# Consumer Durables and Monetary Policy According to HANK*

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**Abstract**

Durable and nondurable consumption comovement is central to monetary policy transmission. Using a two-sector Heterogeneous Agent New Keynesian model, we generate realistic sectoral comovement while capturing key household spending patterns. Both direct and indirect effects matter: intertemporal substitution strongly influences durable spending, while income effects drive persistence in nondurable responses. Comovement also extends to households sorted by liquid asset holdings. Distinguishing transmission channels is crucial for understanding the macroeconomic impact of targeted fiscal policies, as subsidies for durable goods purchases.

**Keywords**: Durable goods, sectoral comovement, monetary policy, HANK

**JEL codes**: E21, E31, E40, E44, E52.

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# 1 Introduction

Stimulating household expenditure on durables is widely regarded as a key channel through which monetary policy influences aggregate household spending (see, e.g., Mankiw, 1985; Erceg and Levin, 2006; Sterk and Tenreyro, 2018). Consumer durables play a disproportionately large role in explaining variations in both household and aggregate private expenditures (see, e.g., Stock and Watson, 1999; Attanasio, 1999)—a striking feature, considering they account for only a small fraction of total private consumption.[1] Moreover, they exhibit positive and persistent comovement with the nondurable component of household expenditure, in response to monetary policy. Yet, standard monetary models typically struggle to generate positive conditional comovement, in the presence of asymmetric degrees of sectoral price stickiness (see, e.g., Barsky et al., 2007).

We investigate the dynamics of durable and nondurable expenditures within a Heterogeneous Agent New Keynesian (HANK) setting, where households face idiosyncratic income risk and financial constraints that limit their access to liquid financial assets. With a reasonable parameter calibration, the model captures realistic sectoral expenditure responses and comovement in the transmission of monetary policy while also matching other key aspects of household spending.

The *direct effect* of monetary transmission—which operates mainly through intertemporal substitution—and the *indirect effects*—which predominantly influence households' disposable income via general equilibrium effects on labor demand—are both crucial for generating persistent sectoral comovement. While the direct effect is mainly responsible for large responses of durable spending, in the face of a monetary tightening, indirect effects induce persistence in durable and, especially, nondurable expenditure, ensuring tight and prolonged sectoral comovement. Marked sensitivity of durables to intertemporal substitution implies that the response of aggregate expenditure is not overwhelmingly driven by indirect effects, which typically dominate in HANK economies with only nondurables (e.g., Kaplan et al., 2018).

Using the Consumption Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF), we construct sectoral expenditure series based on households' holdings of liquid asset. This enables us to analyze how durable and nondurable expenditures respond to monetary policy shocks across household groups with direct counterparts in the model. Positive conditional comovement between durable and nondurable expenditures emerges as a defining feature for both savers and liquidity-constrained households, both in the model and the data. This implies that sectoral comovement is not merely driven by strong income effects disproportionately affecting low-liquidity households, as embodied by standard two-agent NK (TANK)

[1] Notional consumption of a given durable corresponds to the consumption flow derived from owning that durable.

settings (e.g., Monacelli, 2009).

Controlling for income and relative price movements—so as to disentangle the relative contribution of direct and indirect effects, as in Holm et al. (2021)—we find that household-level *nondurable* expenditure responses are primarily shaped by income effects in monetary transmission, while the direct effect operates fairly uniformly. This tendency is even more pronounced for *durable* spending, where savers and liquidity-constrained households exhibit remarkably similar responses, largely driven by the direct effect. Yet, income effects play a key role in extending the response of durable spending beyond its peak. This pattern closely aligns the model with the data, and holds across both broad and finely discretized classifications of the assetholding status.

Our modeling strategy rests on two steps. First, building on McKay and Wieland (2021), we devise the demand block of the HANK economy—allowing for household heterogeneity and financial constraints—and incorporate the projected path of the U.S. real interest rate, the relative price of durables, and GDP in response to a monetary shock. We show how this model generates realistic spending dynamics at both the aggregate and household levels. Second, we embed the demand block in a general equilibrium setting with price and wage rigidities. We leverage this framework to evaluate the macroeconomic effects of subsidies for durable goods purchases. Our findings suggest that the policy's impact is at best limited, and highly dependent on the response of monetary policy. When interest rates remain fixed, as in a ZLB environment, the direct effect reinforces the expansionary impact of increased disposable income, though the overall effectiveness of such policies remains modest. This aligns with evidence from transitory 'cash-for-clunkers' programs (see, e.g., Mian and Sufi, 2012).

These results refine our understanding of how different channels of monetary policy transmission interact in the presence of idiosyncratic risk and financial frictions. Moreover, they offer key insights into sectoral expenditure comovement and how it also applies at the household level, despite heterogeneous holdings of liquid assets.

**Related literature** Our work is inspired by the seminal work of Kaplan et al. (2018), who investigate the effects of monetary policy in New Keynesian models with rich wealth distributions (see also Alves et al., 2020). A main takeaway of this work is that, in the presence of uninsurable income risk, general-equilibrium effects affecting household disposable income drive the brunt of the response (of nondurables) to monetary shocks. This stands in stark contrast with the predictions of standard Representative Agent NK (RANK) economies, where nearly the entire response is driven by intertemporal substitution. Multi-sector RANK economies featuring durables are no exception to this property, being based on the view that durables' interest-rate sensitivity is primarily dictated by movements in the real rate of interest (Barsky et al., 2007). Instead, we show that *both* direct and indirect effects are essential for capturing monetary policy transmission and replicating the realistic expenditure comovement observed in the data. We also relate to McKay and Wieland (2021) and McKay and Wieland (2022), who incorporate durables in a HANK framework, emphasizing the role of the extensive margin of adjustment. We instead focus on sectoral expenditure comovement, incorporating household heterogeneity within an otherwise standard two-sector NK model, as in Erceg and Levin (2006).

A large literature has tackled the comovement puzzle plaguing two-sector New Keynesian models with asymmetric price rigidity. Within this baseline setting, some of the remedies to the puzzle have consisted of envisaging devices capable of limiting the sensitivity of the relative price of durables to a monetary tightening. Among these, we recall non-separable preferences between a composite of sectoral consumption goods and labor supply (see, e.g., Katayama and Kim, 2013), and sticky prices of the production inputs: in this respect, Carlstrom and Fuerst (2010) assume sticky wages, while Bouakez et al. (2011) allow for input-output interactions. Other remedies have placed emphasis on the importance of financial frictions. Specifically, Tsai (2016) stress the role of working capital and habits preferences, whereas Monacelli (2009) emphasizes the importance of households' collateralized borrowing. Our framework takes a different route, highlighting the role of transitory income movements in the presence of market incompleteness.

HANK models with a two-asset structure—one liquid and one relatively illiquid—share similarities with our dual-good model. However we emphasize that, despite their partial illiquidity, durables can serve as an imperfect self-insurance device for liquidity-constrained households (Cerletti and Pijoan-Mas, 2012; Asdrubali et al., 2020), unlike capital, which is typically managed by savers. Relatedly, Auclert et al. (2020) highlight how comovement between aggregate (nondurable) consumption and investment can arise from income effects that disproportionately impact low-liquidity households. However, our empirical evidence—demonstrating the presence of comovement even at the disaggregate level—rules out this channel as the primary driver of sectoral comovement. Instead, we show that both direct and income effects—albeit with varying importance across sectors and household groups—are essential for replicating the observed comovement at both aggregate and disaggregate levels.

