Nominal Maturity Mismatch and the Liquidity Cost of Inflation

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Abstract

We document a liquidity channel through which unexpected inflation generates substantial welfare losses. Household balance sheets are nominal maturity mismatched: nominal liabilities have a longer duration than nominal assets. Due to this mismatch, losses from unexpected inflation are concentrated over short time horizons, while gains are spread out over the longer run. This has negative effects on liquidity-constrained households, who cannot easily borrow against their future gains. We quantify the importance of the liquidity channel and show that the recent 2021–2022 unexpected inflation shock caused welfare losses valued at 0.5% of lifetime wealth for households in the lower half of the wealth distribution; this is a monetary loss equal in size to 15% of single-year consumption. More than 75% of that loss is due to the previously unexplored liquidity channel, with the remainder coming from the more commonly studied wealth channel.

JEL: E2, E3, G5

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1 Introduction

We measure how unexpected inflation affects households through their balance sheets. It is widely understood that inflation redistributes wealth from nominal lenders to nominal borrowers, with many papers documenting how much households gain or lose due to their net holdings of nominal assets and liabilities. We refer to this channel as *the wealth channel*. For households without borrowing constraints, the size of this wealth channel correctly summarizes the welfare effects of unexpected inflation. However, for liquidity-constrained households who cannot move resources freely across time, losses in some periods can have severe consequences that are not necessarily offset by gains in other periods. We refer to this intertemporal mismatch of gains and losses as *the liquidity channel* of unexpected inflation. We argue that this liquidity channel accounts for a significant proportion of the welfare effects of inflation.

We illustrate this liquidity channel with a standard consumption-saving model, allowing for illiquidity from convex borrowing costs and fixed borrowing constraints. A household receives streams of payments over time from its assets, which include human capital, stocks, and cash. The household also makes payments on their liabilities, like mortgages. Part of each payment stream is nominal and is affected by unexpected changes in the price level (i.e., an *inflation shock*). We express the effect of an inflation shock on household welfare with a formula containing two terms: (1) the wealth channel: absent illiquidity, the welfare effect is proportional to the change in a household's lifetime wealth; and (2) the liquidity channel: due to the existence of borrowing costs and constraints, the welfare effect contains an interaction term that captures the misalignment across time between household's gains and losses and how much households value these gains and losses. We use this formula to guide our empirical measurement and quantify the effects of the two channels.

For each household in the U.S., we construct a nominal stream of payments using balance sheet information from the Survey of Consumer Finances (SCF). For asset and liability categories on household balance sheets that are relatively homogeneous, we assign nominality and duration based on available individual-level information. We deconstruct assets that represent claims on other assets and liabilities, such as equity holdings and pension funds, into indirect holdings of homogeneous assets and

liabilities with known nominality and duration. We use the granular items on households' consolidated balance sheets to estimate the complete stream of nominal flows that households expect to pay and receive over different time horizons.

We show that households' nominal balance sheets display a large maturity mismatch: the average household holds nominal liabilities with significantly longer duration than its nominal assets. As an example, many U.S. households hold large nominal liabilities in the form of fixed-rate mortgages, spread out over time horizons of up to 30 years. On the other hand, nominal assets, such as deposits, have a short horizon. Another important type of "asset," future labor income, is also partially nominal due to nominal wage rigidities; while wages do not adjust immediately to inflation shocks, they do adjust over the course of a few years, making future labor income an asset with short nominal duration. Because of this maturity mismatch of nominal assets and liabilities, a typical U.S. household suffers losses in the short run and gains in the long run as a result of unexpected inflation.

We measure the level of illiquidity faced by households from two sources: borrowing costs and borrowing constraints. To calculate borrowing costs, we use information from the SCF about whether households have revolving credit and, if so, the interest rate they pay on that credit. To estimate the level of illiquidity due to borrowing constraints, we compute a *shadow rate*: how much a household would have been willing to pay had they been able to borrow more. We propose a method to recover this rate from data on households' high-frequency consumption responses to one-time unexpected transfers. We measure the shadow rate for U.S. households and show that the total level of illiquidity—combining the spread and the shadow rate—varies across the wealth distribution, with poor (bottom wealth decile households) willing to borrow at a marginal rate up to 20 percentage points above the Treasury rate. The rich (top wealth decile households), on the other hand, are only willing to borrow with a 5% spread. Moreover, the source of illiquidity differs for the poor and rich: poor households are illiquid mostly due to borrowing constraints, while illiquidity for rich households is mostly reflected in their borrowing costs.

We use the 2021–2022 inflation episode as a case study to quantify the relative welfare effects of the wealth and liquidity channels in response to an unexpected inflation shock. For each household, we calculate these welfare effects by combining annual gains and losses from inflation with our measures of illiquidity over different time

horizons. For a large majority of U.S. households, the liquidity channel causes welfare losses almost three times the size of the standard wealth channel. For households in the bottom half of the wealth distribution, the unexpected increase in inflation during this period leads to a welfare loss equivalent to an average of 0.5% of lifetime wealth, which is equal (in dollar terms) to 15% of single-year consumption. The effects of the liquidity channel are particularly stark for poor households: more than three-quarters of the welfare loss for the bottom wealth decile is due to illiquidity.

Our work builds on Doepke and Schneider (2006), who provided the first empirical analysis of how households are affected by inflation through the net nominal positions of their balance sheets. Recent work by Cardoso et al. (2022) and Pallotti et al. (2024) evaluates the Covid-19 inflation episode through a similar lens. We introduce a novel 'liquidity' channel of unexpected inflation that is absent in previous analyses. This channel arises from the interaction between household illiquidity and the nominal maturity mismatch on their balance sheets. We argue that this liquidity channel is more important for the majority of U.S. households than the wealth channel, which has been a key focus of previous research. The quantitative importance of the liquidity channel provides a new perspective on the question of why people dislike inflation (Shiller, 1997; Stantcheva, 2024).

Our work also relates to several other papers that quantify the heterogeneous effects of aggregate shocks on households, including Auclert (2019), Pugsley and Rubinton (2023), and Del Canto, Grigsby, Qian and Walsh (2023). These studies explore how inflationary shocks (including monetary policy and oil shocks) affect households through changes in output, real interest rates, and asset prices. A common thread in these papers is the wealth channel through which inflation impacts households' lifetime wealth because of their net nominal positions, as in Doepke and Schneider (2006). We argue that our liquidity channel will be a common and quantitatively important factor in analyzing these (and other) inflationary shocks. As we show, the interaction between household illiquidity and the nominal maturity mismatch on their balance sheets is of first-order concern when studying any macroeconomic shock that affects inflation.

Our focus on household illiquidity connects to a large literature emphasizing the importance of heterogeneous consumption responses to transitory income shocks, such as Jappelli and Pistaferri (2014), Kaplan et al. (2014) and Aguiar et al. (2020). Our ap-

proach to measuring household illiquidity draws from this literature, linking household consumption responses to the extent to which they are borrowing constrained. We estimate household consumption responses using high-frequency consumption data from Karger and Rajan (2023), building on recent work by R. Baker et al. (2023) and Fagereng et al. (2021). We develop a new method to map these consumption responses into estimates of household-level illiquidity due to borrowing constraints.

2 Framework

To precisely describe the liquidity channel of unexpected inflation and the related empirical objects we measure in data, we use a standard consumption-saving model with borrowing frictions. We first derive a benchmark result: without liquidity constraints, the welfare effects of unexpected inflation shocks are proportional to changes in households' lifetime wealth. We then show that when households face illiquidity in the form of convex borrowing costs or borrowing constraints, the welfare effects of inflation shocks are determined by an additional statistic that summarizes the intertemporal misalignment between liquidity and the gains and losses caused by inflation.

2.1 Households' Problem

We are interested in the welfare effect of a one-time unexpected change in the path of price levels from $\{\bar{P}_t\}$ to $\{P_t\}$:

$$\log P_t = \log \bar{P}_t + (t+1) \times \hat{\pi}^t.$$

Changes in future price levels are given by a sequence of unexpected inflation shocks $\{\hat{\pi}^t\}$ over different time horizons. Given a time horizon t, $\hat{\pi}^t$ indicates the unexpected change in the average inflation from the beginning of period 0 to the end of period t.

Consider a household solving a consumption-saving problem. The household derives utility from consumption and can hold various types of assets, denoted by a set $\mathcal{J}$. The household's initial positions in these assets are represented by streams of nominal payments $\{\bar{Y}_{j,t}\}_{j\in\mathcal{J}}$ over different time horizons, t. Each asset j is characterized by its

nominality for each horizon, $\theta_{j,t} \in [0,1]$, with fraction $1-\theta_{j,t}$ of the payment indexed to the price level in period t. Given their initial positions and the inflation shocks, the household receives payment $Y_{j,t}$ from each asset type j:

$$Y_{j,t} = \Big(\theta_{j,t} + \frac{P_t}{\bar{P}_t}(1-\theta_{j,t})\Big)\bar{Y}_{j,t}.$$

After the unexpected inflation shock $\{\hat{\pi}_0^t\}$ realizes at time 0, the household can implement a sequence of adjustments on their positions for each asset j, $\boldsymbol{a}_t = \{a_{j,t}\}_{j\in\mathcal{J}}$, where $\boldsymbol{a}_t$ denotes the difference in real value from the initial positions at time t and $\boldsymbol{a}_0$ is normalized to zero. Holding assets $\boldsymbol{a}_t$ over period $t+1$ generates (gross) returns $\boldsymbol{R}_{t+1}^A$, and households pay adjustment cost $\phi(\boldsymbol{a}_t, \boldsymbol{a}_{t-1})$ to change their holdings. Examples of these costly adjustments include paying down a mortgage early, taking out a home equity loan, or withdrawing money early from a pension. Besides assets in $\mathcal{J}$, the household can also save and borrow without adjustment costs using a liquid asset, b_t. However, the household faces a real interest rate schedule $R_{t+1}^B(b_t)$ for the asset and a fixed borrowing constraint, χ_t, that bounds the level b_t that the household can hold from one period to the next. Since these adjustments happen after the one-time inflation shock, without loss of generality, we assume $\{\boldsymbol{a}_t, \boldsymbol{R}_{t+1}^A, \phi(\boldsymbol{a}_t, \boldsymbol{a}_{t-1}), b_t, R_{t+1}^B(b_t)\}$ are all real variables. In Appendix C, we show our setup is equivalent to that where the household chooses how many units of physical assets to hold with an appropriately chosen adjustment cost function.

Given any sequence of price level $\{P_t\}$, the household maximizes utility subject to real budget constraints and borrowing constraints:

$$U = \max_{c_t, b_t, \boldsymbol{a}_t} \sum_{t\geq 0} \beta_t u(c_t), \quad \text{s.t.} \tag{1}$$

$$\boldsymbol{a}_t^\intercal \mathbf{1} + b_t + c_t + \phi(\boldsymbol{a}_t, \boldsymbol{a}_{t-1}) \leq z_t + \boldsymbol{a}_{t-1}^\intercal \boldsymbol{R}_t^A + b_{t-1} R_t^B(b_{t-1}), \tag{2}$$

where $z_t = \frac{1}{P_t}\sum_{j\in\mathcal{J}} Y_{j,t} = \frac{1}{P_t}\sum_{j\in\mathcal{J}}(\theta_{j,t} + \frac{P_t}{\bar{P}_t}(1-\theta_{j,t}))\bar{Y}_{j,t}$ and $b_t \geq \chi_t$.

The stream of real income z_t comprises payments $\{Y_{j,t}\}$ from the household's initial position with nominality adjustments. It represents the net resources available in period t based on the household's already-committed contractual obligations. For example, the household might expect to receive labor income in period t, which will be a positive entry $Y_{j,t}$ for some j, but has a pre-committed fixed-rate mortgage to

be paid off in future years, which will be a negative entry $Y_{j,t}$ for another j. How much the household's labor income or mortgage adjusts with inflation depends on their nominality $\theta_{j,t}$. The income stream $\{z_t\}$ is the total real positions the household expects at time 0 for each time horizon, absent any subsequent adjustments. The liquid asset b_t acts like a cash deposit if $b_t > 0$ or like credit card borrowing if $b_t < 0$. Holding b_t pays or incurs interest rate $R^B_{t+1}(b_t)$, depending on the level of saving or borrowing. After the inflation shock, the household can adjust their holdings of assets in $\mathcal{J}$ by paying an adjustment cost $\phi(\boldsymbol{a}_t, \boldsymbol{a}_{t-1})$. To isolate our mechanism, we assume the returns $\boldsymbol{R}^A_{t+1}$ and return schedule $R^B_{t+1}(\cdot)$ are unaffected by changes in price levels.[1] In a more general framework, there would be shocks or policies causing changes in these returns along with inflation. One can interpret our result as a detailed analysis of how inflation generated by these shocks affects households through their nominal balance sheet.

2.2 Welfare Effects

Let $\{\bar{c}_t\}$ denote the optimal consumption-saving plan of the household, given the initial sequence of price levels $\{\bar{P}_t\}$ without the inflation shock. The following lemma describes the welfare effects of an unexpected inflation shock $\{\hat{\pi}^t\}$:

Lemma 1 *The first-order effect of the inflation shock on the household's welfare is given by:*

$$dU = \sum_{t \geq 0} \beta_t u'(\bar{c}_t) \Delta z_t$$

where $\Delta z_t \coloneqq -\frac{1}{\bar{P}_t} Y^\theta_t \times (t+1) \times \hat{\pi}^t$, *and* $Y^\theta_t \coloneqq \sum_{j \in \mathcal{J}} \theta_{j,t} \bar{Y}_{j,t}$.

Proof. See Appendix A.1. □

Intuitively, Δz_t captures how the inflation shock affects the real value of the nominal payment streams in each period. If the household has net nominal liabilities in a period, then a positive inflation shock will reduce the cost of paying off those liabilities, thereby increasing the size of Δz_t; the effect is reversed for net nominal assets. The

[1] For example, this assumption separates our channel from the "interest rate exposure channel" in Auclert (2019) through which households' welfare is affected by changes in real interest rate.

total effect is a sum of these effects weighted by the household's marginal utility of consumption in each period.

We now consider two cases: (1) a frictionless benchmark, where the household can borrow and save across time at the market rate, and (2) a case in which the household faces illiquidity due to convex borrowing costs and constraints that hinder their ability to borrow and save across time.

Frictionless Benchmark

Consider the benchmark with no borrowing constraints, $\chi_t = -\infty$, and linear borrowing costs, $R^B_{t+1}(b_t) \equiv R_{t+1}$, where R_{t+1} is the market rate for short-term borrowing and saving (which we will assume is equal to the treasury rate). The sequence of household consumption solves the standard Euler equation:

$$u'(\bar{c}_t) = \beta_{t,t+1} u'(\bar{c}_{t+1}) R_{t+1}, \quad \beta_{t,t+1} \coloneqq \beta_{t+1}/\beta_t. \tag{3}$$

In this benchmark scenario, the welfare effect in Lemma 1 reduces to:

Lemma 2 *If $\chi_t = -\infty$ and $R^B_{t+1}(b_t) \equiv R_{t+1}$,*

$$dU = u'(\bar{c}_0)\Delta w_0, \quad \Delta w_0 \coloneqq \sum_{t\geq 0} \frac{\Delta z_t}{R^t}.$$

where $R^t = \prod_{s=0}^{t} R_s$.

Proof. See Appendix A.1. □

In other words, without any frictions in borrowing and saving, the welfare effects of unexpected inflation from all periods are summarized by Δw_0, which is the total effect of inflation shocks on the household's lifetime budget, with $u'(\bar{c}_0)$ mapping the change in lifetime wealth into welfare through the marginal utility of consumption. When households can freely borrow and save across time at the market rate, the marginal utility of consumption is equalized in all periods. It doesn't matter how gains and losses are allocated across the time horizon, as long as they lead to the same net present value of wealth. Households can always borrow and save on their own to smooth their consumption.

This is a standard result that motivates the typical calculation of the redistributive effects of inflation in the literature: the effect of an unexpected inflation shock on welfare is proportional to the change in the net present value of wealth, discounted at the market rate. For example, Doepke and Schneider (2006) and Auclert (2019) use this baseline calculation to estimate the redistributive effects of inflation on households of different types due to their nominal balance sheet (the Fisher channel). Yet, when households are illiquid and cannot freely move resources across time, the welfare effects can no longer be summarized by the changes in the value of wealth calculated with a single market rate. Relaxing the assumption that households can easily move resources across time leads us to our key mechanism.

Household Illiquidity

When the household cannot freely borrow and save at the market rate R_{t+1}, the Euler equation in Equation (3) does not hold. Yet, there exists a sequence of "wedges" τ_t, such that the sequence of consumption $\{\bar{c}_t\}$ solves a modified Euler equation:

$$u'(\bar{c}_t) = \beta_{t,t+1} u'(\bar{c}_{t+1}) R_{t+1}(1 + \tau_{t+1}), \tag{4}$$

where $\tau_t > 0$ if either the borrowing constraint binds (as there will be a Lagrange multiplier) or if the marginal cost of borrowing is above R_t. If $\tau_t > 0$, the household would like to move resources from period $t+1$ to period t under the market rate R_{t+1} (thereby increasing c_t and decreasing c_{t+1}). However, due to the borrowing cost and constraint, they settle on consumption path $\{\bar{c}_t\}$. The size of the wedges represents how far away the household is from being able to equalize its marginal utility across time.

To incorporate the consideration for illiquidity, we need to know how the effects of inflation in each period (Δz_t) align (or not) with the household's need for liquidity. To capture this (mis)alignment over time, let $q_0 \coloneqq \sum_{t\geq 0} \frac{1}{R^t}$ be the price of a perpetuity that pays one unit of real good in each period until $t = \infty$; let $\upsilon_t \coloneqq \frac{1}{q_0}\frac{1}{R^t}$ be weights that describe how the value of these payments distribute over time horizon for the perpetuity, where $\sum_{t\geq 0} \upsilon_t = 1$. The following lemma characterizes the first-order welfare effects of unexpected inflation with household illiquidity:

Lemma 3

$$dU = avg\Big[\frac{u'(\bar{c}_0)}{1+\tau^t}\Big]\Big(\underbrace{\Delta w_0}_{\text{wealth channel}} + \underbrace{q_0 \times \Big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \Big\rangle}_{\text{liquidity channel}}\Big),$$

where $1+\tau^t = \prod_{s=0}^{t}(1+\tau_s)$, *and*

$$avg[x_t] \coloneqq \sum_{t\geq 0} \upsilon_t \times x_t, \quad \langle x_t, y_t \rangle \coloneqq \sum_{t\geq 0} \upsilon_t \times x_t y_t.$$

Proof. See Appendix A.1. □

Due to illiquidity, the welfare effect differs from the frictionless benchmark in a few important ways. The term $avg[\frac{u'(c_0)}{1+\tau^t}]$ measures the average marginal utility across periods. While marginal utilities are not generally equalized across time due to illiquidity, the term reduces to $u'(c_0)$ if τ_t are zeros for all periods. The average marginal utility multiplies the sum of two terms: (1) Δw_0, which corresponds to the wealth channel defined in Lemma 2 and captures the direct effect of the inflation shock on the net present value of lifetime wealth; and (2) an additional term given by $\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \rangle$. This term captures the interaction between the household's need for liquidity in period t, represented by $\frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1$, and the household's gain and loss due to inflation shocks, given by Δz_t.

An intuition for this interaction term is that it captures whether the inflation shock redistributes the household's wealth to time periods where they would value those dollars more or less relative to the market returns. For example, if the household's marginal utility of consumption is lower in periods where they are net nominal borrowers than in periods where they receive nominal payments, the interaction term will be negative: Following the inflation shock, the household's nominal assets lose their real value in periods where the household would benefit marginally more from additional income; gains from the reduced real burden of debt, however, are spread out across periods where the marginal value of resources is lower. As inflation shocks shift resources away from periods in which the household has high marginal utility to periods in which they have low marginal utility, these shocks exacerbate the household's liquidity problem.

Lemma 3 provides us with a framework to understand how households are affected by unexpected inflation due to their balance sheets, allowing for illiquidity. It shows that to account for the effect of illiquidity, we not only need to measure the total gain and loss in wealth, Δw_0, but also two new elements: (1) how these gains and losses (Δz_t) are distributed over different time horizons, and (2) the size of the wedges (τ_t). In the following sections, we measure these two elements for U.S. households to document how they are affected by the unexpected inflation shock in the recent (2021–2022) inflation episode.

3 Household Nominal Balance Sheet

We calculate streams of nominal payments $\{Y_t^\theta\}$ that each household expects to receive in future years based on their current holdings of assets and liabilities and their characteristics. Our data for this calculation come from the 2019 Survey of Consumer Finances, which contains household balance sheet information in detailed asset and liability categories. Since the SCF is triennial and we would like to study the 2021–2022 inflation episode, we use the last SCF release immediately preceding the inflation shock, assuming that these balance sheet data represent an accurate pre-shock image of household wealth, income, and characteristics.

