Asset Market Participation, Redistribution, and Asset Pricing[*]

Francesco Saverio Gaudio[†] Ivan Petrella[‡] Emiliano Santoro[§]

Abstract

The dynamics of consumption inequality is key to understanding asset pricing and its connection with macroeconomic fluctuations. We document marked heterogeneity in the transmission of different aggregate shocks to the consumption and income of U.S. assetholders relative to non-assetholders. Factor-share shocks redistributing income from labor to capital generate strongly procyclical relative consumption and income, and drive the time-variation in expected stock returns. A limited-participation model rationalizes these findings, highlighting that asset prices mostly reflect risk from factor-share shocks, despite a modest contribution to macroeconomic fluctuations. This explains the renowned challenge of modeling links between asset prices and the macroeconomy.

Keywords: Consumption, Income, Heterogeneity, Limited participation, Asset pricing.

JEL Codes: D31, E13, E21, E25, E32, E44, G12, G51.

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1 Introduction

A long-standing tradition in macro-finance has sought to provide a unified explanation of macroeconomic and financial fluctuations (see, e.g., Cochrane, 2017, and references therein). While this literature has originally taken a representative agent perspective, which presumes aggregate (average) consumption growth to be an appropriate measure of systematic risk, recent advances have emphasized how neglecting household heterogeneity may severely limit our ability to understand the connection between fluctuations in asset prices and the macroeconomy. Indeed, the representative agent assumption stands in contradiction with the most basic observation about asset ownership—about a third of U.S. households do not own any form of liquid assets, on average—and has a poor performance in explaining stylized asset-pricing facts (Brunnermeier et al., 2021). As a consequence, various contributions have stressed the need to (re)consider limited asset market participation as a crucial dimension of consumer heterogeneity (see, e.g., Mankiw and Zeldes, 1991; Attanasio et al., 2002; Guvenen, 2009; Malloy et al., 2009).

An inherent property of economies where a substantial share of the population has no access to financial investment is the emergence of a wedge between the consumption of the average market participant and aggregate consumption. In turn, this wedge is related to a metric of consumption inequality: the consumption of assetholders *relative* to that of non-assetholders.[1] In this paper, we posit that examining the drivers of cyclical variation in relative consumption is essential to reconcile salient macroeconomic and asset-pricing facts. To this end, we highlight important differences in the response of relative consumption to different aggregate shocks, and explain how this novel evidence is useful in devising and validating production-based asset-pricing frameworks with limited capital ownership.

We use data from the U.S. Consumer Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF) to construct consumption and income series for two distinct household groups. These are distinguished by their holdings of liquid financial assets, consistent with models that feature limited asset market participation (e.g., Mankiw and Zeldes, 1991; Mankiw, 2000). Thus, we retrieve the dynamic responses of both aggregate and household-level variables to structural technology shocks—both neutral and investment-specific—and to factor-share shocks. The latter capture the notion of biased technical change through the redistribution of the rewards of production between capital and labor, for given TFP and availability of the production factors (see, e.g., Blanchard, 1998; Young, 2004). All the structural shifters we identify are typically recognized in the macro-finance literature as drivers of macroeconomic and financial

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[1] In the remainder, when referring to this measure, we will interchangeably use the expressions *relative consumption* and *consumption inequality*.

fluctuations (see, e.g., Jermann, 1998; Guvenen, 2009; Papanikolaou, 2011; Lansing, 2015). In line with Lettau et al. (2019) and Greenwald et al. (2019), we acknowledge the important role of redistribution between labor and capital income as a driver of expected returns. However, our analysis rests on the important distinction between *exogenous* movements in the labor share triggered by factor-share shocks, which we show to be particularly effective in redistributing income between capital and labor, as compared with *endogenous* movements in the labor share that are driven by technology shocks of either type (see, e.g., Ríos-Rull and Santaeulalia-Llopis, 2010).

All shocks produce similar expansionary effects on real GDP, investment, and aggregate consumption. Yet, they have distinct income and consumption redistribution effects across households sorted by their assetholdings. By inducing a marked contraction in the labor share, an expansionary factor-share shock shifts resources from non-assetholders—who primarily finance consumption out of labor income—to assetholders—whose consumption also relies on financial income. In contrast, neutral technology shocks attenuate households' consumption and income inequality, while investment-specific shocks display limited impact on both. Put differently, factor-share shocks are the only shifter, among those we consider, to induce pronounced procyclicality in relative income and consumption.

Differences in the conditional cyclicality of consumption and income inequality are key to understanding the drivers of fluctuations in asset prices. Shocks that redistribute resources from workers to owners of capital and expand aggregate economic activity have been considered as a key source of risk priced in the stock market (see, e.g., Lansing, 2015). Yet, we are the first to provide direct evidence on the link between redistributive shocks, relative consumption, and risk premia. To this end, we run a battery of predictive regressions for excess stock returns, decomposing the growth rate in the consumption of the marginal investor into an aggregate- and a relative-consumption component. As expected, both variables bear significant predictive power. However, only fluctuations in relative consumption triggered by factor-share shocks induce both qualitatively and quantitatively meaningful time-variation in expected future excess returns. This is not the case for either type of technology shock, conditional on which consumption inequality is either counter- or only mildly cyclical.

This novel evidence is important for at least two reasons: *i*) first, it shows it is not unconditional changes in relative consumption (or the labor share) *per se* to exhibit strong explanatory power for expected returns, rather procyclical redistribution as triggered by factor-share shocks; *ii*) second, it can be exploited to discriminate among theories that are seemingly consistent at the *aggregate* level, but that bear very different implications at the *household* level (i.e., in terms of consumption and income inequality). Indeed, our evidence restricts the set of exogenous drivers that can be considered as a source of risk in heterogeneous agent economies, while being consistent with the empirical evidence.

We devise a calibrated two-agent production-based asset-pricing model that reproduces the empirical consumption patterns of assetholders in comparison to non-assetholders, conditional on each of the shocks we identify. Unlike technology shocks of either type, negative factor-share shocks prompt a drop in assetholders' consumption that is mostly impacted by temporarily lower dividends. In light of this, redistributive shocks induce strong positive comovement between assetholders' consumption growth and stock returns, mapping into a large average equity premium, relative to comparable representative agent economies. Most notably, our framework predicts that a stronger fall in dividend relative to labor income during contractions imposes large cuts in investors' consumption, so that the ensuing drop in stock prices is matched by a persistent increase in expected excess returns. This explains how factor-share shocks stand behind the strong predictive power of relative consumption through the persistent—-yet, mean-reverting—redistribution they trigger. Finally, we underscore a profound disconnect between asset-pricing and macroeconomic fundamentals. On one hand, technology shocks—both neutral and investment-specific—explain the largest share of the variance in macroeconomic aggregates. On the other hand, redistributive shocks are mainly responsible for driving fluctuations in relative consumption and, consequently, asset returns. Relatedly, varying degrees of participation in financial markets have muted influence on the volatility of macroeconomic aggregates, while exerting substantial impact on asset-pricing moments. These properties can rationalize the renowned challenge in establishing a connection between macroeconomic fundamentals and asset prices (see Cochrane, 2017).

Related literature This paper relates to several strands of the literature. First and foremost, we speak to those studies exploring the potential of limited asset market participation to tackle a number of financial puzzles within general-equilibrium frameworks (Danthine and Donaldson, 2002; Guvenen, 2009; De Graeve et al., 2010; Lansing, 2015). We contribute to this broad line of inquiry by showing how replicating the conditional dynamics of relative consumption represents an essential input for the design of production-based asset-pricing models. In particular, our work suggests that previous contributions employing technology-neutral shocks as a primary source of economic fluctuations could match asset-pricing moments only by implying counterfactual dynamics at the household level. In these settings, sizeable equity premia are generated by embedding specific mechanisms, such as operating leverage (Danthine and Donaldson, 2002) or preference heterogeneity (Guvenen, 2006, 2009), that entail stronger sensitivity of assetholders' consumption to aggregate fluctuations, relative to that of non-assetholders and, as a byproduct, procyclical household inequality.

However, a main takeaway from our empirical analysis is that relative consumption is markedly countercyclical, conditional on technology-neutral shocks, while being procyclical in connection with factor-share shocks.[2]

A number of contributions have examined income redistribution between factors of production from an asset-pricing perspective. In this respect, it is important to stress that our focus is on drivers of *cyclical* changes in the income of share of labor—and, thus, capital—rather than its *low-frequency* movements. Therefore, our work adds to the literature that seeks to establish the role of movements in household inequality along the income or the wealth dimension in predicting stock returns (see, e.g., Lettau et al., 2019; Toda and Walsh, 2019, respectively).[3] In doing so, we focus on *cyclical* redistribution and identify its essential stochastic drivers—factor-share shocks—explaining the nature of their interaction with household heterogeneity. Therefore, we move past using observed changes in the composition of different income sources as a predictor of financial returns (see, e.g., Santos and Veronesi, 2006), and underscore the need to identify their deep structural drivers. In this sense, our empirical evidence supports contributions that highlight factor-share shocks as an important source of risk being priced in the stock market (Lansing, 2015; Greenwald et al., 2019).

We also relate to recent developments in the macroeconomic literature that examine the role of household heterogeneity for the transmission of aggregate shocks (see Mankiw, 2000; Galí et al., 2007; Bilbiie, 2008; Debortoli and Galí, 2017; Broer et al., 2019; Bilbiie, 2020; Cantore and Freund, 2021; Bilbiie et al., 2022, among others). These works emphasize how the amplification of monetary and fiscal policy shocks requires *countercyclical* consumption (and income) inequality between assetholders and hand-to-mouth households. Conversely, our findings stress how *procyclical* consumption (and income) inequality is required to match asset-pricing moments in the presence of household heterogeneity. Moreover, we focus on shocks traditionally considered as key inputs in production-based asset-pricing models. To this end, while much is known about the empirical transmission of these shocks on macroeconomic aggregates, less is understood about their impact on households characterized by different degrees of assetholding. In this respect, we complement the work of Cloyne and Surico (2017) and Cloyne et al. (2019), who highlight that the transmission of monetary and fiscal shocks mainly hinges on their impact on the disposable income of consumers who are financially/liquidity constrained. In contrast, we stress that heterogeneous consumption and income responses to the shocks we consider map into the asymmetric reaction of labor and financial income.

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[2] Otherwise, investment-specific shocks—which play a key role in Justiniano and Primiceri (2008), Papanikolaou (2011), Kogan and Papanikolaou (2013), Garlappi and Song (2017), and Kogan et al. (2020)—do not induce sizeable cyclicality in relative consumption.

[3] See also Danthine and Donaldson (2002) and Greenwald et al. (2019), about the redistribution between labor and capital income as a source of risk being priced in the stock market.

Finally, we document an important macro-finance disconnect, in that shocks that matter to capture business-cycle moments are not equally important drivers of asset-pricing moments (and *vice versa*), within a standard real business cycle framework with concentrated capital ownership. A related work, in this sense, is Bianchi et al. (2018): while retaining a representative-agent perspective, they stress that shocks driving the business cycle are unlikely to account for the volatility of stock prices.

Structure The rest of the paper is organized as follows. Section 2 introduces the aggregate and the household survey data employed in the analysis. Section 3 presents the identification of the aggregate shocks of interest, the responses of macroeconomic and household-level variables, and connects this evidence to time-variation in asset prices. Section 4 examines the role of different shocks and that of household heterogeneity within a quantitative setting with concentrated capital ownership. Section 5 concludes.

2 Data description

In this section, we describe the data—macroeconomic, financial, and survey-based—employed in the empirical analysis.

2.1 Aggregate data

The identification of the structural shocks relies on data about TFP and the relative price of investment from Fernald (2014), as well as on the labor share of income series from the Bureau of Labor Statistics (BLS). The impulse-response analysis employs NIPA quarterly aggregate series on Consumption (non-durable goods and services, as well as durables), Gross Domestic Product (GDP) and Total Investment, in addition to the Consumer Price Index (CPI) for all items, from the BLS. Per-capita real measures are obtained by dividing their aggregate counterparts by the U.S. total population (NIPA) and by the CPI. We also investigate the responses of labor and dividend income, both collected by the Bureau of Economic Analysis (BEA). As for financial data, both (quarterly) stock returns and the risk-free rate are retrieved from Amit Goyal's webpage (see Welch and Goyal, 2008). In all cases, the sample spans over the 1982Q4-2017Q4 period, in line with the availability of household-level data employed in the regression analysis. Further details on aggregate data sources are reported in Appendix A.

2.2 Household survey data

To estimate consumption expenditure and income at the household level, we rely on the U.S. CEX. Produced by the BLS since 1980, the CEX is a national survey featuring household-level data on consumption expenditure—along with income and other financial and demographic information—on a sample that is designed to represent the non-institutionalized civilian population. This section summarizes the main steps to obtain the consumption and income series for the two representative household groups of interest, namely assetholders and non-assetholders. Appendix B offers a comprehensive explanation of each step involved in constructing the household-level series.

2.2.1 Assetholding status definition and imputation

In the baseline analysis, we focus on a key dimension of household heterogeneity, defined by households' holdings of financial assets. In line with a wide set of macroeconomic two-agent models (Bilbiie, 2008; Lansing, 2015; Debortoli and Galí, 2017, among others), we distinguish between assetholders and non-assetholders. Unlike assetholders, non-assetholders typically hold very little liquid financial assets. In this respect, the CEX collects information on whether a household holds "stocks, bonds, mutual funds and other such securities" (including checking and savings accounts). However, it does not encompass indirect assetholdings, with the likely implication of underestimating households' participation in financial markets.[4] Thus, to accommodate our sorting criterion also resort to information available through the SCF.

Using SCF data over the 1989-2016 sample, we estimate a probit model for the probability of a household holding assets, directly or indirectly, based on a set of established socio-economic predictors of the assetholding status that are also available through the CEX (see, e.g., Attanasio et al., 2002; Malloy et al., 2009). As in Mankiw and Zeldes (1991), we define a household to be an assetholder if the dollar value of held assets (namely, stocks, bonds, and liquid accounts) plus liquid accounts exceeds 1000\$. The estimated coefficients are then used to predict the probability that a household in the CEX holds assets. In the baseline analysis, we construct a 'continuous' measure of asset-market participation. To obtain such a measure for the representative assetholder, each household's population weight is multiplied by the imputed probability of holding assets in amounts that exceed the threshold, to then divide it by the total population. As for the representative non-assetholder, we employ the complement to one of such probability.

Following the outlined procedure, we obtain a series of the participation rate that

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[4] Appendix B discusses this point in detail.

closely tracks the one based on the SCF, especially in the last part of the sample, where the two rates are essentially identical (as depicted in Figure B.1). Even in the first half of the sample, where the imputed rate is lower, the difference amounts to few percentage points, and the imputation captures the upward trend observed in SCF data. From a quantitative perspective, our procedure classifies between 25% and 40% (35%) of the households as non-assetholders in the CEX (SCF). These values are very close to the range considered in the existing literature. For example, Kaplan et al. (2018) estimate that around a third of the U.S. population consists of hand-to-mouth households, while Aguiar et al. (2020) estimate such percentage to be around 40%.

Two further remarks are in order. First, our main focus is on households' liquid financial assets, rather than total net wealth, as in Kaplan et al. (2018) or Aguiar et al. (2020). However, as shown in the robustness exercises in Section 3, our procedure can easily accommodate the wealthy vs poor hand-to-mouth distinction (Kaplan et al., 2014, as in), or the stockholder vs non-stockholders dichotomy (Mankiw and Zeldes, 1991). Thus, our approach allows us to speak to both the macroeconomic and the asset-pricing literature. Second, it is well known that no joint data on consumption, income, and wealth at the household level are available for the US. While our chosen strategy allows us to combine wealth information from the SCF with consumption and income data from the CEX, an implicit assumption is that households with the same demographic and income characteristics in the two datasets are seen as equally likely to have sufficient liquid wealth. We see our continuous measure of participation—which weighs household-level variables by estimated probabilities, rather than univocally assigning them to either category—as a sensible option to deal with the potential imprecision of the classification. However, Section 3 tests the robustness of our evidence to alternative sorting procedures.

2.2.2 Household-level consumption and income

We focus on household expenditure on non-durable goods and services and after-tax income. We compute quarterly consumption expenditure (and income) based on calendar periods for the representative agent of each category (i.e., assetholders and non-assetholders) as the population-weighted expenditure (and income) within the group.[5] Spending and income variables are expressed in per-capita real terms by dividing nominal dollar amounts by family size and the CPI. More in detail, we construct a raw measure of per-capita assetholders' consumption (and income) by multiplying households' population-weighted consumption (and income) by the imputed probability of holding assets in amounts that exceed the threshold and divide this by the to-

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[5] Calendar periods are intended as quarters in which spending actually takes place, while collection periods refer to the quarters in which spending is reported. See the CEX documentation at `https://www.bls.gov/cex/`, for a detailed discussion.

tal population of assetholders. Per-capita non-assetholders' variables are constructed in a symmetric way. Thus, in each quarter group-level expenditure and income are adjusted by the ratio between the corresponding NIPA national account aggregate and the aggregate from the CEX. The resulting series are reported in Figure B.2.[6]

3 Empirical evidence

In this section, we first discuss the identification of the shocks of interest. Thus, we examine the conditional dynamics of different macroeconomic variables, as well as that of assetholders' and non-assetholders' consumption and income. Finally, we explore the extent to which the (unconditional and conditional) dynamics of household consumption inequality help predict U.S. excess stock returns. For all these exercises, several robustness checks are performed at the end of the section.

3.1 Identification

We consider three shocks that have been widely regarded as key drivers of both macroeconomic and asset-pricing variables, namely neutral and investment-specific technology shocks, as well as redistribution shocks in the form of shifters to the factor shares of income. A long-standing literature (see Gali, 1999; Fisher, 2006, among others) has studied the transmission of technology shocks to the macroeconomy. However, these contributions typically assume that factor shares are constant over time. Recently, several studies (Ríos-Rull and Santaeulalia-Llopis, 2010; Santaeulalia-Llopis, 2011; Choi and Ríos-Rull, 2020) provide evidence that accounting for time-variation in the factor shares profoundly modifies the propagation of productivity shocks to aggregate variables.

Our identification strategy follows the procedure outlined by Santaeulalia-Llopis (2011). We specify a trivariate Vector Autoregression (VAR) model with four lags, where the growth rate of the (inverse) relative price of investment to that of consumption goods ($\Delta \log(\mu_t)$), the growth rate of total factor productivity ($\Delta \log(z_t)$) and the linearly detrended (log) labor share of income ($\log(ls_t)$) are the endogenous variables. The choice of detrending the labor share follows Choi and Ríos-Rull (2020), and is intended to deal with the secular decline observed over the last few decades. We define the system

$$\boldsymbol{y}_t = \boldsymbol{\alpha} + \sum_{j=1}^{4} \boldsymbol{\Gamma}_j \boldsymbol{y}_{t-j} + \boldsymbol{\epsilon}_t, \tag{1}$$

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[6] The adjusted series are then smoothed through a backward-looking moving average, which includes both the current and the previous three quarters, to deal with seasonal adjustment and the noise that typically characterizes survey data.

where $\boldsymbol{y}_t = [\Delta \log(\mu_t), \Delta \log(z_t), \log(ls_t)]'$, $\boldsymbol{\alpha}$ is a vector of constant terms, $\boldsymbol{\Gamma}_j$ (with $j = 1, ..., 4$) are the matrices of dynamic coefficients and $\boldsymbol{\epsilon}_t \sim N(0, \Sigma)$ is a vector of normally-distributed innovations with mean zero and variance-covariance matrix Σ.

We estimate the reduced-form system (1) over the 1981Q4-2017Q4 sample.[7] The innovations $\boldsymbol{\epsilon}_t$ are linearly related to the structural shocks, $\boldsymbol{\epsilon}_t = \boldsymbol{H}\boldsymbol{u}_t$, and the matrix $\boldsymbol{H}$ is identified based on (standard) long-run restrictions. The identification strategy imposes that shocks to the factor share of income do not affect the long-run levels of TFP and the relative price of investment, and are therefore purely redistributive in the long run. As for the remaining shocks, we follow Fisher (2006) in assuming that neutral technology shocks do not affect the relative price of investment in the long run. Thus, investment-specific technology shocks are the only ones capable to permanently affect the relative price of investment.[8]

The interpretation of the factor-share (FS) shocks deserves further discussion. From an identification point of view, these shocks account for innovations to the factor shares of income that are orthogonal to (neutral and investment-specific) technology shocks. This captures the notion of *biased technological innovation*. For given levels of TFP, aggregate capital and labor inputs, an exogenous negative shift in the labor share implies an increase in the marginal product of capital and a fall in the marginal product of labor (see, e.g., Blanchard, 1998; Young, 2004). Analogous shifters are labeled as ”distribution shocks” in Lansing (2015), or as ”factor-share shock” in Ríos-Rull and Santaeulalia-Llopis (2010) and Greenwald et al. (2019).[9] Bergholt et al. (2022) discuss various potential explanations for exogenous movements in the factor shares.

The impulse-response functions are reported in Figure 1. A neutral technology (TFP) shock persistently increases the relative price of investment, while the labor share falls on impact, to then display a temporary increase above the trend (see Ríos-Rull and Santaeulalia-Llopis, 2010; Choi and Ríos-Rull, 2020). An investment-specific (IST) shock is associated with a permanent fall in the relative price of investment and a permanent increase in TFP, while the labor share only displays a mild and short-lived expansion. Finally, a FS shock is associated with a significant and prolonged decline in the labor share, while contracting the relative price of investment and expanding

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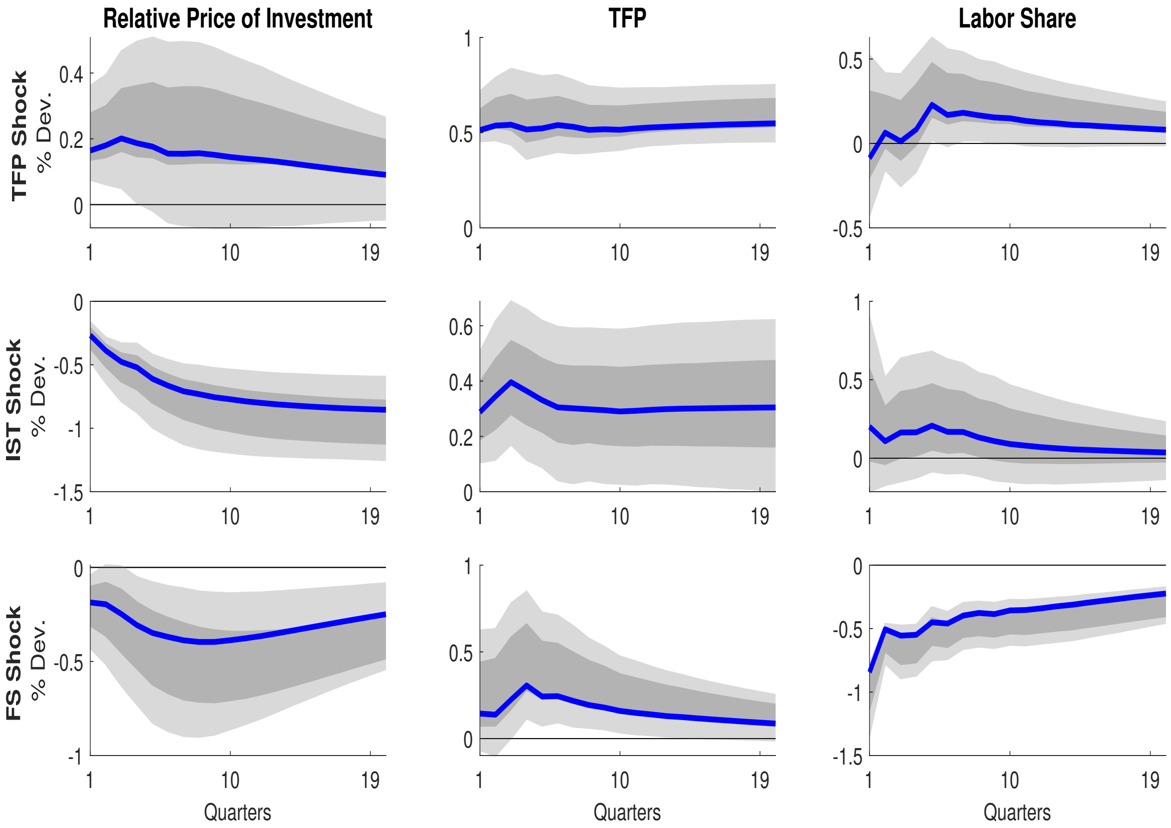
[7] This sample is chosen for three main reasons. First, given that the household-level data are available over the 1982Q4-2017Q4 time-window, and we use a VAR(4) model, we need to consider that the first 4 time-series observations will be discarded. Second, Fisher (2006) documents the presence of a structural break in the trend of the relative price of investment in 1982. Finally, the sample is consistent with a large literature focusing on the Great Moderation period (e.g., Stock and Watson, 2002). Note that labor-share detrending is performed over the 1947Q3-2017Q4 sample to avoid overfitting low-frequency variation in the last part of the sample.

[8] We have implicitly assumed that all three variables in the system are fully explained by the identified shocks. In Section 3.5 we extend the VAR system to capture additional shocks, and highlight how our results remain robust to this variation.

[9] In addition, by isolating unexpected variation in the labor share, our shock implicitly bundles together shifts in both the capital and the profit shares of income (Barkai, 2020).

Figure 1: Responses of the relative price of investment, TFP, and income share of labor



Notes: The figure displays the impulse-response functions, estimated from the VAR in equation (1), to the identified neutral technology (TFP, top panel), investment-specific technology (IST, middle panel), and factor-share (FS, bottom panel) shocks over the sample 1982Q4-2017Q4. Light-grey (dark-grey) shaded areas represent the 90% (68%) confidence intervals. The latter are computed using the moving block bootstrap (Bruggemann et al., 2016), with small-sample bias correction (Kilian, 1998).

TFP. Notably, the last column of Figure 1 highlights that positive FS shocks significantly contract labor income in favor of capital income. In contrast, the labor share only displays modest expansions in response to technology shocks.

The impulse-response functions in Figure 1 underscore significant dynamic interdependence among the endogenous variables. Table 1 quantifies the contribution of each shock to observed changes in the endogenous variables. Every shock has a tangible impact on all endogenous variables, with none emerging as a significantly dominant driver. The IST shock explains most of the variability of changes in the relative price of investment (56%). Yet, TFP growth is mostly explained, almost by an even share, by TFP and FS shocks. As for the labor share, instead, technology shocks jointly account for three-fifths of the observed variation (the TFP shock playing a key role, by vitue of the overshooting effect it induces; see, e.g., Ríos-Rull and Santaeulalia-Llopis, 2010), while FS shocks account for a non-negligible residual share. This evidence suggests caution against assuming that endogenous variables can be taken as proxies for the underlying shocks.

Table 1: Variance Contribution

	Rel. Price of Investment	TFP	Labor Share
TFP Shock	0.29	0.42	0.47
IST Shock	0.56	0.18	0.15
FS Shock	0.15	0.40	0.38

Notes: Contribution of each shock (rows) to the total variance of each variable (columns) estimated from the historical decomposition from the trivariate VAR in equation (1) over the sample 1982Q4-2017Q4. For each endogenous variable, the relative contribution is computed as the ratio between the variance conditional on a given shock and the unconditional variance.