**Structure** The paper is structured as follows: Section 2 introduces a partial equilibrium model of household spending on durables and nondurables, assessing its ability to replicate sectoral comovement and key empirical patterns in household expenditures. Section 3 presents novel survey-based evidence on how durable and nondurable expenditures respond to monetary shocks across households sorted by their holdings of liquid financial assets. Section 4 explores comovement in a two-sector HANK framework, and studies monetary transmission in greater detail. Finally, it examines the implications of our analysis for the effectiveness of government subsidies aimed at stimulating durable spending. Section 5 concludes.

## 2 A model of durable and nondurable demand

We devise a model of household consumption decisions in partial equilibrium. The economy is populated by a continuum of infinitely lived households, indexed by $s \in [0,1]$. Their preferences are defined over nondurable consumption and durables—$C_{n,t}(s)$ and $D_t(s)$, respectively.[2] Households' intertemporal utility reads as[3]

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \frac{\left( C_{n,t}^{\theta}(s) D_t^{1-\theta}(s) \right)^{1-\sigma}}{1-\sigma} \right\}. \tag{1}$$

We define the durable flow as $C_{d,t}(s) = D_{t+1}(s) - (1-\delta)D_t(s)$. Household $s$'s budget constraint (deflated by the price of nondurables) is given by

$$C_{n,t}(s) + Q_t C_{d,t}(s) + B_{t+1}(s) = (1 + r(B_t(s))_t)\, B_t(s) + \exp\{e_t(s)\} Y_t - \tfrac{\alpha}{2} \left( \tfrac{C_{d,t}(s)}{D_t(s)} \right)^2 D_t(s), \tag{2}$$

where $B_{t+1}(s)$ denotes bond holdings, $Q_t$ is the price of durables relative to that of nondurables, $Y_t$ denotes aggregate income, $\alpha$ scales the adjustment cost on durables, $\delta$ is the depreciation rate and $e_t(s)$ is an idiosyncratic productivity shock with zero mean. Furthermore, $r(B_t(s))_t$ is the real return on bonds when $B_t(s) > 0$, while it equals the real rate plus a borrowing wedge, $\kappa$, when $B_t(s) < 0$ (see Kaplan et al., 2018). Finally, households face a borrowing constraint:

$$B_t(s) \geqslant -\psi Y, \tag{3}$$

where $\psi$ is a scaling parameter and $Y$ denotes steady-state income.

Convex adjustment costs are primarily introduced to limit the interest rate elasticity of durables. This simplifying assumption restricts the model's ability to capture key aspects of durable spending, such as the lumpiness (see, e.g., Caballero, 1993) and sudden surges in purchases . These features are central to McKay and Wieland (2021), McKay and Wieland (2022), and Beraja and Zorzi (2024). Yet, Attanasio et al. (2022) highlight the complementarity between the intensive and the extensive margin. Therefore, modeling only the intensive margin does not inherently bias the model toward generating sectoral comovement in response to a monetary policy shock.

[2]Our definition of durable goods excludes housing for two key reasons: i) housing is unique among durables as it can also serve as collateral for borrowing; ii) housing differs from other durable goods in several aspects, including depreciation rates, construction time, and the frequency of price adjustment.

[3]The assumption of Cobb-Douglas preferences is rather conservative, as empirical estimates of the substitution elasticity between durables and nondurables range from below one to around one; see Ogaki and Reinhart (1998), Davis and Ortalo-Magné (2011), and Pakos (2011).

**Sticky expectations** We assume sticky expectations as in Gabaix and Laibson (2002) and Mankiw and Reis (2007). Specifically, we follow Carroll et al. (2020) and Auclert et al. (2020), such that households update their expectations of aggregate states infrequently while knowing their idiosyncratic state. Expectation updating of aggregates occurs each period with an i.i.d. probability of $1 - \Xi$. Households observe their current interest rate, $r(B_t(s))$, and their current income state, $\exp\{e_t(s)\}\, Y_t$, ensuring that they do not violate the borrowing constraint. As shown in Auclert et al. (2020), this feature helps generate hump-shaped IRFs, while still producing high impact marginal propensities to spend, since a one-time income change does not affect future aggregate states.

## 2.1 Empirical strategy and calibration

Our empirical strategy involves feeding the estimated paths of the real interest rate, total income, and the relative price changes induced by a monetary shock into the model, then matching the responses of aggregate and sectoral expenditures. The impulse response function (IRF) of a generic outcome variable, $z_t$, to a monetary policy shock is estimated using an instrumental variable extension of the local projection (LP-IV) approach. Specifically, we estimate:

$$z_{t+h} - z_{t-1} = \alpha^h + \beta^h \Delta r_t + \mathbf{x}_t \boldsymbol{\gamma}^h + \omega_{t+h}, \tag{4}$$

for $h = 0, 1, \ldots, H$, where $\Delta r_t$ denotes the change in the (ex-ante) real interest rate. The coefficient $\beta^h$ captures the average dynamic causal effect of this shift. The vector $\mathbf{x}_t$ includes control variables, namely 12 lags of the real interest rate and the dependent variable, along with a linear trend.[4] The change in the real interest rate is instrumented using monetary policy shocks identified by Romer and Romer (2004), as updated by Wieland and Yang (2020), so that the available sample spans from 1969:Q1 to 2007:Q3.[5]

The estimated IRFs can be interpreted as the local average treatment effect of an exogenous shift in the real interest rate driven by monetary policy shocks (see, e.g., Jordà and Taylor, 2024). To enhance interpretability and ensure comparability between the IRFs for aggregate variables and those we will be estimating for household-level data—which cover a shorter sample—we report IRFs corresponding to a cumulative 100 basis point (bp) increase in the Federal Funds Rate over five years.[6] In the full sample, this normalization implies a contemporaneous in-

[4]Olea and Plagborg-Møller (2021) demonstrate that lag-augmented LP inference remains robust in the presence of persistent data, ensuring reliable coverage even at longer horizons. Valid confidence intervals are constructed using heteroscedasticity-robust standard errors.

[5]Aggregate data are constructed from the the St. Louis Fed FRED database. See A.1 for further details.

[6]Specifically, for each IRF, we report $\beta_h \times \kappa$, where $\kappa = \sum_{j=0}^{19} \beta_{h,FF}$ and $\beta_{h,FF}$ corresponds to the LP coefficients from equation (4), estimated over the relevant sample, taking the Federal Funds Rate as outcome variable. Normalizing by the cumulative IRF partially accounts for differences in the persistence of the nominal interest rate response across different samples.

crease of the Federal Funds Rate of roughly 15 bp, following the monetary policy tightening.

**Impulse responses** The responses of GDP, the relative price of durables, and the real interest rate are reported in the top-left panel of Figure 1.[7] The monetary tightening is associated with a persistent increase in the real interest rate, leading to a prolonged, hump-shaped contraction in GDP. Furthermore, we find that the relative price of durables rises following monetary tightening, indicating that the price of nondurables contracts more sharply than that of durables. This is consistent with Cantelmo and Melina (2018), who document a positive reaction of the relative price, when focusing on durable goods and excluding housing.[8] The remaining panels of the figure report the responses of aggregate, durable and nondurable consumption expenditures. These all serve as explicit targets of our calibration. The shock induces a contraction in aggregate consumption expenditures, reaching a trough after about seven quarters. This decline is largely driven by durable expenditures, which exhibit relatively strong interest-rate sensitivity, peaking at a response an order of magnitude greater than that of nondurables at the trough. Beyond durables exhibiting greater responsiveness than nondurables, both types of expenditure display significant comovement, reaching a trough in the same quarter as aggregate expenditure, and recovering at a similar pace. This pattern broadly aligns with previous studies using sectoral data, such as Erceg and Levin (2006), Monacelli (2009), and Beraja and Wolf (2021).