We use granular observations of each household's holdings to construct payment streams based on the characteristics of each asset and liability category. We first consolidate balance sheet items that represent claims with heterogeneous characteristics; for example, a household's equity holdings may contain both claims on commercial real estate (real asset) and corporate deposits (nominal asset). We deconstruct these balance sheet items and convert household balance sheets from the SCF into consolidated balance sheets that tell us their claims on assets and liabilities with relatively homogeneous properties. We then use information about each category, with some necessary assumptions, regarding its nominality (whether payments track the price index or not) and duration (the time horizons over which payments are expected) to construct plausible estimates of $\{Y_t^\theta\}$. We adjust the data so that household-level data in the SCF are consistent with national aggregate statistics. We describe our empirical procedure and results in this section, and provide details in Appendix D.

3.1 Direct and Indirect Holdings

We begin by separating all assets and liabilities on households' balance sheets in the SCF into two categories: *final* and *intermediate*. Final assets and liabilities include vehicles, homes, cash, the franchise value of a business, or a well-defined stream of nominal payments such as Treasury debt or fixed-rate mortgages. Intermediate assets are those that define ownership stakes in final assets and liabilities or other intermediate assets. These intermediate assets include shares of stocks and mutual funds or claims to investment in retirement accounts.

Final assets and liabilities are either directly held by households or indirectly held through intermediate assets. For final assets and liabilities that a household reports to hold directly in the SCF, we refer to them as the household's *direct holdings*. For final assets that households claim through intermediate assets, we refer to them as their *indirect holdings*. Below, we describe households' direct and indirect holdings and how we deconstruct intermediate assets into households' indirect holdings of final assets and liabilities.

Direct Holdings

Household's direct holdings of final assets include items such as cash, certificates of deposit, and vehicles, as well as liabilities such as mortgages, credit card debts, student loans, etc. In addition to these typical assets and liabilities, we also include a household's expected future labor income as a final asset. We assume each household holds a stock of human capital that pays dividends in the form of labor income. As we discuss below, we assume that a fraction of labor income in each future period is nominal and is exposed to unexpected inflation shocks. Since expected labor income is one of the largest sources of wealth for many households, its response to inflation shocks will be crucial. This extends the work of Doepke and Schneider (2006), who do not consider labor income in their calculation of household wealth.

Indirect Holdings

Households hold assets and liabilities indirectly through intermediate assets such as pension funds, mutual funds, and corporate equity. As an example, consider a household that owns $100,000 of shares in a mutual fund. If the mutual fund holds 10%

of its value in Treasury debt, then the household indirectly holds $10,000 of Treasury debt. Moreover, if the mutual fund holds 50% of its value in the general stock market, and the corporate sector together invests 10% of its value in Treasury debt, then the household holds another $5,000 of Treasury debt through this second-level linkage. We rely on national financial accounts (the Flow of Funds, or FOF) to trace the indirect holdings of various asset classes. The FoF reports the cross-holdings of assets and liabilities of financial and corporate entities at the aggregate level, such as holdings of pension funds, mutual funds, etc.[2] We consolidate the balance sheets of these entities to calculate each household's final asset holdings of these entities. Details of the consolidation process are provided in Appendix D.1.

Consolidated Household Balance Sheet: Descriptive Statistics

Figure 1 shows the consolidated balance sheet of U.S. households in each wealth decile. The X-axis represents the household decile in the wealth distribution and the Y-axis shows gross assets and liabilities held by each decile. The left panel summarizes holdings in 2021 dollars, while the right panel describes holdings as a fraction of net worth. As we can see, assets and liabilities are held in strikingly large quantities by the top decile of the wealth distribution, and a large component of assets and liabilities are indirectly held, which means that those asset holders are indirect holders of debt through these indirect assets. With the consolidated household balance sheet, we observe the outstanding amount of each final asset eventually owned by or owed to a household.

[2]Because our calculation of indirect holdings relies on aggregate data, we cannot account for portfolio heterogeneity across households within each intermediate asset category.

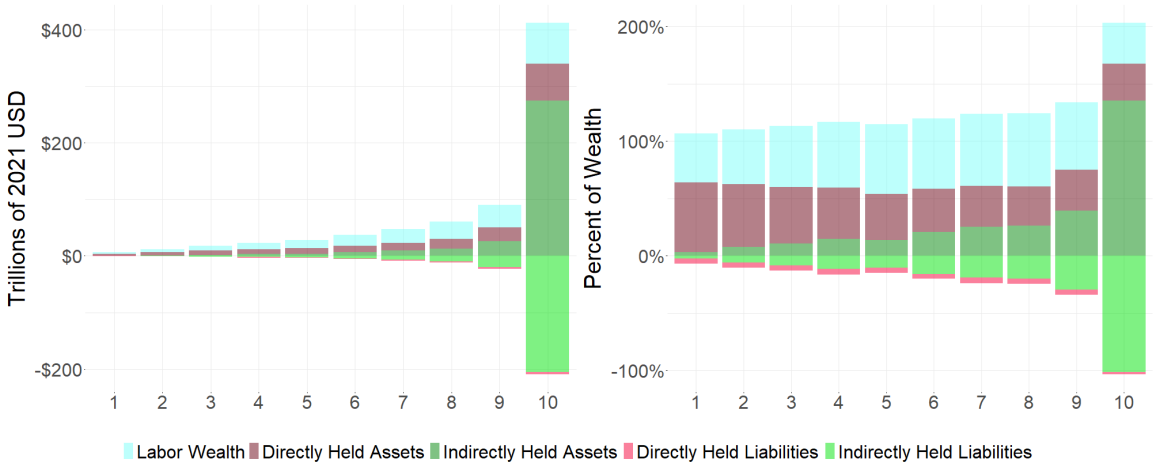


Figure 1: Consolidated balance sheet of U.S. households by wealth decile: dollars and percent of net wealth.

In Figure 2, we show the assets and liabilities held by households in the SCF, broken down by the highest-value holdings. The vast majority of wealth for households outside the top wealth decile comes from expected labor income — a channel we discuss further below. In contrast, the highest wealth decile holds a significant fraction of wealth in corporate business value (accounted as "Goodwill") and other business interests. As a fraction of net worth, we also see large differences between the poor and the rich. For the poorest decile, expected future labor income and housing make up a significant fraction of total net worth, while for the richest decile, business interests are relatively more important.

These differences between the rich and the poor also correlate with other household characteristics. In Appendix Table B.1, we summarize the demographic composition of households by decile of wealth. Here, we see that the low-wealth households are less educated, less likely to be white, and older. Since we account for future labor income in our calculation of wealth, many of these low-wealth households contain retirees without significant sources of income beyond social security. In comparison, the highest-wealth households are younger and are significantly more likely to be white and to have attended college.

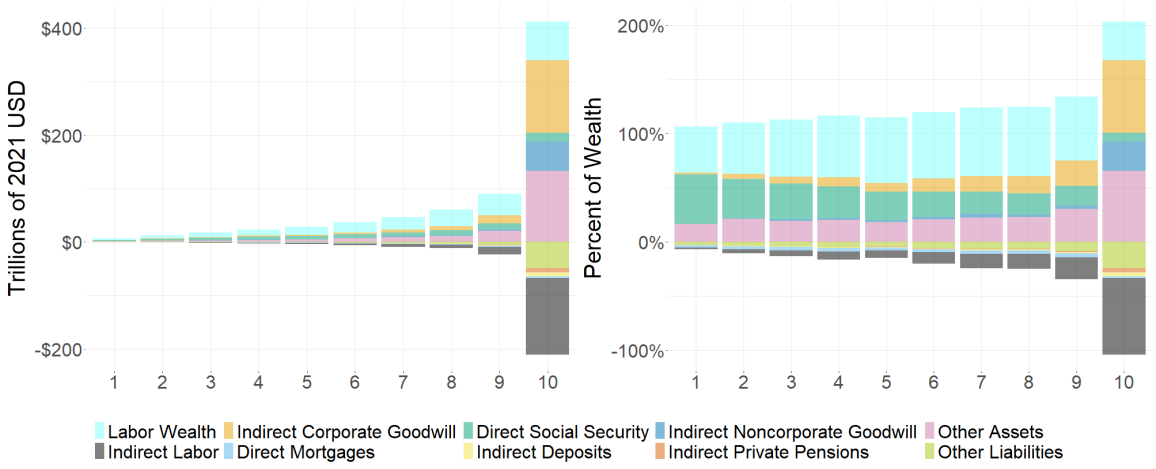


Figure 2: Consolidated balance sheet of U.S. households by wealth decile: dollars and percent of net wealth (top holdings).

3.2 Nominality and Duration

Given the consolidated balance sheets of final assets and liabilities for each household, we use information about each asset/liability category to specify two of their characteristics: (1) the level of *nominality*, $\theta_{j,t}$, and (2) the *duration*. With these two characteristics, we construct the stream of nominal payments $\{Y_t^\theta\}$ for each household.

The nominality of assets and liabilities describes how much their real value changes with the general price level. A checking deposit of one dollar is a simple example of a nominal asset with nominality $\theta_{j,t} = 1$ and $Y_{j,0} = 1$ and $Y_{j,t} = 0$ for $t > 0$: A household with such deposit holdings loses purchasing power dollar-for-dollar with a positive realized inflation. However, it can be freely adjusted after the shock, as only the initial holding is pre-committed. Certificates of deposits and some nominal bonds have similar characteristics, although they have a longer maturity. Now consider what we treat as a real asset with nominality $\theta_{j,t} = 0$: the value of a homeowner's home. As most households directly consume the service flows from their houses, these service flows are not affected by changes in the price level. Therefore, we regard the value of homes reported in the SCF to be real assets whose value adjusts one-to-one with inflation.

Many assets and liabilities—like treasuries and mortgages—can be either nominal or

real assets depending on the household's holdings. For example, if a mortgage has a fixed rate, then it is nominal because the interest rate is prespecified and unchanging. If a mortgage has an adjustable rate, then it is real because the rate is often pegged to real-time interest rates. Similarly, a Treasury security can be nominal or real depending on whether it is inflation-protected or not.

Below, we discuss a selection of important asset and liability categories, and we detail assumptions underlying the rest of the assets and liabilities in Appendix D.2.

Treasury Securities

Most treasuries held directly and indirectly by households are nominal assets that lose value (in real terms) when there is a positive inflation shock. Only a small minority (roughly 9%) of treasuries are TIPS: Treasury Inflation-Protected Securities. We do not observe which households hold typical or inflation-protected treasuries; so for every household in the SCF that directly or indirectly holds treasuries, we assume that 9% of their holdings are adjustable-rate (real) and 91% are fixed-rate (nominal). We also use annual issuances of treasuries of different maturities to construct the stream of nominal payments from outstanding treasuries, and we assume that all households holding treasuries receive streams of nominal payments that are proportional to the aggregate stream of nominal payments from Treasury securities.

Mortgages

Mortgages can be adjustable or fixed-rate. For each household with a mortgage, SCF reports whether the interest rate adjusts, the number of years remaining, the prevailing interest rate, and the remaining principal. We use this detailed information in the SCF to identify households with fixed-rate mortgages. We assume all fixed-rate mortgages are nominal and all adjustable-rate mortgages are real. For households with fixed-rate mortgages, we construct a stream of nominal mortgage payments, which the household is expected to pay over the remaining years of the mortgage.

Labor Income

We estimate the expected stream of labor income for each household using the income reported by households in the SCF and their demographic characteristics. We regress logged labor income on fixed effects for sex, age, race, and college, allowing

income to vary non-linearly with those demographic characteristics. We use the estimated regression to calculate expected income growth rates over the life-cycle for each demographic group. We then apply these expected growth rates to every individual's income in the SCF, replacing any zeros (unemployment and non-employment) with the 10th income percentile for a given person's sex-age-race-college demographic group. We apply mortality rates (at the age level) to future income to account for the age-varying probability of death, and apply federal and local tax rates to each projected income stream.[3]

We allow households' expected stream of future labor income to contain a nominal component. For example, salaried workers' contracts are often determined on a year-by-year basis. Moreover, for both salaried and hourly wage workers, their labor income could fail to keep up with the general price level due to contracting frictions. We incorporate the nominality of labor income using estimates from Hajdini et al. (2023). The authors survey respondents surrounding the 2021 inflation shock and find that when respondents report a 1.0 percentage point increase in inflation expectations, other things equal, they expect their labor income to increase by only 0.20 percentage points (95% confidence interval $[0.07, 0.34]$). We interpret this result as saying that for each household's income, between 66% and 93% does not adjust within one year (in expectation) in response to an inflation shock; that is, the nominality of the first year of labor income after an increase in inflation is between 0.66 and 0.93.

In our main specification, we take a conservative approach and assume that only 70% of labor income is nominal in year 1. This is a conservative assumption for estimating how much households are harmed by inflation due to the nominality of their labor income—short-run losses would be larger if we assume a higher level of nominality. For labor income after the first year, we assume a gradual adjustment where 40% is nominal in year 2, and 10% is nominal in year 3. By year 4, we assume wages have completely adjusted with inflation. We test the robustness of our assumptions about the speed of nominal wages to inflation in Appendix E.

Other Assets/Liabilities

We assemble data describing each of our 20 main asset and liability classes that allow

[3]To include "labor wealth" in the calculation of household wealth decile, we use the net present value of future labor income calculated from each household's future income stream, discounted with a 10-year treasury rate.

us to characterize the nominal duration for each asset and liability in our data. This involves a series of imputations and assumptions about liability types like car loans (with three years remaining) and credit card loans (with an assumed maturity of one year). We describe these assumptions in more detail in the data appendix and in Appendix Figure C.3, showing the wide range of assumptions about duration and nominality.

3.3 Nominal Balance Sheet and Maturity Mismatch

In Figure 3, we show the nominal holdings of each household, breaking wealth into specific assets and liabilities held by households in each wealth decile; panel A shows the level of these holdings while panel B is normalized by the total net worth of each wealth decile. Among poor households, most nominal wealth is held in the form of expected labor income, with holdings of fixed-rate mortgages on the liability side partially offsetting those nominal assets. For wealthy households, labor income plays a much smaller role in nominal asset holdings, and households instead hold significant nominal assets and liabilities of other types, which together form a larger fraction of net worth.

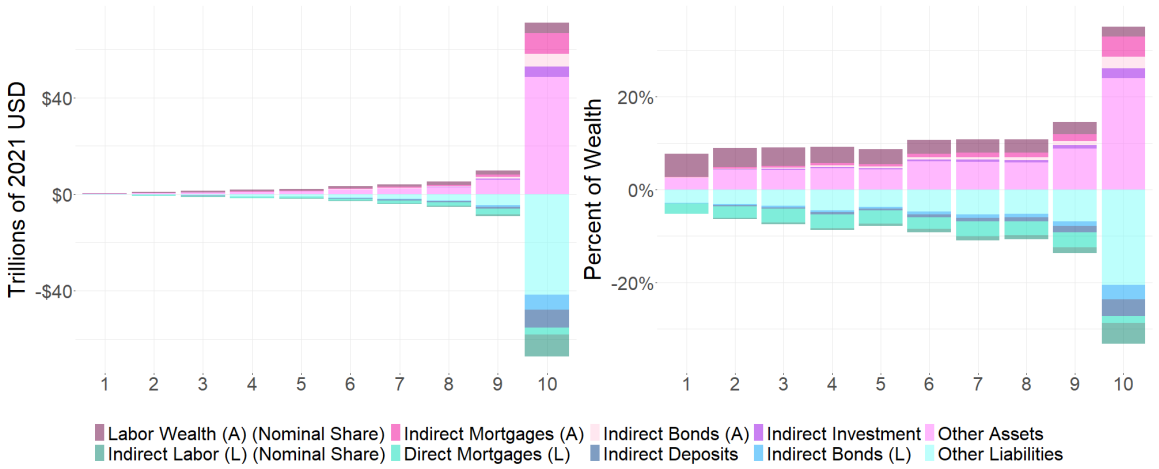


Figure 3: Consolidated nominal balance sheet of U.S. households by wealth decile: holdings in dollars (left) and percent of net wealth (right). Appendix Figure B.1 shows versions of this figure conditional on household age groups.

In Table 1, we show the present values and average duration of nominal assets and

liabilities from the average household balance sheet in the 1st, 5th, and 10th decile, where present values are discounted using Treasury yields. We can see that household assets and liabilities have quite different durations. However, except for households in the 10th decile, the duration of liabilities is much longer than the duration of assets. This phenomenon is what we refer to as a "nominal maturity mismatch". In fact, nominal maturity mismatch is not only a key feature for the 1st and 5th deciles but a common phenomenon for all deciles besides the 10th. We show the prevalence of this phenomenon across wealth deciles in Appendix Table B.2, which contains the same calculation of nominal durations for each wealth decile, and Appendix Table B.3, which shows the share of nominal maturity mismatched households. We will show later on that this nominal maturity mismatch has important implications for the effects of an unexpected inflation shock on illiquid households.

Table 1: Nominal balance sheet across wealth decile

Household Decile	1	5	10
Assets	36	168	5,519
Liabilities	24	150	5,228
Assets Duration	1.6	2.8	4.1
Liabilities Duration	5.6	6.4	3.8

Note: Levels are in thousands, 2021 USD; duration in years.

4 Timing of Gains and Losses from Inflation

With the nominal payment stream for each household, we can calculate how each household was affected by the 2021–2022 inflation episode. We use data on realized inflation and inflation expectations to construct a path of inflation shocks $\hat{\pi}^t$ over different time horizons. Combining these shocks with the nominal payment streams for each household, we compute their gains and losses over different horizons.

4.1 Inflation Shocks

We construct our measure of inflation shocks $\hat{\pi}^t$ for horizon t as:

$$\hat{\pi}^t := E_1[\pi_0^t] - E_0[\pi_0^t],$$

where $E_0[\pi_0^t]$ and $E_1[\pi_0^t]$ are, respectively, the (log) inflation expectations of annualized inflation from time 0 to t, based on information available at time 0 and 1. For example, for the initial inflation shock, $\hat{\pi}^0$, we take the difference between the realized inflation during period 0 and the inflation expectation at the beginning of that period. Similarly, $\hat{\pi}^t$ represents the updates in inflation expectations over the t periods, incorporating the initial shock and updates of expectations over future periods due to changes in policies or economic conditions in the initial period; that is, we have

$$E_1[\pi_0^t] = \pi_0^1 + E_1[\pi_1^t].$$

We construct our measure of realized inflation using the CPI. For inflation expectations, we use data from the Federal Reserve Bank of Cleveland, which combines information about Treasury yields, inflation swaps, and survey-based measures into one comprehensive measure of inflation expectations.

Figure 4 shows the inflation shock for the 2021–2022 inflation episode (January 2021 to January 2022, dark blue line) and contrasts it with the corresponding measure from the year before (January 2020 to January 2021, gray line). The X-axis represents the horizon of expectations, and the Y-axis represents the initial inflation shock (squares) and inflation expectation updates for longer horizons (circles). We can clearly see that over the year 2021, U.S. households experienced a large increase in realized inflation and a significant increase in their inflation expectations over longer horizons. These unexpected changes in inflation and inflation expectations alter the real value of nominal assets and liabilities for each household.

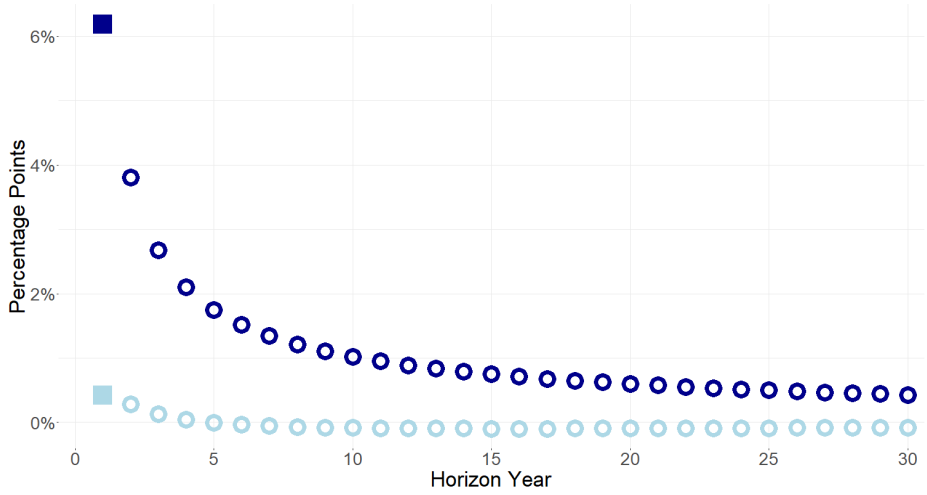


Figure 4: Realized inflation shock (squares), $\pi_0^1 - E_0[\pi_0^1]$, and expectation updates (circles), $E_1[\pi_0^t] - E_0[\pi_0^t]$, over different horizons in 2021 (Dark) and 2020 (Light, for comparison).

4.2 Gains and Losses

We now combine our measure of households' nominal positions and the inflation shocks from Figure 4 to calculate changes in the real value of households' payment streams over different horizons. Table 2 provides an example of the effects of inflation on the nominal payment streams of a 'typical' household: the average household in the 5th wealth decile.