3.2 Responses of main macroeconomic aggregates

To retrieve the impact of the identified shocks on selected macroeconomic variables, we estimate the following autoregressive distributed-lag model:

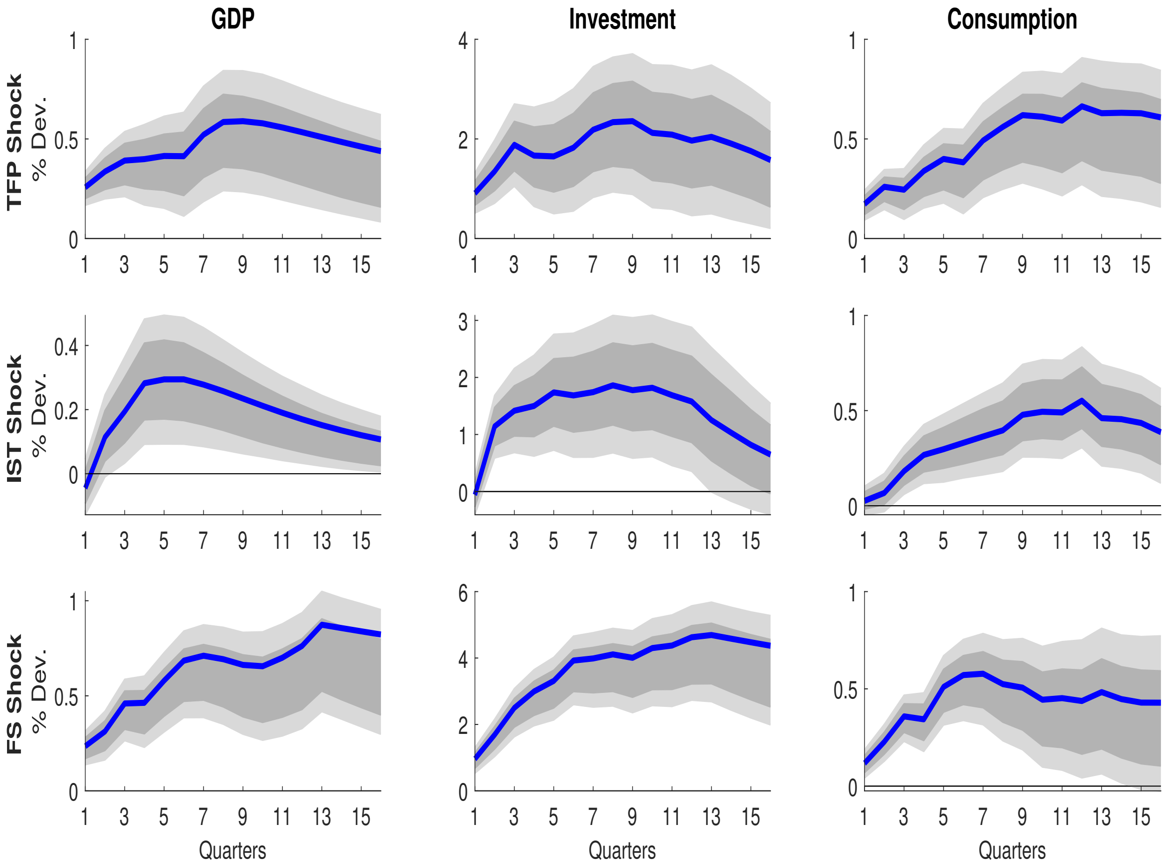
$$x_t = \alpha_0 + \alpha_1 t + \sum_{r=0}^{R} \beta_r u_{j,t-r} + \sum_{p=1}^{P} \delta_p x_{t-p} + e_t, \tag{2}$$

where t denotes the time trend, while x_t denotes the (log) aggregate variable for which we compute the impulse-response function to either of the three shocks, as captured by $u_{j,t}$ where $j \in \{TFP, IST, FS\}$. We control for R lags of the shock and P lags of the endogenous variable, with both R and P being optimally determined by a corrected-Akaike information criterion, for each regression separately. Finally, heteroskedasticity-consistent standard errors are computed using the wild bootstrap methodology of Gonçalves and Kilian (2004).

Figure 2 reports the responses of output, investment and consumption. Shocks are set so that a positive TFP shock increases TFP, whereas positive IST and FS shocks decrease the relative price of investment and the labor share of income, respectively (in line with Figure 1). All shocks are associated with strong positive comovement among the three macroeconomic aggregates. A TFP shock generates a simultaneous increase in GDP, consumption, and investment, with the full impact of the shock taking roughly two years to be fully reflected into a persistent increase. All variables display a more hump-shaped response following an IST shock, with the impact on output and investment being somewhat transitory. This is consistent with the view that the expansionary effects of an improvement in investment-specific technology unfold through the formation of new capital (in line with Greenwood et al., 1988).

While the business-cycle implications of IST and TFP shocks have been widely studied by both the theoretical and the empirical literature, less is known about the

Figure 2: Macroeconomic aggregates



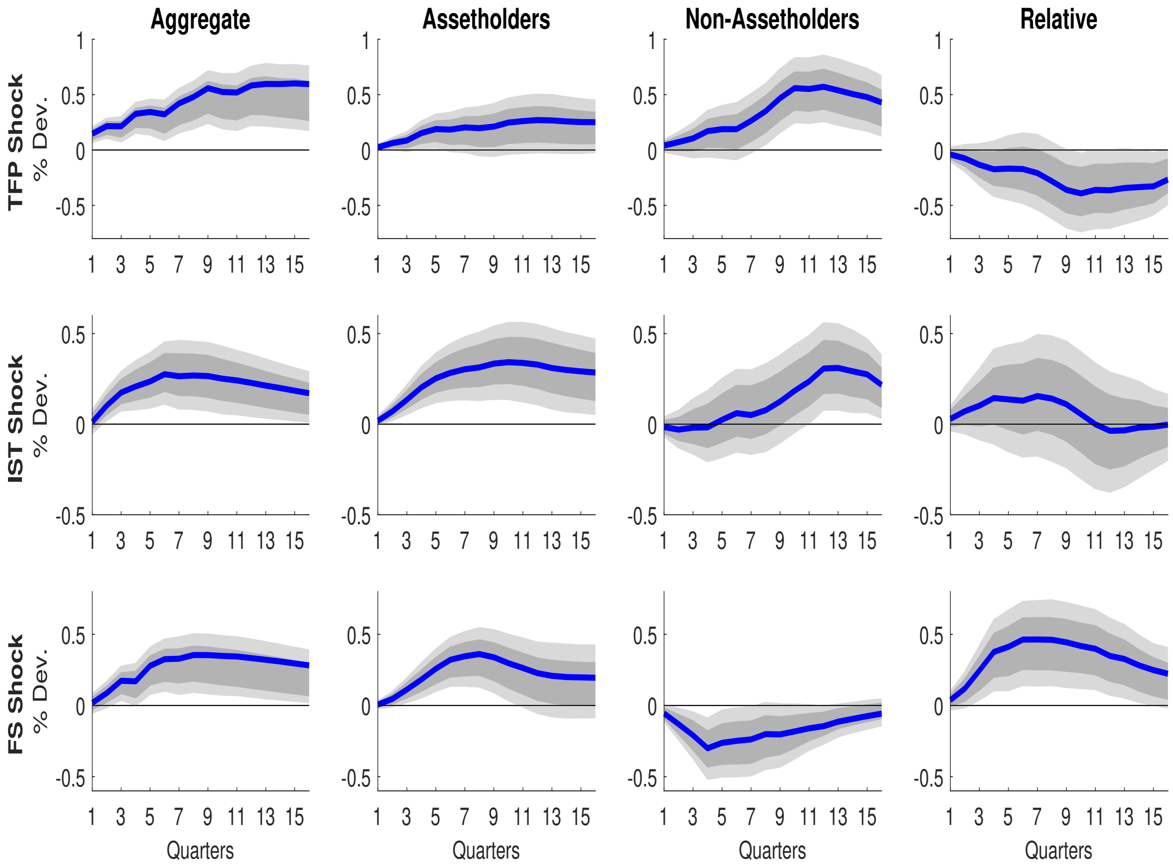
Notes: The figure displays the IRFs of GDP, investment and consumption to the identified neutral technology (TFP, top row), investment-specific technology (IST, middle row), and factor-share (FS, bottom row) shocks, estimated over the sample 1982Q4-2017Q4. Dark and light-grey shaded areas represent the 68% and 90% confidence intervals, respectively.

macroeconomic consequences of exogenous shifts in the factor shares of income. The third row of Figure 2 shows that FS shocks are expansionary, being characterized by particularly delayed and protracted responses. This type of shock is also associated with a very large reaction of investment, the peak response being almost twice as large as that induced by a TFP shock. Indeed, a FS shock renders physical capital more productive, thus exerting a sustained expansionary force on output. On the other hand, the response of consumption is more muted, reaching its peak after about 6 quarters, to then steadily decline back to trend.

3.3 Consumption and income responses at the household level

While the responses of main macroeconomic aggregates display strong positive comovement—conditional on each of the three aggregate shocks—we document major differences in the responses of consumption and income of households sorted based on their asset ownership. Figures 3 and 4 report the IRFs of non-durable and ser-

Figure 3: Non-durables and services expenditure



Notes: The figure displays the IRFs of non-durables and services expenditures for the representative agent (first column), the representative assetholder (second column), the representative non-assetholder (third column), and the ratio between assetholder's and non-assetholder's (fourth column) to the identified neutral technology (TFP, top row), investment-specific technology (IST, middle row), and factor-share (FS, bottom row) shocks, estimated over the sample 1982Q4-2017Q4. Dark and light-grey shaded areas represent the 68% and 90% confidence intervals, respectively.

vices expenditure, as well as of net income, respectively, both of which are obtained by estimating (2) with household-level variables.[10] We focus on the response of: *i*) the economy-wide representative household (first column), *ii*) the representative assetholder (second column), *iii*) the representative non-assetholder (third column), and *iv*) the ratio between the consumption (or income) of the representative assetholder and that of the non-assetholder (fourth column), which is taken as a metric to account for inequality between the consumption (or income) responses of the two representative households.

Figure 3 underscores significant heterogeneity in the way each shock impacts either agent. Both types of technology shocks induce positive comovement between the consumption of the two representative households. However, facing a TFP shock,

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[10] Table C.1 in Appendix C reports the cumulative response of different measures of household-level consumption and income over 16 quarters, following the shock of interest. Moreover, since the two groups of households have different average consumption (and income) levels, we check that the sign of the relative consumption (or income) response also holds in absolute dollar values (see Table C.2).

non-assetholders' consumption rises relatively more than that of the assetholders, thus implying a contraction in relative consumption. The latter tends to expand, instead, following an expansionary IST shock, although the overall response is not statistically significant: on impact, and for the first few quarters, non-assetholders' consumption response is flat and insignificantly different from zero, whereas assetholders' IRF is strongly significant and positive, displaying a hump-shaped pattern. As for the FS shock, we document a strong contraction in non-assetholders' expenditure, as opposed to the surge displayed by assetholders. Thus, a positive FS shock inevitably widens the gap between the consumption of the two agents'.[11] Therefore, FS shocks induce strong procyclicality in consumption inequality, while this is conditionally countercyclical in connection with TFP shocks. The unconditional correlation between the growth rate of relative consumption and that of GDP, measured at 0.15, reflects the balance between these opposing forces. Seen through this lens, our structural analysis shows how models based on TFP shocks alone generate a form of *procyclical* consumption inequality that does not square with the data. Once more, we emphasize the importance of examining the conditional properties of the data to validate macro-finance models.

One last but salient element deserves our attention before we link conditional changes in consumption and income inequality to the dynamics of asset returns. In principle, heterogeneity in consumption responses may reflect different propensities to consume out of disposable income—for given and comparable income responses—or heterogeneous responses of income itself. Examining Figure 4, we observe that conditional income dynamics, both at the aggregate and at the household level, align closely with the behavior of corresponding expenditure measures. Therefore, the consumption responses of the two groups of households reflect, at least partially, the heterogeneous sensitivity of different income sources to the aggregate shocks under scrutiny.

3.4 Relative consumption and stock-return predictability

Our novel evidence on the conditional dynamics of household inequality in consumption and income is now exploited to elicit the role of household heterogeneity and redistribution for asset valuation. In this respect, Mankiw and Zeldes (1991) and Guvenen (2009) highlight how reconciling an empirically plausible equity premium

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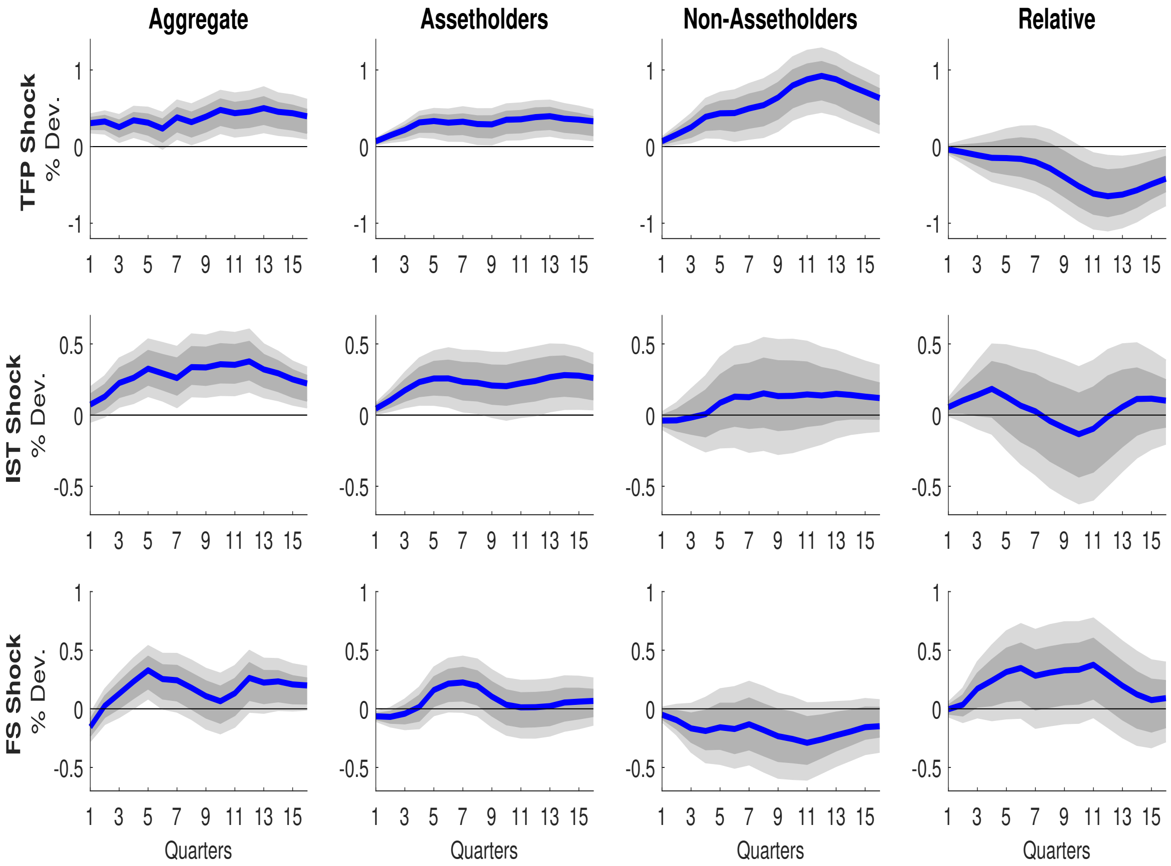
[11] While classifying households into assetholders and non-assetholders, we implicitly assume that the transition between groups is reason for no particular concern and that shocks do not trigger significant endogenous changes in assetholding status. This condition is required to interpret the consumption responses as actual changes in expenditures, rather than as mere compositional effects. Figure C.1 in Appendix C supports this view. Despite the conditional behavior of the share of assetholders being in line with that of relative consumption—as expected on theoretical grounds—little variation emerges, regardless of the specific shock we consider.

Figure 4: Net income



Notes: The figure displays the IRFs of net income for the representative agent (first column), the representative assetholder (second column), the representative non-assetholder (third column), and the ratio between assetholder's and non-assetholder's (fourth column) to the identified neutral technology (TFP, top row), investment-specific technology (IST, middle row), and factor-share (FS, bottom row) shocks, estimated over the sample 1982Q4-2017Q4. Dark and light-grey shaded areas represent the 68% and 90% confidence intervals, respectively.

with a smooth aggregate consumption process requires mechanisms that induce the volatility of assetholders' consumption be greater than that of aggregate consumption. This aspect is strictly related to the dynamic properties of relative consumption, which we show to differ markedly when conditioning on different shocks. To see this, it is convenient to recall that the definition of aggregate consumption growth implies

$$Var(g_{c^a,t}) = Var(g_{c,t}) + \kappa^2 Var(g_{rc,t}) + 2\kappa Cov(g_{c,t}, g_{rc,t}), \tag{3}$$

where g stands for the growth rate of the index variable, while c, c^a, c^{na}, and $rc \equiv c^a/c^{na}$ denote aggregate, assetholders', non-assetholders', and relative consumption, respectively (with κ indicating the long-run share of non-assetholders' consumption in the economy).[12] As the size of the equity premium is bounded by the variabil-

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[12] This property simply derives from the definition of aggregate consumption as a weighted average of assetholders' and non-assetholders' consumption, which implies (up to a first-order approximation)

ity of the marginal investor's consumption (Hansen and Jagannathan, 1991), to obtain a sizable equity premium, one needs $Var(g_{rc,t}) \gg -2Cov(g_{c,t}, g_{rc,t})/\kappa$. Since non-assetholders have a smaller share in aggregate consumption—κ being relatively low—procyclicality of consumption inequality is essential to induce substantially higher volatility of the growth rate of assetholders' consumption. Quite crucially, the previous section has documented this to be the case only conditional to FS shocks.

A different but related question is whether cyclical fluctuations in relative consumption do capture *time-variation* in expected stock returns. Thus, we can test whether changes in consumption inequality act as systematic drivers of expected excess stock returns, while controlling for aggregate consumption growth. To this end, we run a series of predictive regressions of this form:

$$r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta}'\boldsymbol{x}_t + \epsilon_{t+h}, \tag{4}$$

where h denotes the time horizon in quarters, $r^{ex}_{t,t+h}$ denotes annualized excess returns between time t and $t+h$, and $\boldsymbol{x_t}$ accounts for cyclical variation in *aggregate consumption* and alternative measures of *relative consumption*, measured as 2-year growth rates (in line with Hamilton, 2018).

Table 2 reports the estimated coefficients, along with their t-statistics (in parentheses) and p-values (in square brackets), for different forecast horizons over the sample 1982Q4-2017Q4. Panel A reports the model specification including the growth rates of aggregate consumption and of relative consumption (i.e, $g_{rc,t}$). Aggregate consumption growth is found to bear predictive power only from 8 quarters onwards, being somewhat complementary to the growth rate of relative consumption, which displays predictive power up to 12 quarters. Interestingly, we find that the two slope coefficients have opposite signs. While positive aggregate consumption growth predicts lower future excess returns, as in Atanasov et al. (2020), higher-than-average consumption inequality predicts higher excess returns.

What is the economic intuition behind this evidence? On one hand, the coefficient on aggregate consumption growth tends to pick up the (well-known) countercyclicality of the equity premium (Fama and French, 1989). On the other hand, high relative consumption growth is tightly connected with high dividend growth, which predicts future returns with a positive sign. However, the decline in the estimated coefficients as the predictive horizon increases indicates that fluctuations in consumption inequality reflect shifts from labor to financial income that are transitory in nature: cumulated over longer time spans, higher short-run expected returns, induced by temporarily high dividends, are increasingly counter-balanced by lower subsequent future returns associated with mean-reversion in relative consumption (and income). In this respect,

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$g_{c^a,t} = g_{c,t} + \kappa(g_{c^a,t} - g_{c^{na},t})$.

Table 2: Predictive regressions

	Panel A		Panel B			
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g_{rc,t}$		$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g^{TFP}_{rc,t} + \beta_3 g^{IST}_{rc,t} + \beta_4 g^{FS}_{rc,t}$			
h	β_1	β_2	β_1	β_2	β_3	β_4
1	-1.38 (1.43) [0.34]	**2.07** (1.00) [0.04]	-1.52 (1.39) [0.27]	-0.40 (1.92) [0.83]	0.45 (3.27) [0.89]	3.65 (2.30) [0.11]
4	-1.39 (1.11) [0.22]	**1.45** (0.75) [0.06]	-1.72 (1.03) [0.10]	0.16 (1.36) [0.91]	0.71 (2.35) [0.76]	**3.21** (1.64) [0.05]
8	**-2.21** (0.79) [0.01]	**1.21** (0.60) [0.05]	**-2.70** (0.70) [0.00]	-0.22 (0.84) [0.79]	1.02 (1.35) [0.45]	**3.03** (0.96) [0.00]
12	**-2.45** (0.67) [0.00]	**0.96** (0.41) [0.02]	**-2.95** (0.62) [0.00]	-0.97 (0.76) [0.20]	0.82 (1.19) [0.49]	**2.65** (0.77) [0.00]
16	**-2.25** (0.51) [0.00]	0.42 (0.42) [0.32]	**-2.80** (0.52) [0.00]	-0.93 (0.69) [0.18]	0.56 (1.07) [0.60]	**2.02** (0.73) [0.01]
20	**-1.97** (0.41) [0.00]	0.09 (0.41) [0.83]	**-2.44** (0.43) [0.00]	-0.64 (0.79) [0.42]	0.49 (1.19) [0.68]	**1.22** (0.60) [0.04]

Notes: The table presents results of predictive regressions of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which includes: in Panel A, aggregate and relative consumption growth; in Panel B, aggregate consumption growth and relative consumption growth conditioned on each shock at a time. Growth rates are computed as 8-quarters log-differences. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The sample covers the period 1982Q4-2017Q4.

the impulse-response analysis in the previous section provides valuable insights. In fact, Figure 3 suggests that FS shocks should be the main drivers of this mechanism, as they are the only shifters capable of inducing procyclical fluctuations in relative consumption.

In light of this, we re-estimate the predictive regression by replacing relative consumption growth with its *conditional* counterparts.[13] In line with our conjecture, Panel B shows how only variation in relative consumption associated with FS shocks (i.e., $g^{FS}_{rc,t}$) proves significant, from $h = 4$ to $h = 20$. Moreover, the coefficients attached to $g^{FS}_{rc,t}$ are by far the largest, consistent with the idea that redistributive shock are key to observe procyclicality in relative consumption. Hence, the positive relationship between relative consumption fluctuations and expected future returns is driven by shifts in factors shares that, during expansions, *temporarily* move resources towards assetholders. However, such redistribution is expected to dissipate over time, implying expected future negative growth rates in consumption inequality, in tandem with a decline in future returns.

3.4.1 Using the labor share to predict excess returns

Much attention has been devoted to fluctuations in the labor share of income as a key source of risk priced in financial markets (see, e.g., Lansing, 2015; Lettau et al., 2019). In light of this literature, relative consumption may appear as yet another proxy for income redistribution. However, it should be noted that the labor share coincides with relative income only under the specific assumption that assetholders (non-assetholders') income exclusively derives from capital (labor). Moreover, the data reveal a correlation of only -0.22 (-0.25) between cyclical fluctuations in relative income (consumption) and those in the labor share. In light of such discrepancies, this section will first re-examine the drivers of expected returns by taking the rate of growth of the labor share as a proxy for income redistribution between labor and capital, in place of relative consumption growth. Thus, since our study highlights the importance of accounting for the distinct behaviors of relative consumption and income with respect to different business-cycle and asset-pricing drivers, we will use the three *conditional* counterparts of labor-share growth as predictors.

Table 3 presents predictive regressions of future excess returns based on two-year changes in aggregate consumption and the labor share. Notably, the estimated coefficients attached to labor-share growth indicate significant predictive power on future excess returns. The negative and declining coefficients are consistent with temporary shifts of income away from capital around recessions that lead to lower returns in the

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[13] This is constructed as (the growth rate of) the part of relative consumption that is explained by each shock in isolation. Specifically, for $j \in \{TFP, IST, FS\}$ we reconstruct relative consumption as $\log(rc_t)^j \equiv \sum_{r=0}^{R} \hat{\beta}_r u_{j,t-r} + \sum_{p=1}^{P} \hat{\delta}_p \log(rc_{t-p})$, where $\hat{\beta}_r$ and $\hat{\delta}_r$ are the estimated coefficients from (2).

Table 3: Predictive regressions - Labor Share

	Panel A		Panel B			
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g_{ls,t}$		$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g^{TFP}_{ls,t} + \beta_3 g^{IST}_{ls,t} + \beta_4 g^{FS}_{ls,t}$			
h	β_1	β_2	β_1	β_2	β_3	β_4
1	-0.01 (1.51) [0.99]	-1.05 (1.29) [0.42]	-1.33 (1.43) [0.35]	3.23 (3.56) [0.37]	2.58 (3.54) [0.47]	-3.18 (2.09) [0.13]
4	-0.05 (1.12) [0.96]	**-1.82** (0.92) [0.05]	-0.64 (0.90) [0.48]	0.29 (2.33) [0.90]	-0.48 (2.83) [0.87]	**-2.71** (1.44) [0.06]
8	-1.00 (0.68) [0.14]	**-1.77** (0.65) [0.01]	**-1.39** (0.70) [0.05]	-0.17 (1.72) [0.92]	-1.50 (2.35) [0.52]	**-2.20** (0.91) [0.02]
12	**-1.44** (0.58) [0.01]	**-1.50** (0.55) [0.01]	**-1.65** (0.59) [0.01]	-0.45 (1.39) [0.75]	-1.92 (1.94) [0.32]	**-1.56** (0.59) [0.01]
16	**-1.62** (0.51) [0.00]	**-1.18** (0.49) [0.02]	**-1.80** (0.47) [0.00]	0.20 (0.86) [0.82]	**-3.29** (1.39) [0.02]	**-0.97** (0.49) [0.05]
20	**-1.61** (0.42) [0.00]	**-0.84** (0.43) [0.05]	**-1.87** (0.37) [0.00]	1.03 (0.72) [0.15]	**-4.20** (0.91) [0.00]	-0.50 (0.38) [0.19]

Notes: The table presents results of predictive regressions of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which includes: in Panel A, aggregate consumption and labor share growth; in Panel B, aggregate consumption growth and labor share growth conditioned on each shock at a time. Growth rates are computed as 8-quarters log-differences. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The sample covers the period 1982Q4-2017Q4.

short run, followed by higher expected future returns over the subsequent quarters. This is in line with the impact of relative consumption in the same regression setting, as reported in Table 2. When breaking down labor-share growth into its conditional counterparts, it becomes evident that predictability chiefly originates from the regressor shaped by FS shocks. Once again, these findings underscore that cyclical shifts in the labor share appear as a critical state variable for expected returns, precisely because they mainly reflect the impact of redistributive shocks. From this perspective, it becomes clear why, despite a limited unconditional correlation between fluctuations in relative consumption and the labor share, both measures emerge as consistent predictors of future stock returns.

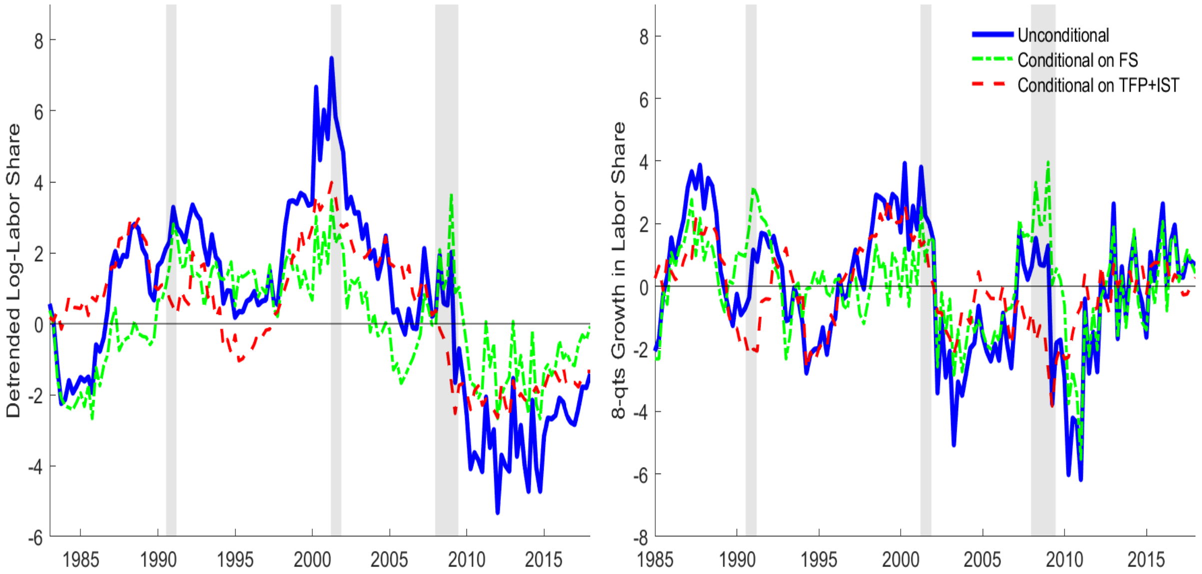
A closer look at the data may help clarify this issue even further. The left panel of Figure 5 reports a historical breakdown of the observed variation in the labor share, distinguishing between the contribution of technology shocks (i.e., TFP and IST shocks altogether), and that of FS shocks. Consistent with the evidence in Table 1, most of the variation in the labor share results from a combination of TFP and IST shocks, which account for the more persistent component of fluctuations in the data. The contribution of FS shocks, conversely, tends to be more cyclical. In fact, the right panel of Figure 5, which reports two-year conditional changes in the labor share, shows how redistributive shocks significantly and consistently increase the labor share during recessions. Overall, FS shocks' contribution to two-year changes in the labor share amounts to 70%, thus providing us with a strong indication that cyclical shifts in income distribution between labor and capital appear as a critical state variable for expected returns, precisely because they mainly reflect the impact of redistributive shocks.