**Calibration and IRF matching** Panel (a) of Table 1 provides an overview of the parameter values assigned in the partial equilibrium model.[9] We set the borrowing wedge, $\kappa$, to 0.05 and the discount factor, $\beta$, to 0.915 to match the steady-state share of liquidity-constrained households and the ratio of total liquid assets to aggregate income (30% and 26%, respectively; see Kaplan et al., 2018). The depreciation rate of durables, $\delta$, is set to 0.054, in line with Fixed Assets and Consumer Durable Goods data from the BEA;[10] the steady-state real interest rate, $r$, is set to 0.03/4, as in Debortoli and Galí (2021); the borrowing limit, $\psi$, is set to 0.833, implying households can borrow up to the average labor income; the idiosyncratic income process parameters, $\sigma_e$ and $\rho_e$, are set to 0.193 and 0.978, following McKay et al. (2016) and Auclert (2019). The remaining parameters are set to match the IRFs of durable and nondurable expenditures, as well as the yearly intertemporal marginal propensity to spend (i-MPX) after a one-time income

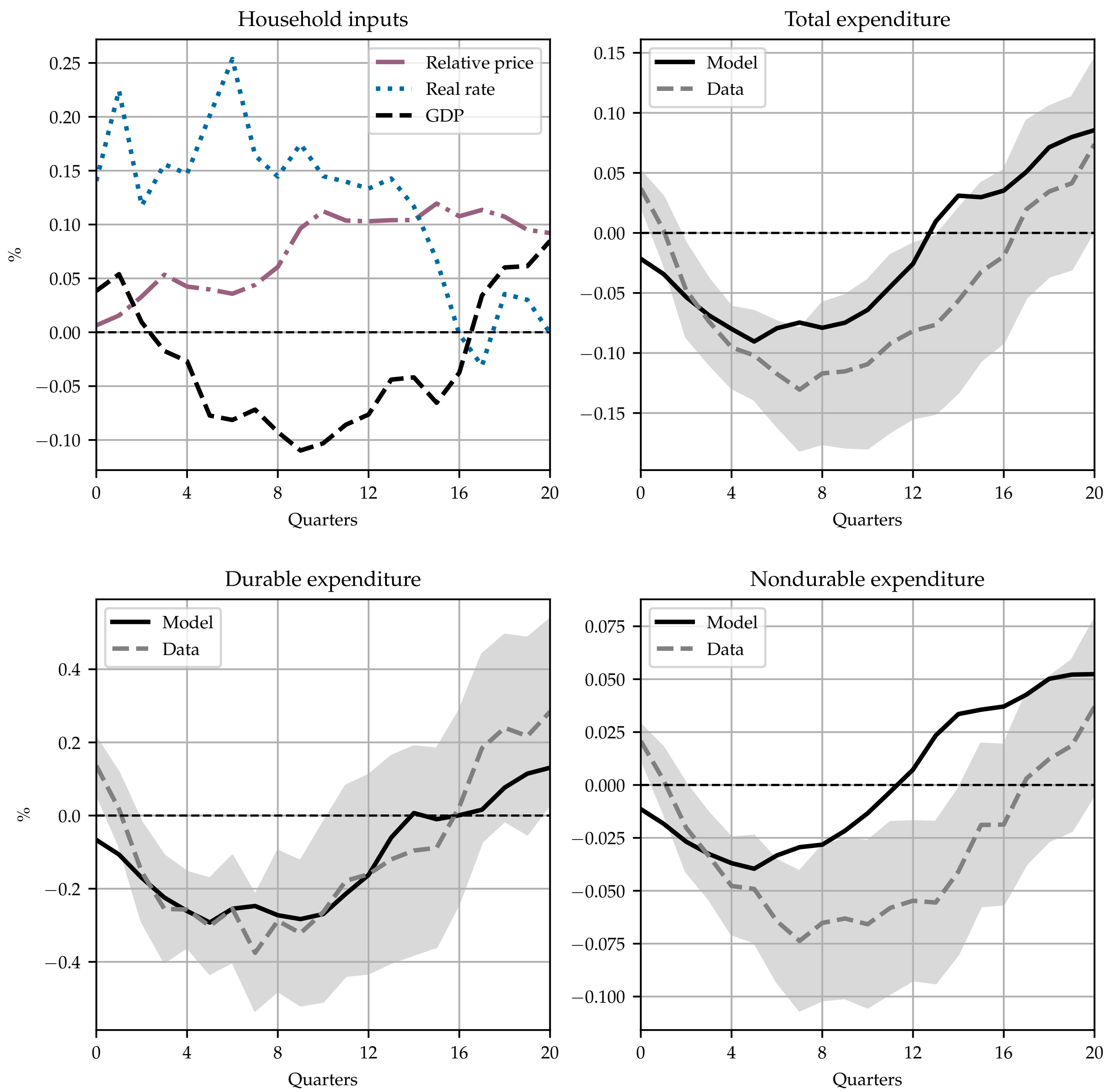
[7] The same responses, together with their confidence intervals, are reported in Figure B.1 (Appendix B).

[8] In contrast, when housing is taken as a measure of durable spending, the relative price exhibits a strongly procyclical response, consistent with the evidence that house prices display limited price stickiness. When both components are aggregated into a single price index, Cantelmo and Melina (2018) report a mildly countercyclical response of relative prices.

[9] To obtain household policy functions we use the endogenous grid method algorithm (EGM) of Auclert et al. (2021). In doing so, we normalize steady-state GDP to one.

[10] This value aligns with Laibson et al. (2022) and reflects our focus on consumer durables, as we exclude inherently illiquid housing.

Figure 1: Expenditure responses: model vs. data




Notes: The top-left panel reports the IRFs of the real interest rate, GDP, and the relative price of durables in response to a monetary policy shock that results in a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years. The remaining panels report the IRFs of aggreage and sectoral expenditures triggered by the same shock (dashed line; the shaded area indicates the 95% confidence interval), against the IRFs of their model counterparts (solid line).

transfer (Fagereng et al., 2021). This results in a Cobb-Douglas weight in household utility of $\theta = 0.657$,[11] a CRRA coefficient of $\sigma = 2.474$ (broadly consistent with existing estimates),

[11] This value implies a durable expenditure share of 0.186, slightly higher than 0.125, as computed by Laibson et al. (2022).