Table 2: Nominal Position: The Average Household in the 5^{th} Decile

horizon	1 year	2-5 year	6+ year
assets	103	49	17
liabilities	47	49	56
net position	56	0	-38
inflation shock × horizon	6%	8%	11%
gains and losses	-3.5	0.1	4.1
effects on networth	-0.18%	0.01%	0.22%

Note: Levels are rounded to thousands, 2021 USD.

Comparing assets and liabilities, the typical household has a net positive nominal position for the 1-year horizon, a neutral position in the medium run (2–5-year), and a net negative nominal position for the longer horizon (6+ years). This feature of their balance sheet is the nominal maturity mismatch that we document in Section

3.3. A positive nominal position in the short run means that the typical household experiences losses from positive inflation shocks as their nominal assets lose more in value than they gain from nominal liabilities. On the contrary, the typical household holds more nominal liabilities than assets in the long horizon, so they expect a gain in the long run as the real value of debt reduces with unexpected increases in inflation and inflation expectations.

To calculate the effects of inflation shocks over different time horizons, we directly calculate Δz_t for each horizon and discount at the Treasury rate R^t, leaving us with the net effect of the inflation shock on wealth:

$$\frac{\Delta z_t}{R^t} = \frac{1}{R^t} \times \frac{-Y_t^\theta}{\bar{P}_t} \times (t+1) \times \hat{\pi}^t.$$

We present the resulting gains and losses in the bottom row of Table 2, where we provide the value in both thousands of 2021 USD and as a percentage relative to the household's wealth. Summing the bottom row of Table 2, we see that the net effect is negative in the short-run (year 1) but positive in the longer-run.

This pattern is representative of most U.S. households. Figure 5 shows the effects from the 2021–2022 inflation shock for the average household in each wealth decile. Gains and losses are separately shown, with gains above the X-axis and losses below the X-axis. Effects of the inflation shock due to assets and liabilities held over different time horizons are presented in different colors. The red dashed line represents the net effect of the inflation shock on household's wealth, which correspondents to the commonly studied wealth channel.

Overall, for wealth deciles 1–9, the pattern is roughly the same as for the 5th wealth decile (as shown in Table 2). This majority of households experience larger short-run losses (the purple bars) and longer-run gains (green and blue bars, representing years 2+). On the other hand, households in the top wealth decile hold different types of assets and liabilities and do not experience the same pattern of losses and gains.

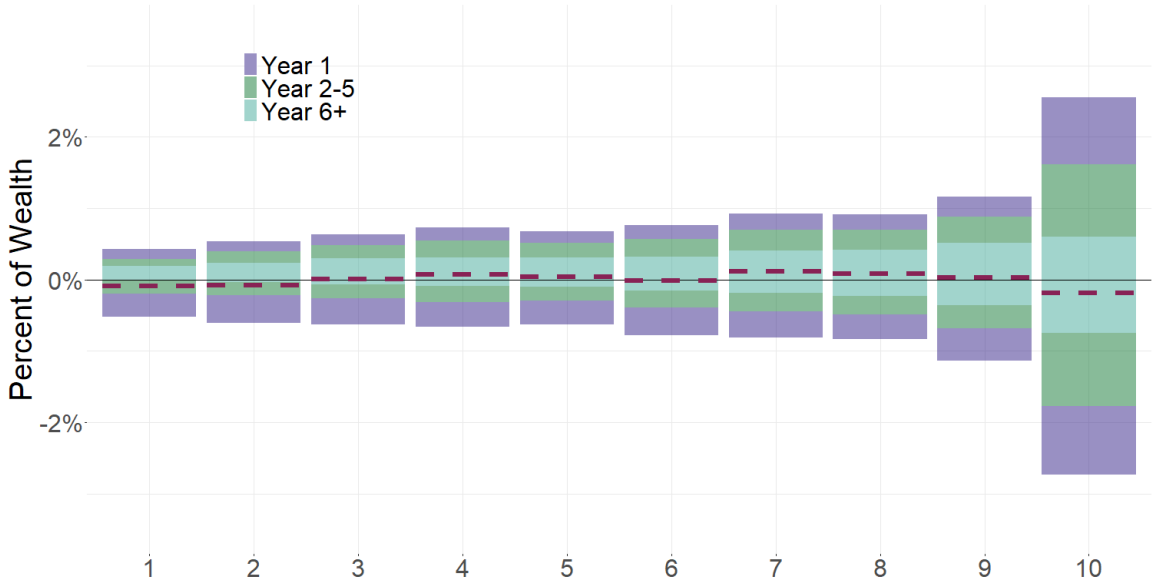


Figure 5: Gains and losses due to nominal exposure across the wealth distribution. X-axis: wealth by net worth; Y-axis: gains and losses as a percentage of wealth. Dashed lines indicate net change. Appendix Figure B.5 shows versions of the figure conditional on household age groups; Appendix Figure B.6 shows these results for the government and the rest of the world.

The literature on the effects of inflation has focused on the *net* effects on each household's lifetime wealth, identifying and quantifying the effects of inflation shocks on net nominal holders of assets and liabilities across the wealth distribution (e.g., Doepke and Schneider (2006), Auclert (2019), Cardoso et al. (2022), and Del Canto et al. (2023)). However, the total wealth effect misses that many households may value these gains and losses differently because they occur over different time horizons: the interaction term in Section 2 between the gain and loss across time horizons and the wedges due to household illiquidity. In the next section, we construct measures of each household's illiquidity — the τ_t term in our model, and we use these measures to incorporate the welfare loss of unexpected inflation shocks due to illiquidity.

5 Measuring Household Illiquidity

We measure the frictions households face when transferring resources across time, represented by the wedge τ_t between their marginal utility of consumption over time.

5.1 Measuring Wedges

In our framework, households can transfer resources across time using various assets. In particular, they can save or borrow with liquid assets (b_t) but are subject to convex borrowing costs and borrowing constraints. Recall that the optimality of households' consumption and savings decisions for the liquid assets implies that

$$u'(\bar{c}_t) = R_t(1 + \tau_{t+1})\ \beta_{t,t+1} u'(\bar{c}_{t+1}).$$

We separate the wedge τ_t into two parts: the part originating from the borrowing cost (*spreads*, s_t), and the part due to the borrowing constraints (*shadow rates*, ζ_t):

$$1 + \tau_t = (1 + s_t)(1 + \zeta_t).$$

In Appendix A, we show that the spreads and shadow rates are respectively given by

$$1 + s_t := \frac{R^B_{t+1}(\bar{b}_t) + \bar{b}_t {R^B_{t+1}}'(\bar{b}_t)}{R_{t+1}}, \quad 1 + \zeta_t := \frac{1}{1 - \bar{\mu}_t}, \tag{5}$$

where $R^B_{t+1}(\bar{b}_t) + \bar{b}_t {R^B_{t+1}}'(\bar{b}_t)$ corresponds to the marginal cost of borrowing relative to the market rate R_t, absent the inflation shock; $\bar{\mu}_t$ represents a Lagrange multiplier associated with the borrowing constraint at time t.[4]

We measure these two parts of the wedges from two sources. To measure the spreads, we rely on detailed questions in the SCF to infer households' marginal cost of borrowing. To measure the shadow rates, we use households' consumption responses to one-time unexpected transfers of liquid assets to bound the additional gap between their marginal utility of consumption.

Spreads

The SCF provides several pieces of information about the marginal costs of borrowing for each household. To calculate the interest rate faced by each household aiming to

[4]The Lagrangian is defined in Equation (**??**) in Appendix A.

borrow an additional dollar this period, we rely on two questions in the SCF:

1. *What interest rate do you pay on the card where you have the largest balance?*
2. *After the last payment was made, what was the total balance still owed?*

Because many households hold revolving credit card balances and rely on credit cards to fulfill unexpected spending needs, we calculate each household's marginal cost of borrowing as the reported interest rate paid on the card with the largest balance, conditional on households having remaining non-trivial balance of at least \$100 on a credit card. If they do not pay interest on their balance or have less than a non-trivial balance, their spread is zero. ALTERNATIVE: Households that do not satisfy the two conditions of paying interest and having a non-trivial balance are assumed to have some cheaper form of borrowing or available savings.

Shadow Rates

When households face a binding borrowing constraint, the Euler equation does not hold with equality even after correcting for the marginal cost of borrowing:

$$u'(c_t) < (1 + s_t)R_t\beta_{t,t+1}u'(c_{t+1}).$$

Such binding constraint has an immediate implication on households' consumption-saving behavior: upon receiving a one-time lump-sum transfer at time t, households increase consumption c_t without changing c_{t+1} until their Euler equations hold with equality. This means that when the borrowing constraint binds, we can measure how close it is to an unbinding constraint based on the size of the consumption response between period t and $t + 1$.

Specifically, consider a one-time lump-sum transfer of value $\check{T}$ at period t. Let $\check{c}_t$ denote the log deviation of consumption in period t in response to the transfer from its original level. The optimality of the household's consumption-saving problem implies:

Lemma 4 *Suppose that* $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$ *and* s_t *is unaffected by the transfer.*[5] *Then*

$$\sigma \times (\check{c}_t - \check{c}_{t+1}) < \log\left(1 + \frac{\bar{\mu}_t}{1 - \bar{\mu}_t}\right).$$

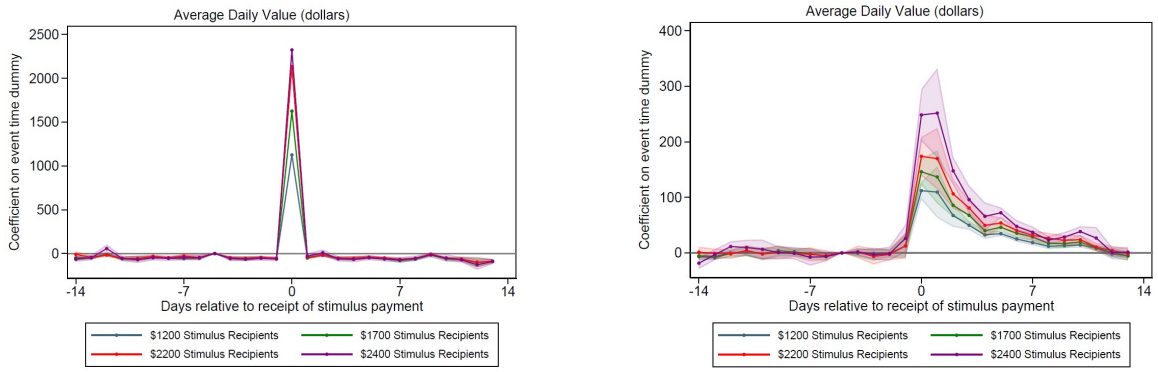
Proof. See Appendix A.2. □

Intuitively, if the constraint is not binding, the household's Euler equation holds, and $\check{c}_t = \check{c}_{t+1}$. As households adjust consumption in response to the transfer, the larger the change in consumption growth, the larger the multiplier $\bar{\mu}_t$ must be, and the higher the associated shadow rates. The mapping between consumption responses and the shadow rates is determined by the intertemporal elasticity of substitution $1/\sigma$. As a result, measuring households' consumption responses gives us lower bonds for their shadow rates. We build on this observation to measure the shadow rates for U.S. households, using high-frequency transaction-level data to identify households' consumption responses to one-time lump-sum transfers.

5.2 Shadow Rates and Consumption Response

We use data from Facteus to estimate household consumption responses to the 2020–2021 stimulus checks. The Facteus panel consists of high-frequency, transaction-level data describing the spending and income of tens of thousands of consumers. We estimate sharp changes in spending surrounding stimulus checks during the Covid-19 pandemic, drawing on Karger and Rajan (2023), and then map the consumption responses to the SCF as a function of age and income. In each bank account in our data, we observe income and spending for each bank account holder. In the Facteus sample, we calculate daily consumption responses to 2020 and 2021 federal stimulus checks, which provided households earning under $150,000 in household income (or less than $75,000 in individual income) with up to three rounds of lump sum payments. Households with different size compositions received different stimulus amounts: for example, single-filers with no children received $1,200 in the first round of stimulus checks in Spring 2021, while single-filers with two children received $2,200.

[5] For example, if the household is at the borrowing constraint and stays constrained after the transfer, then $\check{b}_t = 0$. Since $R(\cdot)$ is a function of b_t, $\check{b}_t = 0$ implies s_t is constant. Alternatively, the condition can also hold if $R(\cdot)$ is a step function and $R'(\cdot) = 0$ locally.



(a) Transfer (b) Spending

Figure 6: One-Time Lump-Sum Transfer and Consumption Responses

As we can see in the event studies in Figure 6, there is no anticipatory change in spending for stimulus recipients in the weeks leading up to the stimulus payment. Then, on the day when each stimulus check is deposited into the recipient's bank account, we see a sharp increase in spending that declines (but remains at elevated levels) in the two weeks following the stimulus check receipt. After two weeks, spending declines to pre-shock levels.

To estimate each household's consumption responses to the lump-sum transfers, we regress each individual recipient's change in consumption, relative to the size of checks, in the two weeks following the stimulus check receipt on age and income using flexible splines, and we project these predicted values onto households in the SCF.[6] After estimating household-level consumption responses for each household in the SCF using the Facteus data, Table 3 below shows the average spending relative to check size as a function of the wealth distribution.

Table 3: Spending/check size, across wealth deciles

Decile	1	2	3	4	5	6	7	8	9	10
Spending/Check Size	0.43	0.41	0.37	0.35	0.32	0.29	0.24	0.18	0.12	0.07

Here, we see that the average short-run consumption response following an unexpected transfer is strongly related to wealth, with the richest wealth decile spending little

[6] We extrapolate our estimates of consumption responses to households with income over $150,000 who do not receive stimulus checks, and winsorize the spending relative to check size to be between 0 and 1.

of the transfer and the poorest wealth decile spending almost half of it in the period following the shock. The substantial heterogeneity in the consumption responses and correlations with income and wealth are consistent with a large literature on MPC estimation (for example, see R. Baker et al. (2023), Fagereng et al. (2021), and Crawley and Kuchler (2023)).

To provide a bound for each household's shadow rate, we calculate $\check{c}_t$ as the changes in consumption relative to the household's yearly consumption. We assume that the consumption response in the subsequent year, $\check{c}_{t+1}$, is 30% of $\check{c}_t$, based on the evidence provided by Auclert et al. (2018). We use Lemma 4 to compute the bound for the multiplier $\bar{\mu}_t$ for each household, assuming that $\sigma = 2$, which corresponds to an elasticity of intertemporal substitution of one half. For a conservative estimate of our channel, we calculate the shadow rate ζ_t using the lower bound for the multiplier. We test the robustness of these assumptions in Appendix E.

5.3 Illiquidity Across the Wealth Distribution

Figure 7 quantifies the level of household illiquidity across the wealth distribution, showing the average size of spreasd s_t and shadow rates ζ_t—two key components of wedges τ_t.

The figure highlights two key facts. First, the level of wedges is decreasing in wealth, starting from around 20% at the bottom wealth decile to 5% at the top decile. Second, the composition of the wedge—the part due to the spread vs. shadow rate—changes across the wealth distribution. If we only rely on spreads as the illiquidity measure, we might conclude that poor households have lower borrowing costs than middle-income households as the average spread increases from lower to middle wealth deciles. However, this is likely to be driven by the fact that many poor households do not have credit cards and cannot easily borrow through standard financial services. This inability to borrow is represented as the borrowing constraints faced by these households and quantified by our measures of the shadow rates. In fact, once we account for the shadow rates, the illiquidity measure τ_t exhibits a monotonically decreasing pattern across the wealth distribution, with borrowing constraints acting as a relatively important source of illiquidity for poor households.

Finally, our measures only provide cross-sectional information. To calculate what

households expect about their level of illiquidity, we assume for our baseline that s_t and ζ_t persist with 90% probability year-over-year for each household. We discuss the empirical basis for this assumption in Appendix D.3 and the robustness of our results in Appendix E.

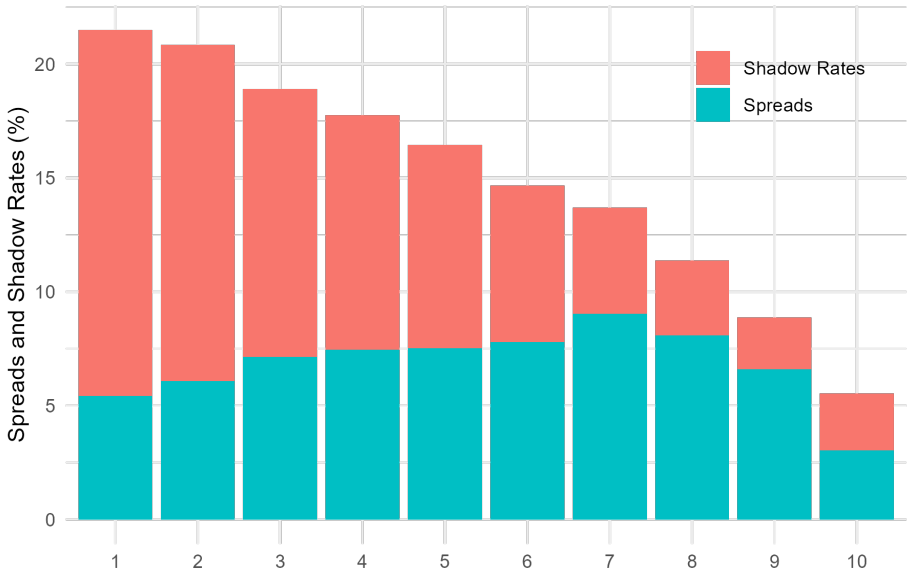


Figure 7: Average Spreads and Shadow Rates by Wealth Decile.

6 Welfare Effects of Inflation Shocks

We now combine all of the information to estimate the welfare effects of the inflation shock for the 2021–2022 inflation episode, taking into account the differences in household balance sheets and their liquidity concerns. Using the formula in Lemma 3

$$dU = u'(\bar{c}_0) \times avg\big[(1+\tau^t)^{-1}\big]\Big(\underbrace{\Delta w_0}_{\text{wealth channel}} + \underbrace{q_0 \times \Big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \Big\rangle}_{\text{liquidity channel}} \Big),$$

we have:

1. the gain (or loss) in each period t (Δz_t) from nominal payment streams (Y_t^θ), estimated using the SCF and FOF, and inflation shocks (π_0^t) from CPI and the inflation expectation data;

2. the level of illiquidity for each household (τ_t), from the SCF (spreads s_t) and consumption responses estimated from Facteus (shadow rates ζ_t).

Wealth vs. Liquidity Channels

Figure 8 shows the welfare effects for U.S. households, calculated from the formula in Lemma 3 and decomposed into detailed channels across the wealth distribution. We separate the effects operating through the wealth channel, adding the effects of illiquidity due to spreads and shadow rates, respectively, and finally, the overall effect, taking into account the liquidity channel. We convert these effects for each household relative into equivalent gains and losses relative to their lifetime wealth (top panel) and single-year consumption (bottom panel) and present the averages for each wealth decile.[7]

Households in the bottom half of the wealth distribution suffer a welfare loss equivalent to around 0.5% of their lifetime wealth (top panel). This is equivalent, in dollar terms, to around 15% of their single-year consumption (bottom panel). Households in the top wealth decile suffer smaller welfare losses, equivalent to 0.15% of their lifetime wealth (top panel). Still, because their annual consumption accounts for a relatively small fraction of their wealth, the loss is equivalent in dollar terms to around 30% of their single-year consumption level (bottom panel). The level of losses varies across the wealth distribution, but the sources of those losses vary as well. For households in the top decile, the losses mainly come from the wealth channel; for households in the bottom half of the wealth distribution, the liquidity channel is particularly important, accounting for most of the losses. Appendix Figure B.3 shows the proportion of households in each wealth decile that see gains and losses through the wealth channel versus the combined effects from wealth and liquidity channels. We show versions of Figures 8 conditional on different age groups in Appendix Figures B.9. Older households experience larger welfare loss than younger households (relative to their wealth), yet the importance of the liquidity channel is common across all age groups.

[7] Details about the calculation are provided in Appendix D.4.