3.5 Robustness

This section briefly summarizes some robustness exercises on the empirical evidence reported so far. The motivation and further details on these can be found in Appendices C.5 (regarding the conditional behavior of household consumption and income) and C.6 (regarding the predictive regressions).

We first conduct a number of exercises with the aim of ensuring that what highlighted so far about the behavior of relative consumption and income is robust to different household sorting criteria, features of the raw data being employed, and shock identification. Specifically, we opt for three alternative household-sorting strategies. First, it is well known that the composition of households' portfolios is strongly correlated with demographic characteristics such as age, education, and gender (Guiso and Sodini, 2013). Moreover, recent work has shown that housing tenure is a key determinant of the responsiveness of households' consumption and income to demand shocks (see Kaplan et al., 2014; Cloyne et al., 2019, among the others). Hence, we con-

Figure 5: Labor Share Decomposition



Notes: The figure displays the conditional decomposition of the labor share both in (detrended) log-levels (left panel) and in 8-quarter growth rates (right panel), as computed from the historical decomposition from the trivariate VAR in equation (1) over the sample 1982Q4-2017Q4.

trol for such potentially relevant dimensions of heterogeneity following Kehoe et al. (2020) (Figures C.3 and C.4 and Table C.3). Second, we sort households based on stockholdings, rather than by their holdings of indistinct financial assets, in line with Mankiw and Zeldes (1991) and Vissing-Jørgensen (2002) (Figures C.5 and C.6 and Table C.4). Finally, we devise a sorting according to which a household is classified as an assetholder either if it fulfills this requirement in the CEX data, or if its SCF-based probability to be an assetholder exceeds a given threshold (Figures C.7 and C.8 and Table C.5). All these exercises lead to results that are very similar to the evidence reported in this section.

The evidence is virtually unchanged also when identifying the shocks of interest in VAR settings where we adopt a utilization-adjusted measure of TFP (Figures C.9 and C.10 and Table C.6), or where we add log per-capita hours as a fourth variable so as to account for the potential role of additional shocks (Figures C.11 and C.12 and Table C.7).[14]

Finally, we perform further tests on the robustness of relative consumption as a significant predictor of future excess returns. Specifically, we verify this to be the case when relying on a sorting based on stockholdings (Table C.8), when controlling for a well-established stock-return predictor—the aggregate consumption-wealth ratio (cay) proposed by Lettau and Ludvigson (2001) (Table C.9)—and when computing the growth rates of the tested predictors on a quarter-to-quarter basis (Table C.10).

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[14] With respect to shock identification, we alternatively pursue a max-share strategy based on Francis et al. (2014). This yields structural shocks that correlate in a 92%-98% range with those employed in the baseline analysis.

4 Framing the empirical analysis

Some key facts stand out from the empirical analysis. Most notably, relative consumption and income display markedly different cyclical behaviors in response to various sources of structural perturbation. Thus, we demonstrate how such evidence is strategic in examining fluctuations in stock returns, whose predictability appears to be connected with both *aggregate risk*—as captured by the rate of growth of aggregate consumption—and consumption/income *redistribution risk* stemming from FS shocks.

We now devise a production-based asset-pricing model featuring limited asset market participation, and show how it replicates most of our empirical findings. This model embeds a direct mapping between relative consumption and the dividend-to-wage income ratio, allowing for a clear interpretation of the mechanics underlying stock-return predictability. We employ the model to examine the relative contribution of each shock to macroeconomic and asset-pricing moments. Finally—and related to the previous point—our theoretical setup enables us to explore how the aforementioned moments are impacted by household heterogeneity in asset-holding status.

4.1 Setup

The model features concentrated capital ownership. Non-assetholders, who constitute a fraction γ of the unit-mass population, are assumed to be excluded from the bond and the stock markets, thus behaving in a hand-to-mouth fashion, and consuming labor income in every period. Assetholders, who represent the complementary fraction $1-\gamma$ of the population, own firms through equity shares, and smooth consumption intertemporally by trading one-period bonds. Both agents are assumed to inelastically supply their entire time-endowment to the firms. The economy's supply side is standard, with firms producing according to a Cobb-Douglas technology with an exogenously time-varying labor share of income and facing capital adjustment costs.[15] Assetholders feature external habit preferences, which generate countercyclicality in risk aversion and excess stock returns (Campbell and Cochrane, 1999). Combined with capital adjustment costs, these preferences sensibly improve the asset-pricing performance of models with endogenous production (Jermann, 1998; Chen, 2017). Appendix D contains all the analytical details about the model economy. Furthermore, Section 4.6 discusses two model variations, one with bondholders (along with stockholders), and one with firm leverage. Both economies deliver numerical evidence that is broadly in line with that from the baseline economy.

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[15] As discussed in Blanchard (1998), time variation in the exponent of the aggregate Cobb-Douglas production function can be rationalized by the introduction of new technologies that lead to a larger proportion of capital-intensive methods. This mechanism manifests itself as an increase in the income share of capital in the aggregate production function.

The model features the same aggregate shocks considered in the empirical analysis. The dynamics of the three exogenous state variables are governed by the trivariate VAR outlined in Section 3.1. Inspired by Ríos-Rull and Santaeulalia-Llopis (2010), we regard the VAR specification as a flexible tool to capture endogenous dynamic interactions between TFP, IST, and the labor share.[16] This modeling strategy contrasts with the traditional approach of assuming independent autoregressive processes for the shocks, thus calibrating them to match the dynamics of macroeconomic data. In fact, our approach is in line with Chari et al. (2007) in that TFP, the relative price of investment and the labor share are conceived as ”wedges”.

4.2 Household inequality and income redistribution

In this section, we highlight a key relationship between relative consumption and the dividend-to-wage ratio that enables us to rationalize the conditional dynamics of relative consumption and its implications for asset pricing. To this end recall that, being excluded from financial markets, non-assetholders consume their wage every period, $c_t^{na} = w_t$. On the other hand, assetholders have access to both the bond and the stock market. It can be shown that, in equilibrium, the consumption of the representative assetholder reads as (see Appendix D)

$$c_t^a = w_t + \frac{d_t}{1-\gamma}, \tag{5}$$

meaning that the representative asset-market participant consumes the wage plus the dividends accruing from firm ownership.[17]

Given the equilibrium consumption levels for both agents, it is easy to see that relative consumption can be expressed as:

$$rc_t = 1 + \frac{1}{1-\gamma}\frac{d_t}{w_t}, \tag{6}$$

implying that the behavior of relative (per-capita) consumption entirely reflects income (re-)distribution between dividends and wages.[18] We test this prediction in the data, conditional on each of the three shocks. Figure 6 graphs the empirical response of after-tax dividend and labor income, as well as the response of (the log of) the ra-

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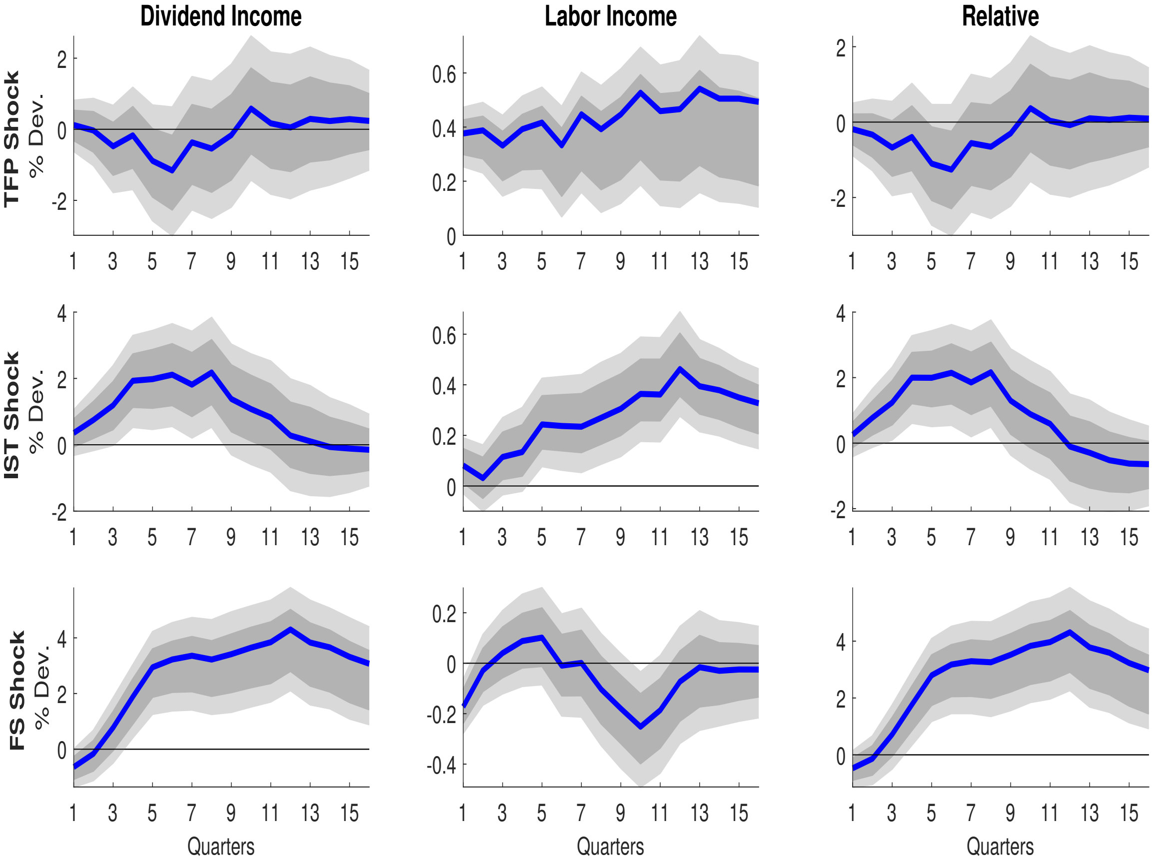
[16] For instance, Choi and Ríos-Rull (2020) show that a combination of putty-clay technology, time-bias—whereby shocks may affect newer firms in a stronger way than older firms—and competitive wage setting, can rationalize overshooting of the labor share, in response to a TFP shock.

[17] Notice that dividends are multiplied by the number of stocks held by the assetholder, $q_t^s = \frac{1}{1-\gamma}$, which derives from the stock market equilibrium condition, $(1-\gamma)q_t^s = 1$, where the supply of stocks is normalized to 1. On the other hand, as bonds are in zero net supply and perfect risk-sharing within groups applies, bond-holdings are always equal to 0, in equilibrium.

[18] This mapping holds, although only approximately, also in the model version featuring a levered corporate sector (see Section 4.6 and Appendix E).

Figure 6: Aggregate dividend and labor income



Notes: The figure displays the IRFs of after-tax dividend income, labor income and the ratio between the two to the identified neutral technology (TFP, top row), investment-specific technology (IST, middle row), and factor-share (FS, bottom row) shocks, estimated over the sample 1982Q4-2017Q4. Dark and light-grey shaded areas represent the 68% and 90% confidence intervals, respectively.

tio between the two. TFP shocks disproportionately affect labor income. By contrast, both IST and FS shocks tend to favor dividend income more than labor income, implying a significant expansion in their ratio. Moreover, the impulse responses emphasize the transient nature of the shift between financial and labor income. This provides an additional source of risk beyond long-term movements in the labor share of income, which instead play a pivotal role in, e.g., Santos and Veronesi (2006) and Greenwald et al. (2019).

4.3 Setting the model to work

The model is solved using second-order perturbation methods. Its parameters are split in two groups. The first group is calibrated to match targeted long-run relationships, while the second group is estimated both via impulse-response matching, as well as by matching a subset of selected unconditional macroeconomic moments. Specifically, the estimated coefficients include the capital adjustment cost parameter, the consumption utility curvature parameter, the parameter capturing the persistence of the habit stock, as well as the parameters of the VAR governing the dynamics of the exogenous process for TFP, the relative price of investment, and the labor share. The estimates are obtained so as to match the responses of TFP, the relative price of investment, and the labor share to the TFP, IST, and FS shocks, as we report in Figure 1. We also target the volatility of (the growth rate of) output, consumption, investment, and dividends, as well as the correlation between the growth rates of dividends and output. Appendix D.1 provides further details on the calibration exercise, the resulting estimates, and matched moments.

Unconditional moments The framework does a fairly good job at replicating both targeted unconditional moments, as well as some non-targeted moments, such as the unconditional volatility of relative consumption (0.45 in the model vs. 0.68 in the data), and key asset-pricing moments.[19] Focusing on the latter, recall that restricting access to financial investment to a limited number of households raises the equity premium they demand, through the connection between their consumption growth and financial income, which is intrinsically more volatile. In fact, we can reproduce plausible excess stock returns, both in level and volatility. The average equity premium is 4.59 (vs. 4.39 in the data), while its volatility is 19.94 (vs. 15.67 in the data).[20] We are also successful at reproducing a plausible risk-free rate (1.17, vs. 1.07 in the data), though this denotes a certain excess volatility, as compared with the data. As in Jermann (1998) and Lansing (2015), consumption habits and capital adjustment costs, while necessary to generate sufficiently volatile stock returns, induce strong variability in investors' marginal utility, which inevitably reflects into a rather volatile risk-free rate.

Conditional dynamics All shocks are associated with broad comovement of output, aggregate consumption and investment, in line with the evidence we provide in Figure 2. Through Figure 7, we evaluate the capacity of the model to reproduce the cyclical properties of consumption and income redistribution between the two representative households, conditional on each shock. Expansionary FS shocks are associated with a positive response of relative consumption, as well as with a stronger response of dividends with respect to labor income. This is also the case for IST shocks, albeit to a more limited extent. Conversely, expansionary TFP shocks induce a countercyclical change in relative consumption, which reflects higher sensitivity of labor income with respect

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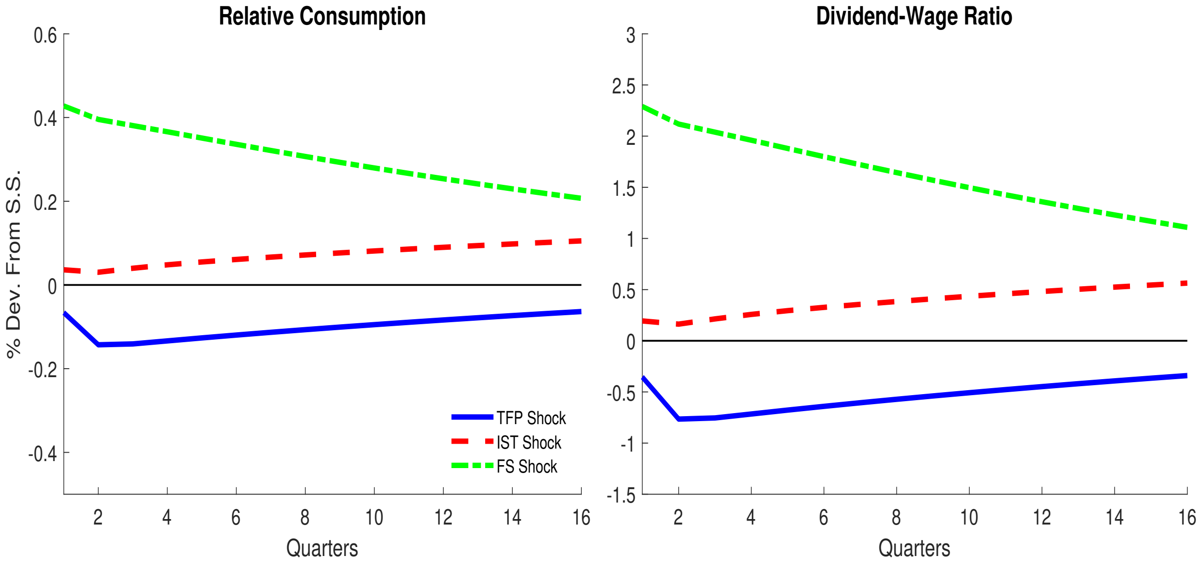
[19] It is worth recalling that, given that the shock structure is imported from our VAR estimates, the calibration entirely relies on the habit parameter and the capital adjustment cost, to target 5 unconditional macroeconomic moments.

[20] The empirical equity premium is estimated following Fama and French (2002), rather than by using average historical excess returns. As argued by the authors, using the latter would largely overestimate the true equity premium, especially when considering the post-WWII period.

Figure 7: Relative consumption and dividend-wage ratio - IRFs



Notes: Responses of relative consumption and dividend-to-wage ratio to TFP, IST, and FS shocks.

to dividend income. Notably, the model-implied IRFs—for both relative consumption and different income sources—are quantitatively consistent with their empirical counterparts, if one abstracts from the lack of a gradual buildup of responses.[21] From a *quantitative* viewpoint, allowing for dynamic interaction among TFP, the relative price of investment, and the labor share turns out to be important to reproduce results in line with the empirical findings.[22] Without such interaction, dividends would otherwise increase persistently after a rise in TFP. By contrast, in Section 3.1 we have documented that an exogenous TFP increase is associated with a rise in the relative price of investment and the labor share of income (after the first period, in this second case), with both effects exerting a negative force on dividends, in line with Figure 6. Coherently, the model produces a relatively muted response of dividends to a TFP shock.

Stock-return dynamics To provide a structural interpretation of the connection between the conditional response of relative consumption and stock returns, Figure 8 reports the Generalized IRFs of the stochastic discount factor (SDF)—as dictated by assetholders' consumption—dividend growth, as well as realized and expected ex-

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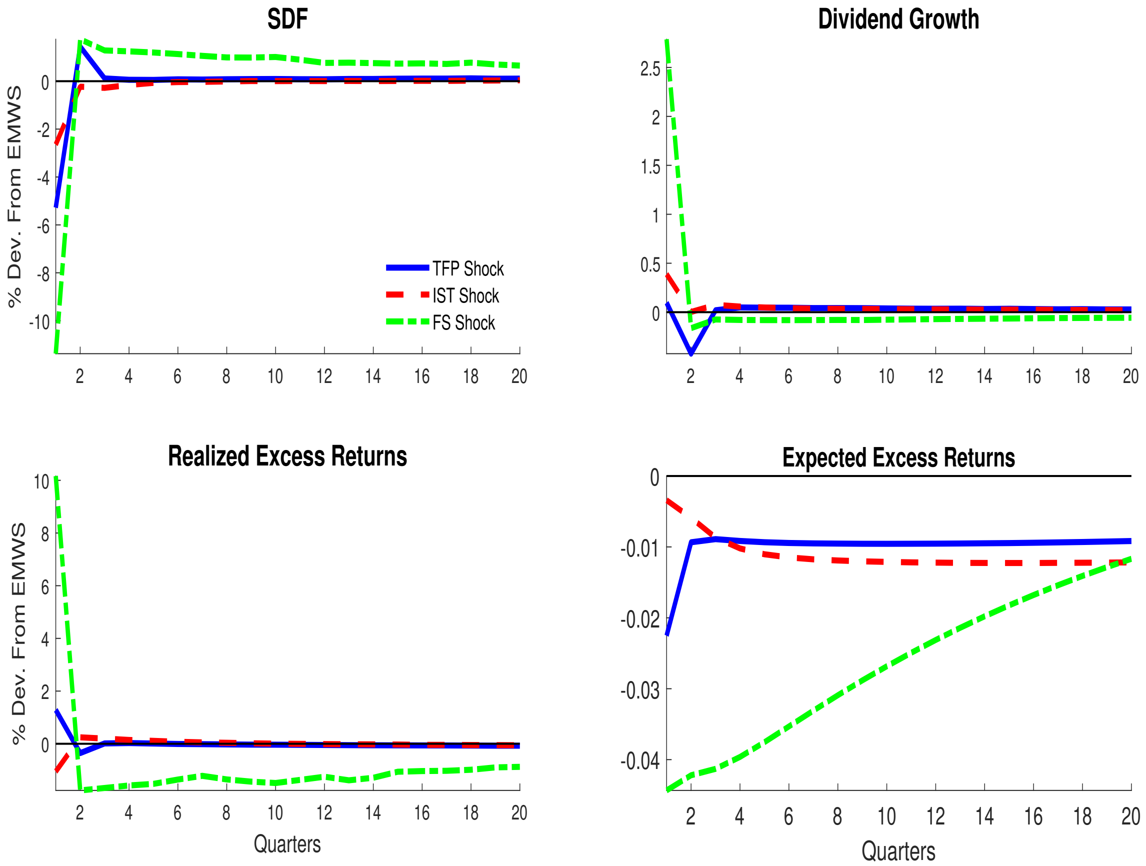
[21] For instance, the peak response (which is reached on impact, in the model) of relative consumption to the FS (TFP) shock is about 0.42% (-0.15%), which is comparable with the IRFs displayed in Figure 3. In addition, the responses of both relative consumption and the dividend-to-labor ratio to the IST shock are relatively more muted, in line with the empirical evidence of Section 3.

[22] We check that the core results in this section carry over, at least qualitatively, in a version of the model where exogenous dynamics for TFP, the relative price of investment, and the labor share follow separate univariate autoregressive processes, rather than being accounted for our baseline VAR structure.

Figure 8: Excess stock returns - IRFs



Notes: Stochastic discount factor, dividend growth and realized and expected excess stock returns responses to TFP, IST, and FS shocks. Generalized IRFs are computed in percent deviation from the ergodic mean with shocks (EMWS). Average GIRFs are computed across 500 replications.

cess stock returns (all in percentage percent deviations from their ergodic mean).[23] All shocks are expansionary, raising assetholders' consumption above the habit level, as dividend income increases (although very mildly so, in the face of TFP shocks). Concurrently, their marginal utility of consumption declines, as implied by the on-impact drop in the SDF. However, those gains are expected to revert—more so, in connection with FS shocks—as the SDF overshoots from the second period after the shock occurs. Indeed, FS shocks trigger a redistribution of resources in favor of assetholders that is only temporary in nature (as we also show in Figure 7). In contrast, technology shocks of either type are associated with much smaller variation in investors' marginal utility and dividend growth.

The strong impact of FS shocks on dividend growth and assetholders' consumption

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[23] As it is well-known, a higher-order approximation is required to produce time variation in expected excess returns (see, e.g., Jaccard, 2014). Therefore, the results for Figure 8 and the predictive regressions with simulated data that we report below are obtained through a third-order approximation of the model solution. Specifically, the Generalized IRFs are computed in deviations from the ergodic mean with shocks (EMWS), which implies that, given a point in the state space, future shock realizations are averaged out (see Born and Pfeifer, 2014, for a discussion). Average IRFs are computed across 500 replications.

reflects in the positive response of realized excess stock returns. Relative to technology shocks, FS shocks render stocks particularly risky, as they command high payoffs in good times, i.e. when the marginal utility of consumption is relatively low. Notably, the excess return response largely exceeds that of dividend growth: through the lens of the Campbell and Shiller (1988) decomposition, this property indicates that also stock valuations rise substantially, a fact that is consistent with the countercyclicality of risk aversion induced by habit preferences. Focusing on FS shocks, these are associated with a strong negative response of expected excess returns, which reflects the classical "mean reversion"—i.e., realized and expected stock returns are negatively correlated (see, e.g. Campbell, 1991; Campbell and Cochrane, 1999). To a lesser extent, this property also holds in connection with TFP shocks. By contrast, IST shocks lead to a modest increase in dividends without exerting a large impact on prices, thus implying a (mildly) negative response of realized returns, a fall in the price-to-dividend ratio, and protractedly negative expected returns.

4.4 Macroeconomic and asset-pricing drivers

Our quantitative setting allows us to ask which shock acts as the main driver of macroeconomic and asset-pricing variables.

Shock contribution Table 4 reports the relative contribution of each shock to the macroeconomic (top panel) and asset-pricing (bottom panel) moments of interest. As for the volatility of macroeconomic variables, the shock decomposition is performed over both the short run (up to 16 quarters) and the long run. As for asset-pricing variables, instead, we only decompose their long-run moments.[24]

Shock decompositions highlight a clear disconnect between asset-pricing and macroeconomic drivers. Technology shocks (both investment-specific and neutral) are responsible for a large part of business fluctuations, jointly accounting for roughly 70% of the (unconditional) volatility of output, investment and consumption. In fact, both the short-run and the long-run decompositions consistently identify IST shocks as the main drivers of macroeconomic fluctuations, in line with Justiniano and Primiceri (2008). Turning our focus to the equity premium, IST shocks account for a negligible fraction of its volatility, consistent with the fact that such shocks emerge as being rather neutral, in terms of consumption redistribution between the two classes of households, as indicated by the empirical analysis of Section 3. Though to a lesser

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[24] The short-run variance decomposition is performed as in den Haan (2000), while the shock contribution to long-run moments is obtained by following Jensen et al. (2018). Specifically, for the generic stationary variable x and the corresponding moment $\mathcal{M}(x)$, the relative contribution of shock ξ to the moment of interest is defined as $\mathcal{M}(x)_\xi = \frac{\mathcal{M}(x)-\mathcal{M}(x)_{-\xi}}{\sum_\xi[\mathcal{M}(x)-\mathcal{M}(x)_{-\xi}]}$ for $\xi = u^\mu, u^z, u^\alpha$, where $\mathcal{M}(x)_{-\xi}$ is the unconditional moment of x when shock ξ is turned off.

Table 4: Shock contribution

Moment		TFP	IST	FS
Macro aggregates				
$\sigma^2_{\log(\tilde{y})}$	SR	16.5	56.8	26.6
	LR	12.9	57.4	29.7
$\sigma^2_{\log(\tilde{c})}$	SR	25.9	59.1	14.9
	LR	17.7	55.5	26.8
$\sigma^2_{\log(\widetilde{inv})}$	SR	6.8	49.5	43.6
	LR	8.5	58.5	33
$\sigma^2_{\log(\widetilde{rc})}$	SR	9.4	4.9	85.6
	LR	7.6	53.1	39.3
Financial moments				
$E(r^b)$		16.8	4.1	79.1
$E(r^s - r^b)$		5.6	-2.2	96.6
$\sigma^2_{r^b}$		28.1	5	66.9
$\sigma^2_{(r^s - r^b)}$		1.5	1	97.5

Notes: Each entry indicates the (percentage) contribution of the corresponding shock to a specific macroeconomic or asset-pricing moment. Along each row, the sum of the three shock contributions amounts to 100. For the macroeconomic variables, the decomposition is presented over both the short run (SR) and the long run (LR). For the asset-pricing variables, the decomposition is only presented in terms of long-run moments.

extent, this is also the case for TFP shocks, which have traditionally been considered a key source of risk in production-based asset-pricing models. Therefore, TFP and IST shocks play a marginal role when it comes to reproducing fluctuations in asset prices, whereas the first and second moments of the equity premium and, to a lesser extent, the risk-free rate, can almost entirely be attributed to FS shocks.

Notably, while the unconditional volatility of relative consumption is mostly explained by IST and FS shocks, its short-run volatility stems almost exclusively from the latter. This finding is key to understanding the emergence of a disconnect between the drivers of financial volatility and macroeconomic fundamentals. To build intuition, assume power utility and joint log-normality,[25] and note that the log-expected excess stock return can be expressed as follows:

$$
\begin{aligned}
E(r^s_t - r^b_t) &= \text{RRA} \times Cov(g_{c^a,t}, r^s_t) \\
&= \text{RRA} \times [Cov(g_{c,t}, r^s_t) + \kappa Cov(g_{rc,t}, r^s_t)]. \qquad (7)
\end{aligned}
$$

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[25] While these assumptions allow for closed-form solutions, they necessarily neglect the impact of fluctuations in effective risk aversion, as implied by habit preferences, on asset-pricing moments. However, in this model relative risk aversion is countercyclical conditional on each type of shock, and the magnitude of the three impulse responses is quite similar (see Figure D.2 in Appendix D). Therefore, we believe that preserving the assumption of habit utility would not alter our conclusions.