Table 1: Calibrations

**(a) Partial equilibrium model**

| Parameter | Description | Value | Target/Source |
|---|---|---|---|
| $\sigma$ | CRRA coefficient | 2.474 | IRF matching |
| $\theta$ | Cobb-Douglas weight in household consumption utility | 0.657 | IRF matching |
| $\alpha$ | Stock of durables adjustment-cost parameter | 5.401 | IRF matching |
| $\Xi$ | Houseolds' probability of not updating expectations | 0.959 | IRF matching |
| $\delta$ | Durables' depreciation rate | 0.054 | BEA; Laibson et al. (2022) |
| $\psi$ | Borrowing limit | 0.833 | Borrowing up to the average labor income |
| $\beta$ | Discount factor | 0.915 | Liquid asset holdings to income = 0.26 |
| $\kappa$ | Borrowing wedge | 0.05 | Steady-state share of households with $B = 0$ |
| $\rho_e$ | Autoregressive parameter, households' idiosyncratic income process | 0.978 | McKay et al. (2016) and Auclert (2019) |
| $\sigma_e$ | Standard deviation, households' idiosyncratic income process | 0.193 | McKay et al. (2016) and Auclert (2019) |
| $r$ | Steady-state real rate of interest | 0.03/4 | Debortoli and Galí (2021) |

**(b) General equilibrium model**

| Parameter | Description | Value | Target/Source |
|---|---|---|---|
| *Household* | | | |
| $\varphi$ | Inverse of the Frisch elasticity of labor supply | 1.07 | IRF matching |
| $\psi_N$ | Weight of labor disutility | 0.469 | IRF matching |
| *Supply side* | | | |
| $\xi_n$ | Sector $n$'s price-adjustment cost (mapping to a 0.541 Calvo probability) | 11.670 | IRF matching |
| $\xi_d$ | Sector $d$'s price-adjustment cost (mapping to a 0.734 Calvo probability) | 42.014 | IRF matching |
| $\xi_w$ | Nominal wage-adjustment cost (mapping to a 0.761 Calvo probability) | 52.380 | IRF matching |
| $\epsilon_n, \epsilon_d$ | Sectoral elasticities of substitution across different intermediate-good varieties | 6 | Monacelli (2009) |
| $\epsilon_w$ | Elasticity of substitution of across different labor services | 6 | Erceg et al. (2000) and Hagedorn et al. (2019) |
| *Policy rules* | | | |
| $\phi_\tau$ | Taxation rule: reaction parameter to debt deviations from steady state | 0.109 | IRF matching |
| $\phi_{\bar{\pi}}$ | Taylor rule: inflation reaction | 1.670 | IRF matching |
| $\phi_{\bar{y}}$ | Taylor rule: real-activity reaction | 0.462 | IRF matching |
| $\rho_i$ | Taylor rule: interest-rate smoothing | 0.627 | IRF matching |
| *Shock param.* | | | |
| $\rho_{r^*}$ | Autoregressive parameter in the m.p. shock | 0.875 | IRF matching |
| $\sigma_{r^*}$ | Std. dev., innovation in the m.p. shock | 0.379 | IRF matching |

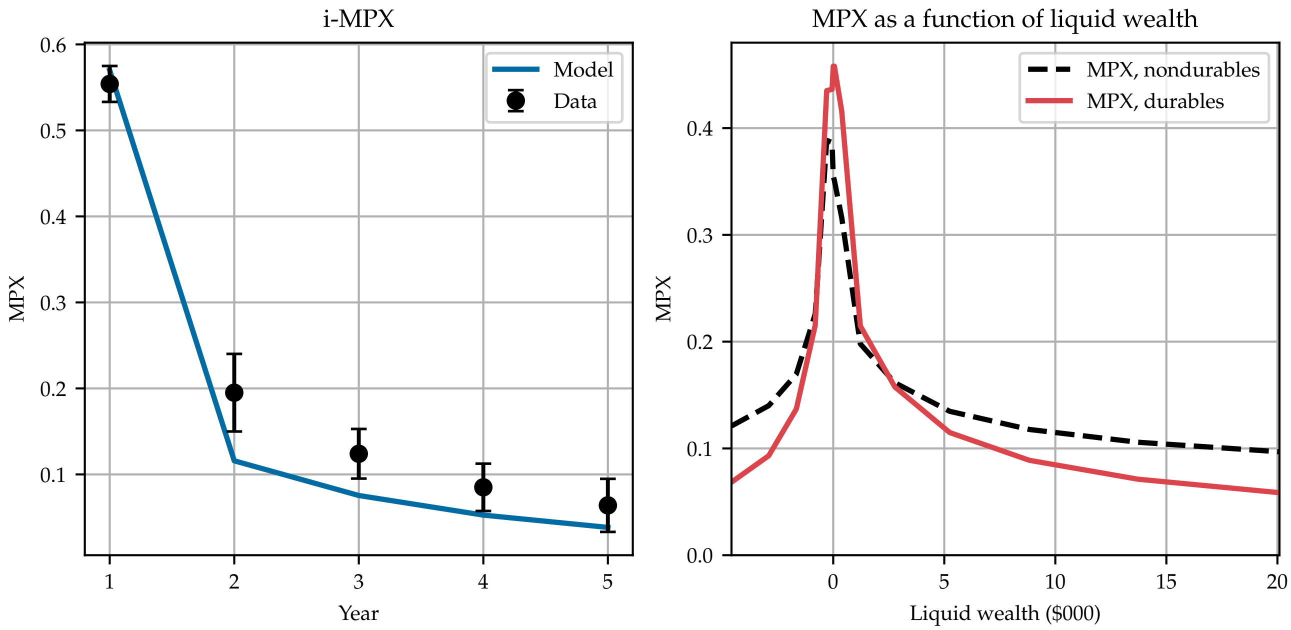
and an adjustment-cost parameter of $\alpha = 5.401$ (somewhat lower than in alternative calibrations; see, e.g., Erceg and Levin, 2006).[12] Finally, we set expectation stickiness at $\Xi = 0.959$, a relatively high value that helps the model generate hump-shaped macroeconomic responses (Auclert et al., 2020).

## 2.2 Empirical performance of the model

Figure 1 compares the model-implied expenditure responses to their empirical counterparts. The framework successfully reproduces persistent comovement between sectoral expenditures, aligning particularly well with the observed hump-shaped response of durable expenditures in the data. Focusing on the i-MPX for total private spending, the left panel of Figure 2 shows how this is broadly consistent with the evidence of Fagereng et al. (2021), which constitutes an explicit target of our calibration strategy. Concurrently, the right panel of Figure 2 reports the steady-state marginal propensities to spend as a function of liquid asset holdings (in thousands of dollars). Both distributions peak at the point where bond holdings are nil due to the borrowing wedge, $\kappa$. Fagereng et al. (2021) report a gradual decline in the marginal

[12] Our analysis of sectoral comovement does not depend on the presence convex adjustment costs. Within our setting, realistic comovement can also be achieved by reducing durables' interest rate elasticity through a lower intertemporal elasticity of substitution (see Appendix B).

Figure 2: i-MPX for total expenditure (left) and MPXs as a function of liquid savings (right).




Notes: The left panel reports the (yearly) i-MPX of total expenditure from a one-off income transfer. The data points and the associated confidence intervals are taken from Fagereng et al. (2021). The right panel reports the steady-state MPX distributions of nondurable and durable expenditure conditional on households' holdings of liquid assets. We set the idiosyncratic income shock, $e(s)$, as well as the stock of durables, $D(s)$, at their respective median steady-state values.

propensities to spend as liquidity increases. Our calibrated model produces a similar pattern over the liquid-wealth domain.[13] On average, we obtain a quarterly marginal propensity to consume (MPC) of 21% for nondurables, which falls comfortably within the range commonly reported in the literature (15–25%; Laibson et al., 2022). The MPX for durables amounts to 26.1%, reflecting higher sensitivity of durable consumption to marginal changes in household income (Beraja and Zorzi, 2024).

Finally, we evaluate some additional moments that are important when calibrating models of durable spending: the sensitivity of durable demand to changes in the real interest rate and the price elasticity. Our model produces a (yearly) interest rate elasticity of durable expenditures of 3.84 and a durable expenditure price elasticity of 26.61. The former falls within the implicit range established by Baker et al. (2019) (1.1) and Mian and Sufi (2012) (4.3–5.0) for interest rate elasticities, as also reported by McKay and Wieland (2021). Regarding price elasticity, our estimate is consistent with the range reported by Orchard et al. (2025) (26-30), based on Mian and Sufi (2012). Last, we obtain a steady-state skewness of the durable stock relative to nondurable consumption of 0.683—a value remarkably consistent with the microeconomic evidence documented by Bertola et al. (2005). This result is particularly noteworthy given that

[13]For context, their cutoff based on the (inflation-adjusted) highest quartile is $21,600 for 2006.

our model does not incorporate adjustments along the extensive margin.