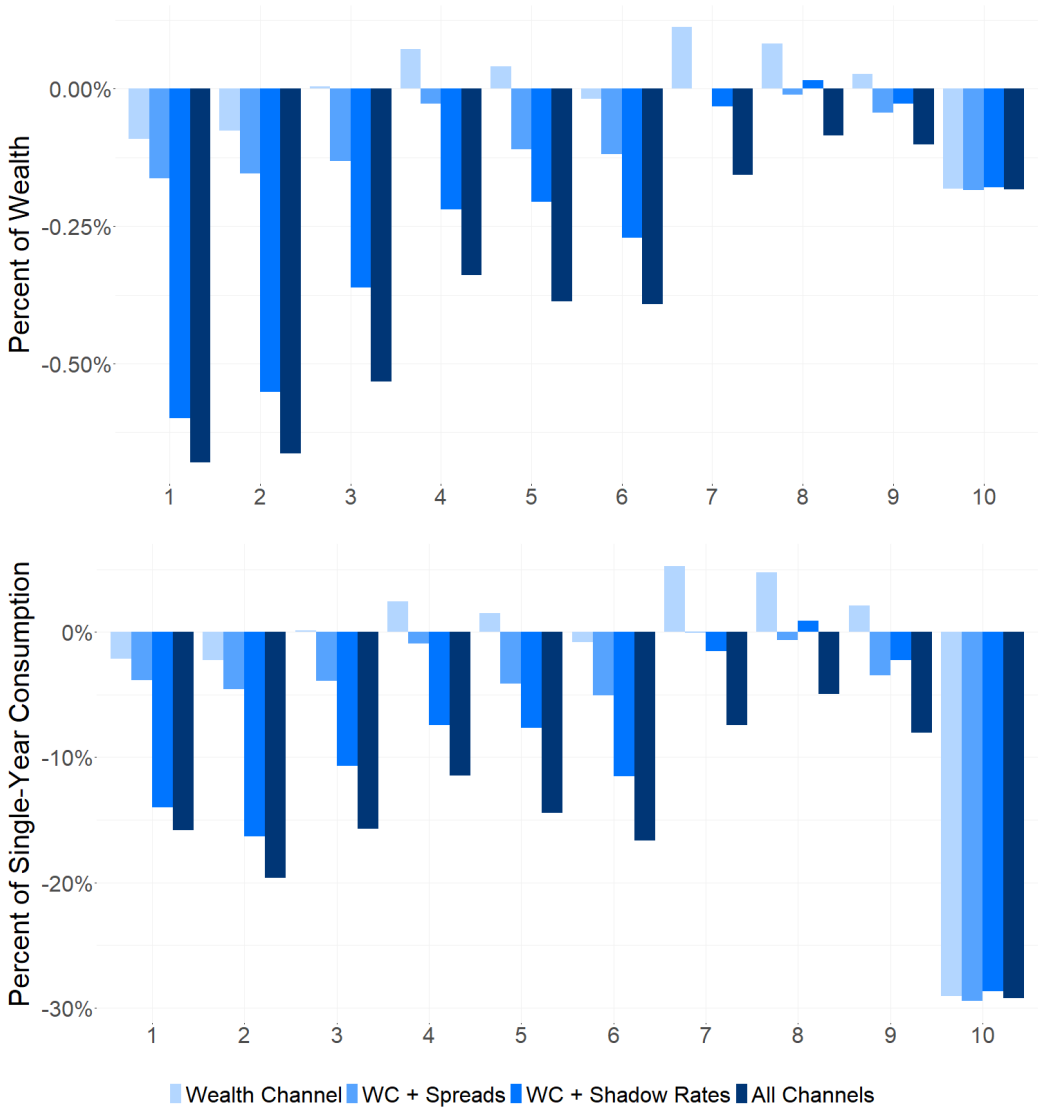


Figure 8: Effects of different channels in wealth equivalence as a percentage of wealth and single-year consumption, averaged within each wealth decile. Appendix Figure B.7 and B.8 compares the two channels at the individual level for each survey correspondent.

Robustness under Alternative Specifications

We emphasize the effects on the poor as our main result and caveat conclusions about the wealthy because our estimates of the welfare effects for the poor rely less on the specific assumption we make about indirect assets, current year nominal labor share, and other parameters.

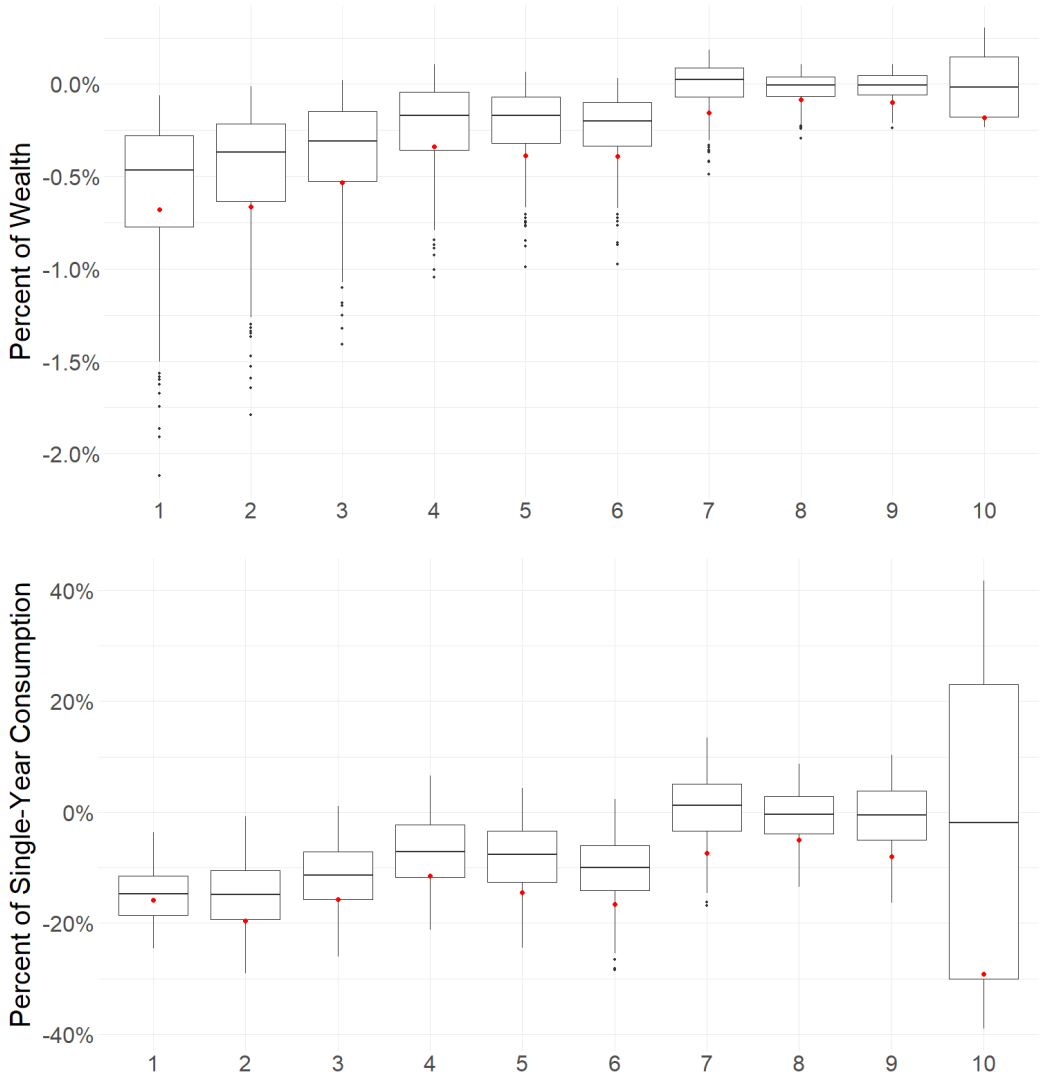


Figure 9: Effects of parameter adjustment on different channels, averaged within each wealth decile as a percentage of single-year consumption and net worth. Boxes represent interquartile ranges, whiskers represent minimum/maximum values, and individual points represent outliers. Red dots represent the specification used in the main results.

In Figure 9, we show the different estimates one would get for the overall welfare effects if we varied the key specifications underlying our empirical analysis. These specifications include whether we adjust the SCF to match aggregate data from the FoF (or vice versa), what levels of nominal rigidities we assume for labor income, alternative assumptions for our estimates of consumption responses, and various levels

of persistence of illiquidity over time. In Appendix E, we describe these assumptions in more detail. As you can see from Figure 9, we can tightly estimate the welfare effects for the poor, while our estimates for the wealthy generally vary from –25% to +25% in terms of single-year consumption. In Appendix E, we demonstrate the robustness of our result. From Appendix Figures D.1 to D.8, we compare the welfare effects through wealth and liquidity channels for households in the lowest and highest wealth decile under all permutation of the alternative specifications. Here, we see that there are some differences in the effects of these two channels among specifications. However, the liquidity channel we document remains a crucial factor in understanding how households are affected by inflation under all alternative specifications.

7 Conclusion

We show that households' balance sheets feature a nominal maturity mismatch, with the average household holding nominal liabilities with a significantly longer duration than their nominal assets. This nominal maturity mismatch has important welfare consequences: unexpected inflation not only generates gains and losses in wealth but also creates a liquidity problem for a large majority of U.S. households. Using a standard consumption-saving model that features household illiquidity, we quantify the liquidity channel empirically. We show that during the 2021–2022 inflation episode, the liquidity channel caused welfare losses almost three times the size of the standard wealth channel. These effects are particularly stark for low-wealth households, as many of them face significantly higher levels of illiquidity.

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A Derivations and Proofs

A.1 Welfare Effects

We focus on the first-order effects of a change in the path of the price levels from $\bar{P}_t$ to P_t. Specifically, we consider the changes in the path of the price levels as parameterized by a scalar δ, where

$$\log P_t(\delta) - \log \bar{P}_t = (t+1) \times \hat{\pi}^t \times \delta.$$

The household's problem in (2) has the following Lagrangian:

$$\begin{aligned} \mathcal{L} \coloneqq & \sum_{t \geq 0} \beta_t u(c_t) \\ & + \lambda_t \big[z_t + \boldsymbol{a}_{t-1}^\intercal \boldsymbol{R}_t^A + b_{t-1} R_t^B(b_{t-1}) - \boldsymbol{a}_t^\intercal \mathbf{1} - b_t - c_t - \phi(\boldsymbol{a}_t, \boldsymbol{a}_{t-1}) + \mu_t \big(b_t - \chi_t\big) \big], \end{aligned} \tag{6}$$

where $\lambda_t \geq 0$ and $\lambda_t \mu_t \geq 0$ are the multipliers for the budget and borrowing constraints. Multiplier λ_t represents the value of a unit resource available in the budget constraint at time t; multiplier μ_t represents the value of relaxing the borrowing constraint by one unit of goods, where the value is expressed in terms of resource at time t.

Proof of Lemma 1. Given the parametrization of the price levels with δ, we have

$$z_t(\delta) = \frac{1}{P_t(\delta)} \sum_{j \in \mathcal{J}} \big(\theta_{j,t} + \frac{P_t(\delta)}{\bar{P}_t} (1 - \theta_{j,t}) \big) \bar{Y}_{j,t}.$$

An expansion with respect to δ gives the first-order effect of the inflation shock on z_t:

$$\frac{d}{d\delta} z_t(\delta) \coloneqq \Delta z_t = \frac{-Y_t^\theta}{\bar{P}_t} \times (t+1) \times \hat{\pi}^t,$$

where $Y_t^\theta \coloneqq \sum_{j \in \mathcal{J}} \theta_{j,t} \bar{Y}_{j,t}$.

By the envelope theorem, the effect on the household's welfare is $dU = \sum_{t \geq 0} \lambda_t \Delta z_t$. □

To decompose the welfare effects into different channels, note that at $\delta = 0$, the first-order conditions with respect to c_t and b_{t+1} give us:

$$\lambda_t = \beta_t u'(\bar{c}_t), \tag{7}$$

$$\beta_t u'(\bar{c}_t)(1 - \bar{\mu}_t) = \beta_{t+1} u'(\bar{c}_{t+1}) \big(R_{t+1}^B(\bar{b}_t) + \bar{b}_t R_{t+1}^{B\,\prime}(\bar{b}_t) \big). \tag{8}$$

Define wedges τ_t as

$$1 + \tau_{t+1} \coloneqq \frac{R_{t+1}^B(\bar{b}_t) + \bar{b}_t R_{t+1}^{B\,\prime}(\bar{b}_t)}{(1 - \bar{\mu}_t) R_{t+1}}, \tag{9}$$

then we have

$$u'(\bar{c}_t) = \beta_{t,t+1} u'(\bar{c}_{t+1}) R_{t+1}(1 + \tau_{t+1}), \quad \text{where} \quad \beta_{t,t+1} \coloneqq \frac{\beta_{t+1}}{\beta_t}.$$

Recall that $R^t \coloneqq \prod_{s=0}^t R_s$ and $1 + \tau^t \coloneqq \prod_{s=0}^t 1 + \tau_s$, then Equation (7), (8), and Lemma 1 imply

$$dU = u'(\bar{c}_0) \sum_{t \geq 0} \frac{\Delta z_t}{R^t (1 + \tau^t)}. \tag{10}$$

The formula in Lemma 2 is a special case:

Proof of Lemma 2. If $\chi_t = -\infty$, then $\bar{\mu}_t \equiv 0$. Together with $R_{t+1}^B(\cdot) \equiv R_{t+1}$, we have $\tau_t = 0, \ \forall t$. Therefore, the welfare effect in Equation (10) reduces to

$$dU = u'(\bar{c}_0) \Delta w_0,$$

where $\Delta w_0 \coloneqq \sum_{t\geq 0} \frac{\Delta z_t}{R^t}$. $\square$

Our goal now is to decompose the welfare effects into the portion due to a change in wealth and the portion due to the misalignment of gains and losses over different horizons. To this end, we compare the total welfare effect to a change in wealth in the form of a perpetuity that pays one unit of a real good in each period until $t = \infty$.

Proof of Lemma 3. Recall that we define $q_0 \coloneqq \sum_{t\geq 0} \frac{1}{1+r^t}$ and $\upsilon_t \coloneqq \frac{1}{q_0}\frac{1}{1+^t}$, and use notation $avg[\cdot]$ and $\langle \cdot, \cdot \rangle$ defined in Lemma 3. From Equation (10),

$$dU = u'(\bar{c}_0) \times \sum_{t\geq 0} \frac{\Delta z_t}{R^t(1+\tau^t)} = u'(\bar{c}_0) \sum_{t\geq 0} \frac{\Delta z_t}{R^t} + \frac{\Delta z_t}{R^t}\frac{-\tau^t}{1+\tau^t},$$

and using the notation defined above,

$$dU = u'(\bar{c}_0) \times q_0 \Big(avg[\Delta z_t] + \big\langle \Delta z_t, \frac{-\tau^t}{1+\tau^t} \big\rangle \Big).$$

Because $1 + \frac{-\tau^t}{1+\tau^t} = (1+\tau^t)^{-1}$ and $\langle \Delta z_t - avg[\Delta z_t], 1 \rangle = 0$, we have

$$\begin{aligned} dU &= u'(\bar{c}_0) \times q_0 \times \Big(avg[\Delta z_t] + \big\langle \Delta z_t - avg[\Delta z_t], \frac{-\tau^t}{1+\tau^t} \big\rangle + avg[\Delta z_t] avg[\frac{-\tau^t}{1+\tau^t}] \Big) \\ &= u'(\bar{c}_0) \times q_0 \times \Big(avg[\Delta z_t] avg[(1+\tau^t)^{-1}] + \big\langle \Delta z_t - avg[\Delta z_t], (1+\tau^t)^{-1} \big\rangle \Big). \end{aligned}$$

Further rearranging and simplification gives

$$\begin{aligned} dU &= u'(\bar{c}_0) \times q_0 \times avg[(1+\tau^t)^{-1}] \Big(avg[\Delta z_t] + \big\langle \Delta z_t - avg[\Delta z_t], \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} \big\rangle \Big) \\ &= u'(\bar{c}_0) \times q_0 \times avg[(1+\tau^t)^{-1}] \Big(avg[\Delta z_t] + \big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \big\rangle \Big). \end{aligned}$$

Because $q_0 \times avg[\Delta z_t] = \Delta w_0$,

$$dU = u'(\bar{c}_0) \times avg[(1+\tau^t)^{-1}] \Big(\Delta w_0 + q_0 \Big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \Big\rangle \Big).$$

$\square$

A.2 Bounds for Shadow Rates

By the definition of s_t and ζ_t in (5), Equation (9) implies

$$1 + \tau_t = (1 + s_t)(1 + \zeta_t).$$

Proof of Lemma 4. Using the functional form $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, the household's optimality condition is given by:

$$-\sigma \log \bar{c}_t = -\sigma \log \bar{c}_{t+1} + \log \beta_{t,t+1} R_t + \log(1 + s_t) - \log(1 - \bar{\mu}_t) \tag{11}$$

Let $\tilde{c}_t$, and $\tilde{c}_{t+1}$ be the consumption response when the household receives the one-time unexpected transfer $\check{T}$, and $\tilde{\mu}_t$ be the corresponding multiplier. If s_t remains constant under the transfer, then:

$$-\sigma \log \tilde{c}_t = -\sigma \log \tilde{c}_{t+1} + \log \beta_{t,t+1} R_t + \log(1 + s_t) - \log(1 - \tilde{\mu}_t). \tag{12}$$

Let $\check{c}_t \coloneqq \log \tilde{c}_t - \log \bar{c}_t$. Taking the difference between Equation (11) and (12), we have

$$\sigma \times (\check{c}_t - \check{c}_{t+1}) = \log \frac{1 - \tilde{\mu}_t}{1 - \bar{\mu}_t} = \log \left(1 + \frac{\bar{\mu}_t - \tilde{\mu}_t}{1 - \bar{\mu}_t}\right).$$

Because the Lagrangian $\tilde{\mu}_t \geq 0$, we have

$$\sigma \times (\check{c}_t - \check{c}_{t+1}) \leq \log \left(1 + \frac{\bar{\mu}_t}{1 - \bar{\mu}_t}\right).$$

Rearranging gives us a lower bound for the multiplier $\bar{\mu}_t \geq \frac{\exp(\sigma \times (\check{c}_t - \check{c}_{t+1})) - 1}{\exp(\sigma \times (\check{c}_t - \check{c}_{t+1}))}$. □

B Additional Tables and Figures

B.1 Summary Statistics

Demographics across the Wealth Distribution

Table B.1 shows the demographic characteristics of each wealth decile. Both net worth and income increase with wealth decile, as does home ownership. Wage income and

Table B.1: Demographic Characteristics by Decile

Decile	1	2	3	4	5	6	7	8	9	10
Networth	438	788	1131	1448	1808	2236	2787	3572	4915	14851
Income	22	33	46	51	62	71	88	115	156	451
Income 0-50k	0.98	0.9	0.63	0.56	0.44	0.31	0.12	0.02	0	0.01
Income 50-200k	0.02	0.1	0.37	0.44	0.56	0.69	0.86	0.92	0.8	0.28
Income 200k+	0	0	0	0	0	0	0.02	0.07	0.19	0.71
Wage Income	0.1	0.32	0.54	0.61	0.67	0.73	0.77	0.81	0.79	0.67
Business Income	0	0.04	0.06	0.07	0.08	0.06	0.09	0.08	0.07	0.24
Dividend/Interest Income	0	0	0	0.01	0.01	0.01	0.01	0.01	0.02	0.1
Capital Gain Income	0	0	0	0.03	0.01	0	0	0.01	0.01	0.07
Social Security/Pension Income	0.66	0.48	0.31	0.24	0.16	0.15	0.13	0.09	0.09	0.1
Transfer Income	0.14	0.09	0.07	0.06	0.05	0.04	0.02	0.03	0.01	0.02
Home Owner	0.44	0.57	0.57	0.57	0.6	0.6	0.68	0.72	0.82	0.91
Mortgage	0.09	0.18	0.26	0.29	0.35	0.36	0.5	0.55	0.66	0.62
Working	0.17	0.42	0.61	0.68	0.76	0.8	0.85	0.87	0.89	0.84
College	0.08	0.15	0.21	0.22	0.29	0.33	0.41	0.48	0.63	0.83
Male	0.39	0.56	0.63	0.68	0.68	0.78	0.82	0.88	0.92	0.95
White	0.59	0.63	0.58	0.62	0.63	0.65	0.73	0.73	0.77	0.86
Black	0.28	0.23	0.23	0.17	0.17	0.17	0.11	0.12	0.08	0.03
Other Races	0.13	0.14	0.19	0.22	0.19	0.19	0.16	0.15	0.16	0.11
Age	69.75	62.26	56.76	51.43	47.42	46.17	44.58	43.18	44.25	51.42
Age 18-29	0.03	0.06	0.07	0.11	0.16	0.18	0.19	0.17	0.15	0.07
Age 30-49	0.02	0.1	0.23	0.35	0.35	0.42	0.45	0.54	0.54	0.39
Age 50-64	0.29	0.38	0.36	0.27	0.33	0.24	0.22	0.19	0.18	0.33
Age 65-95	0.67	0.47	0.34	0.27	0.15	0.17	0.13	0.11	0.14	0.21

Net Worth and Income are in thousands of 2021 USD. Age is in years. Income is bottom-coded at the 5th percentile. Other variables are shares.

business income shares peak for the 8th and 7th deciles, respectively, consistent with these deciles being wealthy and active in the labor force. In contrast, the 10th decile is the only decile with significant shares of income coming from interest/dividends and capital gains. This is likely due to the high number of retirees in the 10th decile relative to other higher-wealth deciles. Social security and pension income and transfer income generally make up high shares of total income for lower wealth deciles. The fraction of households with mortgages and with a working head of household also increases with deciles, though the 10th decile has slightly smaller shares, again due to retirees. Overall, the old are concentrated in the bottom and top deciles. Wealthier households are also more likely to be college-educated and white.