The average equity premium is determined by the product between assetholders' risk aversion (RRA) and the covariance between their consumption growth and realized stock returns. The latter reflects aggregate consumption growth as well as relative consumption growth, which allows us to express $Cov(g_{c^a,t}, r^s_t)$ as a linear function of the covariances of $g_{c^a,t}$ and $g_{rc,t}$ with the return on the risky asset. Notice how, if positive and sufficiently large, $Cov(g_{rc,t}, r^s_t)$—which disappears in a representative-agent economy—helps match a relatively high equity premium. According to Figures 7 and 8, FS shocks emerge as the only disturbance that generates large positive comovement between relative consumption and stock returns, given the strong sensitivity of the dividend-to-wage ratio to this shock. Conditional on technology shocks, instead, such covariance appears negligible. A similar argument applies to the risk-free rate:[26]

$$\begin{aligned} E(r^b) &= -\frac{1}{2}\text{RRA}^2 \times Var(g_{c^a,t}) \\ &= -\frac{1}{2}\text{RRA}^2 \times [Var(g_{c,t}) + \kappa^2 Var(g_{rc,t}) + 2\kappa Cov(g_{c,t}, g_{rc,t})], \end{aligned} \tag{8}$$

where the second iteration rests, again, on equation (3). The above expression indicates how FS shocks help match a relatively compressed risk-free rate by inducing strong procyclicality and volatility in relative consumption (i.e., a large positive $Cov(g_{c,t}, g_{rc,t})$ and large $Var(g_{rc,t})$). The procyclical redistribution of resources induced by shifts in the factor shares strengthens investors' precautionary-saving motive (as captured by the second-order terms in (8)), which in turn increases the demand for bonds.

Predictive regressions with simulated data Table 4 reports the decomposition of unconditional (long-run) asset-pricing moments. To study the model-implied drivers of short-run fluctuations in asset prices—with a special focus on excess stock returns—we replicate the estimation of regression (4) with simulated data. Panel A of Table 5 reports the estimated coefficients when featuring the growth rates of aggregate and relative consumption as regressors. The slope coefficients are quite consistent—both in terms of sign and size—with those reported in Table 2, suggesting that the dynamics of relative consumption are significantly connected with fluctuations in expected future returns, even after controlling for aggregate consumption. Again, a natural question is to what extent this result is driven by technology rather than by redistribution shocks. In this respect, Panel B confirms that the model attributes to fluctuations induced by FS shocks the entirety of relative consumption's predictive power of future excess returns.

In line with the empirical estimates reported in Table 2, the regressions with artificial data indicate that higher aggregate (relative) consumption growth predicts lower (higher) excess returns in the future. Moreover, the regressions replicate the decline in

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[26] For simplicity, we ignore constants and impose zero average consumption growth (as in the model).

the coefficients attached to relative consumption as a function of the predictive horizon. The theoretical setup allows us to provide a more transparent interpretation of the sign of the coefficients. As seen in Figure 8, countercyclical expected excess returns—as captured by the negative coefficient on aggregate consumption growth—stem from external habit preferences: booms are times of relatively low risk aversion, as investors' consumption rises above the habit, which in turn commands lower required stock returns in the following periods (Campbell and Cochrane, 1999).

Concurrently, only booms associated with FS shocks are periods that temporarily benefit financial relative to labor income, which maps into higher consumption inequality (as in Figure 7). Therefore, these disturbances generate an expansion in assetholders' consumption that is mostly financed by higher dividend rather than labor income. In turn, this tight link between investors' consumption and financial income dynamics entails a strong covariation with the stock market that naturally commands higher returns (hence, positive regression coefficients). Nevertheless, shifts in the rewards of production (towards capital owners) are transitory in nature, and are therefore expected to mean-revert. Temporarily high returns are followed by lower expected returns that are associated with negative relative consumption growth in the periods after the initial expansion. As a result, the coefficient attached to relative consumption growth declines as the forecast horizon rises. This mechanism can alternatively be gauged from Figure 8: following an expansionary FS shock, the SDF overshoots, while expected excess returns decline.

4.5 On the role of household heterogeneity

As a last exercise, we examine the specific contribution of concentrated capital ownership to the results detailed so far. To this end, we perform simple comparative-statics exercises, contrasting a RA benchmark to two alternative two-agent (TA) economies that only differ in the degree of asset-market participation. Specifically, we set the share of hand-to-mouth households (γ) to 0.33—as in the baseline—or to 0.8—in line with previous studies that aim at matching the striking heterogeneity between wealthy households and the rest of the population (e.g., Guvenen, 2009; De Graeve et al., 2010; Lansing, 2015; Lansing and Markiewicz, 2017).[27] Otherwise, we stick to the baseline calibration of all other parameters.

Table 6 summarizes the results by reporting macroeconomic and asset-pricing moments, both unconditionally and conditioning to each of the shocks separately. For the RA ($\gamma = 0$) benchmark, we report moments in absolute value. As for the TA economies, we report the same moments relative to the RA benchmark (in percent).

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[27] In our baseline model configuration, non-stockholders have no access to financial markets. Section 4.6 shows that all our core results go through when allowing these households to trade bonds, as in Guvenen (2009) and De Graeve et al. (2010).

Table 5: Predictive regressions - Simulated data

	Panel A		Panel B			
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g_{rc,t}$		$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g^{TFP}_{rc,t} + \beta_3 g^{IST}_{rc,t} + \beta_4 g^{FS}_{rc,t}$			
h	β_1	β_2	β_1	β_2	β_3	β_4
1	**-1.12** (0.54) [0.04]	**2.91** (1.04) [0.01]	**-1.92** (0.78) [0.01]	-1.22 (3.07) [0.69]	6.46 (4.69) [0.17]	**4.42** (1.54) [0.00]
4	-0.39 (0.42) [0.35]	**1.68** (0.82) [0.04]	**-1.11** (0.60) [0.06]	-2.15 (2.44) [0.38]	3.54 (3.87) [0.36]	**3.13** (1.18) [0.01]
8	-0.49 (0.31) [0.11]	**1.37** (0.67) [0.04]	**-1.17** (0.47) [0.01]	-2.33 (1.80) [0.20]	2.53 (3.20) [0.43]	**2.79** (0.97) [0.00]
12	**-0.60** (0.26) [0.02]	**1.01** (0.56) [0.07]	**-1.24** (0.41) [0.00]	-2.42 (1.55) [0.12]	2.20 (2.81) [0.43]	**2.34** (0.85) [0.01]
16	**-0.59** (0.23) [0.01]	**0.88** (0.48) [0.07]	**-1.10** (0.35) [0.00]	-1.99 (1.38) [0.15]	1.54 (2.44) [0.53]	**1.95** (0.74) [0.01]
20	**-0.58** (0.21) [0.01]	**1.03** (0.44) [0.02]	**-0.93** (0.32) [0.00]	-1.12 (1.21) [0.36]	0.85 (2.13) [0.69]	**1.80** (0.67) [0.01]

Notes: The table presents results of predictive regressions, estimated on simulated data, of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which includes: in Panel A, aggregate and relative consumption growth; in Panel B, aggregate consumption growth and relative consumption growth conditioned on each shock at a time. Growth rates are computed as 8-quarters log-differences. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The regressions are estimated over the last 2000 observations of a simulated sample of $50,000$ periods. Simulated time-series data are obtained by solving the model by third-order perturbation methods.

Table 6: Effects of household heterogeneity

		Macro aggregates					Asset prices		
		RA	TA				RA	TA	
			$\gamma = 0.33$	$\gamma = 0.8$				$\gamma = 0.33$	$\gamma = 0.8$
		Abs.	**Rel. to RA (%)**				**Abs.**	**Rel. to RA (%)**	
$\sigma_{\log(\tilde{y})}$	unc.	7.28	0.5	0.4	$E(r^b)$	unc.	1.54	-23.5	-85.1
	TFP	2.58	1.75	4.72		TFP	3.76	0.96	2.8
	IST	5.63	-1.45	-6.6		IST	4.21	-0.41	-2.4
	FS	3.83	4.08	12.4		FS	2.21	-17.1	-59.1
$\sigma_{\log(\tilde{c})}$	unc.	5.30	0.15	0.96	$E(r^s - r^b)$	unc.	3.96	15.9	57.1
	TFP	2.24	-0.32	-0.76		TFP	0.29	-11.3	-36.6
	IST	3.96	-0.15	-0.52		IST	-0.09	12.1	48.3
	FS	2.72	1.1	5.1		FS	3.76	17.9	64.1
$\sigma_{\log(\tilde{inv})}$	unc.	13.47	0.87	0.95	σ_{r^b}	unc.	4.10	10.9	37
	TFP	3.81	3.9	10.2		TFP	2.11	14.1	46.4
	IST	10.71	-3	-13.7		IST	0.98	2.9	12
	FS	7.22	8.1	25.3		FS	3.37	10.3	35.2
					$\sigma_{(r^s - r^b)}$	unc.	18.44	8.1	27.6
						TFP	2.86	-9	-31.8
						IST	1.88	4.6	8.1
						FS	18.14	8.5	28.8

Notes: The entry for the RA column ($\gamma = 0$) reports the (unconditional or conditional) moment of interest in absolute value. Each entry for the TA columns indicates the percent variation in the moment relative to the RA economy. Results for the TA economy are shown for both the baseline value of the fraction of non-assetholders ($\gamma = 0.33$) and for $\gamma = 0.80$.

The degree of asset market participation has an extremely muted impact on the volatility of the three macroeconomic aggregates. Conversely, restricting access to financial markets has a remarkable impact on the asset-pricing front: at $\gamma = 0.8$, the average equity premium (risk-free rate) increases (decreases) by 57.1% (85.1%), relative to the RA case. This marked non-linearity primarily stems from the curvature of the exposure factor, $1/(1-\gamma)$, which weighs assetholders' dividend income in their budget constraint.

In line with the results in Table 4, the conditional analysis reveals that household heterogeneity is not enough to generate realistic asset-pricing features when the model only contemplates technology shocks. For example, conditional on TFP and IST shocks, the RA benchmark generates an extremely high (low) risk-free rate (equity premium), and the introduction of household heterogeneity does not improve the picture. If anything, the conditional countercyclicality of consumption inequality induced by TFP shocks—which entails both $Cov(g_{rc,t}, r_t^s) < 0$ and $Cov(g_{c,t}, g_{rc,t}) < 0$—implies that limiting access to the asset market further depresses the average and the volatility of excess returns, conditional on this type of disturbances. On the contrary, the TA structure significantly tilts the asset-pricing moments in the 'right' direction, conditional on FS shocks, which trigger a marked procyclicality of consumption inequality. In summary, despite the model features habits and capital adjustment costs as standard propagators, household heterogeneity *per se* is not sufficient to replicate asset-pricing moments. Instead, it is the interplay between household heterogeneity and shocks that induce procyclical consumption inequality that matters, in this respect.

4.6 Robustness

In this section, we summarize two extensions of the baseline model, which relax some of its basic assumptions (see Appendix E for details). First, we explore a model allowing non-stockholders to trade with stockholders in the bond market (see Guvenen, 2009; De Graeve et al., 2010). Second, we consider an economy where the representative firm finances a constant fraction of its capital stock through the emission of long-term bonds, akin to Jermann (1998).[28]

When allowing agents to smooth income fluctuations via bond trade, the exact mapping between relative consumption and the dividend-to-wage ratio, as from equation (6), is disrupted (see Figure E.1). Noticeably, in this setting the ability of both agents to save and smooth consumption reflects in more gradual adjustments in relative consumption, which brings the overall picture closer to the evidence documented in Section 3. However, the analysis of shock contribution (Table E.2), expected return dynamics (Figure E.2), and the sensitivity of artificial data moments to household heterogeneity (Table E.3) still point to FS shocks as the primary risk source in financial markets, despite their muted contribution to macroeconomic fluctuations. Finally, introducing a *levered* corporate sector has a direct impact on dividends and stock return dynamics. However, due to the Modigliani-Miller theorem, it has no effect on real allocations. This factor disrupts the mapping in equation (6), as shown in Figure E.3. However, the essential picture remains unchanged, as detailed in Tables E.5-E.6 and Figure E.4.

5 Conclusion

Technology and redistributive shocks induce markedly different responses of the consumption and income of households sorted according to their assetholdings. Only shocks to the income share of the production factors generate sizable procyclicality in relative consumption and income. This property is key to replicating stylized asset-pricing facts. Moreover, we show that the risk associated with redistributive shocks is closely linked to the time variation in expected excess returns. The facts we highlight are useful to distinguish among different theories that are seemingly consistent at the

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[28] In both cases, we re-estimate the parameters using the baseline procedure.

aggregate level, while implying very different properties at the household level. A model with concentrated capital ownership is able to account for our empirical evidence, with the propagation of each type of shock resting on its capacity to stimulate dividend *vis-à-vis* labor income, a prediction that is robustly confirmed by the data. In this setting, household inequality is quantitatively irrelevant to macroeconomic volatility, while being central to the understanding of asset prices.

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Internet Appendix to
Asset Market Participation, Redistribution, and Asset Pricing

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A Data sources

Below is reported the list of sources for the macroeconomic data employed in the empirical analysis. Unless otherwise noted, the data are provided by the Bureau of Economic Analysis (NIPA) and retrieved from the FRED website. Real per-capita measures are obtained by dividing nominal values by the U.S. population and the end-of-the-quarter monthly Consumer Price Index for all items computed by the Bureau of Labor Statistics.

- GDP: Gross Domestic Product, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. Code: GDP.
- Investment: Gross Private Domestic Investment, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. Code: GPDI.
- Non-durables: Personal Consumption Expenditures: Nondurable Goods, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. Code: PCEND.
- Services: Personal Consumption Expenditures: Services, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. Code: PCES.
- Durables: Personal Consumption Expenditures: Durable Goods, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. Code: PCEDG.
- Total Consumption: Non-durables + Services + Durables.
- CPI: Consumer Price Index for All Urban Consumers: All Items in U.S. City Average, Index 1982-1984=100, Monthly, Seasonally Adjusted. Code: CPIAUCSL. Aggregated to quarterly frequency by taking the end-of-quarter value. CPI Inflation is computed as the first log-difference in the quarterly series.
- Gross Income: Personal Income, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 1.
- Net Income: Disposable Personal Income, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 27.
- Wages: Compensation of Employees, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 2.
- Financial Income: Personal Income Receipts on Assets, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 13.

- Interest Income: Personal Interest Income, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 14.
- Dividend Income: Personal Dividend Income, Billions of Dollars, Quarterly, Seasonally Adjusted at Annual Rate. NIPA, Table 2.1, Line 15.
- Population: Population, Thousands, Quarterly, Not Seasonally Adjusted. Code: B230RC0Q173SBEA.
- Relative Price of Investment: Price of "equipment" relative to price of "consumption", Quarterly, Annualized Growth Rates (400×log-difference), from Fernald (2014).
- TFP: Business Sector (both not utilization-adjusted and utilization-adjusted) Total Factor Productivity, Quarterly, Annualized Growth Rates (400×log-difference), from Fernald (2014).
- Labor Share of Income: Nonfarm Business Sector: Labor Share, Index 2012=100, Quarterly, Seasonally Adjusted. Code: PRS85006173.
- Aggregate Hours: Index/Level and Office of Productivity And Technology and Work Hours: Hours Worked, Nonfarm Business. BLS. Code: PRS85006033. The per-capita measure is obtained by dividing over Population 16+.
- Population 16+: Civilian noninstitutional population, Level (in thousands), 16 years and over. BLS. Code: LNU00000000.
- Quarterly financial data are sourced from Amit Goyal's website (as discussed in Welch and Goyal, 2008), and the equity premium is computed from the average dividend yield and dividend growth following Fama and French (2002).

After-tax dividend and labor income. The definition of after-tax aggregate dividend and labor income series employed for the IRFs in Figure 6 in the main text follows Lettau and Ludvigson (2013) and relies on data from the NIPA, Table 2.1. Specifically, after-tax labor income is defined as compensation of employees (Line 2) + transfer payments (Line 16) − employee contributions for social insurance (Line 25) − taxes. Taxes are defined as [wages and salaries (Line 3) / (wages and salaries + proprietors' income with IVA and Ccadj (Line 9) + rental income (Line 12) + personal income receipt on assets (Line 13))] times personal current taxes (Line 26). After-tax dividend income is defined similarly as personal dividend income (Line 15) – taxes, where the latter are defined as above, but replacing dividend income at the numerator.

B Construction of household-level series from the CEX

In this appendix, we describe the dataset and preliminaries used to construct quarterly time series of consumption and income at the household level over the period 1982-2017 from the U.S. CEX.

B.1 Description of the dataset

The CEX is a national survey collecting household-level data on detailed consumption expenditures together with income, financial and demographic information on a sample that is designed to represent the non-institutionalized civilian population of the US. The survey is divided into two parts: the Interview Survey and the Diary Survey. The analysis developed in this paper focuses on the first one. Data from the CEX are available from the start of 1980 to the end of 2017. The survey is a rotating panel containing interviews of about 4,500 households per quarter before 1999, increasing to about 7,500 thereafter. About 20% of the sample is replaced each quarter. In each interview, households report detailed expenditures made in the previous three months. Households are interviewed every 3 months, for a maximum of 5 interviews. The first interview is just for practice, and as such is not made publicly available, while financial information is collected only in the last interview.

B.2 Sample choice

Our analysis employs data available for the whole sample (1980Q1-2018Q1). Standard restrictions are applied to the sample. Only households who completed the survey, i.e. for which five interviews are available in the FMLY/FMLI files, are included. Matching households across quarters is not possible around changes in sample design, which happened at the beginning of 1986, 1996, 2005 and 2015.[1] Such changes imply new household ID numbers. Therefore, all the households who did not finish their interviews before their ID changed are dropped.

Households with negative net income or incomplete income responses are excluded from the sample. Regarding the latter restriction, for the period 1980-2013 the variable RESPSTAT is used, which indicates whether the household is a complete or an incomplete income reporter. Since 2014 this variable is no longer available. Hence, we use the variable ERANKH, which measures the weighted cumulative percent expenditure outlay ranking of the household to total population is left blank for incomplete income

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[1] The year-specific documentation files report this type of information. These files can be found at: http://www.nber.org/ces

reporters. Moreover, all consumption observations for households interviewed in the years 1980 and 1981 are dropped as the ’food’ question was changed in 1982, leading to a drop in reported food expenditures.[2] Finally, we exclude all households who denote a change in the household head’s age between any two consecutive interviews that is different from either 0 or 1.

B.3 Assetholding status definition

The FMLY/FMLI files report household-level financial information on holdings of “stocks, bonds, mutual funds and other such securities” and of liquid accounts such as savings and checking accounts.

For the period 1980-2012, we use the following variables: SECESTX, which reports the amount of the household holdings in the aforementioned asset categories (on the last day of the month preceding the interview); CKBKACTX, which reports the amounts (at the last day of the month preceding the interview) “in checking accounts, brokerage accounts, and other similar accounts”; SAVACCTX, which asks “On the last day of (last month), what was the total amount your CU had in savings accounts in banks, savings and loans, credit unions, and similar accounts?”. Since 2013, these three variables were removed from the survey. However, at the same time a new variable STOCKX was added, which asks “As of today, what is the total value of all directly-held stocks, bonds, and mutual funds?”. Similarly, the new variable LIQUIDX was introduced, which measures the amounts invested in “checking, savings, money market accounts, and certificates of deposit or CDs”.

Given these variables, we define a household as an assetholder if the sum of SECESTX, CKBKACTX and SAVACCTX or STOCKX and LIQUIDX exceeds the threshold of 1000$. To keep comparability with the SCF variables, dollar amounts in year t are multiplied by the absolute variation between year $t-1$ and year t in the (yearly average of the monthly) current-methods version of the CPI for all urban consumers (CPI-U-RS).[3]

Crucially, indirect holdings cannot be retrieved from the CEX, as also noted by Malloy et al. (2009). In fact, the stock-market participation rate that we retrieve from this survey trends up until the early 2000s, to then stabilize around 10%, which is way below the actual share of US households that are typically classified as stockholders. Moreover, in 2013 the ’financial assets’ question was changed to consider only direct holdings. In fact, Lettau et al. (2019) argue that the CEX provides inferior measures

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[2] As noted by Malloy et al. (2009), the ’food’ question was changed back to the initial one in 1988, but there is no sensible way to solve this issue without losing a substantial number of observations.

[3] Available at: https://www.bls.gov/cpi/research-series/home.htm

for financial holdings, as compared with other surveys such as the SCF, which can potentially explain the lower estimated rates.

B.4 Imputation procedure

To refine the assetholding status definition to account for indirect holdings, we follow the imputation procedure proposed by Attanasio et al. (2002) and Malloy et al. (2009). Specifically, we perform a probit analysis based on the SCF. This dataset contains wealth information on both direct and indirect stock or assetholdings that can be used to predict the probability that a household holds assets, directly or indirectly, in the CEX. We use the SCF, from 1989 through 2016 (i.e., the last available year). For the asset definition we generate a dummy variable equal to 1 if the sum of (direct and indirect) holdings in equity, bonds, savings accounts, and checking accounts exceeds the threshold of 1000$.

Following Malloy et al. (2009), we then estimate a probit model where the dependent variable is the assetholding dummy and the regressors are the observable characteristics that are also available in the CEX: age, age squared, an indicator for the household head with education of > 12 but < 16 years (highschool), one for education > 16 years (college), an indicator for race not being white/caucasian, year dummies, (log) real total household income before taxes, an indicator for positive interest+dividend income, and a constant. We also include interaction terms between age and highschool (agehs) and between age and college (ageco).[4] Here are the estimated coefficients (with t-statistics in parentheses) from the probit regression for assetholdings:

$$
\begin{aligned}
x'_{SCF}b_{asst} = {} & \underset{(-56.72)}{-5.07} + \underset{(13.72)}{0.022} age - \underset{(-5.96)}{0.00008} age^2 + \underset{(14.75)}{0.51}\, highschool + \underset{(35.86)}{1.22}\, college \\
& - \underset{(-2.92)}{0.002} agehs - \underset{(-13.07)}{0.008} ageco - \underset{(-45.76)}{0.38}\, nonwhite + \underset{(1.57)}{0.03} Y_{1992} + \underset{(9.27)}{0.20} Y_{1995} \\
& + \underset{(15.93)}{.35}\, Y_{1998} + \underset{(20.19)}{0.43}\, Y_{2001} + \underset{(14.65)}{0.31}\, Y_{2004} + \underset{(17.50)}{0.37}\, Y_{2007} + \underset{(16.67)}{0.33}\, Y_{2010} + \underset{(16.30)}{0.32}\, Y_{2013} \\
& + \underset{(18.42)}{0.37}\, Y_{2016} + \underset{(44.36)}{0.37}\, log(income) + \underset{(73.13)}{0.95}\, (int + div > 0).
\end{aligned}
$$

We then use these coefficients to predict the probability that a household in the CEX holds assets as $\Phi(x'_{CEX}b_{asst})$, where Φ is the CDF of the standard normal distribution and x_{CEX} is the vector of the same regressors as in the SCF. When predicting the assetholding probability for a household in the CEX, we use the dummy *1992* coeffi-

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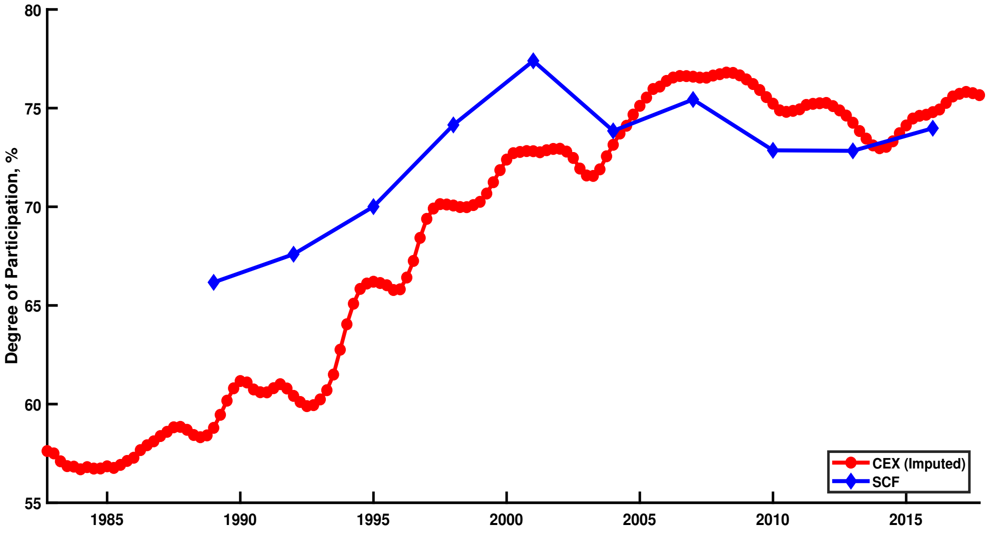
[4] Importantly, SCF weights are employed to map household-level estimates into population estimates.

Figure B.1: Direct and indirect asset-ownership rates



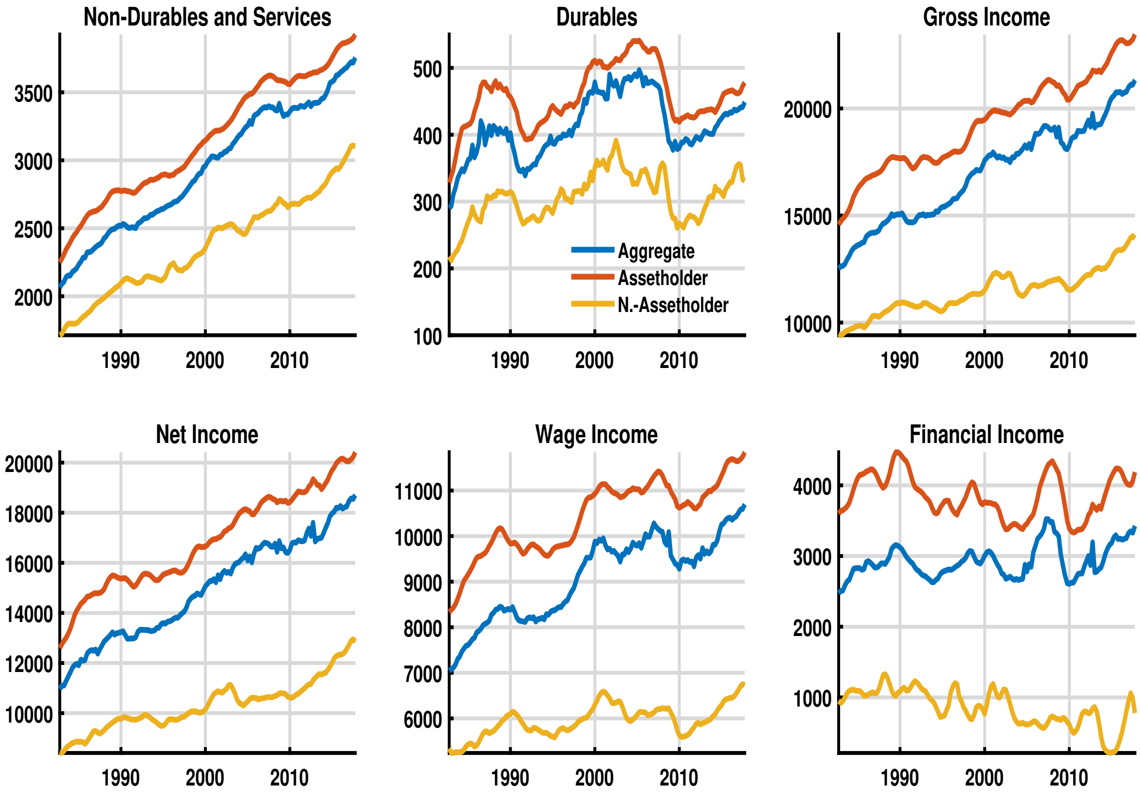
Notes: The figure compares the rates of direct and indirect asset-ownership, as measured from the SCF (blue line) and the CEX (red line).

cient for the years 1990-1993, the dummy *1995* coefficient for the years 1994-1996, the dummy *1998* coefficient for the years 1997-1999, and so on.

We employ a 'continuous' measure of participation, whereby every household contributes to the population weight, consumption and income of the representative assetholder, according to the predicted probability. Specifically, we use the probability predicted for the last month each household is observed, since financial information is reported only in the last interview. Notice that this imputation procedure is applied only to those households who have non-missing responses to all the questions involved in the imputation procedure. Otherwise, the household receives a probability 0 of being an assetholder.

Figure B.1 compares the resulting participation rate with the one from the SCF. As for the resulting consumption series, the participation rates in the CEX are smoothed through a backward-looking 4-quarters moving average filter. We can see that the imputed series closely tracks the original (SCF) one, with differences of the order of few percentage points. The level discrepancy between the two participation rates likely reflects the different survey designs. As stressed by Lettau et al. (2019), the SCF contemplates relatively wealthy households. On the other hand, the CEX has some well-known limitations, when trying to measure the top-end of the wealth distribution, mostly due to under-reporting.

