owner-occupied, rented out full time, or rented out intermittently. Specifically, the assets return to secondary housing, $r^a_{oh,it}$, is given by

$$r^{n,a}_{oh,it} = \begin{cases} (a_{oh,it-1} rr + \tau_{it} ptax_{oh,it} + yg_{oh,it})/a_{oh,it-1}, & \text{if occupied} \\ (y_{oh,it} - a_{oh,it-1}\delta - ptax_{ohit} + yg_{oh,it})/a_{oh,it-1}, & \text{if rented} \end{cases} \tag{25}$$

where $ptax_{oh,it}$ are the property taxes on the secondary housing. It is assumed that the tenant pays for the cost of utilities. The PSID includes information on the repairs and maintenance of the primary residence, beginning in 2005. To incorporate this information, the average depreciation rate, δ, is set to 1.7 percent, the average value of the repairs and depreciation costs for the years observed. For the baseline sample, 10.9 percent of homeowners own secondary properties and 42.2 percent of secondary properties report rental income.

The PSID contains detailed information on mortgage rates for primary housing. A nominal mortgage interest rate, $r^n_{ph,it}$, is calculated as the debt weighted average of the first and second mortgage. The real after-tax mortgage rate, $r^m_{ph,it}$, is measured as

$$r^m_{ph,it} = \frac{1 + (1 - \tau_{it}) r^n_{ph,it}}{1 + \pi_t} - 1,$$

where π_t is the inflation rate as measured by the consumer price index. The interest costs of the primary housing are denoted $m_{ph,it}$. The calculation of the mortgage interest payments utilizes information on monthly mortgage payments, the current interest rate on the loan, the year the mortgage was obtained, and the years left to pay it out, following the TAXSIM recommendations to calculate mortgage deductibility.

Returns to wealth for housing are calculated as the sum of the capital gains and income flow net of non-tax-deductible interest payments over lagged wealth. The return to primary-housing wealth, net of interest costs, is thus

$$r^{n,w}_{ph,it} = \frac{yt_{ph,it} + yg_{ph,it} - (1 - \tau_{it}) m_{ph,it}}{a_{ph,it-1} - d_{ph,it-1}}, \tag{26}$$

and the return to secondary-housing wealth is

$$r^{n,w}_{oh,it} = \frac{yt_{oh,it} + yg_{oh,it} - (1 - \tau_{it}) moh_{it}}{a_{oh,it-1} - d_{oh,it-1}}, \tag{27}$$

where $a_{oh,it-1} - d_{oh,it-1} = w_{oh,it-1}$ and $a_{ph,it-1} - d_{ph,it-1} = w_{ph,it-1}$ are the lagged wealth in other and primary housing, respectively.

If an individual in the household actively participates in a private business, the PSID assigns half of business income to assets and half to labor. If an individual reports business income but does not actively participate in the business, the PSID assigns all the business income to business asset income. If the household reports a loss in total business income, then the loss is attributed only to business asset income. The PSID does not distinguish between labor and asset income from farming, so it is assumed that farm owners actively contribute labor to farm activities and that farm income is, thus, split evenly between labor and asset income, as is the case for businesses. The flow profits from private businesses are denoted by $y_{b,it}$. The returns to business assets are defined as the sum of income from businesses and farms plus capital gains:

$$r^{n,a}_{b,it} = \frac{y_{b,it} + yg_{b,it}}{a_{b,it-1}}, \tag{28}$$

where the return to business wealth is defined over the wealth of the business in the last period,

$$r^{n,w}_{b,it} = \frac{y_{b,it} + yg_{b,it}}{a_{b,it-1} - d_{b,it-1}}. \tag{29}$$

The PSID does not report on net investment in low-risk assets. The value of the low-risk asset is thus calculated following Fagereng et al. (2020) by assuming that wealth is the average between the current and last period. The average value of assets in low-risk assets is thus $\bar{w}_{it} = (w_{f,it}+w_{f,it-1})/2$.