Features of Nominal Balance Sheets

Table B.2 shows a version of Table 1 for all deciles. All but the top decile experience nominal maturity mismatch.

Table B.3 shows that more than half of households in deciles 3-10 experience nominal maturity mismatch. While the gap between average duration is largest for the 1st

Table B.2: Nominal balance sheet across wealth decile

Decile	1	2	3	4	5	6	7	8	9	10
Assets	36	75	109	142	168	255	320	409	757	5519
Liabilities	24	53	90	135	150	217	322	405	713	5228
Assets Duration	1.6	1.8	2.2	2.6	2.8	3.1	3.6	4.4	4.7	4.1
Liabilities Duration	5.6	5.9	6.2	5.7	6.4	5.7	6.1	6.5	6.4	3.8

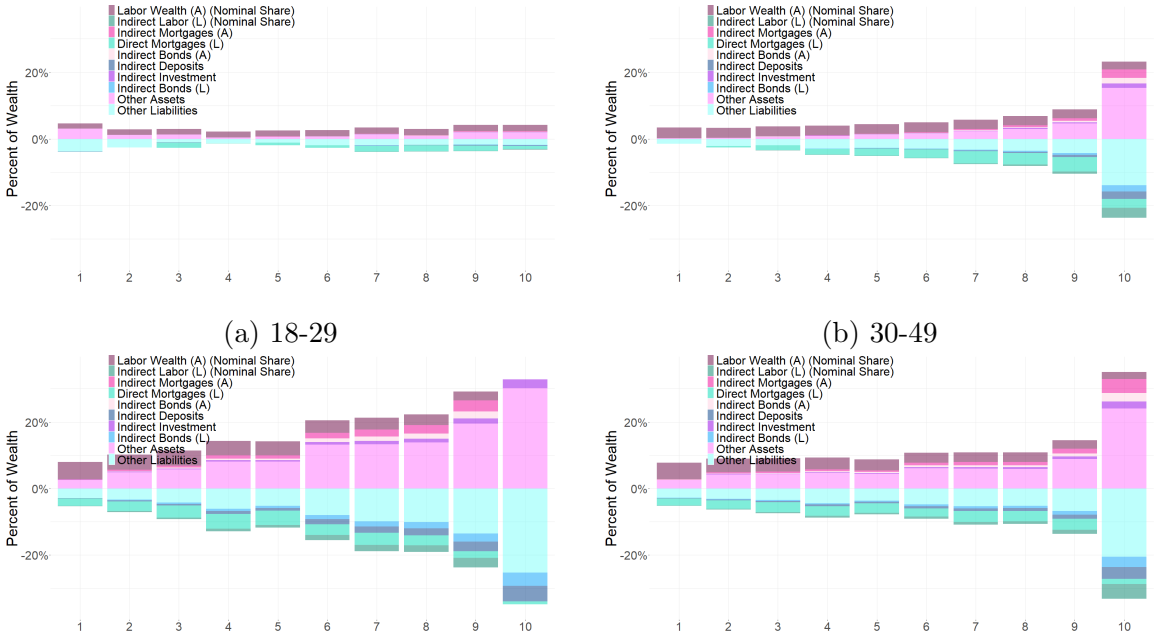
Note: : Levels are in thousands, 2021 USD; duration in years.

decile, only 25% of these households are actually nominal maturity mismatched. This result is driven by some households with long-duration mortgages.

Table B.3: Share of Nominal Maturity Mismatched Households across Wealth Deciles

Decile	1	2	3	4	5	6	7	8	9	10
Share NMM	0.25	0.45	0.54	0.62	0.65	0.71	0.76	0.73	0.69	0.52

Figure B.1 split Figure 3 into different age groups. It shows that most of the holdings are concentrated in the higher age groups.



(a) 18-29

(b) 30-49

(c) 50-95

(d) Full Sample

Figure B.1: Decomposition of Top Nominal Holdings by Age Group

Government and the Rest of the World

Figure B.2 shows the consolidated balance sheets for the U.S. government and the rest of the world. Government liabilities outweigh assets, with both mostly held directly. For the rest of the world, assets exceed liabilities, and both are held mostly indirectly.

Table B.4 shows the present values and average duration of nominal assets and liabilities for the government and the rest of the world. Again, we see that the government has more liabilities than assets, while the rest of the world has more assets than liabilities. While asset maturities are similar for both owners, government liabilities are of much longer duration than those held by the rest of the world.

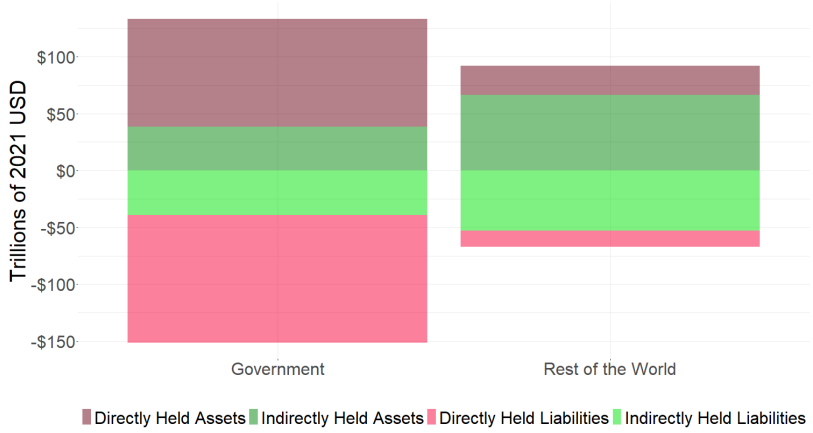


Figure B.2: Consolidated balance sheet of Government and Rest of the World.

Table B.4: Nominal balance sheet for Government and Rest of the World

	Government	Rest of the World
assets	30	39
liabilities	43	29
assets duration	3.7	3.8
liabilities duration	4.1	2.4

Note: Levels are in trillions, 2021 USD; duration in years.

B.2 Gains and Losses

Figure B.3 shows the percentage of households that gain and lose through the wealth channel vs the liquidity + wealth channel in each decile. The majority of households

lose through both combinations of channels, particularly for the lower deciles. The seventh decile sees the most households gain through both or at least one of the two channels. By far the fewest households lose through the wealth channel while gaining through the liquidity + wealth channel.

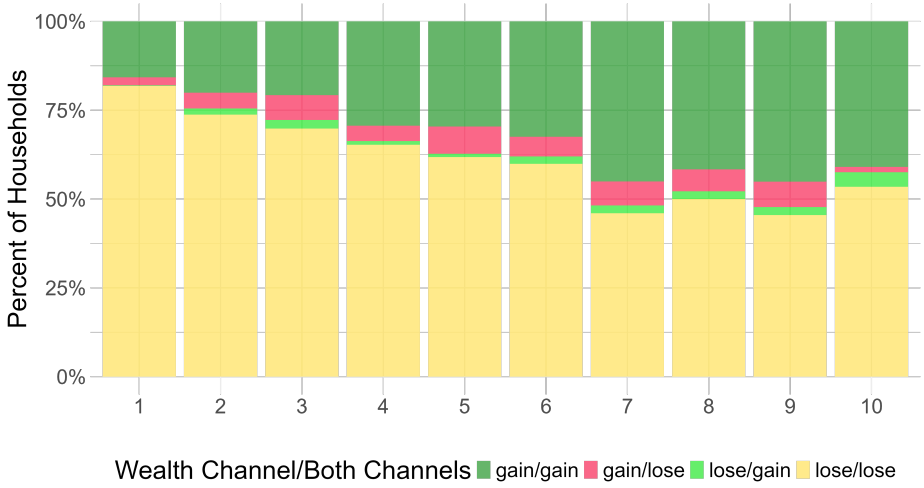


Figure B.3: Percent of households that gain and lose through the wealth channel and liquidity+wealth channel for each wealth decile

Figure B.4 shows the effect of the 2021–2022 inflation shock on the average household in each wealth decile relative to single-year consumption. The effects are most prominent for the 10th decile because its consumption is relatively small compared to the size of its balance sheet.

Figure B.5 split the results of Figure 5 by age group. The size of the effects tends to increase with age. For households in the 30-49 age range, almost all deciles gain, while for households in the 50-95 range, almost all deciles lose.

Figure B.6 shows the effects of the 2021–2022 inflation shock on the government and the rest of the world. Due to the government's large holding of treasury securities as a liability, it gains overall from the inflation shock, particularly in the long run; the rest of the world loses, primarily due to nominal payments from 6+ years.

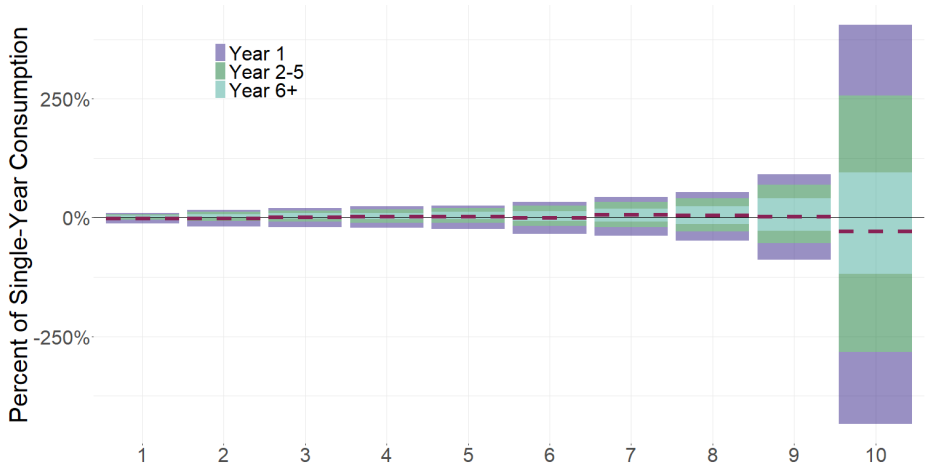
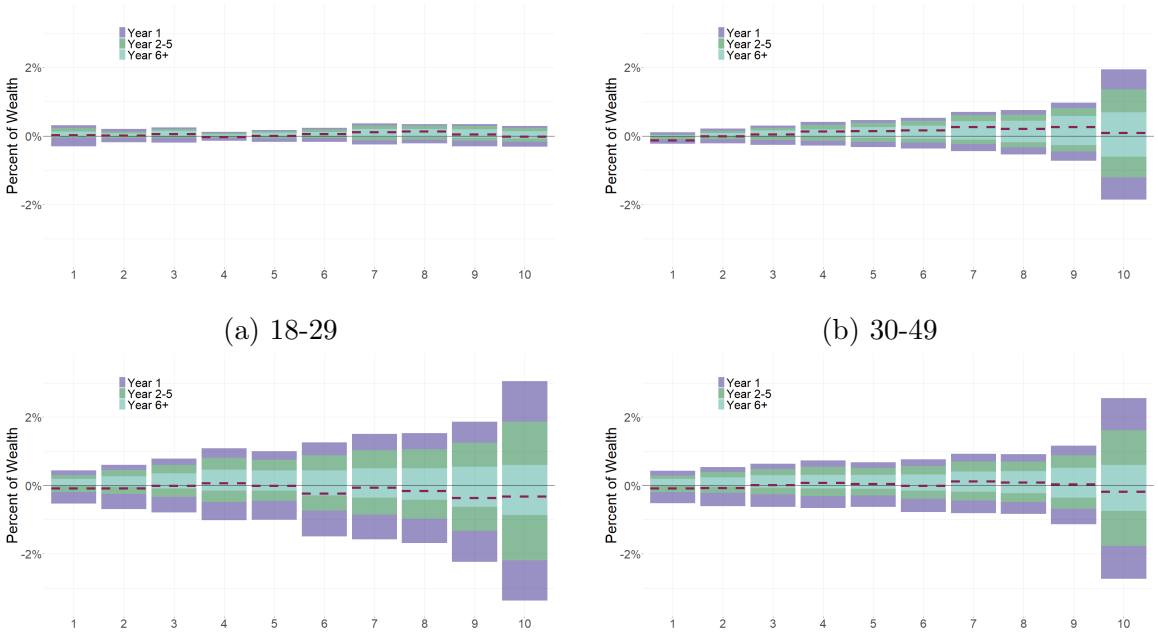


Figure B.4: Gains and losses due to nominal exposure across the wealth distribution. X-axis: wealth by net worth; Y-axis: gains and losses relative to single-year consumption. Dashed lines indicated net change.



(a) 18-29

(b) 30-49

(c) 50-95

(d) Full Sample

Figure B.5: Gains and losses due to nominal exposure by age group

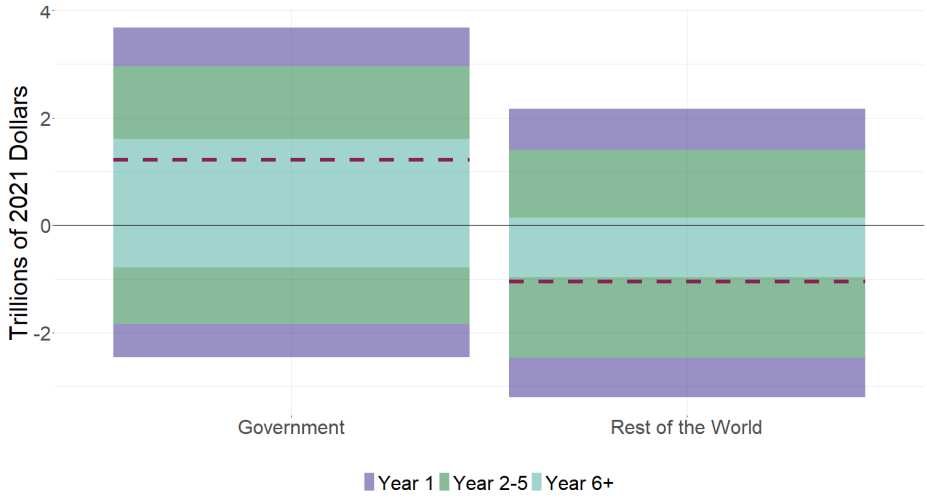


Figure B.6: Gains and losses due to nominal exposure for government and rest of the world. X-axis: wealth; Y-axis: gains and losses in trillions of dollars. Dashed lines indicated net change.

B.3 Wealth and Liquidity Channel

Wealth and Liquidity Channel at the Individual Level

Figure B.7 shows the relative size of the traditional wealth channel (X-axis) and the combined effects of the wealth and liquidity channel (Y-axis). Each blue dot is an individual from the SCF. The axes measure the effects of the 2021–2022 unexpected inflation shock in terms of wealth. If the liquidity channel did not matter, we would see all individuals laying on the 45% line. Instead, we see that many blue dots lie below the 45%. This means that the liquidity channel is generating a loss for many individuals. Figure B.8 shows the same results in terms of single-year consumption.



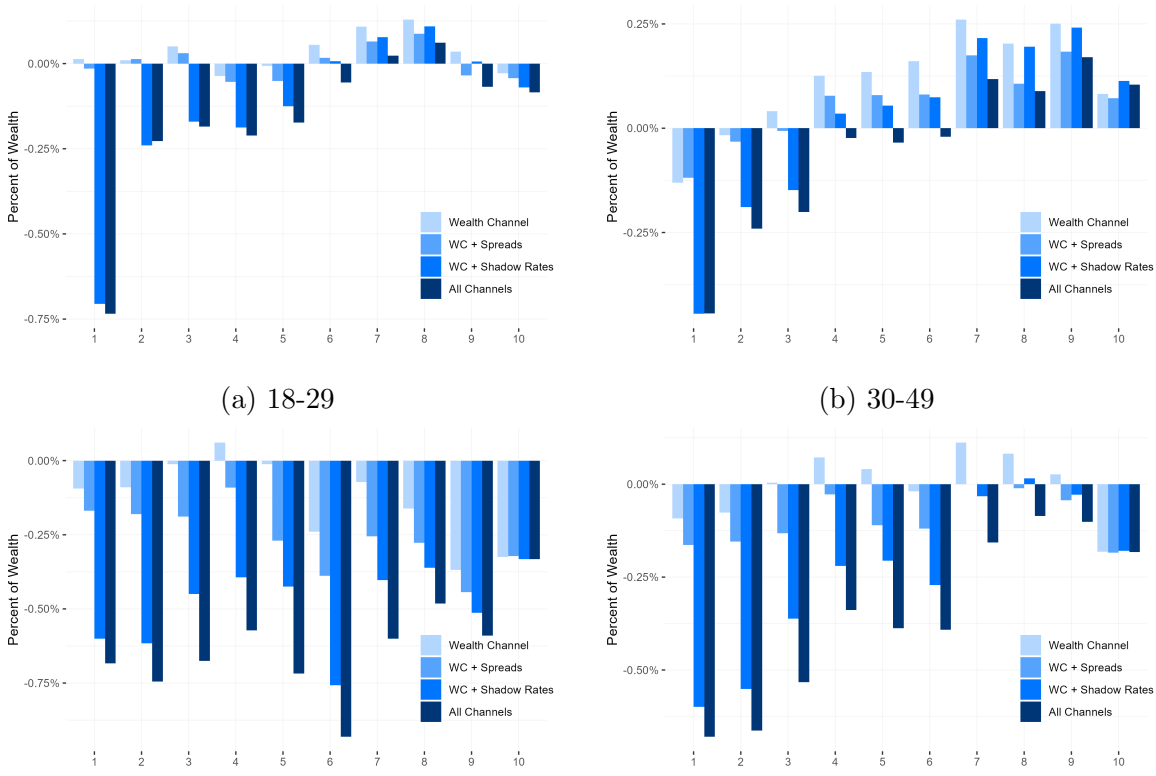
Figure B.7: Welfare effects of unexpected inflation. X-axis: the wealth channel; Y-axis: the wealth and liquidity channels. Units: percentage of lifetime wealth.



Figure B.8: Welfare effects of unexpected inflation. X-axis: the wealth channel; Y-axis: the wealth and liquidity channels. Units: percentage of single-year consumption.

Wealth vs. Liquidity Channel by Age Groups

Figure B.9 shows the results of Figure 8, split by age group. Here, households in the 18-29 age range experience the biggest losses for 1st decile households. For households in the 30-49 age range, households in the top 4 deciles experience gains. This age group tends to hold more debt, especially in the form of mortgages, and thus gains when the value of their liabilities decreases with inflation. In contrast, almost all households in the 50-95 range lose, regardless of decile, with 6th decile households seeing the largest losses overall. These households are more likely to have paid off mortgages and accumulated assets, which now decline in value due to inflation.



(a) 18-29

(b) 30-49

(c) 50-95

(d) Full Sample

Figure B.9: Effects of Different Channels as Percentage of Networth by Age Group

Supplementary Appendices

C Household Problem: Alternative Formulation

In this section, we show that the household problem in Section 2 is equivalent to a problem where the household chooses a portfolio of assets $s_t = \{s_{1,t}, .., s_{J,t}\}$, where $s_{j,t}$ is the number of units of asset j in the portfolio at time t. The household works one unit of time at a nominal wage W_t. The nominal price of each asset is $Q_{j,t}$. Each asset pays a stream of nominal payments $\tilde{Y}_{j,t}$ per unit. The nominal adjustment costs of rebalancing portfolios is given by $\Phi(\{s_{j,t}, Q_{j,t}, P_t\})$. There is also one-period nominal liquid asset B_t paying gross return $\check{R}_t^B$, and subject to a borrowing constraint $B_t \geq P_t \chi_t$. The household problem is

$$\max_{\{s_{j,t}, B_t, c_t\}} \sum_{t=0}^{\infty} \beta^t u(c_t)$$

s.t.

$$\sum_{j=1}^{J} Q_{j,t} s_{j,t} + B_t + \Phi(\{s_{j,t}, Q_{j,t}, P_t\}) + P_t c_t = W_t + \check{R}_t^B B_{t-1} + \sum_{j=1}^{J} (\tilde{Y}_{j,t} + Q_{j,t}) s_{j,t-1},$$

where the initial portfolio $s_{j,-1} = \bar{s}_j$ is given.

To see the mapping between the two problems, first define the real market value of assets and the real value of nominal liquid assets as

$$\tilde{a}_{j,t} \coloneqq \frac{Q_{j,t} s_{j,t}}{P_t}, \quad b_t \coloneqq \frac{B_t}{P_t}.$$

The real budget constraint is

$$\sum_{j=1}^{J} \tilde{a}_{j,t} + b_t + \frac{\Phi(\{s_{j,t}, Q_{j,t}, P_t\})}{P_t} + c_t = \frac{W_t}{P_t} + \frac{\check{R}_t^B}{1+\pi_t} b_{t-1} + \sum_{j=1}^{J} \Big(\frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)} + \check{R}_{j,t}^A \Big) \tilde{a}_{j,t-1},$$

where $1 + \pi_t \coloneqq \frac{P_t}{P_{t-1}}$ is the gross inflation rate, and $\check{R}_{j,t}^A \coloneqq \frac{Q_{j,t}}{Q_{j,t-1}} \frac{1}{1+\pi_t}$ is the part of real return from changes in asset prices.