Figure B.2: Household-level consumption and income



Notes: Selected consumption and income variables for the representative household (blue line) from the NIPA, together with the representative assetholder (orange line) and the representative non-assetholder (yellow line), as estimated from the CEX, based on the probability-weighted assetholding status imputed from the SCF.

B.5 Household-level consumption and income series

We compute consumption of non-durable goods and services and durable goods aggregated from the disaggregated expenditure categories reported in the monthly expenditure files (MTAB and MTBI files) of the CEX. Non-durables and services consist of food, alcoholic beverages, apparel and services, gasoline and motor oil, household operations, utilities, tobacco, public transportation, fees and admissions, personal care products, reading, other vehicle expenses, and other entertainment supplies, equipment, and services. Durable goods include purchases of vehicles, house furnishings, and tv and audio equipment. Finally, gross and net income are defined as before and after-tax income, respectively, while financial income is computed as the sum of dividend and interest income. Wage income is given by the sum of wages and salaries.

The ultimate aim of the analysis is to obtain time series of both consumption and income—for a representative assetholder and a non-assetholder—by employing the assetholding status definition obtained from the imputation procedure described above. To do so, we compute population-weighted quarterly mean expenditure and income by aggregating from monthly data, and following the formulae provided in the CEX documentation.[5]. Nominal expenditure values are deflated by the end-of-the-quarter CPI for all items, and divided by family size in order to obtain per-capita expenditures.

In line with Cloyne et al. (2019), the group-specific consumption expenditure and income series are adjusted every quarter by the ratio between the corresponding aggregate NIPA series and the estimated CEX aggregate. Finally, to limit some of the noise inherent to survey data and to seasonally adjust the consumption and income series, these are smoothed through a backward-looking moving average encompassing the current and the previous three quarters. Figure B.2 displays the results based on the chosen sorting criterion. Mean estimates are also calculated for the representative household, i.e. over the whole sample and for all households, so as to obtain an aggregate consumption estimate from the CEX. The final quarterly consumption and income series cover the sample 1982Q4-2017Q4.

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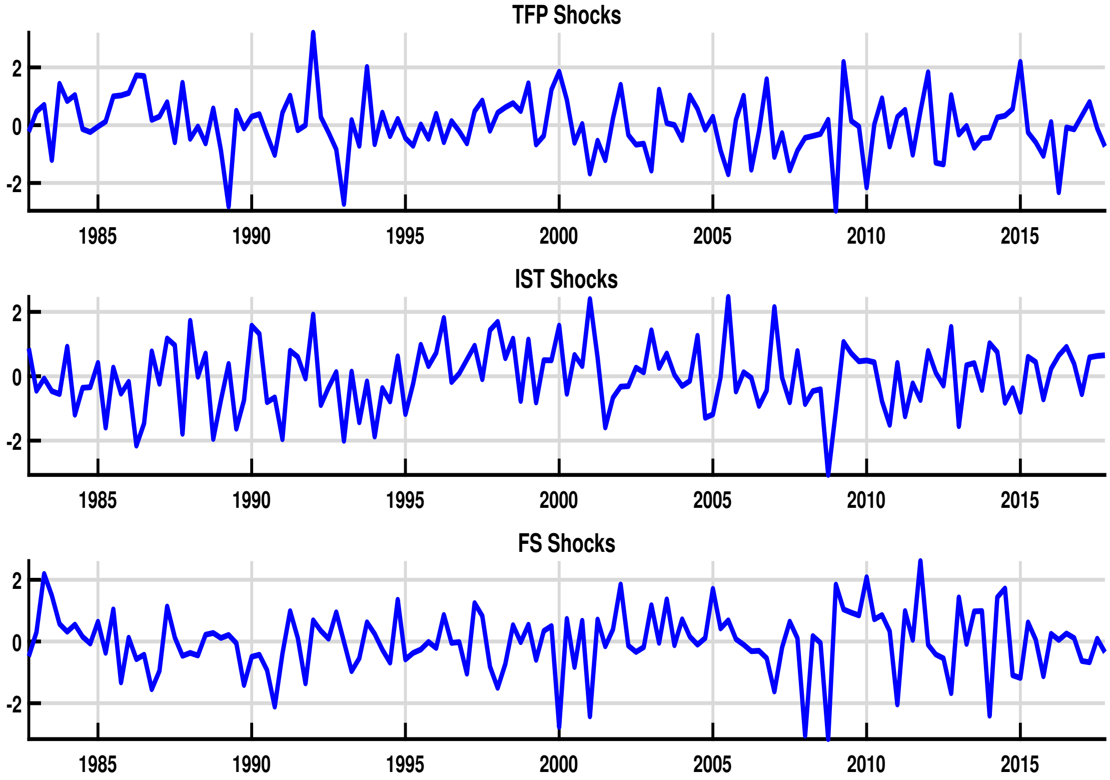
[5] In particular, we employ the example codes provided at the link: `https://www.bls.gov/cex/pumd-getting-started-guide.htm#section5`. These codes allow one to compute calendar period estimates.

C Additional results and robustness

In this appendix, we report, along with the identified shocks, additional evidence on the response of consumption and income inequality in Section 3.3, as well as on the predictive regressions in Section 3.4, together with all the details—including figures and tables—about the robustness exercises discussed in Section 3.5.

C.1 Identified structural shocks

Figure C.1: Structurally-identified shocks

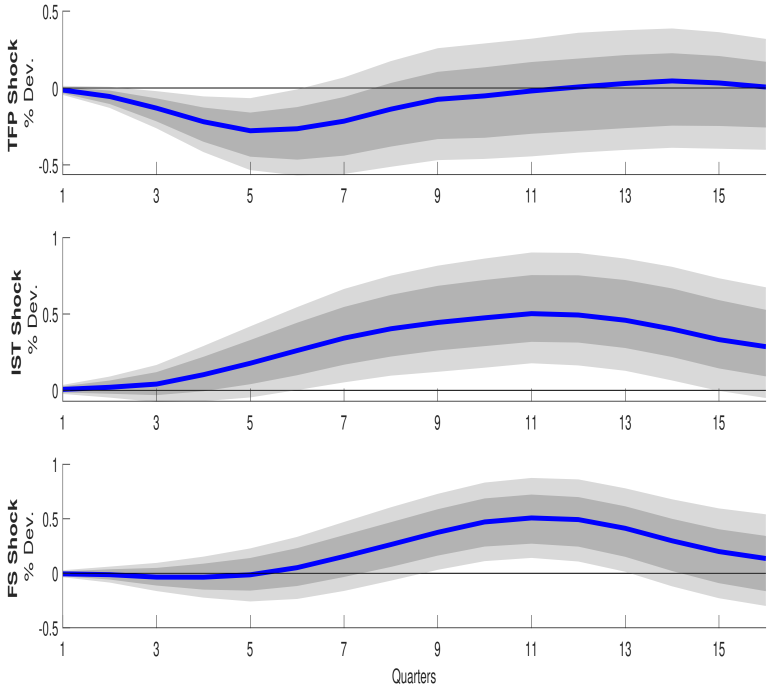


Notes: The figure displays the time series of the identified neutral technology (TFP, top panel), investment-specific technology (IST, middle panel), and factor-share (FS, bottom panel) shocks over the sample 1982Q4-2017Q4.

C.2 Compositional change

As discussed in the main text, the interpretation of changes in consumption and income by assetholders and non-assetholders as a causal effect of exogenous shocks requires that the same shocks do not cause a sizeable transition of households from one group to the other. To address this point, Figure C.1 reports the responses of the assetholders' population share to TFP, IST and FS shocks. All the three shocks generate statistically significant responses, with a peak response to TFP (IST and FS) shocks of about -0.4% (0.5%). Nevertheless, we argue that their economic significance is negligible. To see this, recall that assetholders constitute, on average, 67% of the population. Therefore, the IRF to a TFP (IST and FS) shock implies that the assetholding rate decreases (increases) from 67% to about 66.7% (67.3%) at the peak. Clearly, these fluctuations are extremely small, thus allowing us to interpret our estimated household-level consumption and income responses as the causal effect of exogenous shocks.

Figure C.1: Assetholders' population share

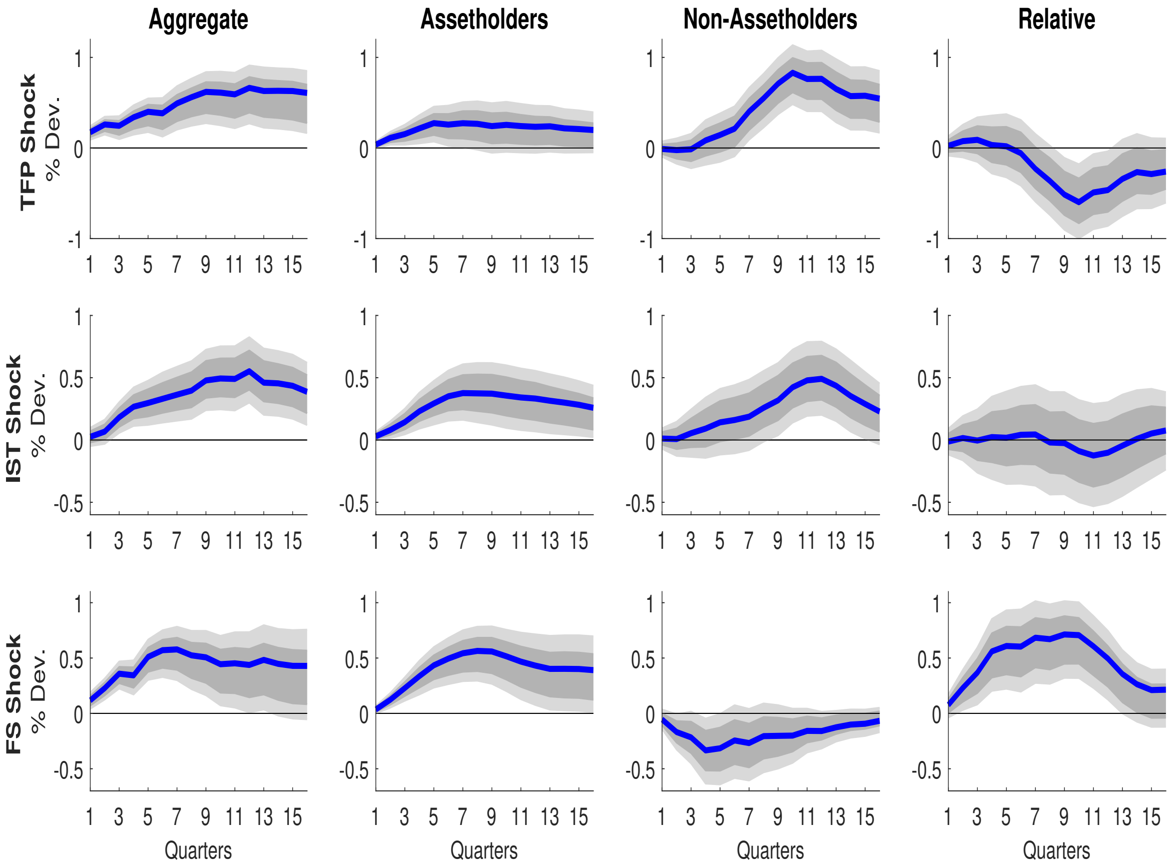


Notes: The figure displays the IRF of the assetholders' population share.

C.3 Total consumption responses

Figure C.2 reports the aggregate and household-level IRFs of total consumption, defined as the sum of non-durables and services and durable goods, for the baseline analysis. The inclusion of durables does not affect the conditional dynamics of relative consumption, which declines (rises) following TFP (FS) shocks and is not significantly affected by IST shocks.

Figure C.2: Total consumption



Notes: The figure displays the IRFs of total expenditure.

C.4 Cumulative responses: percentage and Dollar values

Table C.1 in reports the cumulative response of different measures of household-level consumption and income over 16 quarters, following the shock of interest. According to Panel A, following a positive TFP shock non-assetholders increase their spending on non-durables and services, as well as total consumption expenditure, by a statistically significant 5.35% and 6.59%, respectively, as compared to the 3.05% and 3.36% increase in assetholders' spending. Thus, consistent with the IRF analysis on relative consumption, TFP shocks exert long-lasting and large effects that favor, in relative terms, non-assetholders. Non-assetholders also denote a more marked rise in net income (8.82%, compared to 4.73% for assetholders).[6] As for the IST shock (Panel B), this triggers a rise in assetholders' total consumption (4.34%), which exceeds, albeit marginally, the overall upward adjustment in their net income (3.42%). At the

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[6] However, when looking at total consumption for each representative agent, this adjusts relatively less, as compared with their net income, suggesting that part of the increase in the disposable income is actually saved.

Table C.1: Cumulative responses

	Non-Durables and Services	Total Consumption	Net Income
	Panel A: TFP Shock		
Assetholders	3.05	3.36	4.73
	[0.99,4.25]	[1.19,4.69]	[2.73,5.72]
Non-Assetholders	5.35	6.59	8.82
	[3.07,6.82]	[3.95,8.42]	[5.28,10.69]
	Panel B: IST Shock		
Assetholders	4.02	4.34	3.42
	[2.55,5.32]	[2.46,5.87]	[1.9,4.75]
Non-Assetholders	2.01	3.84	1.46
	[0.67,3.52]	[2.28,5.76]	[-0.96,3.81]
	Panel C: FS Shock		
Assetholders	3.49	6.2	0.99
	[1.5,4.6]	[3.64,7.75]	[-0.75,2.23]
Non-Assetholders	-2.64	-2.87	-2.85
	[-3.71,-1.29]	[-4.33,-1.23]	[-4.68,-0.3]

Notes: Cumulative responses over 16 quarters to the identified neutral technology (TFP, Panel A), investment-specific technology (IST, Panel B), and factor-share (FS, Panel C) shocks, estimated over the sample 1982Q4-2017Q4. Bootstrapped 68% confidence intervals reported in brackets. The cumulative responses are computed as the present discounted value (given an average annual real interest rate equal to 1%) of the relative change in expenditure or income over the 16 quarters following the shock.

same time, the cumulative response of non-assetholders' income is statistically indistinguishable from zero, while their consumption rises by 3.84%. While this should imply an expansion of both consumption and inequality, there is substantial overlapping between the household-specific confidence bands associated with different variables, in line with Figures 3 and 4. Finally, following a FS shock (Panel C), the cumulative response of non-assetholders' consumption and income is negative and statistically meaningful.

As discussed earlier, a decline (increase) in relative consumption and income indicates a relatively stronger response for non-assetholders (assetholders). Nevertheless, one should consider that these household types feature different average consumption and income levels. In particular, assetholders are richer and consume more than non-assetholders, on average. Therefore, a hypothetical increase in the relative measure would mechanically translate into a stronger adjustment for assetholders, also in *monetary* terms. However, the same is not necessarily true for non-assetholders, in the present scenario characterized by a decline in relative consumption and income. Our estimates stress the potential emergence of such a discrepancy in the case of TFP shocks. To check whether this is actually the case, Table C.2 reports the cumulative

Table C.2: Cumulative responses - Dollar values

	Non-Durables and Services	Total Consumption	Net Income
	Panel A: TFP Shock		
Assetholders	597.85	755.4	1236.39
	[195.38,815.98]	[268.17,1075.58]	[724.76,1493.01]
Non-Assetholders	787.17	1085.9	1410.72
	[448.73,1005.65]	[657.95,1400.41]	[842.27,1719.76]
	Panel B: IST Shock		
Assetholders	787.31	977.64	892.22
	[518.8,1054.1]	[561.48,1308.57]	[495.17,1251.88]
Non-Assetholders	296.49	632.46	233.68
	[101.61,526.37]	[359.87,932.27]	[-170.24,625.87]
	Panel C: FS Shock		
Assetholders	683.32	1394.85	258.4
	[303.32,918.93]	[808.03,1726.97]	[-188.78,591.49]
Non-Assetholders	-388.18	-472.89	-456.09
	[-560.03,-206.21]	[-722.14,-204.71]	[-779.82,-68.57]

Notes: Cumulative responses over 16 quarters expressed in dollar values. To obtain a total expenditure/income effect at the household level in 2017 dollars, the magnitude is multiplied by the group-specific average expenditure over the sample, an average household size of 2.5, and by a price-adjustment factor equal to 2.48 (recall that the CPI for all items is expressed in 1982-1984 basis.)

responses expressed in dollar values (adjusted for the group-specific means). According to Panel A, following a positive neutral technology shock non-assetholders increase their spending on non-durables and services, as well as total consumption expenditure, by a statistically significant dollar amount of $787\$$ and $1085\$$, respectively, as compared to the $598\$$ and $755\$$ expenditure increase by the assetholders. Consistent with the IRF analysis, the larger consumption adjustment by non-assetholders reflects a more marked rise in net income ($1411\$$, compared to $1236\$$). By contrast, an investment-specific technology shock (Panel B) triggers a remarkable cumulative rise in assetholders' total consumption ($977\$$), which is in the ballpark of the dollar-amount upward adjustment in net income ($892\$$). At the same time, the cumulative response of non-assetholders' consumption and income are relatively smaller. Finally, similar conclusions apply for the factor-share shock (Panel C), although the cumulative responses of the hand-to-mouth consumers' consumption and income are now significantly negative.

C.5 Robustness: consumption and income inequality

Controlling for observable heterogeneity Our first robustness exercise aims at controlling for households' observable heterogeneity. Most heterogeneous agent models assume that households are ex-ante identical, and therefore do not differ by dimensions other than their income history, or the ability to access financial markets. Nevertheless, it is well known that the composition of households' portfolios is strongly correlated with demographic characteristics such as age, education, and gender (Guiso and Sodini, 2013). Moreover, recent work has shown that housing tenure is a key determinant of the responsiveness of households' consumption and income to demand shocks (see Cloyne and Surico, 2017; Cloyne et al., 2019, among the others). To control for such potentially relevant dimensions of heterogeneity, we follow Kehoe et al. (2020). Based on CEX data, we partition the population into twenty-four groups for all possible combinations of the following classifications: gender (male and female), age (young-up to 40 years, and old-above 40 years), education (college and no college) and housing tenure status (renter, mortgagor and outright owner). We then compute the average consumption and income series for assetholders and non-assetholders (based on the baseline sorting criterion) within each group. We then reweigh each group by the respective population share, and compute the consumption and income series for the representative assetholder or non-assetholder. As a consequence, after the reweighting the two groups are equally balanced in terms of age, gender, education or housing tenure status. More specifically, for the variable x (e.g., consumption) we compute:

$$\bar{x}_t^a = \sum_k x_{k,t}^a \times \omega_{k,t} \quad \text{and} \quad \bar{x}_t^{na} = \sum_k x_{k,t}^{na} \times \omega_{k,t},$$

for the representative assetholder and non-assetholder, respectively, where k indicates the group (for example, male-no college-renter or female-college-outright owner), $x_{k,t}^{a,na}$ denotes the within-group k average assetholder or non-assetholder variable, and $\omega_{k,t}$ represents the population share of group k at time t.

Figures C.3 and C.4 show that the relative responses of household-level consumption and income are essentially invariant, with respect to the original specification. Table C.3 also reassures us of the size and significance of the cumulative responses remaining essentially unchanged.

Sorting based on stockholdings Our analysis has focused on a assetholders vs. non-assetholders dichotomy. However, not only the distinction between stockholders and non-stockholders has traditionally received wide consideration in the asset-pricing literature (Malloy et al., 2009). Thus, it seems appropriate to verify that the conditional cyclical properties of relative consumption and income also apply to this type of household groups. The sorting procedure is exactly symmetric to the baseline presented in the main text. The only difference lies in the types of assets we consider. In this case, we sort households only based on their (direct or indirect) holdings of stocks. Specifically, we re-estimate a probit regression where the dependent variable is a dummy taking value one if the variable EQUITY in the SCF is positive. The variable equity summarizes the value of stocks held directly, in mutual funds or pension schemes, by the household. Therefore, this sorting criterion is much more in line with most of the asset-pricing literature. Consistently, we estimate that only about 20% of the households participated in the stock market at the beginning of the sample. At the end of the sample, instead, the participation rate is estimated around 50%.

As displayed by Figures C.5 and C.6, the responses remain in line with the baseline analysis. In particular, over a 16-quarters horizon the cumulative response of both agents' non-durables and services consumption is very similar, in the face of both TFP and IST shocks (see Table C.4). Furthermore, non-stockholders' cumulative consumption response to a positive FS shock is still negative, yet not statistically indistinguishable from zero.

Different sorting method The representative household-specific series are constructed using a 'continuous' measure of participation to the asset market. While we deem this method appropriate to deal with the uncertainty entailed by the imputation procedure, it involves two unappealing features. First, it ignores the information on assetholdings provided in the CEX (as the probability of being an assetholder is computed based on SCF data). Second, it implies that the same household's consumption (income) simultaneously contributes to the representative assetholder's and non-assetholder's consumption (income), according to the imputed probability. Therefore, as a robustness check we employ a method whereby: *i*) the imputation based on the SCF is applied only to those households who cannot be defined as assetholders, according to the financial information in the CEX; *ii*) a household is univocally classified as an assetholder or a non-assetholder. According to this, we predict the probability of a household being an assetholder only for those households who are not defined as such based on the CEX variables, using the same probit coefficients as for the baseline analysis. Next, to uniquely partition households between the two groups, we apply a threshold method. In particular, households are classified as assetholders for sure (hence, with probability 1) if the predicted probability exceeds 70%. By contrast, households are defined as non-assetholders for sure (thus receiving a probability 0 of being assetholders) if the predicted probability is below 70%. In other words, according to this method a household is defined as an assetholder either if it fulfills the requirement in the CEX data, or if the imputed probability exceeds 70%. The fraction of hand-to-mouth households estimated according to this sorting criterion is essentially unchanged, compared to the baseline case.

Figures C.7 and C.8 and Table C.5 show that, based on this sorting procedure, the results are even more clearcut, compared to the baseline. For example, the IRFs of relative consumption and income to the IST shock are now statistically significant, and the negative comovement between the two agents' consumption responses is further exacerbated, conditional on a FS shock.

Utilization-adjusted TFP We also check the robustness of our results to changing the series for total factor productivity. Specifically, we employ a measure of utilization-adjusted TFP (Fernald, 2014) in the VAR system (1), rather than a non-utilization-adjusted measure. Figures C.9 and C.10, and Table C.6, show that this departure from the baseline analysis is essentially inconsequential for the household-level responses we report.

Extended VAR We repeat the empirical analysis by extending the VAR system in equation (1) to include (log) per-capita hours as a fourth variable. This allows us to control for the potential impact of additional shocks on TFP, the relative price of investment, and the labor share. The identification assumptions on the purely redistributive effects of FS shocks remain intact also in this quadrivariate version of the VAR. We then use the structurally identified IST, TFP and FS shocks to compute household-level consumption and income responses. Figures C.11 and C.12 show that the responses of household-level consumption and income—as well as those of their relative measures—maintain the same dynamic properties as in the baseline analysis. Also, Table C.7 reports cumulative responses that are very close to the baseline estimates.

Table C.3: Cumulative responses - Observable heterogeneity

	Non-Durables and Services	Total Consumption	Net Income
Panel A: TFP Shock			
Assetholders	2.86	3.6	3.75
	[1.01,3.97]	[1.3,5.32]	[2.02,4.8]
Non-Assetholders	5.7	6.89	5.86
	[3.17,6.83]	[3.77,8.21]	[2.89,7.61]
Panel B: IST Shock			
Assetholders	3.88	4.43	3.39
	[2.64,5.11]	[2.87,6.1]	[1.79,4.74]
Non-Assetholders	2.91	3.79	2.64
	[1.58,4.39]	[2.34,5.47]	[0.71,4.31]
Panel C: FS Shock			
Assetholders	4.66	6.73	1.7
	[2.83,5.65]	[4.29,8.05]	[-0.05,2.87]
Non-Assetholders	-0.26	1.88	-2.16
	[-2.19,1.25]	[-0.68,3.81]	[-4.15,-0.23]

Notes: Cumulative responses over 16 quarters, controlling for observable heterogeneity.

Table C.4: Cumulative responses - Sorting based on stockholdings

	Non-Durables and Services	Total Consumption	Net Income
Panel A: TFP Shock			
Stockholders	5.99	4.15	5.63
	[3.03,6.71]	[1.77,5.86]	[3.75,6.99]]
Non-Stockholders	5.88	7.04	8.77
	[4.14,6.83]	[5.45,8.16]	[6.24,10.02]
Panel B: IST Shock			
Stockholders	2.48	4.14	2.03
	[1,3.7]	[2.17,5.89]	[0.18,3.75]
Non-Stockholders	1.26	2.64	1.27
	[0.21,2.53]	[1.52,3.97]	[-1.01,3.29]
Panel C: FS Shock			
Stockholders	2.52	4.76	-0.18
	[0.65,3.67]	[1.99,6.15]	[-2.04,1.57]
Non-Stockholders	-0.99	-0.46	-2.18
	[-2.29,0.26]	[-2.42,1.12]	[-3.75,-0.16]

Notes: Cumulative responses over 16 quarters for households sorted based on stockholdings.

Table C.5: Cumulative responses - Different sorting method

	Non-Durables and Services	Total Consumption	Net Income
Panel A: TFP Shock			
Assetholders	2.83	4.47	3
	[0.69,3.72]	[1.82,5.81]	[1.33,3.83]
Non-Assetholders	4.53	4.62	9.27
	[2.02,6.54]	[1.22,7.05]	[4.15,11.94]
Panel B: IST Shock			
Assetholders	3.9	3.64	2.37
	[2.54,5]	[2.04,5.11]	[1.41,3.41]
Non-Assetholders	-0.57	3.6	-0.82
	[-2.27,1.45]	[1.13,6.48]	[-3.76,2.48]
Panel C: FS Shock			
Assetholders	2.62	4.55	-0.14
	[0.76,3.67]	[1.95,5.28]	[-1.38,0.95]
Non-Assetholders	-4.36	-6.94	-3.66
	[-6.09,-2.88]	[-9.03,-4.54]	[-6.78,-0.47]

Notes: Cumulative responses over 16 quarters for households sorted according to the probability-threshold method.

Table C.6: Cumulative responses - Utilization-adjusted TFP

	Non-Durables and Services	Total Consumption	Net Income
Panel A: TFP Shock			
Assetholders	0.55	0.54	3.63
	[-1.19,2.2]	[-1.21,2.47]	[1.85,4.94]
Non-Assetholders	4.57	5.45	8.96
	[2.67,6.09]	[3.13,7.61]	[5.95,10.96]
Panel B: IST Shock			
Assetholders	3.54	3.7	2.85
	[1.85,5.16]	[1.61,5.19]	[1.01,4.56]
Non-Assetholders	1.28	3.38	-0.56
	[-0.43,3.08]	[1.27,5.71]	[-3.24,2.16]
Panel C: FS Shock			
Assetholders	1.94	3.5	1.32
	[0.09,3.2]	[1.12,4.66]	[-0.4,2.56]
Non-Assetholders	-2.65	-3.81	-1.65
	[-4.24,-1.14]	[-5.91,-1.45]	[-3.64,0.72]

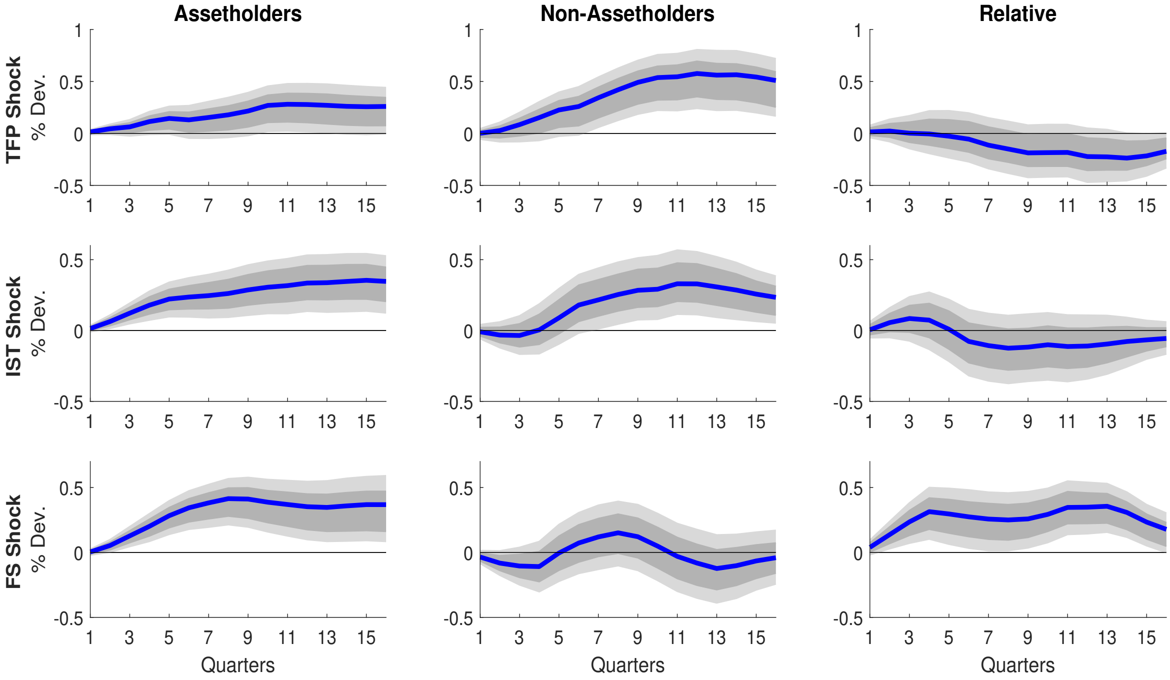
Notes: Cumulative responses over 16 quarters to the shocks identified in the VAR with utilization-adjusted TFP.