## 2.3 Dissecting monetary transmission

We now turn to the analysis of monetary transmission, decomposing the responses of sectoral expenditure—both at the aggregate and household levels—into direct and indirect effects. Following Kaplan et al. (2018), we proceed by total differentiation of the impulse-response path of $\{C_{j,t}\}_{t\geqslant 0}$, for $j = \{n, d\}$:

$$dC_{j,0} = \underbrace{\sum_{t=0}^{\infty} \frac{\partial C_{j,0}}{\partial r_t} dr_t}_{\text{direct effect}} + \underbrace{\sum_{t=0}^{\infty} \left( \underbrace{\frac{\partial C_{j,0}}{\partial Q_t} dQ_t}_{\text{relative-price effect}} + \underbrace{\frac{\partial C_{j,0}}{\partial Y_t} dY_t}_{\text{pure income effects}} \right)}_{\text{indirect effects}} \tag{5}$$

Each effect can be computed by moving only one variable at a time, holding fixed all other variables. As we have two goods with distinct prices, indirect effects can be further categorized into a *relative-price* effect—which involves income and substitution effects, along with a wealth effect of durable holdings—and terms that exert *pure income* effects.[14]

In Figure 3 we decompose sectoral expenditure responses. In the first few quarters of the monetary tightening, durables are primarily affected by the direct effect, after which pure income effects—and to a lesser extent, the relative price—play a key role in prolonging the slump. For nondurable expenditure, indirect effects are decisive in driving the contraction—and, thus, comovement with durables—complementing the limited impact of the direct effect over the first year. In fact, indirect effects are primarily shaped by changes in disposable income. The contribution of relative price to the overall response of nondurables is, at best, marginal and delayed.

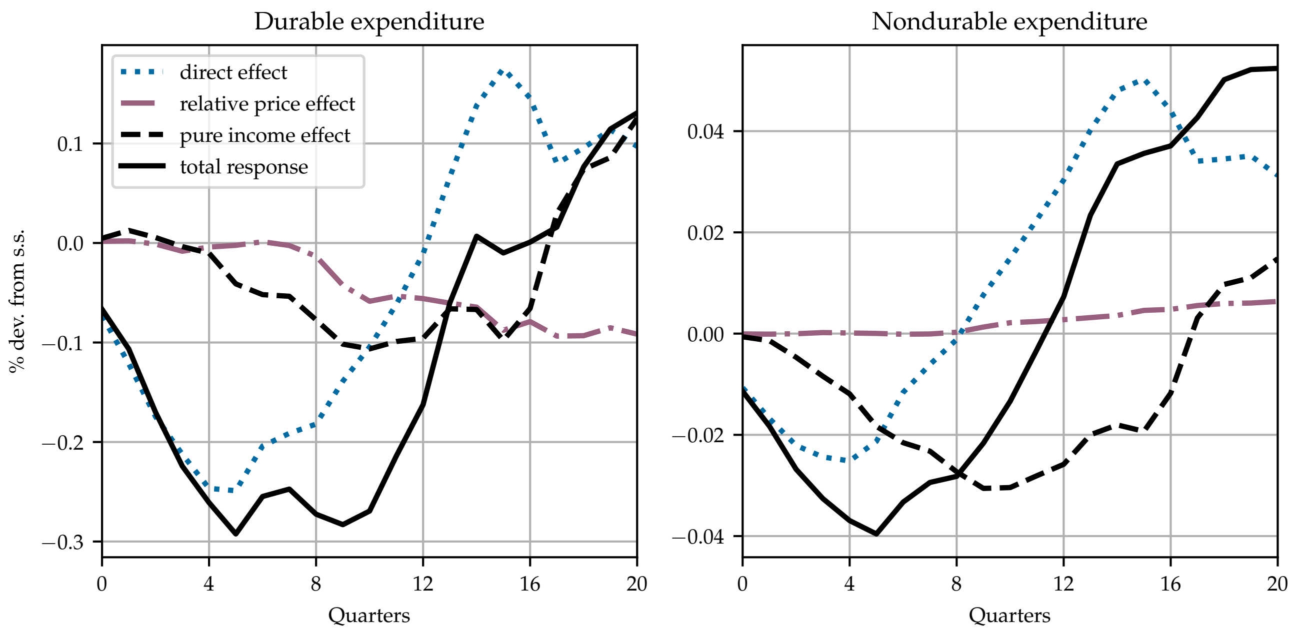
**A decomposition based on household holdings of liquid assets** Figure 4 breaks down the response of durable and nondurable expenditure for both liquidity-constrained households and savers.[15]

Both household groups exhibit strong interest-rate sensitivity, with respect to durable expenditures. For savers, this effect dominates throughout the response. For liquidity-constrained households, the direct impact of the real-rate hike drives the initial contraction, while income effects sustain the downturn after the first year.

[14]Numerically, we compute household paths by varying only the relevant inputs of household Jacobians, while holding the remaining terms fixed.

[15]In line with Mankiw and Zeldes (1991), we define households with $1,000 or less in liquid assets as liquidity constrained.