Denote the real market value of the initial portfolio at period t as

$$\bar{a}_{j,t} \coloneqq \frac{Q_{j,t}\bar{s}_j}{P_t}.$$

We define the relative real market value of assets with respect to the initial portfolio:

$$a_{j,t} \coloneqq \tilde{a}_{j,t} - \bar{a}_{j,t}.$$

Given the portfolio adjustment cost function $\phi(\cdot,\cdot)$ in (2) we can define

$$\Phi(\{s_{j,t}, Q_{j,t}, P_t\}) \coloneqq P_t\phi\Big(\frac{Q_{j,t}}{P_t}(s_{j,t}-\bar{s}_j), \frac{Q_{j,t-1}}{P_{t-1}}(s_{j,t-1}-\bar{s}_j)\Big) = P_t\phi(\{a_{j,t}, a_{j,t-1}\}),$$

and the budget constraint now results in

$$\begin{aligned}\sum_{j=1}^{J} a_{j,t} + b_t + \phi(\{a_{j,t}, a_{j,t-1}\}) + c_t = \frac{W_t}{P_t} + \frac{\check{R}^B_t}{1+\pi_t}b_{t-1} + \sum_{j=1}^{J}\Big(\frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)} + \check{R}^A_{j,t}\Big)a_{j,t-1} \\ + \sum_{j=1}^{J}\Big(\frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)} + \check{R}^A_{j,t}\Big)\bar{a}_{j,t-1} - \sum_{j=1}^{J}\bar{a}_{j,t}.\end{aligned}$$

To map these objects to those in Section (2), we define

$$R^B_t \coloneqq \frac{\check{R}^B_t}{1+\pi_t}, \quad R^A_{j,t} \coloneqq \frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)} + \check{R}^A_{j,t},$$

and

$$\begin{aligned}z_t &\coloneqq \frac{W_t}{P_t} + \sum_{j=1}^{J}\Big(\frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)} + \check{R}^A_{j,t}\Big)\bar{a}_{j,t-1} - \sum_{j=1}^{J}\bar{a}_{j,t} \\ &= \frac{W_t}{P_t} + \sum_{j=1}^{J}\Big(\frac{\tilde{Y}_{j,t}}{Q_{j,t-1}(1+\pi_t)}\Big)\bar{a}_{j,t-1} = \frac{1}{P_t}\Big(W_t + \sum_{j=1}^{J}\tilde{Y}_{j,t}\bar{s}_j\Big).\end{aligned}$$

Define $Y_{j,t} \coloneqq \tilde{Y}_{j,t}\bar{s}_j$ and $Y_{0,t} \coloneqq W_t$, where we treat labor as asset 0. With these

notations, the budget constraint simplifies to:

$$\sum_{j=1}^{J} a_{j,t} + b_t + \phi(a_{j,t}, a_{j,t}) + c_t = R_t^B b_{t-1} + \sum_{j=1}^{J} R_{j,t}^A a_{j,t-1} + z_t, \tag{13}$$

where $z_t = \frac{1}{P_t} \sum_{j=0}^{J} Y_{j,t}$ and the borrowing constraint $b_t \geq \chi_t$.

Since labor is inelastic, we have $a_{0,t} = \tilde{a}_{j,t} - \bar{a}_{j,t} = 0$ for asset 0 (labor) and the budget constraint in 13 is equivalent to that in (2).

Given that our assumption that $\{R_{j,t}^A\}$ remains constant, the nominal prices of assets are given by

$$Q_{j,t} := \frac{\tilde{Y}_{j,t+1} + Q_{j,t+1}}{R_{j,t+1}^A \times (1 + \pi_{t+1})} = \sum_{s=1}^{\infty} \Big(\prod_{u=1}^{s} \frac{1}{R_{j,t+u}^A \times (1 + \pi_{t+u})} \Big) \tilde{Y}_{j,t+s}.$$

Finally, since $\{Q_{j,t}, P_t\}$ are known at time 0, the problem in (2) where the household chooses $\{a_{j,t}\}$ is equivalent to the problem where household chooses $s_{j,t}$.

D Data Appendix

Our household balance sheet data come from two primary sources, the Survey of Consumer Finances (SCF) and the Flow of Funds (FOF), both of which are produced and maintained by the Federal Reserve. The SCF is a triennial detailed survey of household finances, including questions related to their income, asset holdings, mortgages, credit usage, and demographic characteristics. The FoF includes balance sheets for various entities at the aggregate level, including the household sector, the federal government, businesses, and entities in the financial sector. We rely on the FoF for information about the cross-holdings between these sectors. We also use auxiliary data from other sources, including treasury yields and inflation from FRED, inflation expectation data from the Cleveland Fed, and consumption data from Facteus.

In this appendix, we describe in detail how we construct nominal payment streams for each household in the SCF as we present in Section 3, and how we construct the inflation shocks that we present in 4. We refer readers to Karger and Rajan (2023) for details about the Facteus data.

D.1 A Method of Consolidating Indirect Holdings

Before we describe how we construct households' nominal balance sheets, we first present the method that we employ to disentangle the cross-holdings between entities in households' indirect holdings. We use this method to obtain the consolidated balance sheet for the households' indirect holdings.

We categorize all *Sectors* in the Flow of Funds into "end owners" $l = 1, \ldots, L$ and "intermediaries" $i = 1, \ldots, I$. End owners include the household sector, the government, and the rest of the world; intermediaries include all other sectors (e.g., Nonfinancial Business and Mutual Funds). We separate all "Instruments" in the FoF into claims on intermediaries (e.g., Corporate Equities and Mutual Fund Shares) and "final assets" (and liabilities) indexed by $k = 1, \ldots, K$. Final assets do not represent ownership stakes in other assets or liabilities. These final assets include corporate bonds, bank loans, mortgage-backed securities, treasury bills, as well as real estate holdings, corporate valuations, and pension entitlements.

Let

- $b_{i,l}$ denote the share of intermediary i owned by end owner l;
- $\omega_{i,j}$ denote the share of intermediary i owned by intermediary j;
- $a_{k,i}$ denote the share of final asset (liability) k that shows up in intermediary i's balance sheet.

Our goal is to assign all final assets $a_{k,i}$ owned by the intermediaries to end owners. The indirect holding of asset k by end owner l is given by the (k, l) element of matrix $\boldsymbol{a}^{ID}$ s.t.

$$\boldsymbol{a}^{ID} = \boldsymbol{a}(\boldsymbol{I} - \boldsymbol{\Omega})^{-1}\boldsymbol{b},$$

where $\boldsymbol{a} = [a_{k,i}], \boldsymbol{\Omega} = [\omega_{i,j}], \boldsymbol{b} = [b_{i,l}]$.

Note that with this allocation, we should have the total (direct and indirect) ownership of end owners over intermediaries sum to one, and all final assets eventually held by

end owners:

$$(\boldsymbol{I}_{I\times I} - \boldsymbol{\Omega})^{-1} \times (\mathbf{1}_I - \boldsymbol{b}\ \mathbf{1}_L) = \mathbf{1}_I, \quad \sum_l \boldsymbol{a}_l^{ID} + \boldsymbol{a}_l^D = \mathbf{1}_K$$

where $\boldsymbol{a}_l^D$ denotes end owner l's direct share of final asset $k = 1, \ldots, K$. The first restriction is equivalent to saying that all shares of intermediaries by other intermediaries and end owners sum to one:

$$\boldsymbol{\Omega}\mathbf{1}_I + \boldsymbol{b}\ \mathbf{1}_L = \mathbf{1}_I.$$

D.2 Variable Construction

This appendix proceeds in three sections. First, we describe how we take microdata from the SCF to calculate households' most important direct holdings: mortgage payments and expected future labor income. We add to this dataset miscellaneous information regarding rent payments, social security, and taxes.

After we describe the creation of this dataset containing detailed information about SCF households' direct holdings of assets and liabilities, we then discuss our consolidation of indirect holdings into the final ownership of each asset and liability by each household. At this stage, we adjust the SCF data to match Flow-of-Funds (FoF) totals for the U.S. economy, accounting for under- and over-reporting of the average household in the SCF of certain assets and liabilities in their self-reported holdings data. This minimizes the chance that our results in this paper are distorted by reporting bias in the SCF, although we explore the importance of that assumption in later robustness checks.

We describe how we rely on the full data on household-level holdings of assets and liabilities to construct measures of the welfare effect of inflation shocks. We do this by (1) calculating each household's exposure to inflation by transforming the household-level dataset into separately measured holdings of nominal and real assets and liabilities of differing duration; and (2) calculating the size of inflation shock for the 2021–2022 inflation episode, for which we evaluate the welfare effects in this paper.

For all discounting to calculate the present values, we use the Treasury yield curve from year 1 to 30 as the market rate R_0^t for all $t = 1, \ldots, 30$.

D.2.1 Raw Household Balance Sheets

Our main data for household balance sheets come from the 2019 SCF, adjusted to be in 2021 dollars, as our welfare calculation focuses on the 2021–2022 inflation episode. We clean the raw SCF data to obtain household-level demographic data on age, sex, race, and college education of the household head, as well as income and household weights.

For households' mortgage payment streams, we use an SCF extract with more detailed variables on household mortgages. We then use the mortgage principle, current interest rate, and years remaining to calculate streams of annual mortgage payments for each household. For adjustable-rate mortgages, we make further adjustments to address the initial period with fixed rates and contractual caps on the frequency and size of rate changes. Finally, instead of using the current mortgage rate that each household pays, we calculate a forward mortgage rate using the forward treasury rate plus the mortgage spread. This gives us a vector of mortgage payments from the current year (year0) extending into the future for each household with a mortgage.

For household's expected future labor income, we extend the analysis from SCF 2019 to SCF 2010–2019, using demographic information in the surveys to predict income growth rates for each household over the life cycle, using bottom-coded income to impute future income streams for households above age 95. We further adjust these for expected future inflation and conditional mortality. Next, we use these labor income streams to calculated expected streams of social security payments. To account for taxes on income, we use the TAXSIM calculator provided by the National Bureau of Economic Research. TAXSIM uses variables such as marital status, age, number of dependents, rent paid, labor income, and social security income to compute taxes paid by households. We obtain these variables from the SCF. Notably, taxes can vary from state to state, though the SCF does not provide geographic information on households. Consequently, we randomly assign households to states based on their relative weights in the SCF so that the distribution of weights across states closely matches the distribution of population across states, obtained from the Census. We then subtract the taxes to be paid from labor and social security income, implementing a zero lower bound so that income is never negative. We then use the difference between pre-tax and post-tax income to calculate taxes as an asset held by the government. This gives us vectors of post-tax labor and social security income from the

current year extending into the future for each household.

For households paying rent, we add rent (taken from the SCF) as a liability (for those households) and as a corresponding asset held by corporations. Similarly, social security and labor income (from the payment streams we computed earlier) are assets held by households with a corresponding liability held by corporations and the government. Tax (from labor and social security income, computed above) is an asset held entirely by the government.

D.2.2 Balance Sheet Adjustments and Consolidation

We then proceed to construct the main datasets used in our analysis. We will call this dataset "longdata," since it consists of household-level holdings of all the assets and liabilities that households hold, either directly and indirectly.

We follow the method described in Section D.1 and use the Q4 2019 FoF data to consolidate indirect holdings of various assets and liabilities from the FoF for three end owners: households, the U.S. government, and the rest of the world. We use the four-character codes at the beginning of each row in the FoF tables to assign balance sheet items to intermediaries and end owners. Some tables with non-standard organization required additional hardcoding to find all assets and liabilities and ensure the totals match. In the case of discrepancies, we assign them to make the asset and liability totals match. We divide all these balance sheet items by the holding's totals to obtain shares. This gives us matrices containing, for both assets and liabilities, the share of each holding held by intermediaries, the share of each intermediary held by intermediaries, the share of each intermediary held by end owners, and the share of each holding held by end owners. We can then use these matrices, along with the dollar values of each holding, to calculate the final ownership of holdings directly, indirectly, or indirectly through defined contribution (DC) pensions.

To allocate the consolidated indirect holdings for the aggregate household sector in the FoF to individual households in the SCF, we find SCF variables corresponding to FoF intermediaries, such as money market funds, mutual funds, and DC pensions. A full breakdown of the matches between SCF and FoF variables can be found in Table C.1. We then divide by the dollar value of the holding held by all individuals in the SCF to obtain each household's share of that intermediary. We then combine these

with the share of intermediaries held by intermediaries and the share of each holding held by intermediaries (computed from the FoF). Multiplying all these matrices by each other and then multiplying the share by the FoF dollar totals gives us the total of each asset and liability held indirectly or through DC pensions by each household. More details on this process can be found in Appendix D.1. For directly-held holdings, we find SCF variables that match the FoF holdings and use the totals held by each household. For the directly-held assets, labor, and social security income, we use the nominal present value of the payment streams we calculated. Similarly, the directly-held mortgage liability is the net present value of the mortgage payment streams. This gives us longdata.csv, which contains demographic variables and all assets and liabilities held directly, indirectly or through DC pensions for each household in the SCF.

Importantly, we use FoF values to calculate the shares and dollar amounts of holdings held directly and indirectly by households. However, we use SCF values to calculate what share of overall household ownership is held by a particular household. This distinction is important since the overall totals from the SCF and FoF are not always the same. For harmonizing variables across the two datasets, we often rely on imperfect matches. For example, we match "Real Estate" from the FoF to "Total value of primary residence of household, 2019 dollars" from the SCF. However, even when the variable definitions are fairly similar, the totals are occasionally significantly different. We decided to adjust all totals to match the FoF since that dataset provides a more complete view of the entire economy.

This adjustment is necessary since otherwise, assets and liabilities across all end owners in the economy will not match. However, this adjustment has important implications. Adjusting to the FoF instead of the SCF increases the totals of several important holdings, such as Treasury Securities. Since treasuries are overwhelmingly held as a direct liability by the government and an indirect asset by wealthy households, increasing this total means that the government gains more and the wealthiest households lose more from unexpected inflation. Conversely, adjusting to the SCF means the government will gain less, and wealthy households lose less. Figure C.1 shows the household nominal balance sheets when adjusting to the SCF instead of the FoF.

Table C.1 shows the matches between FoF and SCF variables. The first column shows

the names of the FoF variables we use. The second column shows the FoF totals, in trillions of 2021 USD. The third column shows the share of the previous total held directly by households. The fourth and fifth columns give the SCF names and totals, again in trillions of 2021 USD. Finally, the adjustment column is computed by taking the SCF total and dividing it by the FoF total multiplied by the share held directly (computed from the FoF). In order to adjust to the SCF, we multiply FoF totals by the adjustment factor. In order to adjust to the FoF, we divide SCF totals by the adjustment factor. N/A denotes variables that are not held directly by households (like Open Market Paper) and hence have no corresponding SCF variable. Additionally, several holdings, including US Deposits in Foreign Countries, are partially held directly by households, but we have no corresponding SCF variable. Thus, this share of the holdings remains unallocated. Table C.2 shows that this has a relatively minor effect on results.

Table C.1: FoF to SCF Matching

FoF Names	FoF Totals	Shares	SCF Names	SCF Totals	Adjustment
U.S. Reserves and SDR Allocations	0.17	0		0	N/A
SDRs and Treasury Currency	0.06	0		0	N/A
US Deposits in Foriegn Countries	0.8	0.3		0	1
Net Interbank Transactions	1.77	0		0	N/A
Checkable Deposits and Currency	4.44	0.33	(checking+prepaid)	1.38	0.93
Time and Savings Deposits	12.43	0.79	(saving+cds)	2.85	0.29
Federal Funds and SRPA	4.53	0		0	N/A
Open Market Paper	1.07	0		0	N/A
Treasury Securities	17.91	0.11	govtbnd	0.15	0.08
Agency and GSEs	9.18	0.07		0	1
Municipal Securities	4.04	0.47	notxbnd	0.58	0.31
Corporate and ForeignBonds	13.5	0.07	obnd	0.15	0.16
Other Depository Inst Loans	3.69	0.09		0	1
Other Loans and Advances	4.16	0.19		0	1
Total Mortgages	15.28	0.69	npv_mtg (1)	10.47	1
Credit Card Loans	1	1	lloan10	0.37	0.37
Auto Loans	1.16	1	veh_inst	0.83	0.72
Student Loans	1.6	1	edn_inst	1.11	0.7
Other Consumer Credit	0.24	1	oth_inst	0.28	1.2
Trade Credit	5.41	0.07		0	1
Life Insurance Reserves	2.19	0.77	cashli	1	0.59
Taxes Payable by Businesses	0.58	0		0	N/A
Direct Investment	15.44	0		0	N/A
Total Misc Fin Claims	27.77	0.04		0	1
Real Estate	32.42	1	houses	28.73	0.89
Equipment	6.5	0.07		0	1
IP	3.27	0.06		0	1
Inventories	2.55	0		0	N/A
Durable Goods	5.59	1	vehic	2.91	0.52
Corporate Goodwill	228.03	0		0	N/A
Non-Corporate Goodwill	57.68	0		0	N/A
Other Real Estate	26.36	0	nnresre	3.24	N/A
Private DB Pensions	11.84	1	priv_shareof_db*(retqliq*dbplancj) (2)	1.29	0.11
Federal DB Pensions	4.66	1	fed_shareof_db*(retqliq*dbplancj) (3)	1.28	0.27
State and Local DB Pensions	10.47	1	s_l_shareof_db*(retqliq*dbplancj) (4)	3.21	0.31
Labor Income	214.9	1	labor_inc (5)	214.9	1
Social Security	71.97	1	ss_inc (6)	71.97	1
Rent	0.26	1	rent*6	0.26	1
Tax	79.77	0	tax (7)	79.77	N/A

FoF and SCF Totals are in trillions of 2021 USD. Shares denote the share of the FoF Total held directly by households. The adjustment factor is the SCF total divided by the FoF total multiplied by the share.

Several of the cells contain notes concerning their values. For (1), we use npv_mtg, the nominal present value of the mortgage payment streams. For (2), we multiply the privately issued share of defined-benefit pensions (SCF variable priv_shareof_db) by the pension value variable (SCF variable retqliq) and by an indicator that states whether a household holds a defined-benefit pension (SCF variable dbplancj). (3) and (4) are identical to (2), but instead, we multiply first by shares of defined benefit pensions issued by the federal government and state and local governments, respectively. (5) and (6) are the nominal present values of the labor (labor_inc) and social security (ss_inc) income streams. Finally, (7) is the total tax asset we calculated from

labor and social security income.

Table C.2 shows the consolidated holdings across all three end owners.Figures B.2, B.6, and Table B.4 show the main results for the U.S. government and the rest of the world. While households across the wealth distribution tend to lose due to unexpected inflation,Figure B.6 shows that the government has corresponding gains.

Table C.2: Consolidated Holdings Across all End Owners

	Liabilities			Assets			
FoF Names	Households	Government	Rest of World	Households	Government	Rest of World	Ratio A/L
U.S. Reserves and SDR Allocations	0	0.05	0.12	0	0.17	0	1
SDRs and Treasury Currency	0	0.06	0	0	0.06	0	1
US Deposits in Foreign Countries	0	0	0.8	0.4	0.05	0.11	0.7
Net Interbank Transactions	0.07	1.68	0.02	1.18	0.14	0.45	1
Checkable Deposits and Currency	1.74	2.23	0.48	2.7	0.6	1.15	1
Time and Savings Deposits	8.92	1.06	2.44	11.32	0.44	0.67	1
Federal Funds and SRPA	2.7	0.38	1.45	2.93	0.28	1.32	1
Open Market Paper	0.49	0.06	0.52	0.65	0.18	0.24	1
Treasury Securities	0	17.91	0	5.69	5.2	7.02	1
Agency and GSEs	6.57	0.81	1.8	3.98	2.6	1.96	0.93
Municipal Securities	0.43	3.27	0.12	3.48	0.16	0.41	1.06
Corporate and Foreign Bonds	7.55	0.88	5.07	7.24	1.18	5.08	1
Other Depository Inst Loans	2.45	0.11	0.8	2.65	0.32	0.73	1.1
Other Loans and Advances	2.94	0.38	0.38	1.73	0.54	1.12	0.91
Total Mortgages	15.06	0.07	0.15	10.68	1.62	2.91	1
Credit Card Loans	1	0	0	0.49	0.38	0.13	0.99
Auto Loans	1.16	0	0	0.56	0.44	0.15	0.99
Student Loans	1.6	0	0	0.78	0.6	0.21	0.99
Other Consumer Credit	0.24	0	0	0.11	0.09	0.03	0.99
Trade Credit	2.79	1.6	0.63	3.48	0.61	1.05	1.03
Life Insurance Reserves	1.49	0.23	0.47	2.04	0.04	0.11	1
Taxes Payable by Businesses	0.47	0.04	0.08	0	0.58	0	1
Direct Investment	6.07	0.7	8.67	5.15	0.58	9.71	1
Total Misc Fin Claims	15.06	8.88	3.79	16.4	7.48	2.64	0.96
Real Estate	0	0	0	32.42	0	0	N/A
Equipment	0	0	0	4.6	0.44	1.01	N/A
IP	0	0	0	2.28	0.24	0.55	N/A
Inventories	0	0	0	1.9	0.2	0.45	N/A
Durable Goods	0	0	0	5.59	0	0	N/A
Corporate Goodwill	0	0	0	163.67	19.52	44.84	N/A
Non-Corporate Goodwill	0	0	0	57.68	0	0	N/A
Other Real Estate	0	0	0	25.8	1.15	2.65	N/A
Private DB Pensions	0	4.66	0	4.66	0	0	1
Federal DB Pensions	166.87	14.57	33.46	214.9	0	0	1
State and Local DB Pensions	8.5	1.01	2.33	11.84	0	0	1
Labor Income	0.26	0	0	0.19	0.02	0.05	1
Social Security	0	71.97	0	71.97	0	0	1
Rent	0	10.47	0	10.47	0	0	1
Tax	0	0	0	0	79.77	0	N/A
Total	254.43	143.1	63.58	397.68	24.36	37.26	1

Columns show holdings of liabilities and assets by each end owner in the economy. All Totals are in Billions of 2021 USD.