Table C.7: Cumulative responses - Extended VAR

	Non-Durables and Services	Total Consumption	Net Income
	Panel A: TFP Shock		
Assetholders	3.16	3.27	4.32
	[1.24,4.25]	[1.26,4.67]	[2.5,5.28]
Non-Assetholders	4.66	5.81	8.02
	[2.48,6.2]	[3.26,7.73]	[4.45,9.96]
	Panel B: IST Shock		
Assetholders	4.37	4.88	2.95
	[2.8,5.59]	[2.93,6.27]	[1.24,4.24]
Non-Assetholders	2.19	2.38	1.31
	[0.69,3.59]	[0.28,3.86]	[-1.08,3.43]
	Panel C: FS Shock		
Assetholders	2.31	3.65	2.19
	[0.11,3.74]	[1.15,4.93]	[0.11,3.63]
Non-Assetholders	-1.81	-2.86	-1.96
	[-3.67,-0.21]	[-5.4,-0.34]	[-4.36,0.49]

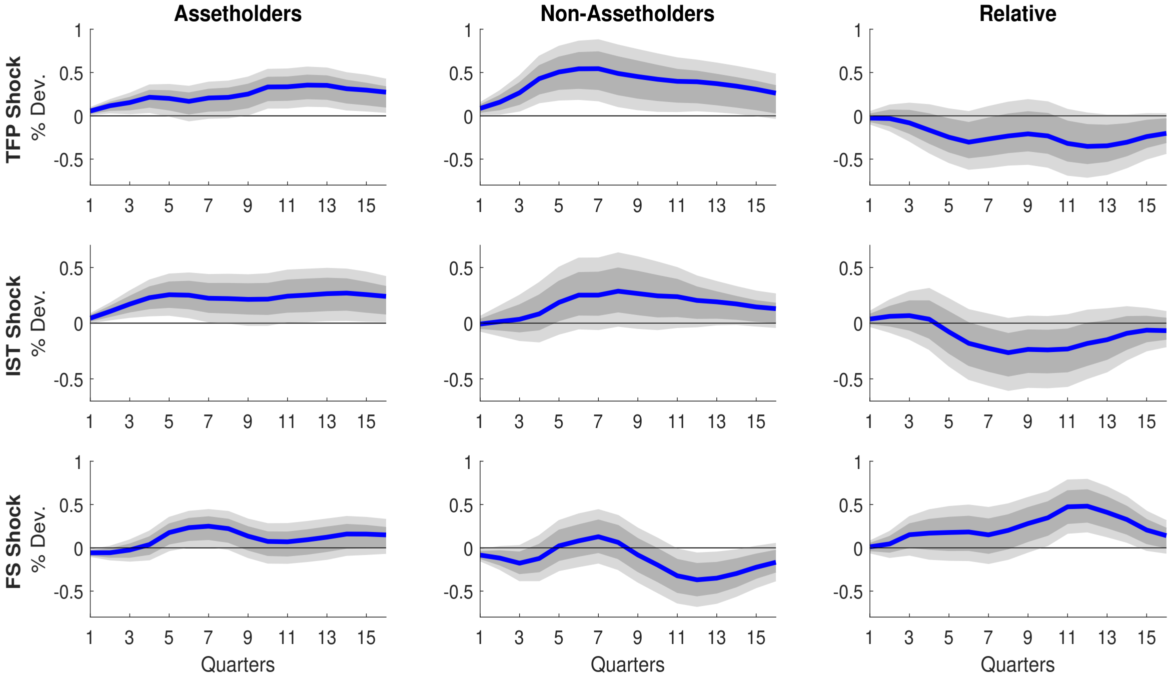
Notes: Cumulative responses over 16 quarters to the shocks identified in the extended VAR.

Figure C.3: Non-durables and services expenditure - Observable heterogeneity



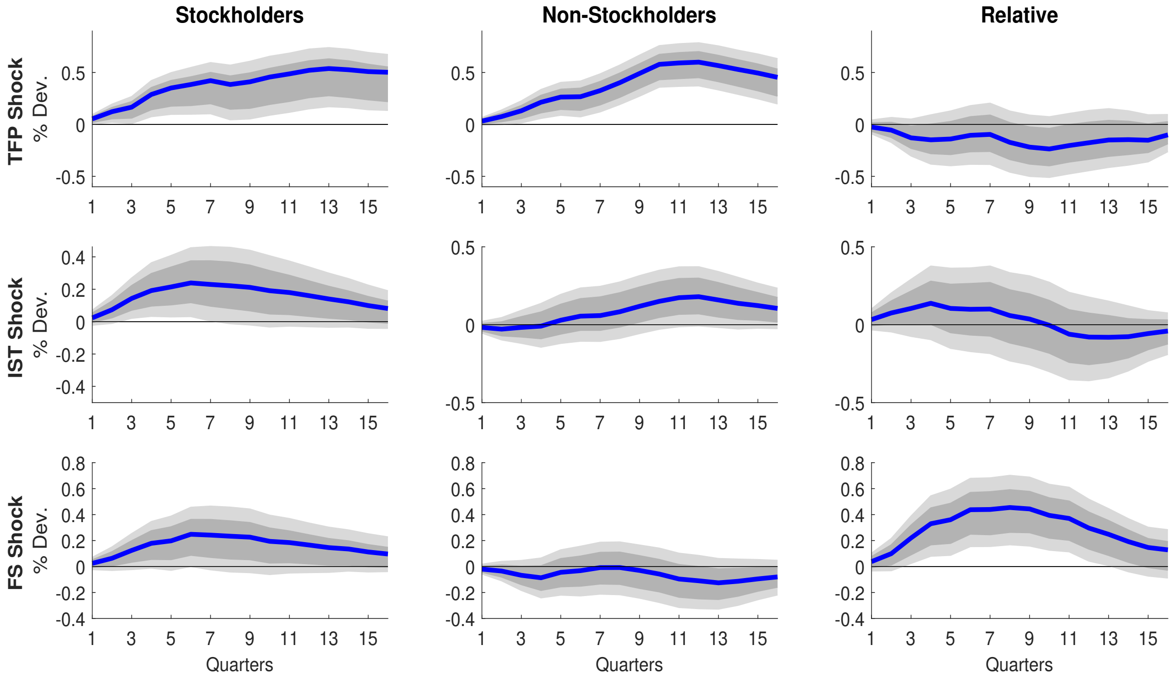
Notes: The figure displays the IRFs of non-durables and services expenditures, controlling for observable heterogeneity.

Figure C.4: Net Income - Observable heterogeneity



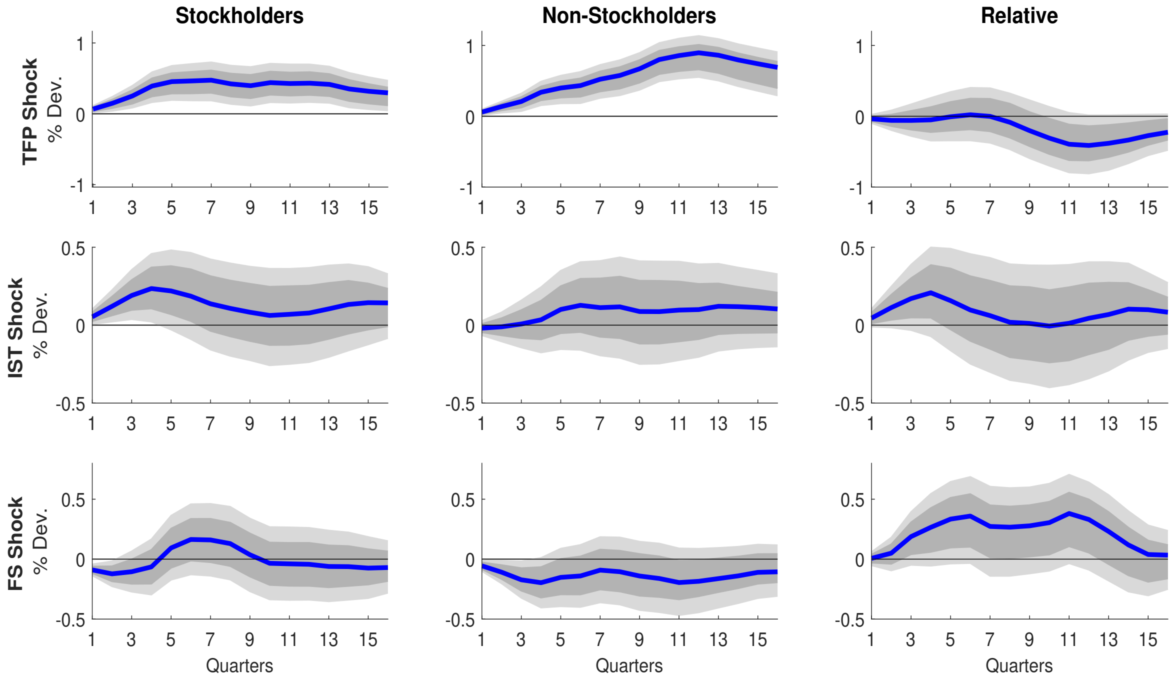
Notes: The figure displays the IRFs of net income, controlling for observable heterogeneity.

Figure C.5: Non-durables and services expenditure - Sorting based on stockholdings



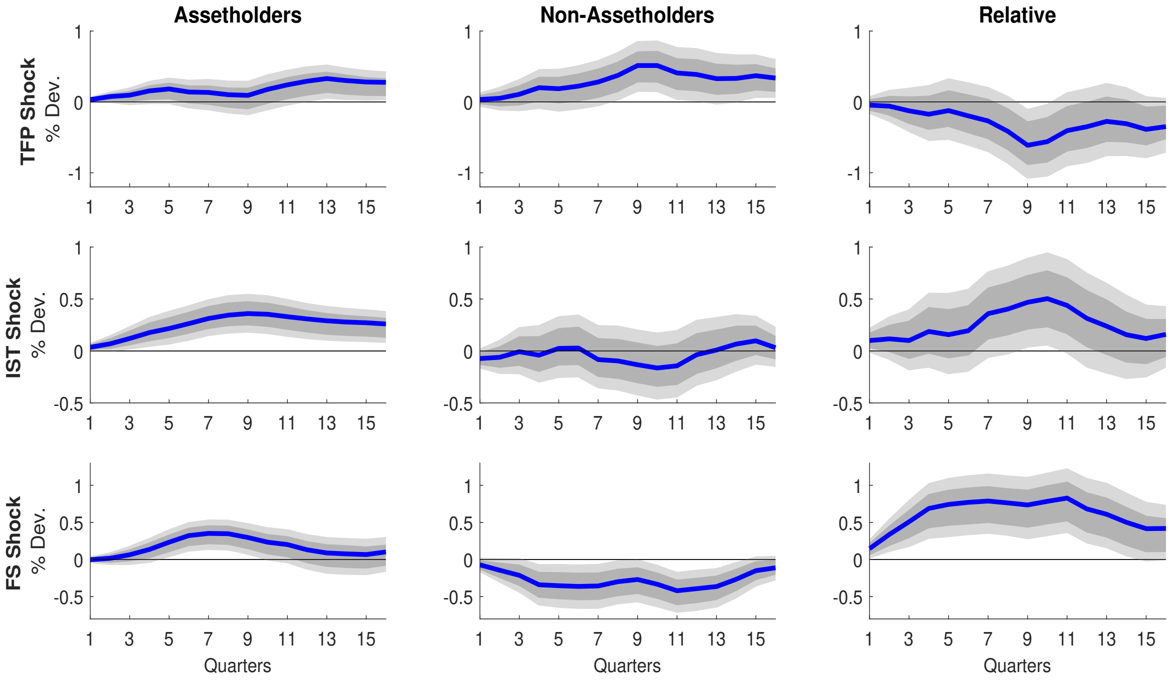
Notes: The figure displays the IRFs of non-durables and services expenditures for households sorted based on stockholdings.

Figure C.6: Net Income - Sorting based on stockholdings



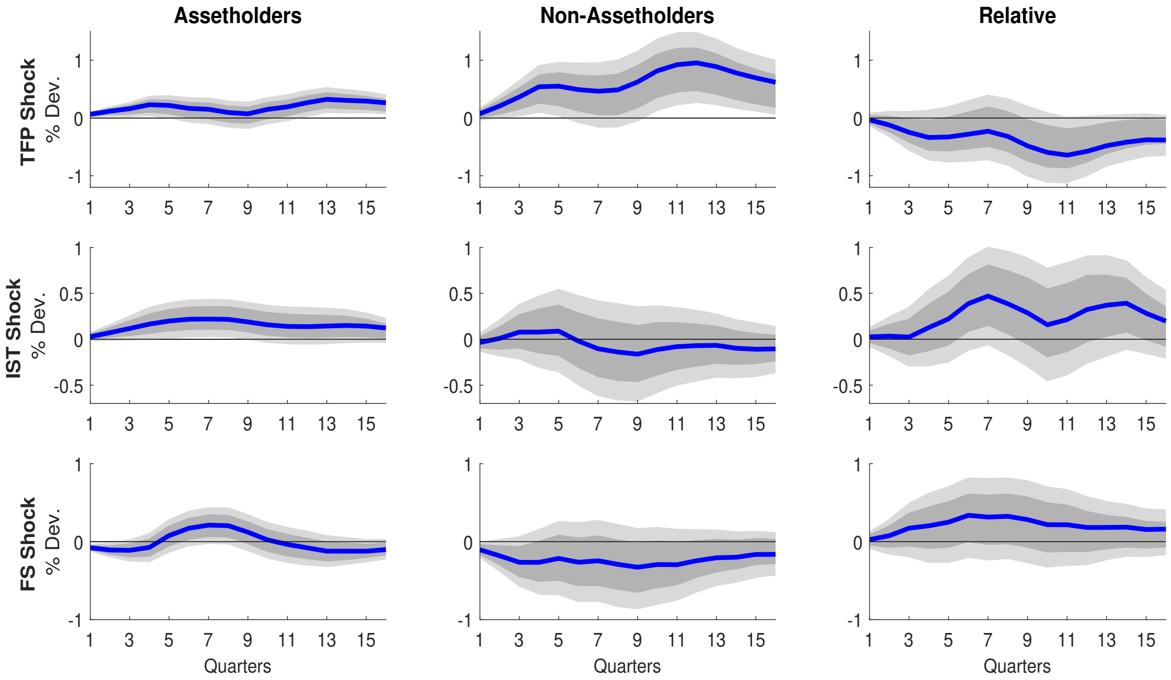
Notes: The figure displays the IRFs of net income for households sorted based on stockholdings.

Figure C.7: Non-durables and services expenditure - Different sorting method



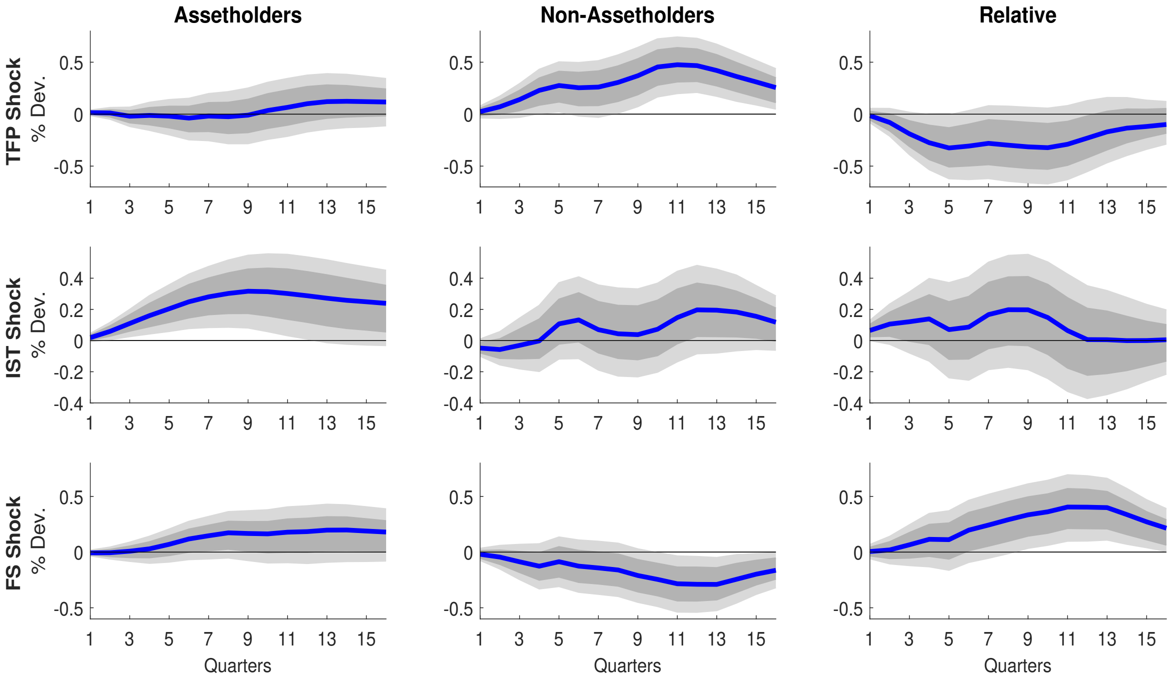
Notes: The figure displays the IRFs of non-durables and services expenditures for households sorted according to the probability-threshold method.

Figure C.8: Net Income - Different sorting method



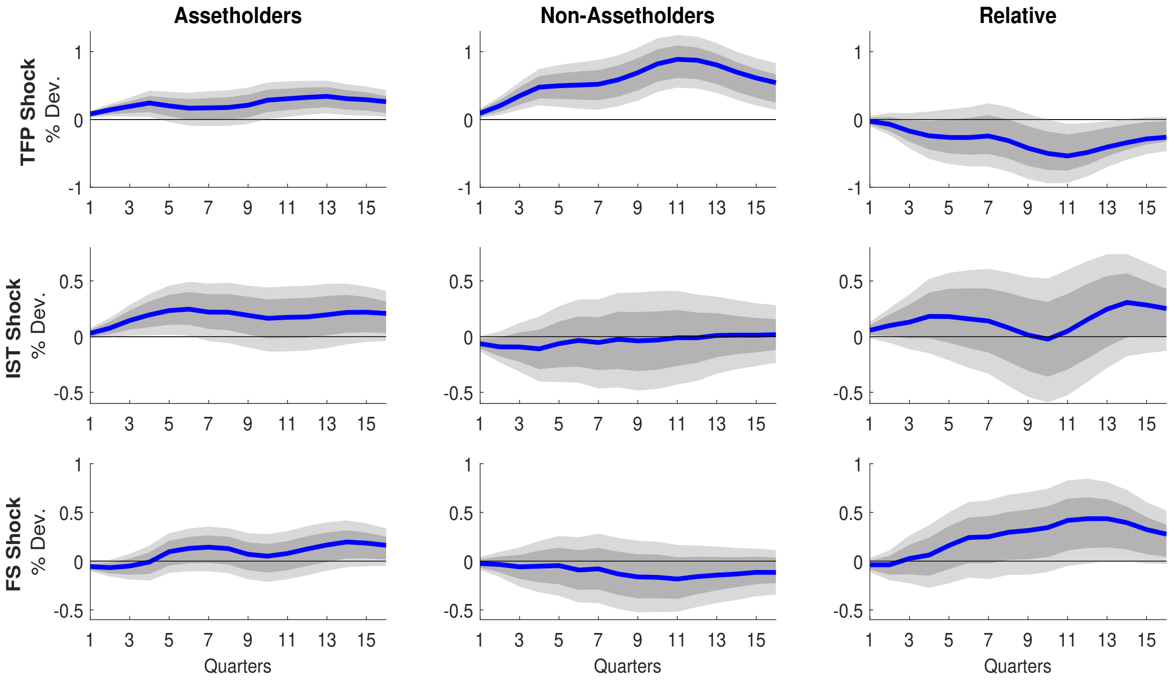
Notes: The figure displays the IRFs of net income for households sorted according to the probability-threshold method.

Figure C.9: Non-durables and services expenditure - Utilization-adjusted TFP



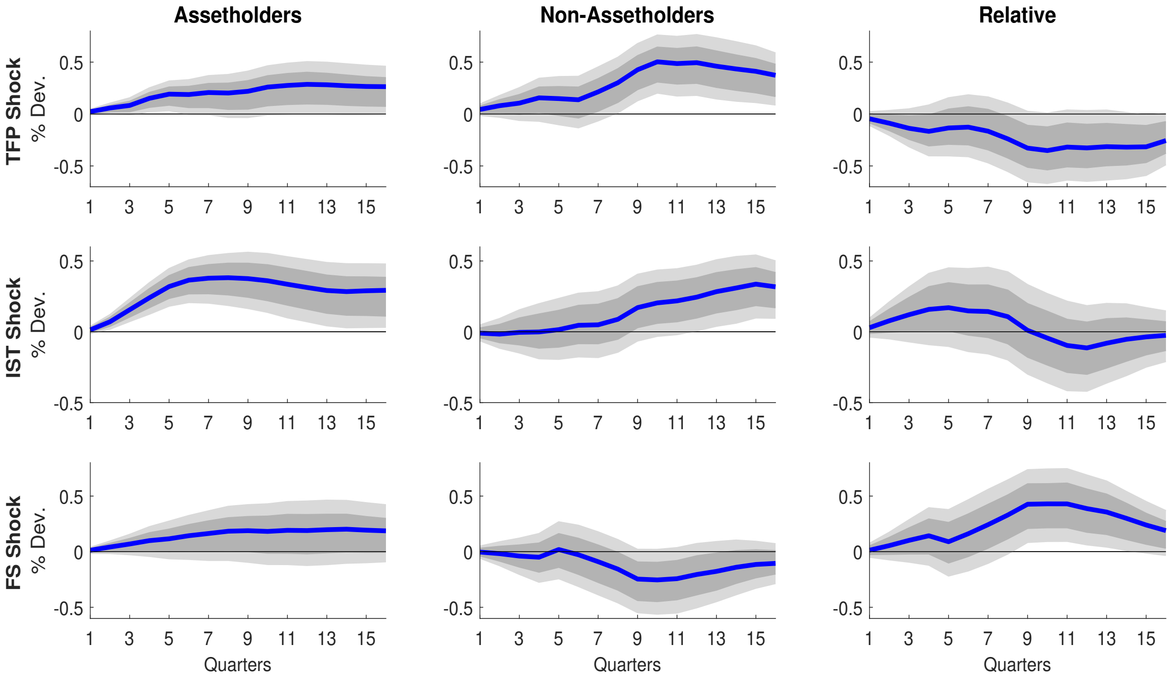
Notes: The figure displays the IRFs of non-durables and services expenditures to the shocks identified in the VAR with utilization-adjusted TFP.

Figure C.10: Net Income - Utilization-adjusted TFP



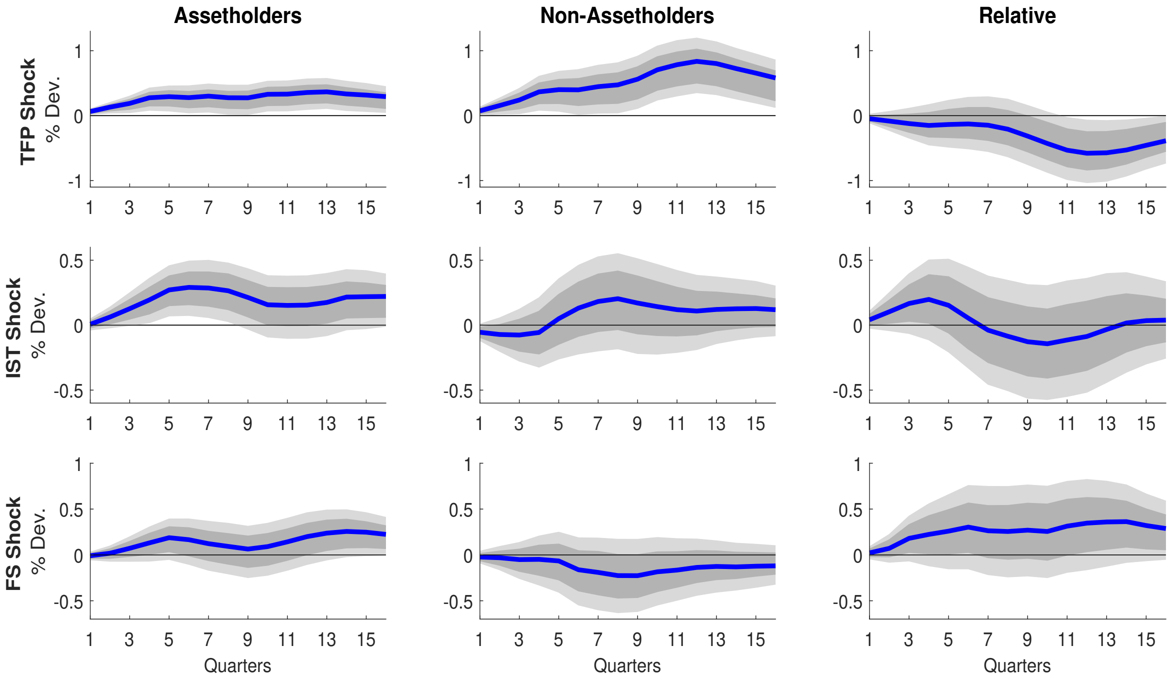
Notes: The figure displays the IRFs of net income to the shocks identified in the VAR with utilization-adjusted TFP.

Figure C.11: Non-durables and services expenditure - Extended VAR



Notes: The figure displays the IRFs of non-durables and services expenditures to the shocks identified in the extended VAR.

Figure C.12: Net Income - Extended VAR



Notes: The figure displays the IRFs of net income to the shocks identified in the extended VAR.

C.6 Robustness: predictive regressions

We now provide further tests on the robustness of relative consumption as a predictor of future excess returns.

Relative consumption based on stockholdings First, we estimate regression (4) by using the consumption of stockholders relative to that of non-stockholders (rather than assetholders vs. non-assetholders). As reported in Table C.8, the results are essentially identical when using this alternative measure of relative consumption—in fact, the unconditional relative measure is now found to significantly predict future excess returns even at the 16-quarters horizon.

Controlling for cay Second, we make sure that relative consumption remains significant even when controlling for an additional, well-known stock return predictor—namely, the aggregate consumption-wealth ratio (cay) proposed by Lettau and Ludvigson (2001). This variable represents the residual from a cointegrating relationship between consumption, asset wealth, and labor income.[7] Such residual captures fluctuations in aggregate consumption relative to aggregate (human and non-human) wealth, and can therefore be seen as an additional measure of aggregate risk. Table C.9 shows that the coefficient on this variable is positive and significant at several horizons, in line with Lettau and Ludvigson (2001). Even in this case, the unconditional relative consumption (Panel A), as well as relative consumption conditional on FS shocks (Panel B) remain strongly significant.

QoQ growth filter Finally, Table C.10 displays the results from considering quarter-on-quarter (QoQ) growth rates for aggregate and relative consumption, rather than 8-quarters log-differences as in Hamilton (2018). Since there is no *a priori* theoretical guidance on what procedure is best suited to isolate cyclical fluctuations, it is instructive to compare the ability of changes in relative consumption to predict future excess returns using a different filter. Clearly, the results remain unaltered in terms of statistical significance, although (obviously) the size of the coefficients varies (given the larger noise inherent to the first-difference filter). Overall, we conclude that the emergence of changes in consumption inequality as a stock return predictor is a reliable feature of the data.

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[7] The series is available at the quarterly frequency from the authors' webpage.