Figure 3: Expenditure response decomposition



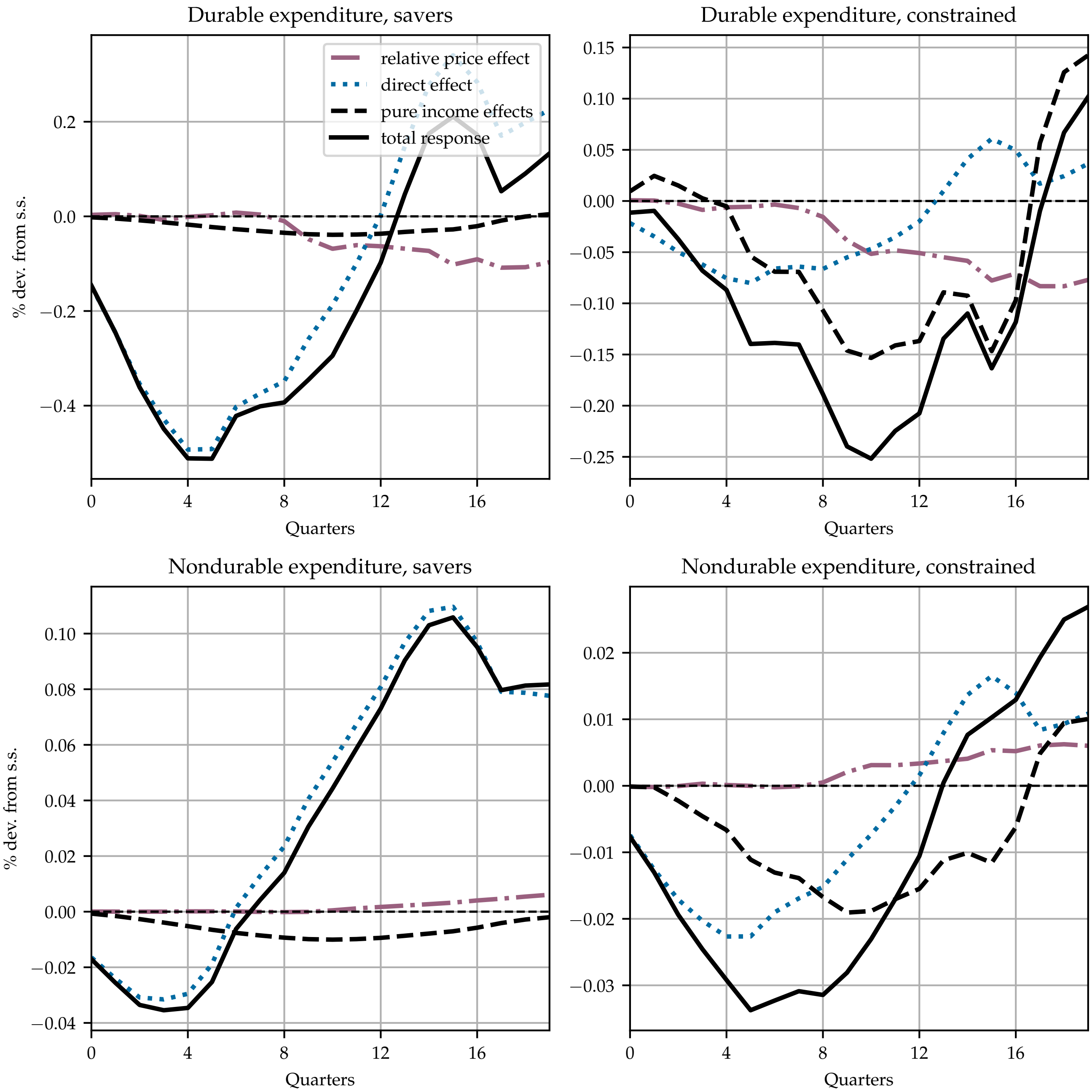

Notes: Decomposition of the response of nondurable and durable expenditure into direct, relative-price and pure income effects.

Turning to nondurable expenditure, the direct effect remains the primary driver of savers' spending decline, while income effects remain relatively muted. As for liquidity-constrained households, the direct effect is responsible for triggering the contraction in nondurable expenditure, though income effects eventually take over, prolonging the downturn. The relative price effect exerts only a weak expansionary force later in the response, with constrained households displaying slightly greater sensitivity to relative-price movements.[16]

Household-level decompositions highlight positive comovement between durable and nondurable expenditures for both household groups. For savers, this comovement is largely driven by the direct effect, while for liquidity-constrained households, the direct effect dominates initially but gives way to income effects over time. This mechanism is key in generating realistic sectoral comovement, even at the household level.

[16] Since these agents lack liquid assets for intertemporal smoothing, their intratemporal allocation between durables and nondurables—closely linked to the relative price and user cost of durable goods—is more pronounced than for savers.

Figure 4: Expenditure response decomposition by steady-state liquid asset holdings




Notes: Decomposition of nondurable and durable expenditure responses into direct, relative-price and pure income effects, for households differing with respect to their steady-state holdings of liquid assets. Liquidity-constrained households are defined as those holding $1,000 or less in liquid assets.

# 3 Household-level empirical evidence

We now produce novel evidence on the empirical responses of durable and nondurable expenditures of households sorted by their holdings of liquid financial assets. To this end, we employ data from the U.S. CEX and the SCF to construct durable and nondurable consumption series for savers and liquidity-constrained households (see Attanasio et al., 2002). Liquid assets include bonds, mutual funds, and liquid accounts such as savings and checking accounts. Further details on household data, as well as the construction of household-specific consumption and income series (all starting in 1982:Q1), are provided in Appendix A.2.[17]

The top row of Figure 5 shows expenditure responses across household groups, obtained from the LP-IV framework described in Section 2.1. As in the model, positive comovement between different types of consumption expenditure is a key feature of the data, even after accounting for households' financial status. However, notable differences emerge. Liquidity-constrained households' nondurable spending is not only conditionally more volatile than that of savers but also more inertial, reaching its trough after 16 quarters. In contrast, savers' responses align more closely with aggregate nondurable spending. Regarding durables, apart from minor initial differences, the two groups exhibit broadly similar responses in both shape and magnitude.

## 3.1 Decomposition of household responses

The IRFs retrieved from the LP-IV framework capture an overall response that reflects both direct and indirect effects of monetary transmission. To isolate the direct component and evaluate its contribution to the total response, we follow Holm et al. (2021) and retrieve counterfactual expenditure responses to a monetary policy shock, holding constant future incomes and relative-price realizations. Specifically, for each of the consumption expenditures of household group $g = \{\text{savers, liquidity-constrained}\}$, we estimate the following extended model:

$$c_{g,t+h} - c_{g,t-1} = \widetilde{\alpha}_g^h + \widetilde{\beta}_g^h \Delta r_t + \mathbf{x}_{g,t}\widetilde{\gamma}_g^h + \mathbf{w}_{g,t+h}\widetilde{\kappa}_g^h + \epsilon_{g,t+h}, \tag{6}$$

where $\mathbf{w}_{g,t+h}$ captures the $h$-step-ahead cumulative changes in disposable income (net of interest income) and in the relative price. Otherwise, the setup remains consistent with the baseline specification in equation (4).

The estimated coefficients $\widetilde{\beta}_g^h$ in equation (6) measure the effect of a monetary policy-induced shift in the real interest rate on household-group $g$'s expenditure at horizon $h$, holding constant the cumulative responses of the relative price and net income at the household-group level.[18] This approach yields an estimate of the direct effect of monetary policy shocks. Any difference between $\widetilde{\beta}_g^h$ in (6) and its counterpart $\beta_g^h$, obtained by removing $\mathbf{w}_{g,t+h}$ (as in equation (4)), reflects the indirect effects of monetary policy transmission. These counterfactual responses

[17] Since the CEX collects detailed respondent characteristics only once, individuals are assigned a fixed probability of belonging to a household group, preventing reclassification over time. Ideally, this probability assignment is sharp, ensuring a high likelihood of clear group allocation. In our sample, the representative respondent has a 90% probability of being assigned to either group, making misclassification highly unlikely.

[18] To better align with the model's decomposition, we exclude the interest rate component from net income, attributing it to the direct effect, as in Kaplan et al. (2018).

appear in the middle and bottom rows of Figure 5.

Regardless of households' financial position, durable spending is predominantly driven by the direct effect, at least during the first eight quarters of the monetary tightening. This explains the substantial homogeneity in household responsiveness for this spending category. Indirect effects, however, play a crucial role—especially for liquidity-constrained households—in prolonging the contraction of durable spending beyond the trough. This is in line with the prediction of the model.

For nondurable expenditures, the direct effect remains the primary driver in the first eight quarters for both household types. This is consistent with Holm et al. (2021)'s evidence on Norwegian data, though financial status is not considered in their analysis. Differences between groups arise from indirect effects, which follow distinct patterns. For the savers, these effects are stronger in the early stages of the monetary tightening, but fade after the trough. For liquidity-constrained households, income effects play a key role in prolonging the downturn. Notably, after accounting for changes in disposable income, both groups exhibit similar responses, suggesting that the direct effect operates uniformly regardless of financial status.[19]

## 3.2 A further discretization of the assetholding status

We test the robustness of our findings by refining the classification of assetholdings, dividing households into four groups (both in the model and the data): those with less than \$1,000 in liquid assets, those holding \$1,000–\$10,000, \$10,000–\$20,000, and those with more than \$20,000.[20] Positive comovement between durable and nondurable expenditures remains a consistent feature across all groups.[21]

Table 2 summarizes our findings, presenting the decomposition of (cumulated) direct and indirect effects across household groups in both the data and the model. The latter comes close to reproduce the empirical decompositions: durable responses are primarily driven by direct effects, while nondurable responses reflect a more balanced role of direct and indirect effects.[22]

[19]Figure B.2 in Appendix B documents major heterogeneity in the income responses of savers and liquidity-constrained households.