Figure C.2 shows all holdings held across all end owners in the economy: Households, U.S. Government, and the Rest of the World. Columns two through four show the

liability totals for each, while five through seven show the asset totals. Column eight shows the ratio between the two. For most of the holdings, the ratio is 1, meaning that the total of assets perfectly matches the total of liabilities. We outlined above that when the FoF indicates direct holdings by households (of either assets or liabilities), but then we are unable to find an SCF variable to account for this ownership, then that share of the holding is unallocated and the sum of assets and liabilities in the economy no longer matches. This explains why not all of the asset-to-liability ratios are exactly 1. However, the majority are extremely close, and those that are farther away represent a tiny portion of holdings in the economy. The ratio of all assets and liabilities together, shown in the "Total" row, is 0.996. This excludes real assets, which have ratios of N/A, since there are no corresponding liability holdings of, for example, real estate.

D.2.3 Household Nominal Payment Streams

Our second main dataset is called 'payment streams'. For this data set, we construct nominal payment streams for all holdings of assets and liabilities with non-zero nominality (excluding, for example, real estate and equipment) based on our assumptions about their nominality and duration. Table C.3 shows the assumptions we made about the nominality and maturity of holdings. Holdings with a maturity of N/A are not considered nominal. Several of the cells contain notes concerning their values for holdings, which are partially real and partially nominal. For (1), we assume that for every household, 9% of their Treasury holdings are adjustable-rate TIPS (real) and 91% are fixed-rate (nominal). For (2), we assume the mortgage is real if a household indicates their mortgages as adjustable-rate mortgages; we assume it is nominal if it is a fixed-rate mortgage. For (3), we assume that 70%, 40%, and 10% of the first three years, respectively, are nominal. For (4), we take 6 months of households' rent liability and assume 1 year of maturity. For (5), we deduct taxes from the labor and social security payment stream, though it features as a payment stream for the government.

Table C.3: Maturity and Nominality

Holding	Maturity	Nominal
U.S. Reserves and SDR Allocations	1	Yes
SDRs and Treasury Currency	1	Yes
US Deposits in Foreign Countries	1	Yes
Net Interbank Transactions	1	Yes
Checkable Deposits and Currency	1	Yes
Time and Savings Deposits	1	Yes
Federal Funds and SRPA	1	Yes
Open Market Paper	1	Yes
Agency and GSEs	20	Yes
Municipal Securities	10	Yes
Corporate and Foreign Bonds	5	Yes
Other Depository Inst Loans	3	Yes
Other Loans and Advances	3	Yes
Credit Card Loans	1	Yes
Auto Loans	3	Yes
Student Loans	10	Yes
Other Consumer Credit	3	Yes
Trade Credit	1	Yes
Life Insurance Reserves	1	Yes
Taxes Payable by Businesses	1	Yes
Direct Investment	3	Yes
Total Misc Fin Claims	3	Yes
Real Estate	N/A	No
Equipment	N/A	No
IP	N/A	No
Inventories	N/A	No
Durable Goods	N/A	No
Corporate Goodwill	N/A	No
Non-Corporate Goodwill	N/A	No
Other Real Estate	N/A	No
Private DB Pensions	N/A	No
Federal DB Pensions	N/A	No
State and Local DB Pensions	N/A	No
Social Security	N/A	No
Treasury Securities	See D.2.3	(1)
Total Mortgages	See D.2.3	(2)
Labor Income	See D.2.3	(3)
Rent	See D.2.3	(4)
Tax	See D.2.3	(5)

For (1), we assume that 9% of each household's Treasury holdings are adjustable-rate TIPS (real) and 91% are fixed-rate (nominal). For (2), we assume a mortgage is real if a household has an adjustable-rate mortgage, and nominal if it is a fixed-rate mortgage. For (3), we assume that 70%, 40%, and 10% of the first three years of labor income, respectively, are nominal. For (4), we take 6 months of household's rent liability and assume 1 year of maturity. For (5), we simply deduct taxes from the labor and social security payment stream and create an asset payment stream for the government representing tax revenue.

For direct holdings of assets and liabilities such as mortgages and labor income, we use the detailed information in SCF to construct the nominal payment streams based on the procedure described in Section D.2 and the assumptions about their nominality

as shown in Table C.3. For rent, we take the next six months of rent from the SCF as nominal liability for households who are paying rent.

For payments to be received from holdings of Treasury debt, we use data from the CRSP US Treasury Database. In that dataset, we observe the outstanding value of each Treasury security outstanding with information regarding its face value, coupon rate, and maturity date. We take all Treasury securities outstanding at the beginning of 2019 and calculate the aggregate Treasury nominal payment streams for all Treasury securities. We assume that, for each household in the SCF, the nominal payment streams from their holdings of Treasury securities are proportional to the aggregate Treasury streams, with the present value matching each household's total Treasury holdings (direct and indirect) after the adjustments described in Appendix D.2.

For other holdings for which we do not have detailed information, we calculate the maturity structure of the outstanding assets (or liabilities) in each category as follows: (1) For each category, we assume that assets and liabilities are issued with a constant maturity as summarized by Table C.3. (2) We use changes in the outstanding values for each category in the FoF since 2006 to calculate the maturity structure of the outstanding value in 2019.[8] This procedure is similar to the approach taken by Doepke and Schneider (2006). Dividing these maturity totals by the nominal present value gives us the value in future payments of $1 today. We then use the values we obtained in longdata to calculate the values in future payments of each holding owned by households. Finally, given all the payment streams, we make one final adjustment: for payment streams from assets and liabilities held through the DC pension fund, we assume that these payments are available for households as a single lump sum obtained when the household head turns 65 or in the current year, whichever is later.

This gives us payment_streams.csv, which contains streams of payments of each holding held by each household in the SCF for thirty periods: from year0 (the current year) to year 29. Now that we have created longdata and payment streams for households, we create three more datasets. The first of these is a nominal version of longdata,

[8] We start with 2006 because earlier data has inconsistent availability. For each asset with an assumed maturity of year m, we assume the initial maturity structure in 2006 is such that the outstanding values are equally distributed over horizon $\{1, \ldots, m\}$.

which is calculated by taking the net present value of all payment streams, which exist only for nominal holdings. The second two datasets are versions of longdata and payment streams created for the U.S. government and the rest of the world. These are constructed in the same manner as we did for households, but instead using FoF data for the remaining two end-owners, the U.S. government, and the rest of the world. This step allows us to verify that totals of assets and liabilities across all end owners (households, the U.S. government, and the rest of the world) match up,[9] and also that each gain has a corresponding loss and vice versa.

D.2.4 Inflation Shocks

In order to calculate the gains and losses experienced by all changes, we construct inflation shocks. We start with monthly inflation expectations data from the Cleveland Fed, which gives us inflation expectations at different dates for different horizons into the future. We then lag these expectations so that the dates now correspond to inflation expectations one year ago. We combine this with monthly CPI data from FRED, which gives us realized inflation over the next year. We then proceed to compute the shocks themselves. We do this by taking the difference in logs between the expectations before the shock for different horizons and the expectations one year later (after a year of realized inflation), as described in Section 4.1. This allows us to compute inflation shocks as the "update" in inflation expectations. Finally, we annualize the shocks and take observations from the first month of every year to have an annual measure of inflation shocks for the years 2020 and 2021.

[9]The aggregate totals for the entire economy are within 1% of each other, though the totals for some individual holdings do not match. For example, the FoF denotes that a portion of US deposits in foreign countries is held directly by households, but there is no corresponding SCF variable to denote this. Consequently, that fraction of direct household ownership is missing from the aggregate asset total, which means that it is slightly smaller than the liability total. We estimate the effects of these discrepancies to be relatively minor.

Discrepancy between SCF and FoF

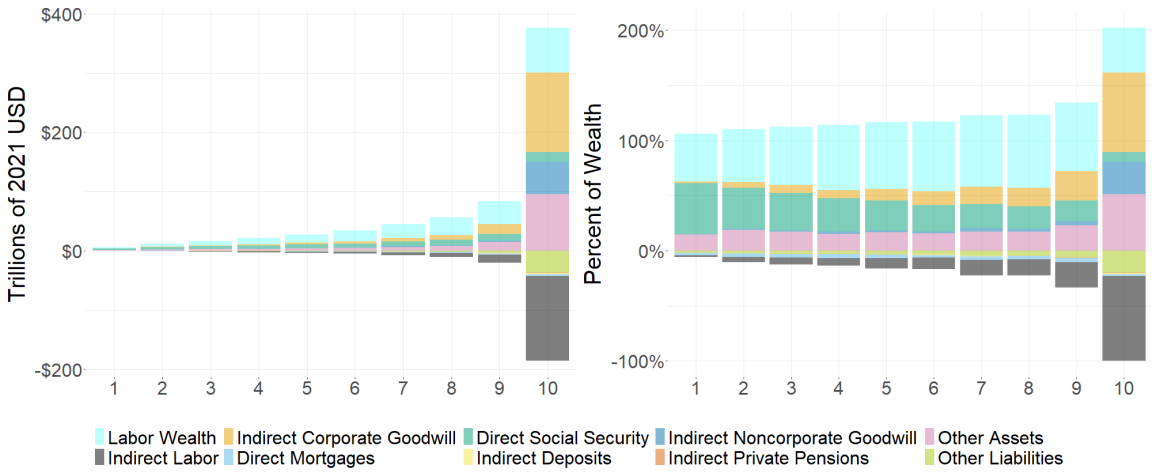


Figure C.1: Consolidated balance sheet of U.S. households by wealth decile (top holdings, adjusted to SCF).

Figure C.1 shows the results of Figure 2, but instead with holdings adjusted to match SCF totals. The overall level of holdings is slightly lower than it was when adjusting to the FoF, but otherwise results are similar. The vast majority of wealth for households outside the top wealth decile still comes from expected labor income. In contrast, the highest wealth decile holds significant amounts of corporate and noncorporate goodwill. As a fraction of net worth, we also see large differences between the poor and the rich. For the poorest decile, expected future labor income, social security, and housing make up a significant fraction of total net worth. While for the richest decile, other business interests are (relatively) more important. While the lowest-wealth households do hold mortgages and take out installment loans, the wealthiest households hold significantly larger mortgages (in levels). Overall, the largest liability is indirect labor, held through intermediate assets such as mutual funds holding corporate equity.

D.3 Persistence of Household Illiquidity

We assume that our measure of household illiquidity τ_t is persistent:

$$\mathbf{E}[\tau_{t+1}|\tau_t] = \rho \times \tau_t.$$

We calculate the persistence by estimating consumption responses for individuals in Facteus in response to two rounds of COVID-19 stimulus checks, the first in April 2020 and the second in March 2021. For each round, we regress changes in an individual's consumption surrounding the receipt of the stimulus check on (as a fraction of the stimulus amount) on separate splines for age and income, allowing for knots at ages 20, 30, 40, 50, 60, and 70; and for knots at income values of $5,000, $10,000, $30,000, $50,000, and $70,000 annually, We then regress the estimated value from round 1 and round 2 on one other, finding a raw correlation of 0.95 (and a rank-rank correlation of 0.94).

For our baseline specification, we take a more conservative stance and assume that $\rho = .9$. That is, liquidity-constrained households have a 90% probability of remaining constrained in the following years, a number corresponding to a slightly weaker liquidity channel than that implied by our estimate. We assume that household's illiquidity due to spreads s_t has the same persistence as τ_t:

$$\mathbf{E}[s_{t+1}|s_t] = \rho s_t.$$

Note that we obtain the estimate at the group level. Therefore, it may overstate the persistence of household illiquidity because we do not account for individual-level changes in economic circumstances within the age-income group. To account for this, we test the robustness of our result under different levels of persistence in Appendix E.

D.4 Welfare Effects Calculation

To calculate the welfare effects in Figure 8, we use the formula in Lemma 3:

$$dU = u'(\bar{c}_0) \times avg\big[(1+\tau^t)^{-1}\big]\Big(\underbrace{\Delta w_0}_{\text{wealth channel}} + \underbrace{q_0 \times \Big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \Big\rangle}_{\text{liquidity channel}} \Big).$$

For our decomposition in Figure 8, we define effects for the four decomposition as Υ_j for $j \in \{1, \cdots, 4\}$:

- the wealth channel:

$$\Upsilon_1 \coloneqq \Delta w_0;$$

- the wealth channel plus the effect of illiquidity due to spreads s_t:

$$\Upsilon_2 \coloneqq \Delta w_0 + q_0 \times \Big\langle \Delta z_t, \frac{(1+s_0^t)^{-1}}{avg[(1+s_0^t)^{-1}]} - 1 \Big\rangle;$$

- the wealth channel plus the effects of shadow rates:

$$\Upsilon_3 \coloneqq \Delta w_0 + q_0 \times \Big\langle \Delta z_t, \frac{(1+\zeta_0^t)^{-1}}{avg[(1+\zeta_0^t)^{-1}]} - 1 \Big\rangle;$$

- the wealth channel plus the liquidity channel:

$$\Upsilon_4 \coloneqq \Delta w_0 + q_0 \times \Big\langle \Delta z_t, \frac{(1+\tau^t)^{-1}}{avg[(1+\tau^t)^{-1}]} - 1 \Big\rangle.$$

To convert welfare effects Υ_j into equivalent values in lifetime wealth and single-year consumption, we calculate

- gains and losses relative to lifetime wealth for each household:

$$\tilde{\Upsilon}_j \coloneqq \frac{\Upsilon_j}{w_0},$$

  where w_0 is the lifetime wealth, constructed as described in Appendix D.2;

- gains and losses relative to single-year consumption for each household:

$$\tilde{\Upsilon}_j \coloneqq \frac{avg\big[(1+\tau^t)^{-1}\big]\Upsilon_j}{\bar{c}_0},$$

  where $\bar{c}_0$ is the level of annual consumption projected for each household from Facteus.

We use the same calculation for Figure 9 and the additional figures provided in this section.

E Robustness

Our results depend on a variety of parameters and assumptions. In this section, we test how alternative assumptions and values of parameters affect our result.

- The first assumption we test is how adjusting the SCF balance sheet totals to match the FoF total affects our result. As described in Section D.2, we chose to adjust the SCF to match the FoF for our main results. Due to the discrepancy between the two data sets that we see in Section D.2, we expect our result to depend on this adjustment. Here, we show how the results change if we instead adjust to match SCF totals.
- The second important parameter is the share of which the first-year labor income is nominal. In our main results, we assume this to be 0.7 in the first year, 0.4 in the second, and 0.1 in the third, with all income being real starting the 4th year. Here, we show how varying the first-year share of nominal labor to be 0.9, 0.7, or 0.5 affects the results.
- The third assumption we test is the persistence of illiquidity. Based on the estimation described in Section D.3, we assume that liquidity-constrained households have a probability of 0.9 of remaining constrained in the following years for our baseline specification. This is a high level of persistence. Since we obtain the estimate at the group level, it may lead to an overstatement of household illiquidity at the individual level because we do not account for individual-level changes in economic circumstances. To account for this, we compare our main results with alternative persistence ρ of 0.99, 0.95, 0.9, 0.8, or 0.6.
- The fourth specification we test for robustness is our estimate of household consumption responses to stimulus checks, which determined their shadow rate. We take our estimates of $\check{c}_0$ for each household from the Facteus data and multiply these estimates by a scalar $\varsigma = 1.5$, 1.0, or 0.5.
- Finally, we test how much our result depends on our assumption of households' intertemporal elasticities of substitution. In our baseline specification, we assume $\sigma = \frac{u''(c)c}{u'(c)} = 2$ to calculate the shadow rates. Here, we show how assigning σ with values of 3, 2, or 1 impacts our result.

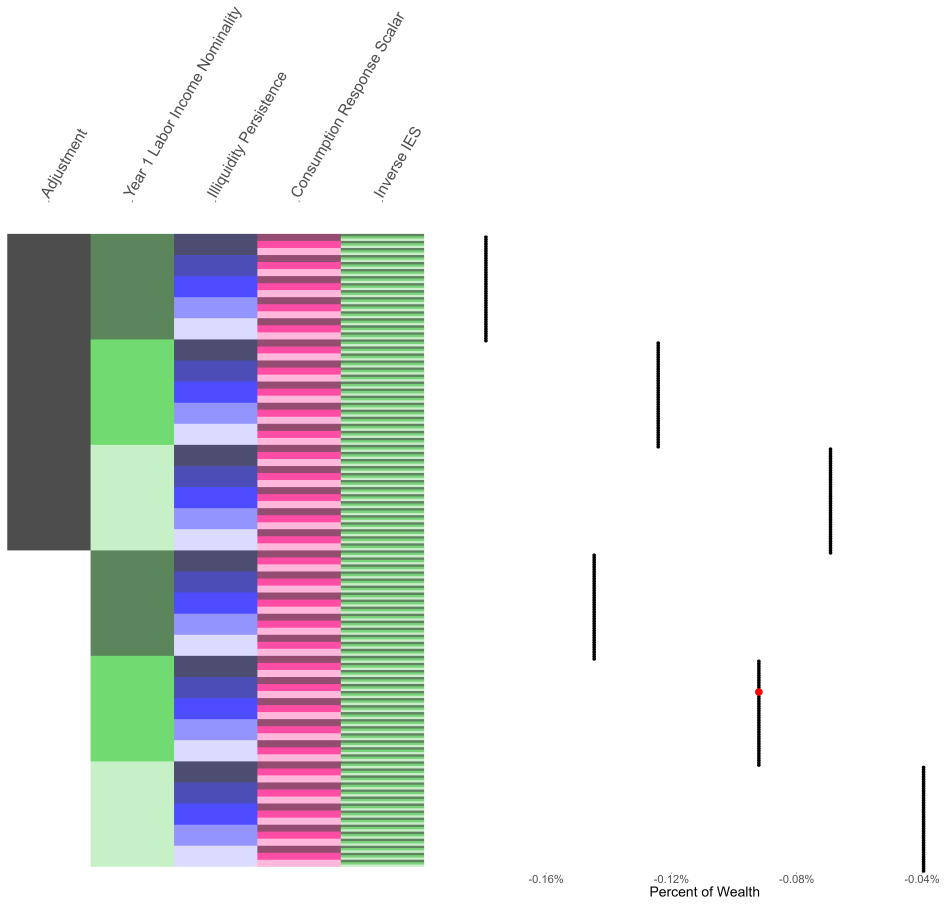
Table D.1 summarizes these alternative specifications.