Interest income is reported by the household but is not allocated to a particular asset category. Interest income from bonds, $y_{c,it}$, is allocated between direct holdings and safe assets and is distinguished by using the 3-month U.S. Treasury bill rate, $r^{n,a}_{tres,t}$. The interest income from bonds that are associated with low-risk assets is the smaller value of the Treasury bill rate times the value of the low-risk assets or the value reported from the bond interest income. That is

$$y_{c,it} = \begin{cases} y_{c,it}, & \text{if } r^{n,a}_{tres,t}\bar{w}_{f,it} \leq y_{c,it} \\ r^{n,a}_{tres,t}\bar{w}_{f,it}, & \text{otherwise} \end{cases} \tag{30}$$

The remainder of the reported interest income, $y_{q,it} = y_{c,it} - y_{f,it}$, is then allocated to IRAs and direct public equity holdings. The return to low-risk assets, $r^a_{f,it}$, is thus defined as

$$r^{n,a}_{f,it} = \frac{y_{f,it}}{\bar{a}_{f,it}}. \tag{31}$$

Similarly, the return to public equity, $r_{s,it}$, is the sum of the dividends, $y_{s,it}$ interest income, $y_{q,it}$, and capital gains from stocks, $yg_{s,it}$, over the value of IRAs, $\bar{w}_{ira,it}$, and direct holdings of public equities, $w_{s,it-1}$:

$$r_{s,it}^{n,a} = \frac{y_{s,it} + y_{q,it} + yg_{s,it}}{\bar{w}_{ira,it} + w_{s,it-1}}. \tag{32}$$

It is assumed that households do not leverage wealth in public equities or low-risk assets and thus their returns to wealth and assets are equivalent, $r_{s,it}^{a} = r_{s,it}^{w}$. There are two main differences with the current measure of stocks, apart from the country, compared to the data sets of Bach et al. (2020) and Fagereng et al. (2020). The first is that pension assets are included in the value of financial assets. The second is that capital gains are computed per period, in contrast to the imputed realized capital gains.

Total household asset income includes the returns to primary and secondary housing, $yt_{ph,it}$ and $yt_{oh,it}$, private business income, $y_{b,it}$, dividends, $y_{s,it}$, interest income, $y_{c,it}$, other asset income, $y_{o,it}$, and trusts, $y_{tr,it}$. Let income from total assets, excluding capital gains, be denoted by $y_{a,it}$:

$$y_{a,it} = yt_{ph,it} + yt_{oh,it} + y_{b,it} + y_{s,it} + y_{c,it} + y_{o,it} + y_{tr,it}. \tag{33}$$

Similarly let total capital gains be denoted by, $yg_{a,it}$:

$$yg_{a,it} = yg_{ph,it} + yg_{oh,it} + yg_{s,it} + yg_{b,it}. \tag{34}$$

The total returns to assets, r_{it}^{a}, includes flow income excluding capital gains from all assets plus capital gains from primary housing, secondary housing, and public and private equity:

$$r_{it}^{n,a} = \frac{y_{a,it} + yg_{a,it}}{a_{b,it-1} + a_{ph,it-1} + a_{oh,it-1} + a_{s,it-1} + \bar{w}_{f,it} + \bar{w}_{ira,it} + \bar{w}_{o,it} + \bar{w}_{v,it}}. \tag{35}$$

The returns to assets represent the pre-tax returns, not including deductibility of interest payments. Thus, the measure is the exogenous returns to these assets if the household had fully paid them off. This distinction is made to isolate the role of leverage, which includes the endogenous amplification of the returns from leverage and the reductions in the yields from non-tax deductible interest payments. The total returns to wealth, which exclude other debts, r_{it}^{wx} are measured as

$$r_{it}^{n,wx} = \frac{y_{a,it} + yg_{a,it} - (1-\tau_{it})(m_{ph,it} + m_{oh,it})}{w_{b,it-1} + w_{ph,it-1} + w_{oh,it-1} + w_{s,it-1} + \bar{w}_{f,it} + \bar{w}_{ira,it} + \bar{w}_{o,it} + \bar{w}_{v,it}}. \tag{36}$$

The total returns to wealth excluding other debt are closely related to the measure reported by Bach et al. (2020) and Fagereng et al. (2020) in the Scandinavian tax administrative data sets. However, their measure of the returns to wealth excludes asset income and wealth from sources that are not taxable. The measure of the returns to wealth in this thesis includes information on durable wealth and other valuables, such as collections, that are reported by the household that would not traditionally report these valuables as asset income for tax purposes. The total returns to assets is the most-similar measure to the returns to households' "net worth" in Fagereng et al. (2020), who use the asset value in the denominator but include primary-housing interest payments in the numerator.