[20]These groups account for approximately 30%, 40%, 10%, and 20% of survey respondents, respectively, when considering the last decade of our sample.

[21]Figures B.3 and B.4 in Appendix B present group-level IRF decompositions for durable and nondurable expenditures, respectively.

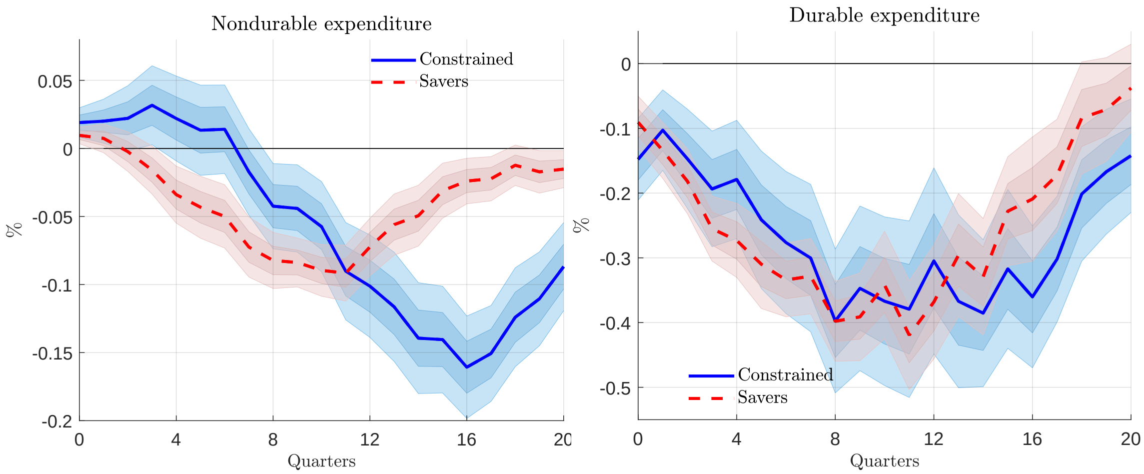
[22]A notable exception is the model's durable response for liquidity-constrained households, which appears weaker than both its empirical counterpart and other groups. This discrepancy arises from the 10-period cumulation in Table 2, which omits much of the group's response. In reality, liquidity-constrained households exhibit greater persistence than savers, as evidenced in the model (Figure 4) and the data (top-right panel of Figure 5).

Table 2: Decomposition of expenditure responses

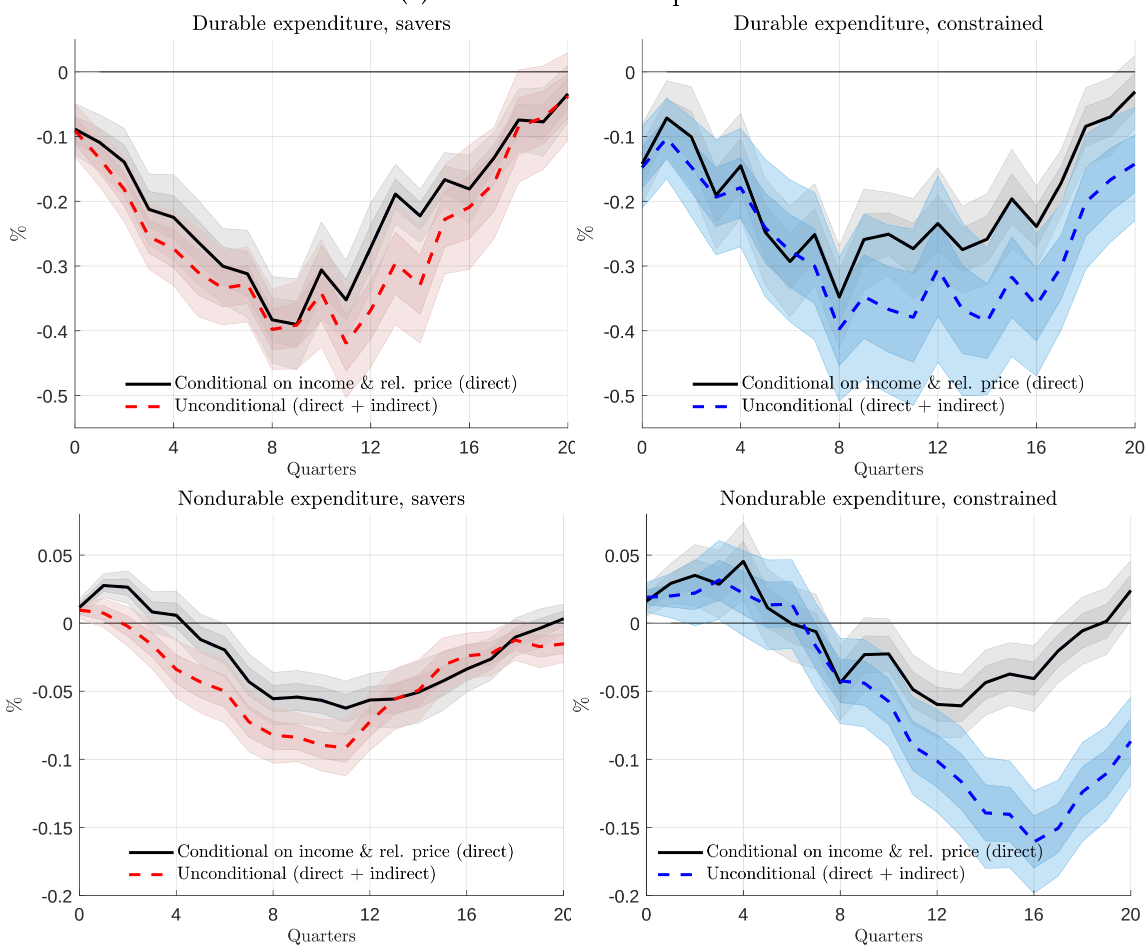
| | (a) Durable expenditure | | | |
|---|---|---|---|---|
| | $B < 1k$ | $1k < B < 10k$ | $10k < B < 20k$ | $B > 20k$ |
| **Data** | | | | |
| Direct effect | -3.19 | -3.24 | -3.68 | -4.66 |
| Total response | -3.74 | -3.79 | -4.22 | -5.26 |
| % contrib. direct | 85.33 | 85.60 | 87.17 | 88.71 |
| **Model** | | | | |
| Direct effect | -0.58 | -2.75 | -2.99 | -3.69 |
| Total response | -1.06 | -3.1 | -3.26 | -3.92 |
| % contrib. direct | 54.72 | 88.71 | 91.72 | 94.13 |
| | **(b) Nondurable expenditure** | | | |
| | $B < 1k$ | $1k < B < 10k$ | $10k < B < 20k$ | $B > 20k$ |
| **Data** | | | | |
| Direct effect | -0.12 | -0.14 | -0.40 | -0.61 |
| Total response | -0.29 | -0.16 | -0.68 | -1.47 |
| % contrib. direct | 41.64 | 91.04 | 58.75 | 41.66 |
| **Model** | | | | |
| Direct effect | -0.16 | -0.16 | -0.17 | -0.05 |
| Total response | -0.25 | -0.23 | -0.24 | -0.11 |
| % contrib. direct | 64.00 | 69.57 | 70.83 | 45.45 |

Notes: Decomposition of (cumulated) durable and nondurable expenditure responses for households differing in their holdings of liquid assets, $B$, in both the data and the model. For comparability, we cumulate over a period that is twice as long as that necessary to attain the trough in total expenditure (see Figure 1). This translates into 10 quarters for the model and 14 quarters for the data.