Table D.1: Parameter Values in Robustness Checks

Parameters	Values
Adjustment	SCF, FoF
Year 1 Labor Income Nominality	0.9, 0.7, 0.5
Illiquidity Persistence	0.99, 0.95, 0.9, 0.8, 0.6
Consumption Response Scalar	1.5, 1.0, 0.5
Inverse IES	3, 2, 1

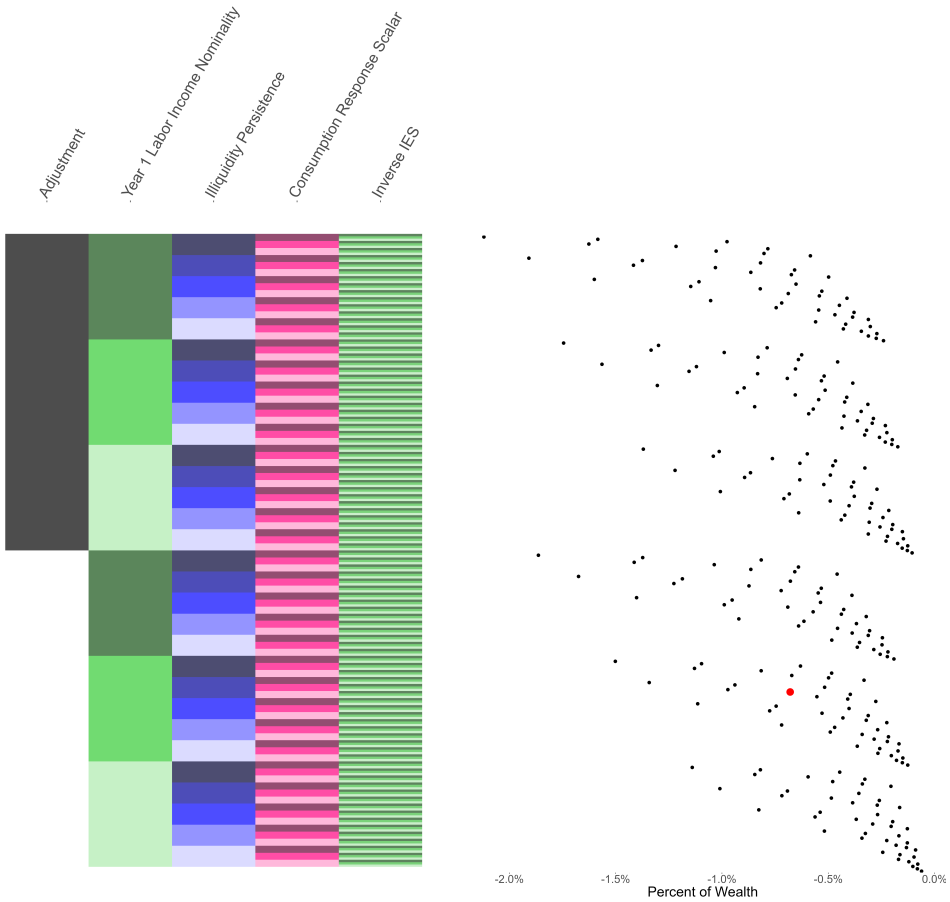
Note: Values in red correspond to our baseline specification.

In Figure D.1 through D.8, we consider all possible permutation of the assumptions in Table D.1, and we show the effects of the unexpected inflation shock for the wealth and liquidity channels for the 1st and 10th wealth deciles, with the effects represented in either lifetime wealth or single-year consumption. In Panel (a), the legend uses darker colors to represent higher values and lighter colors to represent lower values. Each column corresponds to a particular parameter, and each row represents a unique combination of parameter values. For example, in the first column, black represents results adjusted to the SCF total, while white represents adjustments to the FoF total. In the second column, dark green represents a year 1 labor income nominality of 0.9, medium green 0.7, and light green 0.5. In Panel (b), the Y-axis shows unique combinations of parameter values, and the X-axis shows the resulting welfare effect. The point highlighted in red represents the specification used in the main results. As we can see, adjusting to the FoF yields generally reduces the size of welfare losses. Similarly, lower nominal shares of first-year labor also yield more moderate estimates for welfare losses. In Figure D.1 and D.3, the wealth channel relative to lifetime wealth does not depend on illiquidity persistence, consumption response scalars, or the inverse IES; hence we see only 6 unique values on the x-axis. In Figure D.5 and D.7, the wealth channel in terms of single-year consumption depends on these parameters as the conversion depends on illiquidity persistence, consumption response scalars, and the inverse IES.



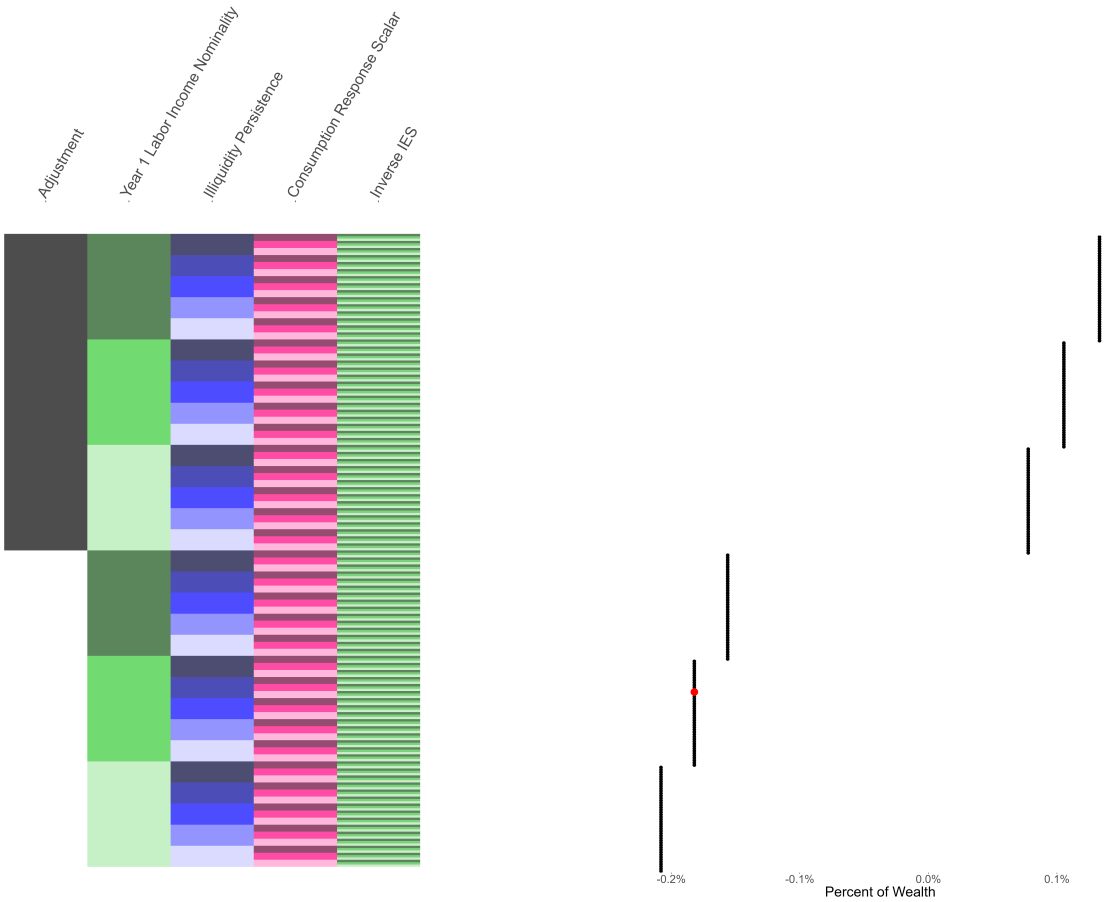
(a) Legend (b) Wealth Channel

Figure D.1: Robustness: Welfare effects in percent of wealth for 1st decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.



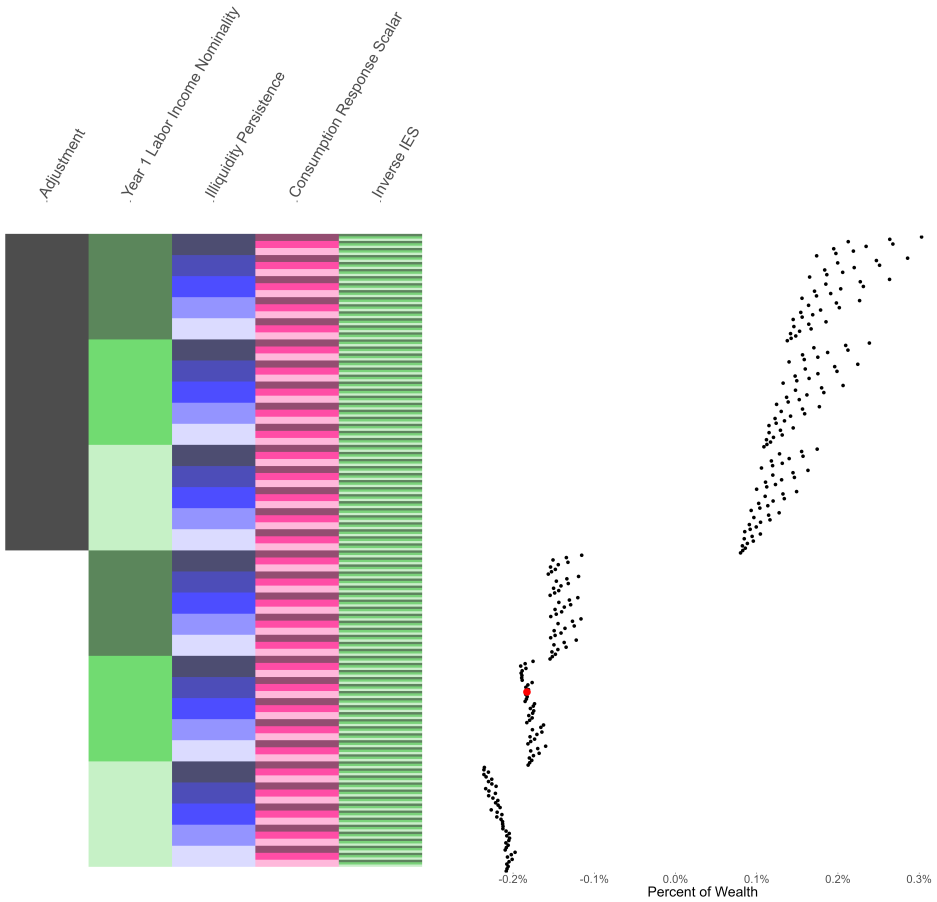
(a) Legend (b) Wealth + Liquidity Channel

Figure D.2: Robustness: Welfare effects in percent of wealth for 1st decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.



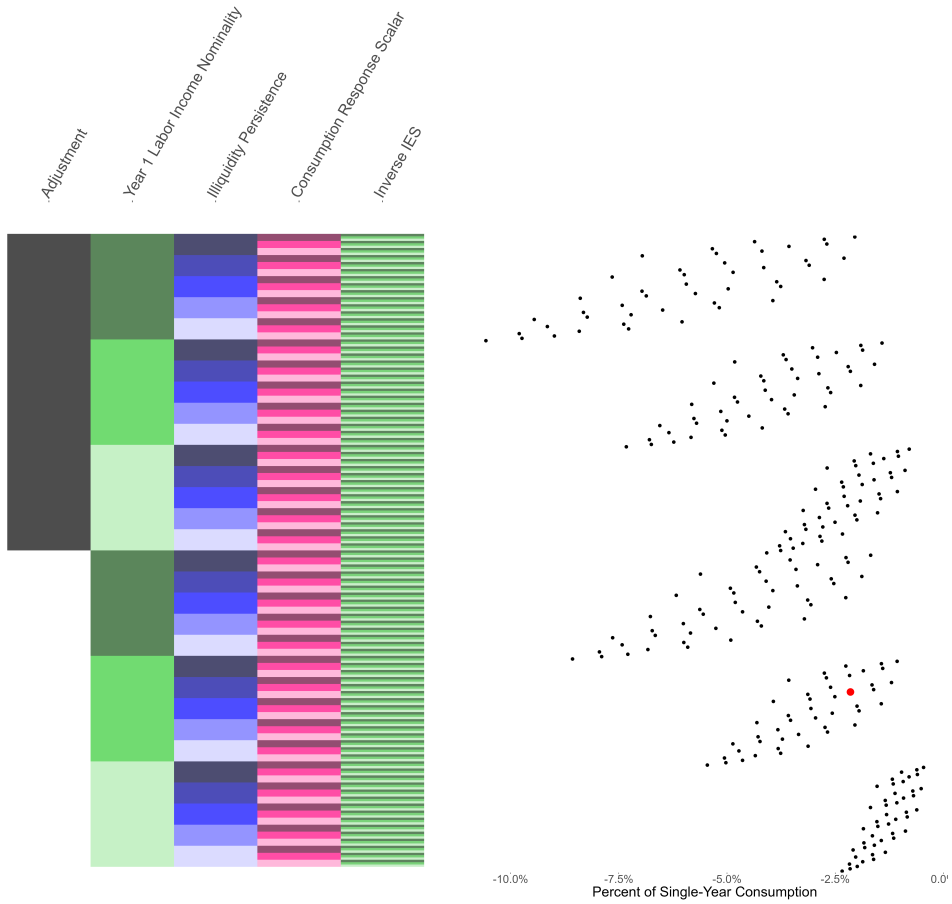
(a) Legend (b) Wealth Channel

Figure D.3: Robustness: Welfare effects in percent of wealth for 10th decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.



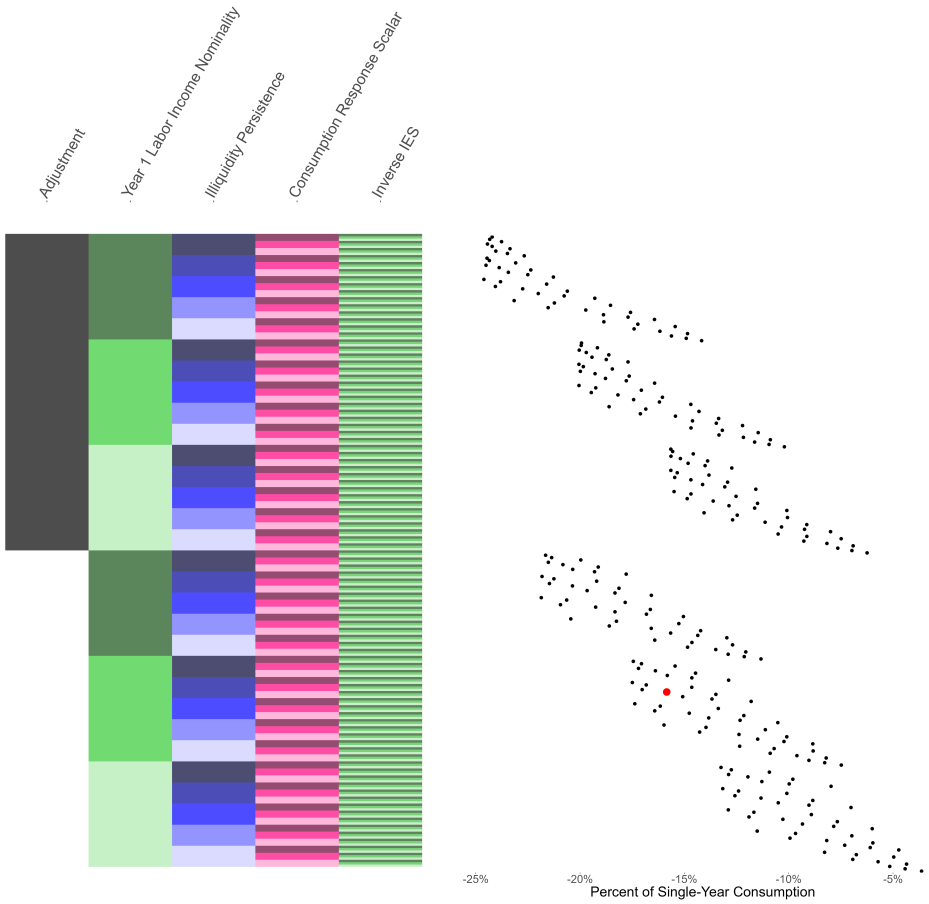
(a) Legend (b) Wealth + Liquidity Channel

Figure D.4: Robustness: Welfare effects in percent of wealth for 10th decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.



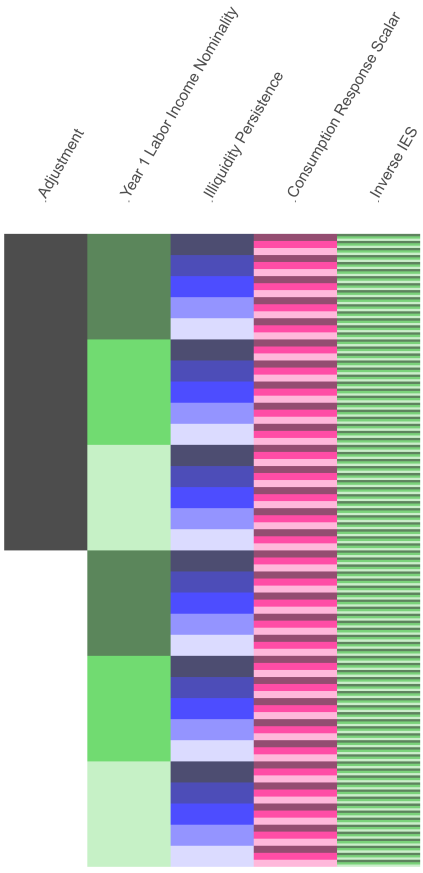
(a) Legend (b) Wealth Channel

Figure D.5: Robustness: Welfare effects in percent of single-year consumption for 1st Decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.

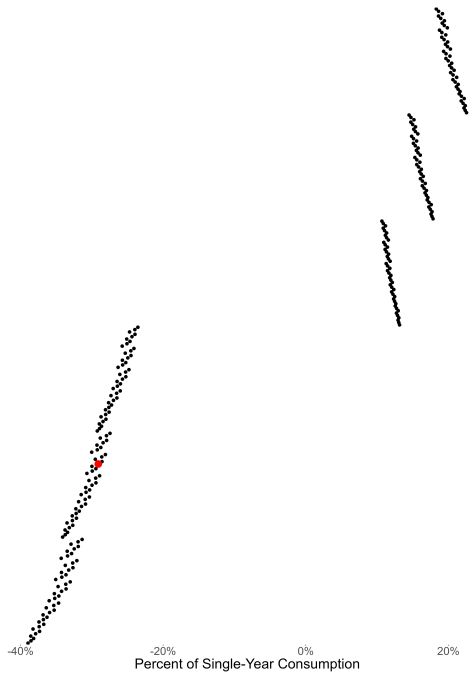


(a) Legend (b) Wealth + Liquidity Channel

Figure D.6: Robustness: Welfare effects in percent of single-year consumption for 1st Decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.

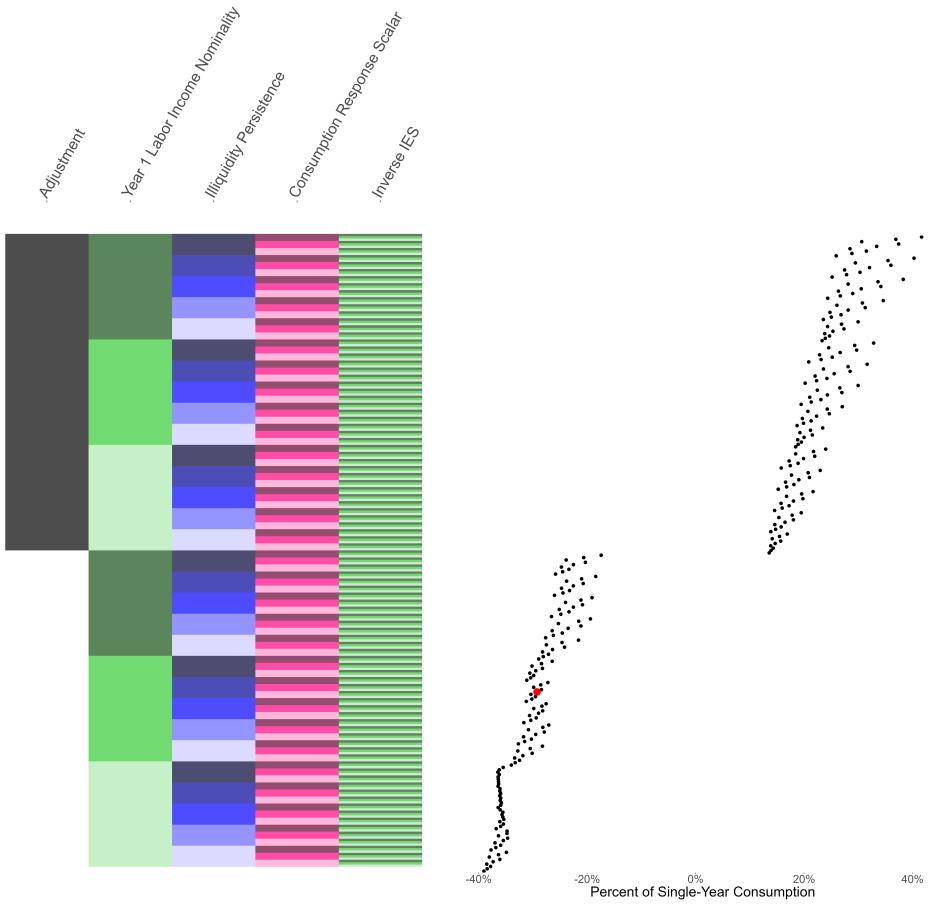


(a) Legend



(b) Wealth Channel

Figure D.7: Robustness: Welfare effects in percent of single-year consumption for 10th decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.



(a) Legend (b) Wealth + Liquidity Channel

Figure D.8: Robustness: Welfare effects in percent of single-year consumption for 10th decile. For (a), for Adjustment, black values represent SCF and white values represent FoF. For other parameters, dark to light values are: Year 1 Labor Income Nominality: 0.9, 0.7, 0.5. Illiquidity Persistence: 0.99, 0.95, 0.9, 0.8, 0.6. Consumption Response Scalar: 1.5, 1.0, 0.5. Inverse IES: 3, 2, 1. For (b), each point represents a parameter combination. The red point highlights the specification in the main results.