The returns to total wealth, $r_{it}^{n,w}$, inclusive of all debts, serves as the main measure of the returns to wealth. This measure is the same as r_{it}^{wx} but is net of other debts, $d_{o,it}$, held by the household such as credit card, student, medical, legal and family debt:

$$r_{it}^{n,w} = \frac{y_{a,it} + yg_{a,it} - (1-\tau_{it})(m_{ph,it} + m_{oh,it})}{w_{b,it-1} + w_{ph,it-1} + w_{oh,it-1} + a_{s,it-1} + \bar{a}_{f,it} + \bar{a}_{ira,it} + \bar{w}_{o,it} + \bar{w}_{v,it} - d_{o,it-1}}. \quad (37)$$

Finally, nominal returns to assets and wealth, $x \in \{a, w\}$, respectively, for all asset classes, $j \in \{b, ph, oh, s, f\}$, and for total household returns, $j = a$, are converted to real returns by using the annualized total consumer price index provided by the Federal Reserve (CPI):

$$r_{j,it}^{x} = \frac{1 + r_{j,it}^{n,x}}{1 + \pi_t} - 1.$$

Total household real wages, W_{it}, are calculated as real total household labor income, Y_{it}, over total hours worked, H_{it},

$$W_{it} = (Y_{it}/CPI_t)/H_{it}. \quad (38)$$

Household labor income includes total head and spousal labor income and household labor income from businesses. Non-business labor income is the sum of total labor income including salaries, hourly work, bonuses, tips, etc.

B.4 Sample Characteristics

The composition of households in the PSID used for the study of wages is now compared to the composition of households for whom returns are observed. We focus on the share of households that hold positive wealth in specific asset classes. The main purpose is to see if any sample of households for which returns are calculated may be over- or underrepresented, compared to a study that uses only the wage data in the PSID.

Table 14. Sample Characteristics

	Real Wage Growth	Return on Total Assets	Return on Assets	Leverage on Total Assets	Leverage on Assets
Demographics					
Head's Age	43	46	45	46	46
Male Head	83.9%	84.7%	84.4%	85.0%	86.2%
Married	74.8%	76.1%	75.1%	76.6%	78.2%
High School Edu.	93.1%	93.7%	94.8%	93.7%	94.3%
Post Sec. Edu.	40.0%	40.0%	43.2%	40.4%	42.6%
Racially White	84.1%	86.5%	86.4%	86.6%	87.2%
Ownership					
Positive Wealth	87.0%	97.7%	91.2%	96.0%	94.9%
Private Business	14.7%	9.1%	15.1%	10.2%	15.2%
Primary Hous.	72.4%	85.2%	79.0%	84.5%	86.0%
Secondary Hous.	15.9%	13.6%	15.1%	14.4%	15.6%
Public Equity	21.7%	23.3%	24.2%	23.4%	25.4%
Risk Free	86.7%	90.5%	91.7%	90.2%	90.6%
Observations	28917	15223	26077	18672	22242

Note: Columns describe the sample characteristics of households for which data are available for at the time of the survey 1999-2019. "Returns to Total Assets" refers to the existence of returns to total household assets, whereas "Returns to Assets" refers to the existence of returns to assets within any asset class.