Table C.8: Predictive regressions - Stockholders

	Panel A		Panel B			
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g_{rc,t}$		$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g^{TFP}_{rc,t} + \beta_3 g^{IST}_{rc,t} + \beta_4 g^{FS}_{rc,t}$			
h	β_1	β_2	β_1	β_2	β_3	β_4
1	−1.47 (1.46) [0.31]	**2.20** (1.06) [0.04]	−1.41 (1.37) [0.30]	0.29 (3.19) [0.93]	−0.19 (3.89) [0.96]	3.29 (2.43) [0.18]
4	−1.46 (1.18) [0.22]	**1.56** (0.85) [0.07]	−1.65 (1.02) [0.11]	1.07 (2.19) [0.62]	0.07 (3.16) [0.98]	2.91 (1.74) [0.10]
8	**-2.37** (0.79) [0.00]	**1.51** (0.66) [0.02]	**-2.66** (0.71) [0.00]	0.64 (1.40) [0.65]	0.54 (1.83) [0.77]	**2.87** (1.01) [0.01]
12	**-2.66** (0.65) [0.00]	**1.35** (0.45) [0.00]	**-3.02** (0.62) [0.00]	−1.26 (1.05) [0.23]	1.60 (1.49) [0.28]	**2.52** (0.80) [0.00]
16	**-2.42** (0.48) [0.00]	**0.73** (0.40) [0.07]	**-2.86** (0.50) [0.00]	−1.19 (0.91) [0.19]	1.32 (1.23) [0.28]	**1.91** (0.78) [0.02]
20	**-2.06** (0.40) [0.00]	0.26 (0.43) [0.55]	**-2.47** (0.41) [0.00]	−0.79 (0.97) [0.42]	0.82 (1.28) [0.52]	**1.25** (0.70) [0.08]

Notes: The table presents results of predictive regressions of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which includes: in Panel A, aggregate and relative consumption growth; in Panel B, aggregate consumption growth and relative consumption growth conditioned on each shock at a time. Growth rates are computed as 8-quarters log-differences. In this robustness check, relative consumption is computed using the consumption series of stockholders and non-stockholders, rather than assetholders and non-assetholders. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The sample covers the period 1982Q4-2017Q4.

Table C.9: Predictive regressions - CAY

	Panel A			Panel B				
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 cay_t + \beta_3 g_{rc,t}$			$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 cay_t + \beta_3 g^{TFP}_{rc,t} + \beta_4 g^{IST}_{rc,t} + \beta_5 g^{FS}_{rc,t}$				
h	β_1	β_2	β_3	β_1	β_2	β_3	β_4	β_5
1	−0.95 (1.48) [0.52]	−1.86 (1.39) [0.18]	**2.08** (1.03) [0.05]	−1.06 (1.45) [0.47]	**-2.45** (1.44) [0.09]	−0.57 (2.09) [0.78]	0.36 (3.34) [0.91]	**4.04** (2.39) [0.09]
4	−1.57 (1.14) [0.17]	0.78 (1.16) [0.50]	**1.47** (0.74) [0.05]	−1.77 (1.06) [0.10]	0.27 (1.11) [0.81]	0.17 (1.33) [0.90]	0.71 (2.34) [0.76]	**3.18** (1.65) [0.06]
8	**-2.78** (0.97) [0.00]	2.06 (1.40) [0.14]	**1.30** (0.58) [0.03]	**-3.13** (0.81) [0.00]	1.71 (1.23) [0.17]	−0.23 (0.74) [0.76]	1.05 (1.19) [0.38]	**2.98** (0.91) [0.00]
12	**-3.63** (0.83) [0.00]	**3.35** (1.14) [0.00]	**1.27** (0.38) [0.00]	**-3.87** (0.67) [0.00]	**2.93** (0.89) [0.00]	−0.96 (0.72) [0.18]	0.79 (1.10) [0.48]	**2.75** (0.64) [0.00]
16	**-3.48** (0.54) [0.00]	**3.40** (0.74) [0.00]	**0.85** (0.31) [0.01]	**-3.71** (0.47) [0.00]	**3.05** (0.57) [0.00]	−0.68 (0.63) [0.29]	0.05 (0.93) [0.95]	**2.28** (0.55) [0.00]
20	**-2.84** (0.46) [0.00]	**2.52** (0.78) [0.00]	0.41 (0.35) [0.24]	**-3.07** (0.44) [0.00]	**2.35** (0.64) [0.00]	−0.33 (0.65) [0.61]	0.01 (1.05) [1.00]	**1.38** (0.46) [0.00]

Notes: The table presents results of predictive regressions of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which, in this robustness check, includes: in Panel A, aggregate consumption growth, the variable CAY, and relative consumption growth; in Panel B, aggregate consumption growth, the variable CAY, and relative consumption growth conditioned on each shock at a time. Growth rates are computed as 8-quarters log-differences. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The sample covers the period 1982Q4-2017Q4.

Table C.10: Predictive regressions - First differences

	Panel A		Panel B			
	$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g_{rc,t}$		$r^{ex}_{t,t+h} = \alpha + \beta_1 g_{c,t} + \beta_2 g^{TFP}_{rc,t} + \beta_3 g^{IST}_{rc,t} + \beta_4 g^{FS}_{rc,t}$			
h	β_1	β_2	β_1	β_2	β_3	β_4
1	1.11 (4.18) [0.79]	**8.10** (4.51) [0.07]	−0.34 (4.91) [0.95]	−4.10 (11.92) [0.73]	−3.19 (14.55) [0.83]	13.21 (13.38) [0.33]
4	−0.26 (3.45) [0.94]	**6.65** (3.18) [0.04]	−1.67 (3.40) [0.62]	−4.45 (8.13) [0.58]	2.23 (10.00) [0.82]	11.76 (7.26) [0.11]
8	−1.09 (2.19) [0.62]	**4.24** (2.41) [0.08]	−2.75 (1.96) [0.16]	−1.11 (5.38) [0.84]	−2.22 (7.63) [0.77]	**15.68** (6.16) [0.01]
12	−2.42 (1.50) [0.11]	2.83 (1.97) [0.15]	**-3.62** (1.43) [0.01]	1.28 (4.39) [0.77]	−0.87 (5.50) [0.87]	**11.85** (3.59) [0.00]
16	**-2.47** (1.28) [0.06]	2.31 (1.68) [0.17]	**-3.57** (1.34) [0.01]	−1.84 (3.61) [0.61]	−0.85 (5.28) [0.87]	**9.51** (3.60) [0.01]
20	**-3.06** (1.17) [0.01]	0.68 (1.43) [0.64]	**-3.77** (1.21) [0.00]	−0.20 (3.06) [0.95]	−3.12 (3.64) [0.39]	**7.33** (3.28) [0.03]

Notes: The table presents results of predictive regressions of the form $r^{ex}_{t,t+h} = \alpha + \boldsymbol{\beta x_t} + \epsilon_{t+h}$, where h denotes the horizon in quarters and $r^{ex}_{t,t+h}$ denotes annualized excess returns between period t and $t+h$. $\boldsymbol{x_t}$ represents the matrix of (demeaned) predictors, which includes: in Panel A, aggregate and relative consumption growth; in Panel B, aggregate consumption growth and relative consumption growth conditioned on each shock at a time. In this robustness check, growth rates are computed as 1-quarter log-differences, instead of 8-quarters log-differences. For each regression, Newey-West corrected standard errors (4 lags) appear in parentheses below the coefficient estimate, while p-values are reported in square brackets. Significant coefficients at the ten percent level are highlighted in bold. The sample covers the period 1982Q4-2017Q4.

D A model with concentrated capital ownership

This appendix details the model employed in Section 4, as well as its calibration and ability to match macroeconomic and asset-pricing moments.

Households Assetholders own firms through equity shares, and smooth consumption intertemporally by trading one-period bonds. Non-assetholders are assumed to be excluded from the bond and the stock markets. Both agents are assumed to inelastically supply their entire time-endowment to the firms. Households are equally productive and, therefore, all earn the same wage, regardless of their type. The fraction of assetholders in the total population of consumers equals $1-\gamma$.

The utility of the representative assetholder reads as

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t^a - \chi_c h_t)^{1-\sigma} - 1}{1-\sigma}, \tag{D.1}$$

where we assume assetholders to exhibit external habits in utility, with the habit stock, h_t, weighing on per-period utility by the parameter χ_c, and evolving according to the following law of motion (Jaccard, 2014):

$$h_t = m h_{t-1} + (1-m) c_{t-1}^a, \tag{D.2}$$

where c_{t-1}^a denotes assetholders' per-capita consumption at time $t-1$. The parameter m allows us to introduce a slow-moving component in habit formation. Similar to Campbell and Cochrane (1999), $1-m$ captures how sensitive the reference level is to changes in assetholders' per-capita consumption.

Consumption and saving decisions are limited by the following budget constraint

$$c_t^a + p_t^s q_{t+1}^s + p_t^b q_{t+1}^b = (p_t^s + d_t) q_t^s + q_t^b + w_t n_t^a. \tag{D.3}$$

which states that consumption and the purchase of equity shares (in quantity q_{t+1}^s at the price p_t^s) as well as of one-period bonds (in quantity q_{t+1}^b at the price p_t^b) must be financed by labor income, $w_t n_t^a$ (where $n_t^a = 1$), and the returns on the financial investments. Shares purchased in the previous period yield a dividend d_t, while one-period bonds yield a single consumption unit per-bond in the following period.

The two agents differ only for their ability to access financial markets.[8] Being un-

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[8] Since non-assetholders do not price securities, they can in principle have exactly the same preferences as assetholders, without affecting the equilibrium conditions.

able to smooth consumption intertemporally, non-assetholders consume their labor income hand-to-mouth, so that

$$c_t^{na} = w_t n_t^{na}, \tag{D.4}$$

where w_t is the wage and $n_t^{na} = 1$.

Asset prices The first-order conditions for assetholders' optimization problem with respect to c_t^a, q_{t+1}^s, and q_{t+1}^b are:

$$\lambda_t = (c_t^a - \chi_c h_t)^{-\sigma}, \tag{D.5}$$

$$p_t^s = E_t m_{t,t+1}(p_{t+1}^s + d_{t+1}), \tag{D.6}$$

$$p_t^b = E_t m_{t,t+1}, \tag{D.7}$$

where λ_t denotes the Lagrangean multiplier on the budget constraint and $m_{t,t+1} \equiv \beta E_t(\lambda_{t+1}/\lambda_t)$ is the assetholder's stochastic discount factor. The first-order conditions (D.6) and (D.7) govern asset-pricing dynamics. In particular, the risk-free rate is given by $r_{t+1}^b = 1/p_t^b = 1/E_t m_{t,t+1}$, while the stock return is $r_{t+1}^s = \frac{p_{t+1}^s + d_{t+1}^s}{p_t^s}$. Asset prices depend on the preferences of the marginal investor: the assetholder, in our case.

Firms Firms operate under perfect competition and employ a production technology that allows for biased technical changes in the context of an otherwise standard Cobb-Douglas function (Young, 2004; Ríos-Rull and Santaeulalia-Llopis, 2010):

$$y_t = A z_t n_t^{1-\alpha_t} k_t^{\alpha_t}, \ \alpha_t \in (0, 1), \tag{D.8}$$

where n_t is aggregate employment, k_t is aggregate capital, z_t is total factor productivity and A is a scaling factor (to be discussed in Section D.1). Finally, changes in α_t alter the production elasticity, share and productivity of labor relative to capital.

Following Jermann (1998), capital accumulation follows a law of motion featuring capital adjustment costs:

$$k_{t+1} = (1 - \delta)k_t + \phi\left(\frac{i_t}{k_t}\right)k_t, \tag{D.9}$$

where δ is the depreciation rate and

$$\phi\left(\frac{i_t}{k_t}\right) = \left[\frac{a_1}{1 - 1/\chi_k}\left(\frac{i_t}{k_t}\right)^{1-1/\chi_k} + a_2\right] \tag{D.10}$$

is a concave adjustment-cost function. In particular, $\chi_k \to 0$ (∞) implies higher (lower) adjustment costs.

The firm's problem consists of choosing labor, capital, and investment to maximize

$$\underset{i_t,n_t,k_{t+1}}{max} \; E_0 \sum_{t=0}^{\infty} m_{t,t+1} \left\{ d_t - q_t[k_{t+1} - (1-\delta)k_t - \phi(i_t/k_t)k_t], \right\} \tag{D.11}$$

subject to the constraints (D.8), (D.9), and (D.10), where q_t is the shadow price of capital.

Dividends are defined as

$$d_t = y_t - w_t n_t - \frac{i_t}{\mu_t}, \tag{D.12}$$

where, following Greenwood et al. (1988) and Liu et al. (2013), μ_t accounts for investment-specific technological change. Profit maximization leads to:

$$w_t = (1-\alpha_t)y_t/n_t, \tag{D.13}$$

implying that dividends can be rewritten as

$$d_t = \alpha_t y_t - \frac{i_t}{\mu_t}, \tag{D.14}$$

whereas the first-order condition with respect to capital investment is

$$\phi^{'}\left(\frac{i_t}{k_t}\right) = \frac{1}{\mu_t q_t}, \tag{D.15}$$

with

$$\phi^{'}\left(\frac{i_t}{k_t}\right) = a_1 \left(\frac{i_t}{k_t}\right)^{-1/\chi_k}. \tag{D.16}$$

Finally, the firm's optimal decision regarding capital yields

$$q_t = E_t \left\{ m_{t,t+1} \left[\alpha_{t+1}\frac{y_{t+1}}{k_{t+1}} + q_{t+1}\left((1-\delta) + \phi\left(\frac{i_{t+1}}{k_{t+1}}\right) - \phi^{'}\left(\frac{i_{t+1}}{k_{t+1}}\right)\frac{i_{t+1}}{k_{t+1}} \right) \right] \right\}. \tag{D.17}$$

Equilibrium All agents take prices as given. The competitive equilibrium in this economy is defined by a sequence of prices and quantities such that the optimality conditions (D.4), (D.5), (D.6), (D.7), (D.13), (D.15) and (D.17) hold, all constraints are satisfied, and all markets clear. More specifically, labor-market clearing requires that

$$n_t = \gamma n_t^{na} + (1-\gamma)n_t^{a} = 1, \tag{D.18}$$

while equilibrium in the good market implies

$$y_t = c_t + i_t, \tag{D.19}$$

where

$$c_t = \gamma c_t^{na} + (1-\gamma)c_t^a \tag{D.20}$$

defines aggregate per-capita consumption. Assuming that the bond market is in zero net supply entails that, in equilibrium, $q_t^b = 0$, $\forall t$. Moreover, assuming that the stock market is in unit supply yields the stock market clearing condition

$$(1-\gamma)q_t^s = 1, \tag{D.21}$$

where the left side of the equality represents the aggregate demand of stocks, since only a fraction $(1-\gamma)$ of the population participates in the stock market. Therefore, in equilibrium the budget constraint (D.3) for the representative assetholder reads as

$$c_t^a = w_t n_t^a + \frac{d_t}{1-\gamma}. \tag{D.22}$$

Finally, plugging (D.4) and (D.22) into equation (D.20) yields

$$c_t = \gamma w_t n_t^{na} + (1-\gamma)\left(w_t n_t^a + \frac{d_t}{1-\gamma}\right), \tag{D.23}$$

which, given the assumption that both non-assetholders and assetholders supply all their time-endowment to firms $(n_t^{na} = n_t^a = 1)$, becomes $c_t = w_t + d_t$; that is, aggregate consumption consists of labor income plus dividends.

Exogenous state variables The dynamics of the three exogenous state variables in the model, namely investment-specific technology μ_t, total factor productivity z_t and the labor share ls_t, are governed by the trivariate VAR estimated as in equation (1). Given the permanent nature of IST and TFP shocks, the model exhibits non-stationary dynamics. Thus, in Appendix D.2 we rewrite it in stationary form. In the remainder, '$\sim$' will be used to denote variables in log-deviation from their trend.

Unlike most of the extant literature (Justiniano and Primiceri, 2008; Papanikolaou, 2011; Lansing, 2015, among the others), we do not assume that exogenous processes are independent. Relatedly, Ríos-Rull and Santaeulalia-Llopis (2010), Santaeulalia-Llopis (2011) and Choi and Ríos-Rull (2020) emphasize the dynamic effects of technology shocks on the labor share, and how this bears important implications for the propagation of the shocks to aggregate variables. To take this into account we assume that TFP, the relative price of investment, and the labor share follow a VAR process whose parameters are estimated, as we describe in the next section.

D.1 Calibration

The model is solved by second-order perturbation methods. A time period in the model is taken to be one quarter. We split the parameters into two groups. The first group of parameters is calibrated to match targeted long-run relationships, while the second group is estimated both via impulse-response matching, as well as by matching a subset of selected unconditional macroeconomic moments. The baseline parameter values are summarized in Table D.1.

D.1.1 Calibrated parameters

The fraction of non-assetholder, γ, is set to 0.33, which represents a mid-value over the sample 1982Q4-2017Q4. The calibration strategy for the depreciation rate (δ), the discount rate (β), and the unit parameter in the production function (A) follows Ríos-Rull and Santaeulalia-Llopis (2010). We target the capital-to-output ratio in yearly terms $k/y = 2.31$, and the investment-output ratio $i/y = 0.25$. Given these targets, from the relationship $i/y = \delta k/y$, we retrieve $\delta = 0.0271$. After evaluating equation (D.17) at the steady state and setting the capital share $\alpha = 0.35$—as in Choi and Ríos-Rull (2020)—we obtain $1 = \beta\left(1 - \delta + \alpha y/k\right)$, which yields $\beta = 0.9893$. Without loss of generality, we normalize steady-state output to one, thus solving equation (D.8) for $A = 1/n(k/n)^{-\alpha}$. Finally, the local utility curvature parameter, σ, is set to 4, which is in line with standard calibrations of production-based asset-pricing models, lying within the range of values adopted in Lansing (2015) (3.3) and Jermann (1998) (5).

D.1.2 Estimated parameters

The remaining coefficients include the capital adjustment cost parameter, χ_k,[9] the consumption utility curvature parameter, χ_c, the parameter capturing the persistence of the habit stock, m, as well as the parameters of the VAR governing the dynamics of the exogenous process for TFP, the relative price of investment, and the labor share.[10]

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[9] Both a_1 and a_2 in equation (D.10) are constructed so that capital adjustment costs do not affect the steady state of the economy. Thus, we set $a_1 = \delta^{1/\chi_k}$ and $a_2 = \delta - \frac{\delta}{1-1/\chi_k}$, which implies that $\phi\left(\frac{i}{k}\right) = \delta$, $\frac{i}{k} = \delta$ and $\phi'\left(\frac{i}{k}\right) = 1$ in the steady state.

[10] In line with the VAR estimated in Section 3.1, we select a VAR(4). The results are robust to choosing a VAR(1).

Table D.1: Baseline parameter values

Description	Parameter	Value
Calibrated		
Fraction of non-assetholders	γ	0.3300
Depreciation rate	δ	0.0271
Capital share of income	α	0.3500
Discount rate	β	0.9893
Local utility curvature	σ	4.0000
Estimated		
Capital adjustment cost	χ_k	0.2089
Habit weight	χ_c	0.6936
Habit stock persistence	m	0.9498

Notes: The model is simulated at a quarterly frequency.

These are estimated by matching both some empirical impulse-responses (e.g., Christiano et al., 2005; Iacoviello, 2005, among others), as well as a selected number of unconditional macroeconomic moments.

Specifically, we match the responses of TFP, the relative price of investment, and the labor share to the TFP, IST, and FS shocks. Figure D.1 reports the estimated impulse-response functions from the model, alongside their empirical counterparts from the VAR model. We also target the unconditional volatility of the growth rates of output, consumption, investment, and dividends, as well as the unconditional correlation between the growth rate of output and that of dividends.[11] The matched moments are reported, alongside their empirical counterparts, in the upper panel of Table D.2.

We estimate $\chi_k = 0.21$, which is in line with Jermann (1998), Guvenen (2009) and Chen (2017). As for χ_c, this is estimated at 0.69, which can be considered in line with standard calibrations in the production-based asset-pricing literature, lying within the range of values adopted in Lansing (2015) (0.2) and Jermann (1998) (0.82). Finally, $m = 0.95$, in line with Cochrane (2017), and close to the persistence of the surplus-consumption ratio considered by Campbell and Cochrane (1999).

Moment matching The theoretical business-cycle statistics, together with their data counterparts, are reported in Table D.2. The framework does a fairly good job at replicating the unconditional targeted moments, returning output and consumption growth volatilities above their data counterparts, while the opposite holds true for investment and dividend growth.[12] The limited participation economy is also able

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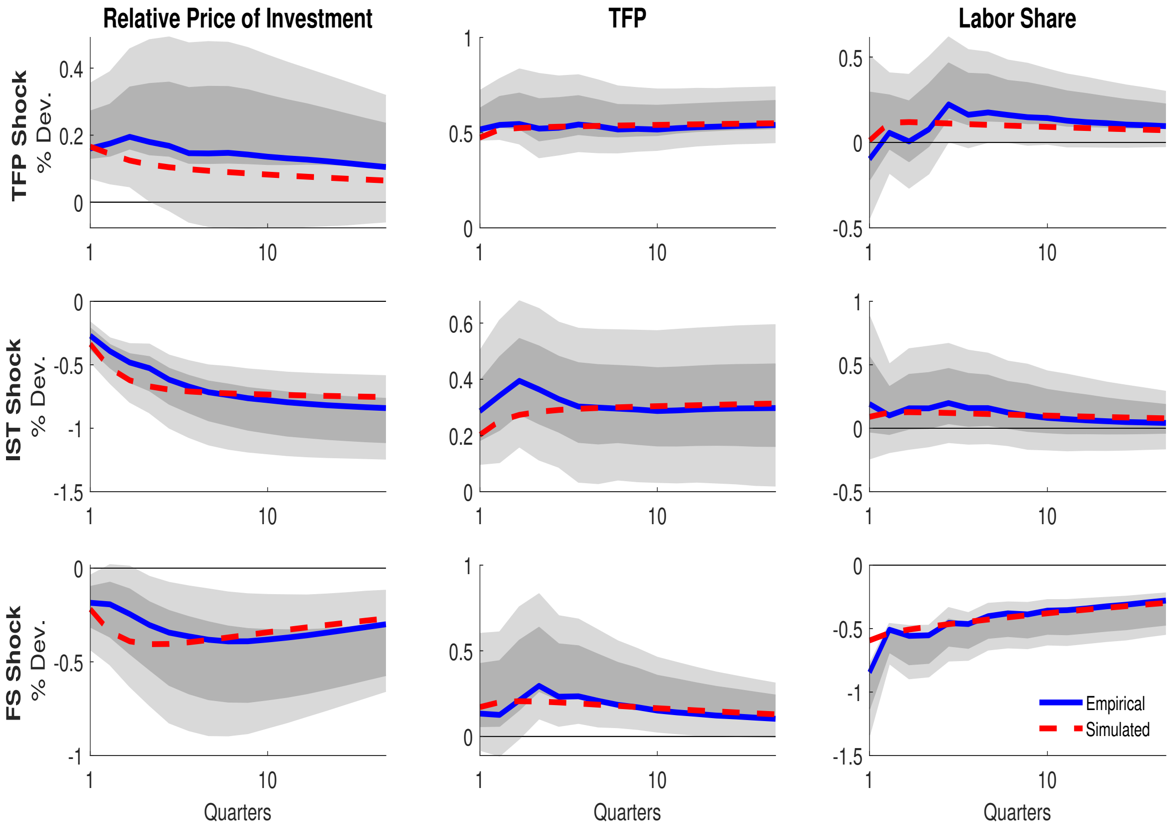
[11] The latter is particularly informative to pin down the capital adjustment cost parameter.

[12] Guvenen (2009) and Chen (2017) have extensively discussed how selecting the parameters characterizing household utility and the capital adjustment costs typically entails some distinctive trade-offs

Figure D.1: IRFs Matching



Notes: The figure displays the structural impulse-response functions estimated from the VAR in equation (1) (blue solid lines) together with the 90% and 68% confidence intervals (light-grey and dark-grey areas, respectively); and the corresponding IRFs generated by the estimated model (red dashed lines).

to replicate a number of non-targeted moments, such as the unconditional volatility of relative consumption, whose dynamics are central to our narrative. Moreover, the model shares a typical feature of RBC frameworks, namely a rather high correlation of all macroeconomic aggregates with output. On the other hand, the output correlations of the exogenous drivers (TFP, IST, and the labor share) compare fairly well with the point estimates.

As shown in Table D.3, the two-agent economy is also able to account for plausible stock excess returns, both in terms of mean and standard deviation. The close mapping between relative consumption and the dividend-to-labor income ratio is of key importance, in this respect. Restricting access to financial investment to a limited number of assetholders raises the equity premium they demand, through the connection between their consumption growth and financial income, which is intrinsically more volatile. Along with these properties, the model returns a risk-free rate that is close in line with the data, though it appears rather volatile. As in Jermann (1998) and Lansing

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when trying to match the volatility of investment, dividends and consumption.

Table D.2: Macroeconomic moments

Variable	Empirical	Simulated
	Targeted	
σ_{g_y}	0.71 $[0.58,0.80]$	1.14
σ_{g_c}	0.52 $[0.42,0.60]$	0.88
σ_{g_i}	3.16 $[2.46,3.81]$	2.18
σ_{g_d}	4.98 $[3.13,7]$	2.82
$corr_{g_d,g_y}$	0.25 $[0.1,0.44]$	0.92
	Implied	
$\sigma_{g_{rc}}$	0.68 $[0.56,0.79]$	0.45
$corr_{g_c,g_y}$	0.74 $[0.64,0.81]$	0.98
$corr_{g_i,g_y}$	0.69 $[0.6,0.75]$	0.97
$corr_{g_{rc},g_y}$	0.15 $[-0.03,0.26]$	0.84
$corr_{g_z,g_y}$	0.49 $[0.33,0.6]$	0.65
$corr_{g_\mu,g_y}$	-0.06 $[-0-16,0.1]$	0.30
$corr_{\log(ls),g_y}$	-0.08 $[-0.27,0.07]$	-0.16

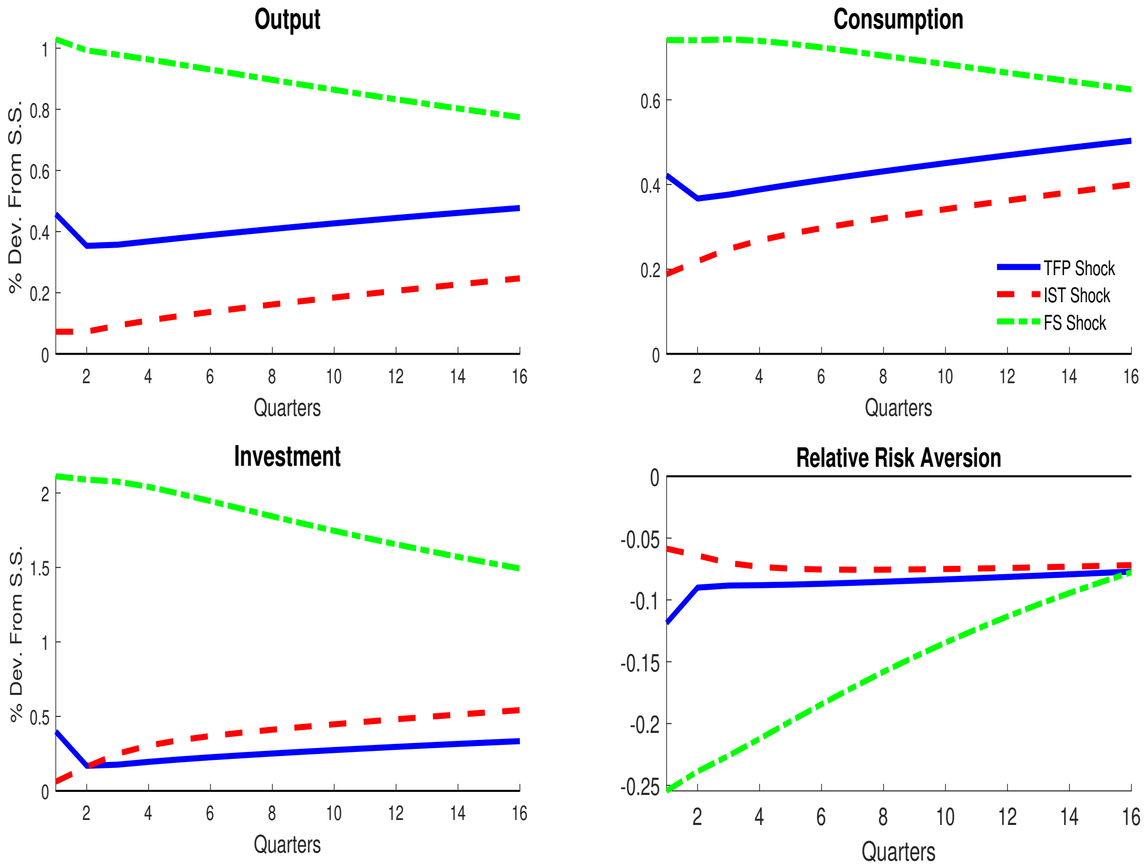
Notes: Bootstrapped 90% confidence intervals in brackets. All moments refer to quarterly variables. g_x denotes the first-differenced logarithm of a generic variable x.