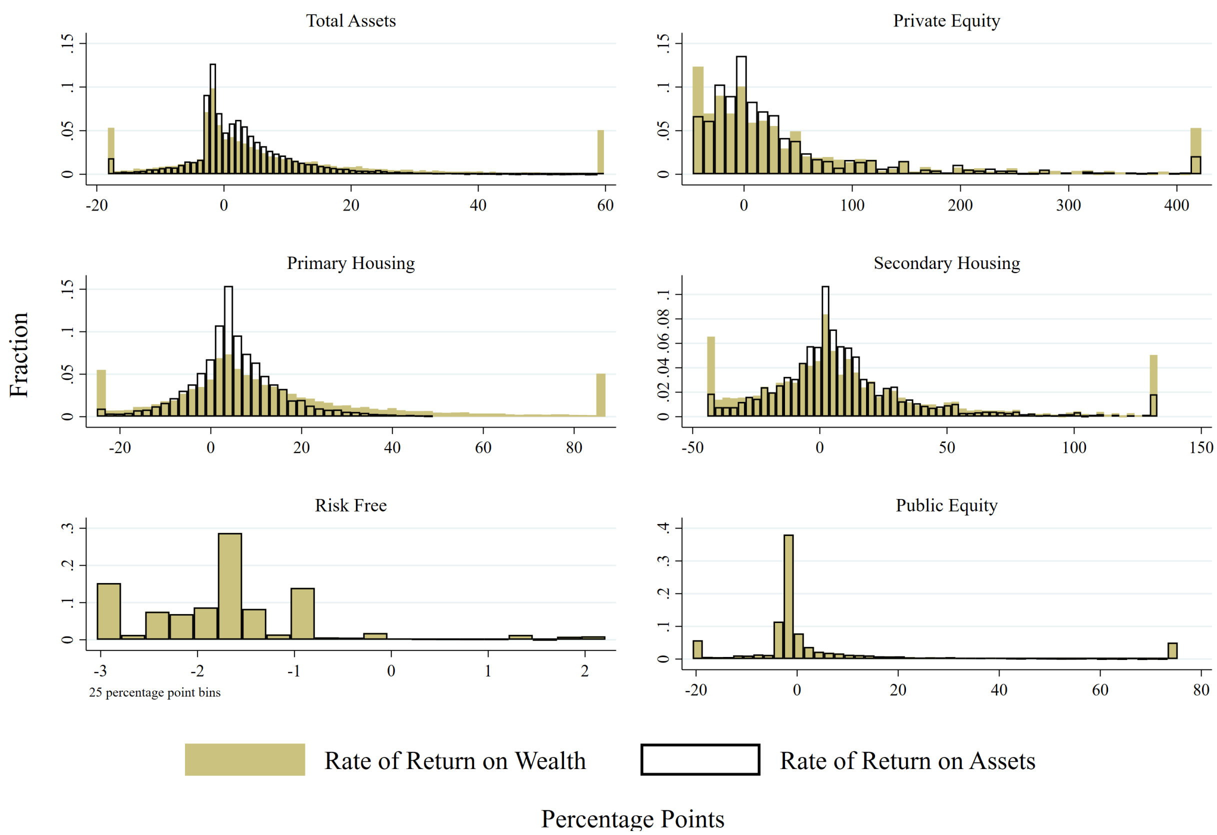
Table 14 reports the share of households with specific demographics and positive wealth in specific asset classes for households. The column "Real Wage Growth" describes the sample characteristics for households with a minimum of two consecutive real wage growth observations. Sample characteristics for households with observed returns to total household assets and wealth are reported in the next two columns, respectively. The last two columns describe households for which there is at least one return within any asset class.

Overall, the demographics profiles of households are consistent across returns and wage samples. The mean head of the households' age is 43 for the wage sample and 46 for the sample with returns to total household assets and wealth. Other demographics characteristics are also similar. Only for private businesses does ownership seem to be smaller than the wage growth sample. The reason for this is twofold: First, wealthy households are more likely to not report some information that is required to calculate their total portfolio returns; second, returns to business assets cannot be imputed unless asset values are observed after 2010. The loss in the number of households from the imputation of asset values for private businesses and secondary housing can be seen by comparing the samples of "the returns to total" and households for which any "returns to assets" can be obtained, as the imputation is only necessary for the calculation of the returns to total assets.

B.5 Additional Data Summary

The summary statistics for the measures of returns and leverage are summarized in Table 1. Figure 10 displays the corresponding histograms for the returns to assets and wealth for each asset class to illustrate the amplification of the returns to wealth from leverage. Returns are skewed right and display more kurtosis than a normal distribution. This is particularly true for business and financial assets. Skewness and kurtosis are amplified when leverage is accounted for in the returns to wealth. The right skewness reflects the limited downside risk arising from the natural limit of zero asset values and the option to either default or sell the asset.

Figure 10. Leverage Disperses Rates of Return to Wealth



Note: Bunched for the top and 5 and 95 percent of the return.