Table D.3: Asset-pricing moments

Variable	Empirical	Simulated
$E(r^b)$	1.07 $[0.19,1.84]$	1.17
$E(r^s - r^b)$	4.39 $[2.56,6.83]$	4.59
σ_{r^b}	1.50 $[1.00,1.78]$	4.54
$\sigma_{r^s-r^b}$	15.67 $[14.43,17.89]$	19.94

Notes: Bootstrapped 90% confidence intervals in brackets. All moments refer to annualized variables.

Figure D.2: Additional variables - IRFs



Notes: Output, consumption, investment, and relative risk aversion responses to TFP, IST, and FS shocks.

(2015), the combination of habit utility and (high) capital adjustment costs that generates sufficiently volatile stock returns induces, at the same time, strong fluctuations in investors' marginal utility, which reflects into the volatility of the risk-free rate.

D.2 Stationary representation of the model

Given the permanent nature of TFP and IST shocks, the model exhibits non-stationary dynamics. As such, it needs to be rewritten in stationary form by appropriately transforming the growing variables. Define $\Gamma_t \equiv (z_t \mu_t^{\alpha})^{\frac{1}{1-\alpha}}$, and the associated growth rate $g_{\Gamma,t} \equiv \Delta \log(\Gamma_t) = \frac{1}{1-\alpha}\left[g_{z,t} + \alpha g_{\mu,t}\right]$, where $g_{z,t} \equiv \Delta \log(z_t)$ and $g_{\mu,t} \equiv \Delta \log(\mu_t)$ denote the growth rates of TFP and IST, respectively. We apply the following transformations:

$$\tilde{y}_t \equiv \frac{y_t}{\Gamma_t}, \quad \tilde{k}_t \equiv \frac{k_t}{\Gamma_{t-1}\mu_{t-1}}, \quad \tilde{i}_t \equiv \frac{i_t}{\Gamma_t \mu_t}, \quad \tilde{q}_t \equiv q_t \mu_t, \quad \tilde{d}_t \equiv \frac{d_t}{\Gamma_t}, \quad \tilde{w}_t \equiv \frac{w_t}{\Gamma_t}, \quad \tilde{c}_t \equiv \frac{c_t}{\Gamma_t},$$

$$\tilde{c}_t^{na} \equiv \frac{c_t^{na}}{\Gamma_t}, \quad \tilde{c}_t^{a} \equiv \frac{c_t^{a}}{\Gamma_t}, \quad \tilde{h}_t \equiv \frac{h_t}{\Gamma_t}, \quad \tilde{\lambda}_t \equiv \lambda_t \Gamma_t^{\sigma}.$$

Then, the stationary equilibrium is the solution to the following system of equations:

$$\tilde{c}_t^{na} = \tilde{w}_t, \tag{D.24}$$

$$\tilde{c}_t^{a} = \tilde{w}_t + \frac{\tilde{d}_t}{1-\gamma}, \tag{D.25}$$

$$\tilde{c}_t = \tilde{w}_t + \tilde{d}_t, \tag{D.26}$$

$$\tilde{h}_t = \exp{(-g_{\Gamma,t})}[m\tilde{h}_{t-1} + (1-m)\tilde{c}_{t-1}^a], \tag{D.27}$$

$$\tilde{\lambda}_t = (\tilde{c}_t^a - \chi_c \tilde{h}_t)^{-\sigma}, \tag{D.28}$$

$$m_{t,t+1} = \beta E_t \left(\frac{\tilde{\lambda}_{t+1}}{\tilde{\lambda}_t}\right) \exp{(-\sigma g_{\Gamma,t+1})}, \tag{D.29}$$

$$p_t^s = E_t m_{t,t+1}(p_{t+1}^s + \tilde{d}_{t+1}), \tag{D.30}$$

$$p_t^b = E_t m_{t,t+1}, \tag{D.31}$$

$$\tilde{y}_t = \exp\left[-\frac{\alpha}{1-\alpha}(g_{z,t} + g_{\mu,t})\right] A n^{1-\alpha_t} \tilde{k}_t^{\alpha_t}, \tag{D.32}$$

$$\tilde{k}_{t+1} = \exp{(-g_{\Gamma,t} - g_{\mu,t})}\left[(1-\delta)\tilde{k}_t + \phi\left(\frac{\tilde{i}_t}{\tilde{k}_t}\right)\tilde{k}_t\right], \tag{D.33}$$

$$\phi\left(\frac{\tilde{i}_t}{\tilde{k}_t}\right) = \frac{a_1}{1-1/\chi_k}\left[\frac{\tilde{i}_t}{\tilde{k}_t}\exp{(g_{\Gamma,t} + g_{\mu,t})}\right]^{1-1/\chi_k} + a_2, \tag{D.34}$$

$$\tilde{d}_t = \tilde{y}_t - \tilde{w}_t n_t - \tilde{i}_t, \tag{D.35}$$

$$\tilde{w}_t = (1-\alpha_t)\frac{\tilde{y}_t}{n_t}, \tag{D.36}$$

$$\phi^{'}\left(\frac{\tilde{i}_t}{\tilde{k}_t}\right) = a_1\left[\frac{\tilde{i}_t}{\tilde{k}_t}\exp{(g_{\Gamma,t} + g_{\mu,t})}\right]^{-1/\chi_k}, \tag{D.37}$$

$$\phi^{'}\left(\frac{\tilde{i}_t}{\tilde{k}_t}\right) = \frac{1}{\tilde{q}_t}, \tag{D.38}$$

$$\tilde{q}_t = E_t m_{t,t+1}\Bigg\{\alpha_{t+1}\frac{\tilde{y}_{t+1}}{\tilde{k}_{t+1}}\exp{(g_{\Gamma,t+1})} + \tilde{q}_{t+1}$$
$$\left[(1-\delta)\exp{(-g_{\mu,t+1})} + \phi\left(\frac{\tilde{i}_{t+1}}{\tilde{k}_{t+1}}\right)\exp{(-g_{\mu,t+1})} - \phi^{'}\left(\frac{\tilde{i}_{t+1}}{\tilde{k}_{t+1}}\right)\frac{\tilde{i}_{t+1}}{\tilde{k}_{t+1}}\exp{(g_{\Gamma,t+1})}\right]\Bigg\}. \tag{D.39}$$

E Robustness

This section reports additional numerical evidence from two model variations, one with bondholders along with stockholders, and one with firm leverage.

E.1 Stockholders and bondholders

In this robustness, we split the household block between stockholders (same as assetholders in the baseline model, denoted by "a") and bondholders, who can only trade bonds. Therefore, asset market non-participants (denoted by "na" as in the baseline) are not hand-to-mouth households in this economy. Bondholders participate in the bond market subject to convex bond portfolio adjustment costs as in Schmitt-Grohé and Uribe (2003) and Cantore and Freund (2021), which penalize deviation of their holdings from their steady-state value. The strength of this financial friction is governed by the parameter χ_b, and adjustment cost takes a simple quadratic form. Notice that portfolio adjustment costs are rebated to the household in lump-sum through. As a consequence, the financial friction does not affect the *level* of consumption, but only bondholders' Euler equation:

$$p_t^b = \frac{E_t m_{t,t+1}^{na}}{1 + \chi_b (q_{b,t+1}^{na} - q_{b,ss}^{na})}, \tag{E.1}$$

where $m_{t,t+1}^{na}$ is the representative bondholder's stochastic discount factor. Finally, the bond market equilibrium condition becomes:

$$0 = \gamma q_{b,t+1}^{na} + (1-\gamma) q_{b,t+1}^{a}. \tag{E.2}$$

Bondholders have the same utility as stockholders. The steady-state bondholdings for stockholders and bondholders are set to zero. We re-estimate the model following the baseline procedure, but adding the parameter χ_b to the estimation. The fraction of bondholders is calibrated to 50%, in line with standard estimates of the stock market participation rate. The results of the estimation are reported in Table E.1.

The key results, namely: 1) the conditional cyclicality of the consumption and dividend-wage gaps (Figure E.1); 2) the dynamics of the stochastic discount factor, dividend growth, realized and expected excess returns (Figure E.2); 3) shock contribution to macro and financial moments (Table E.2); and 4) the unconditional and conditional impact of household heterogeneity (Table E.3) remain mostly unaltered compared to the main text. Crucially, Figure E.1 shows that, in presence of bond trade between stockholders and non-stockholders, the perfect mapping between relative

Table E.1: Parameter values - Stockholders and bondholders

Description	Parameter	Value
Calibrated		
Fraction of bondholders	γ	0.5000
Estimated		
Capital adjustment cost	χ_k	0.2003
Habit weight	χ_c	0.6312
Habit stock persistence	m	0.5000
Portfolio Adjustment Cost	χ_b	0.5515

Notes: The model is simulated at a quarterly frequency.

consumption and dividend-wage ratio dynamics is broken. Indeed, asymmetric income fluctuations between the two groups of households can be smoothed through the exchange of the risk-free asset. Nevertheless, the conditional cyclical properties of relative consumption and income remain in line with the baseline model, and the empirical evidence.

E.2 Financial leverage

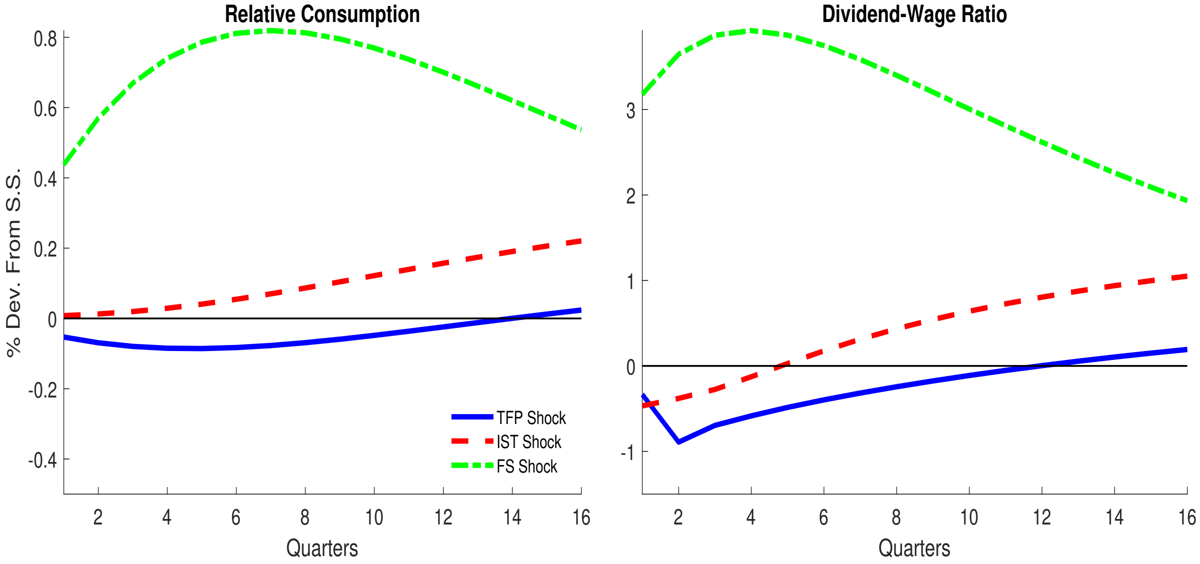
Finally, we consider a version of the model that includes financial leverage. We follow Jermann (1998) and assume that, each period, the firm issues j-period discount bonds for a fixed fraction ν/j of its capital stock, k_{t+1}. Therefore, dividends now are given by:

$$d_t = y_t - w_t n_t - \frac{i_t}{\mu_t} - \frac{\nu}{j}(k_{t-(j-1)} - p_t^{lb} k_{t+1}), \tag{E.3}$$

where $p_t^{lb} = E_t m^a_{t,t+j}$ is the price of the j-period bond. Note however that the Modigliani-Miller theorem holds in this framework. Financial leverage affects the cash flow process and stock returns, but it has no impact on real variables. As in Jermann (1998), we set $j = 40$, meaning that bonds have a duration of ten years. The financial leverage parameter ν is instead estimated by moment matching, again following the baseline procedure. The resulting parameter values are displayed in Table E.4.

Again, the key insights of our analysis hold quite closely. Interestingly, the introduction of financial leverage again decouples the dynamics of relative consumption from that of the dividend-wage ratio. Indeed, the interest payments made by the firm affect fluctuations in dividend income, but they cancel out in the assetholders' budget constraint. Nevertheless, the conditional cyclical properties of relative income still remain informative on the relative consumption response, especially in response to TFP and FS shocks.

Figure E.1: Relative consumption and dividend-wage ratio - IRFs - Stockholders and bondholders



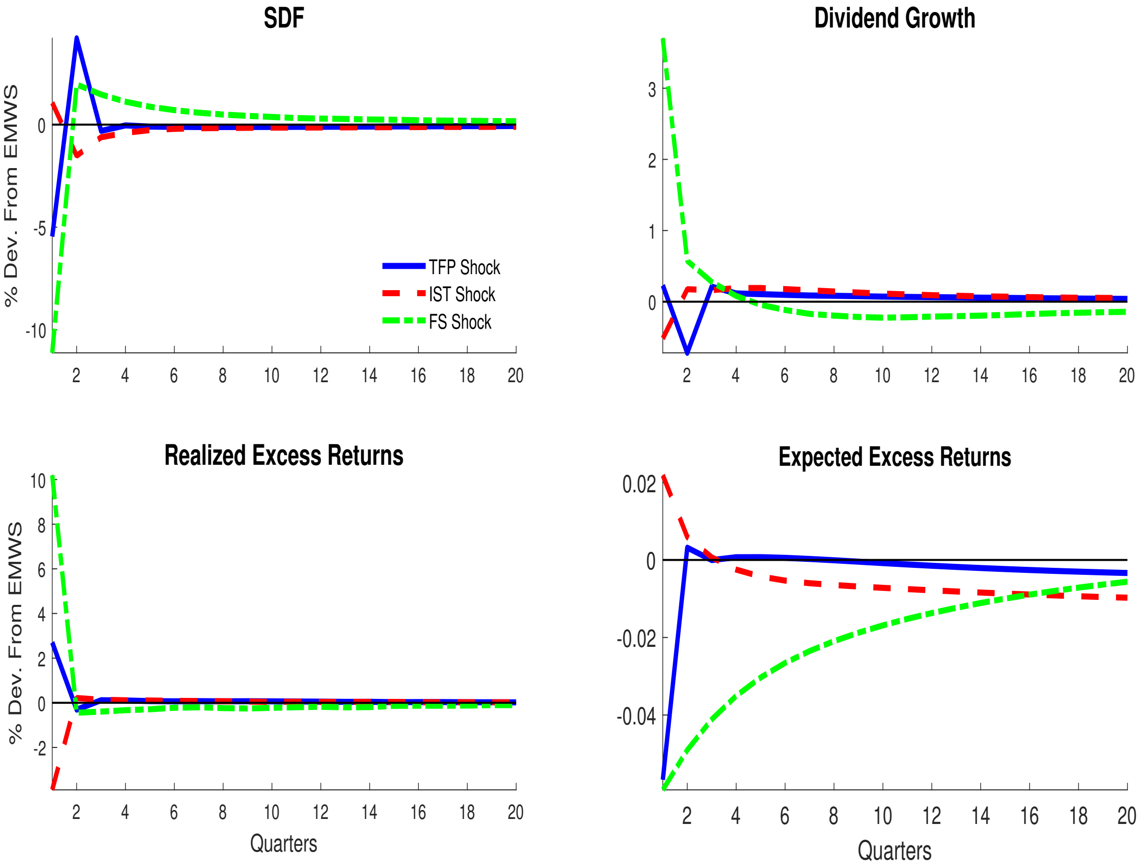
Notes: Responses of relative consumption and dividend-to-wage ratio to TFP, IST, and FS shocks in the model with stockholders and bondholders.

Table E.2: Shock contribution - Stockholders and bondholders

Moment		TFP	IST	FS
Macro aggregates				
$\sigma^2_{\log(\tilde{y})}$	SR	16.6	59.1	24.3
	LR	16.5	71	12.5
$\sigma^2_{\log(\tilde{c})}$	SR	16.8	49.5	33.7
	LR	16.5	65	18.5
$\sigma^2_{\log(\tilde{inv})}$	SR	15.8	69	15.2
	LR	16.3	75	8.7
$\sigma^2_{\log(\tilde{rc})}$	SR	1	3	96
	LR	10.5	53	36.5
Financial moments				
$E(r^b)$		9.9	-1.3	91.4
$E(r^s - r^b)$		10.9	3.1	86
$\sigma^2_{r^b}$		63.5	9.9	26.6
$\sigma^2_{(r^s - r^b)}$		5.4	11.6	83

Notes: Each entry indicates the (percentage) contribution of the corresponding shock to a specific macroeconomic or asset-pricing moment. Along each row, the sum of the three shock contributions amounts to 100. For the macroeconomic variables, the decomposition is presented over both the short run (SR) and the long run (LR). For the asset-pricing variables, the decomposition is only presented in terms of long-run moments.

Figure E.2: Excess stock returns - IRFs - Stockholders and bondholders



Notes: Stochastic discount factor, dividend growth and realized and expected excess stock returns responses to TFP, IST, and FS shocks in the model with stockholders vs bondholders. Generalized IRFs are computed in percent deviations from the ergodic mean with shocks (EMWS). Average GIRFs are computed across 500 replications.

Table E.3: Effects of household heterogeneity - Stockholders and bondholders

	Macro aggregates				Asset prices		
		Baseline	High			Baseline	High
		$\gamma = 0.5$	$\gamma = 0.8$			$\gamma = 0.5$	$\gamma = 0.8$
$\sigma_{\log(\tilde{y})}$	unc.	-0.18	-1.5	$E(r^b)$	unc.	-22.7	-51.5
	TFP	-0.25	-2		TFP	0.58	0.34
	IST	-1.7	-5.3		IST	0.22	0.65
	FS	10	22.2		FS	-21.8	-48
$\sigma_{\log(\tilde{c})}$	unc.	-1.1	-2.2	$E(r^s - r^b)$	unc.	19.2	41.9
	TFP	-0.44	-1		TFP	-9.4	-16.2
	IST	-0.41	-1.1		IST	-11	-58.1
	FS	-4	-7.1		FS	25.8	57.2
$\sigma_{\log(\widetilde{inv})}$	unc.	-1	-4	σ_{r^b}	unc.	0.61	1.4
	TFP	-0.85	-4.4		TFP	0.78	1.6
	IST	-3.1	-9.6		IST	-0.51	-0.59
	FS	24.4	55.9		FS	0.63	1.6
				$\sigma_{(r^s - r^b)}$	unc.	8.9	18.9
					TFP	-8	-16.1
					IST	6.6	12.2
					FS	10.7	22.7

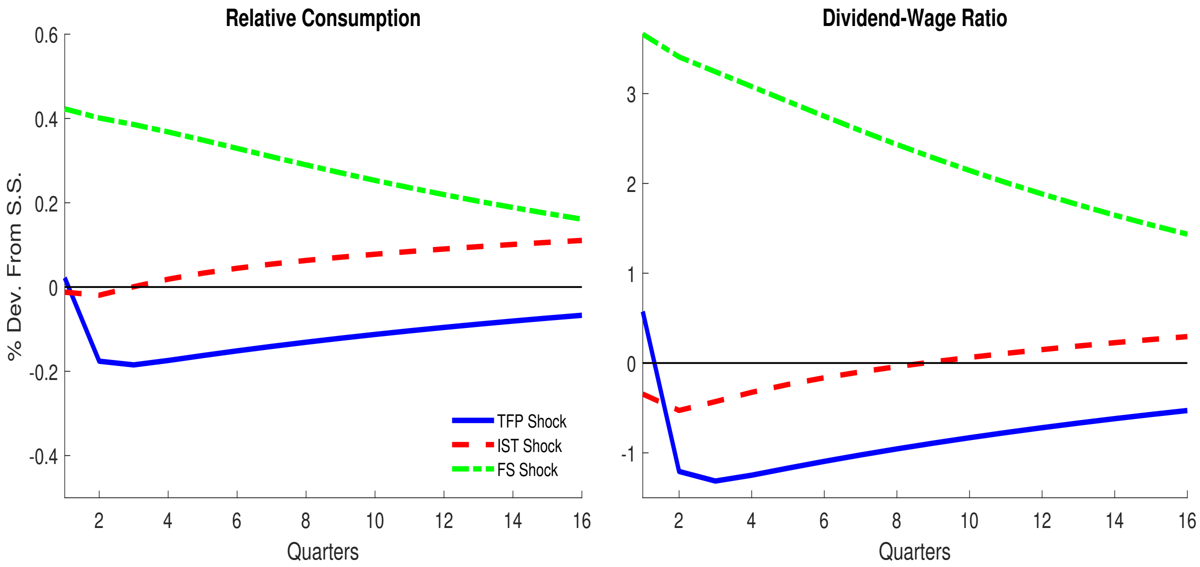
Notes: Each entry indicates the percent variation in the macroeconomic or asset-pricing moment obtained in the TA economy relative to the RA economy. Results are shown for both values of the fraction of bondholders $\gamma = 0.50$ and $\gamma = 0.80$. Both unconditional (unc.) and conditional percentage variations are reported.

Table E.4: Parameter values - Financial leverage

Description	Parameter	Value
Calibrated		
Duration long-term bond	J	40
Estimated		
Capital adjustment cost	χ_k	0.2771
Habit weight	χ_c	0.6251
Habit stock persistence	m	0.9497
Financial leverage	ν	0.1069

Notes: The model is simulated at a quarterly frequency.

Figure E.3: Relative consumption and dividend-wage ratio - IRFs - Financial leverage



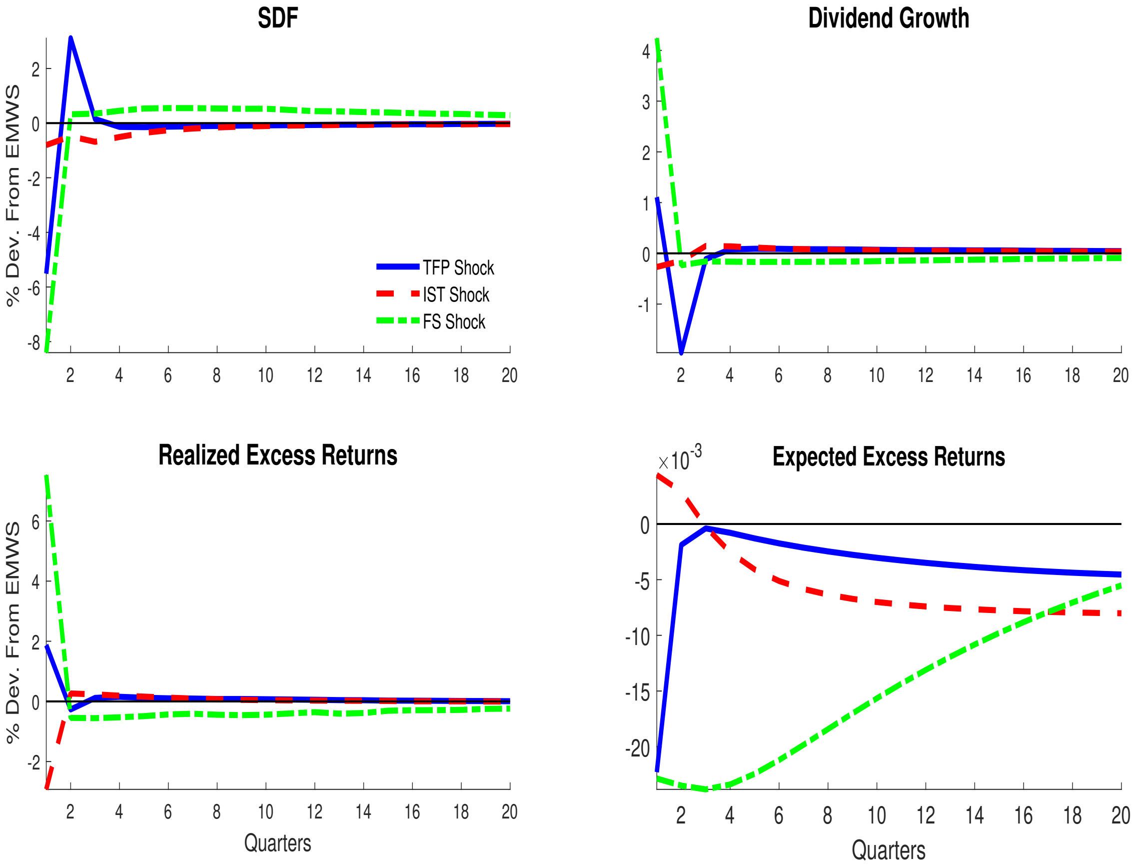
Notes: Responses of relative consumption and dividend-to-wage ratio to TFP, IST, and FS shocks in the model with financial leverage.

Table E.5: Shock contribution - Financial Leverage

Moment		TFP	IST	FS
Macro aggregates				
$\sigma^2_{\log(\tilde{y})}$	SR	17.3	56.2	26.5
	LR	15.3	61.1	23.6
$\sigma^2_{\log(\tilde{c})}$	SR	24.2	60.5	15.2
	LR	19.3	60.9	19.8
$\sigma^2_{\log(\widetilde{inv})}$	SR	10	48.2	41.8
	LR	11	60.1	29
$\sigma^2_{\log(\widetilde{rc})}$	SR	14.6	4.6	80.8
	LR	10.2	54	35.7
Financial moments				
$E(r^b)$		23.8	-0.59	76.8
$E(r^s - r^b)$		14.2	-3.2	88.9
$\sigma^2_{r^b}$		74.7	8.9	16.4
$\sigma^2_{(r^s - r^b)}$		4.9	12.4	82.7

Notes: Each entry indicates the (percentage) contribution of the corresponding shock to a specific macroeconomic or asset-pricing moment. Along each row, the sum of the three shock contributions amounts to 100. For the macroeconomic variables, the decomposition is presented over both the short run (SR) and the long run (LR). For the asset-pricing variables, the decomposition is only presented in terms of long-run moments.

Figure E.4: Excess stock returns - IRFs - Financial Leverage



Notes: Stochastic discount factor, dividend growth and realized and expected excess stock returns responses to TFP, IST, and FS shocks in the model with financial leverage. Generalized IRFs are computed in percent deviations from the ergodic mean with shocks (EMWS). Average GIRFs are computed across 500 replications.

Table E.6: Effects of household heterogeneity - Financial leverage

	Macro aggregates				Asset prices		
		Baseline	High			Baseline	High
		$\gamma = 0.33$	$\gamma = 0.8$			$\gamma = 0.33$	$\gamma = 0.8$
$\sigma_{\log(\tilde{y})}$	unc.	0.34	-0.24	$E(r^b)$	unc.	-6.8	-23.9
	TFP	1.7	4.6		TFP	0.79	2.5
	IST	-1.2	-5.5		IST	-0.01	-0.35
	FS	3.6	10.5		FS	-6.8	-23.1
$\sigma_{\log(\tilde{c})}$	unc.	-0.03	0.41	$E(r^s - r^b)$	unc.	16.3	55.9
	TFP	-0.37	-0.76		TFP	2.6	7.7
	IST	-0.04	-0.06		IST	15.7	99.3
	FS	0.37	3		FS	18.8	66.5
$\sigma_{\log(\widetilde{inv})}$	unc.	0.97	1	σ_{r^b}	unc.	10.4	33.8
	TFP	4.4	12.1		TFP	11.2	35.9
	IST	-2.5	-12.1		IST	4.1	14
	FS	8.1	24.9		FS	10.3	35.1
				$\sigma_{(r^s - r^b)}$	unc.	8	26.2
					TFP	2.1	4.9
					IST	4.1	11
					FS	9	29.9

Notes: Each entry indicates the percent variation in the macroeconomic or asset-pricing moment obtained in the TA economy relative to the RA economy. Results are shown for both the baseline value of the fraction of non-assetholders ($\gamma = 0.33$) and for $\gamma = 0.80$. Both unconditional (unc.) and conditional percentage variations are reported.

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