Figure 5: Household-level responses and decomposition in the data




(a) Household-level responses




(b) Counterfactuals

Notes: The top row of the figure displays the total responses of durable and nondurable expenditures, for savers (dashed line) and liquidity-constrained households (solid line), to a monetary policy shock inducing a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years. The middle and bottom rows display total responses (dashed line) alongside counterfactual responses based solely on the direct effect (solid line), for each household group and spending category. Dark and light shaded areas represent the 68% and 95% confidence intervals, respectively.

# 4 A two-sector HANK model

We now extend the partial equilibrium framework to a general equilibrium setting that captures interactions between households, firms, and the government, providing a basis for studying policy intervention. The complete model is presented in Appendix C. Here, we provide a broad overview of its structure and highlight key modeling features.

**Households** We extend the model of consumption decisions between durable and nondurable goods by assuming that households supply labor to firms in either sector of production, incurring in no frictions to move across sectors. Along with engaging in financial decisions, being subject to idiosyncratic risk and potentially incurring in a liquidity constraint, households are now subject to lump-sum taxation and receive dividends proportional to their productivity.

**Wage setting** Wages are set in a staggered fashion following Erceg et al. (2000). Each household supplies differentiated labor services, which are aggregated into effective labor by perfectly competitive labor packers. A union sets nominal wages in the presence of Rotemberg-type adjustment costs (Rotemberg, 1982), leading to a New Keynesian wage Phillips curve.

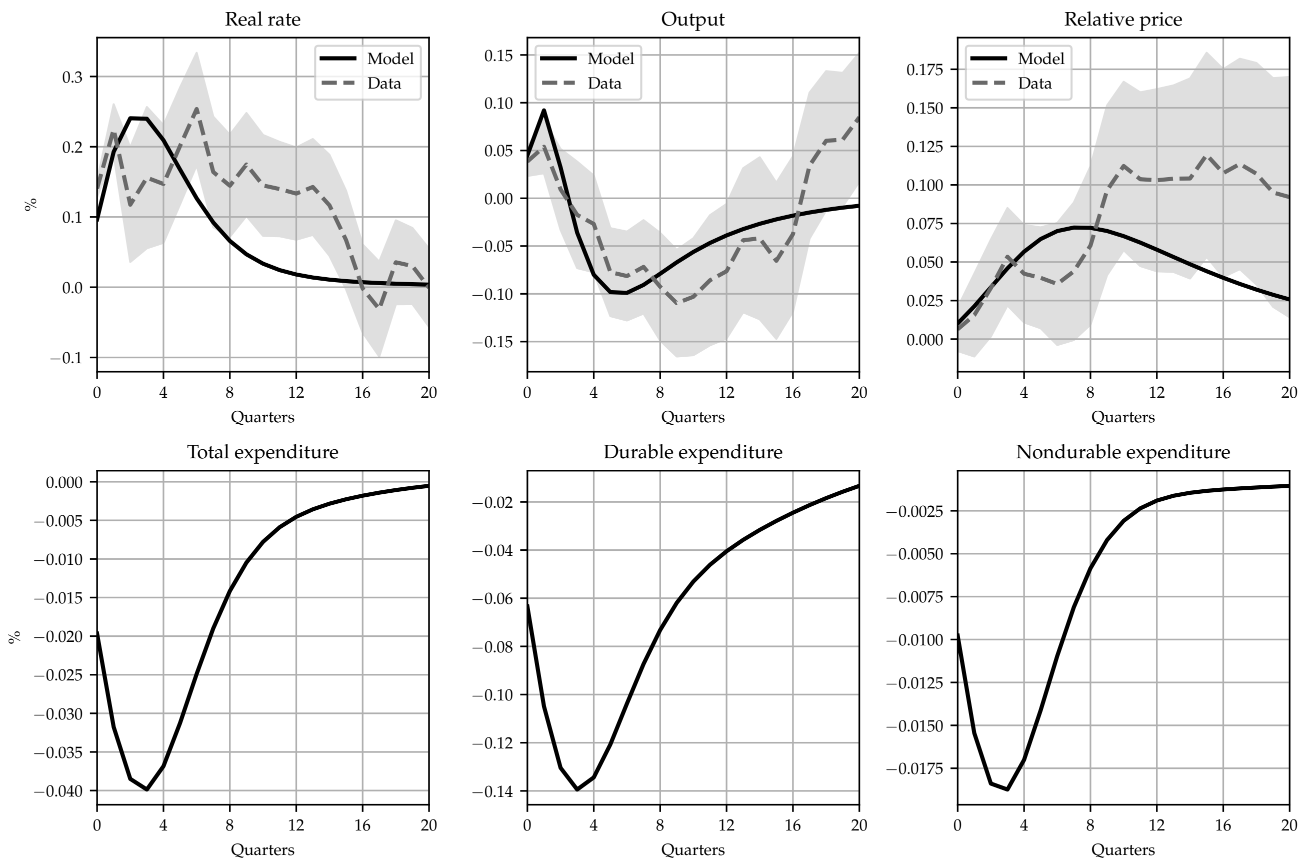
**Production** Each of the two sectors—durables and nondurables—features a two-layer production structure. final-goods producers operate under monopolistic competition and face price-setting frictions à la Rotemberg (1982). Their production technology combines intermediate goods, which are produced by intermediate-goods producers using a linear technology that relies solely on labor as an input.

**Government** The government consists of two branches. Monetary policy is set by the central bank according to a Taylor rule that adjust the nominal rate of interest in response to aggregate inflation and output deviations from steady state, with a certain degree of interest rate inertia, in the vein of Auclert et al. (2020). The non-systematic component of monetary policy follows an AR(1) process. Fiscal policy is pursued by issuing one-period nominal bonds and adjusting lump-sum taxes as in Auclert et al. (2020). Budget balance is ensured through a feedback mechanism linking taxes to government debt.

## 4.1 Calibration and IRF matching

We calibrate the general equilibrium model, keeping all parameters from Section 2.1, while setting a subset of the additional parameters to match the IRFs of the real interest rate, the relative price of durables, and GDP. Specifically, we compute the values of the parameters governing the persistence and variability of monetary policy shocks, the parameters in the

Figure 6: IRF matching to household inputs and expenditure responses in HANK




Notes: The first row reports the IRFs of the real interest rate, GDP, and the relative price of durables in response to a monetary policy shock that results in a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years (dashed line; the shaded area indicates the 95% confidence interval), together with the matched IRFs from the HANK model (solid line). The bottom row reports the IRFs of aggregate and sectoral expenditures from the model.

fiscal and monetary policy rules, the inverse of the Frisch elasticity of labor supply, as well as the parameters governing sectoral price rigidities and wage rigidity. The remaining parameters in the model are set to accommodate steady-state adjustment, or in line with standard values in the literature.

Panel (b) of Table 1 reports the selected parameters. The estimated monetary policy shock exhibits mild persistence, while the fiscal and monetary policy parameters align with standard values in the literature (see, e.g., Taylor, 1993). Similarly, the elasticity of labor supply is close to one—a common assumption in macroeconomic models—in line with the recommendations of Chetty et al. (2011).

Our calibration implies that both durable and nondurable expenditures exhibit significant price stickiness, with durable goods' prices being slightly more rigid. This is essential to generate an increase in the relative price of durables, following a monetary policy shock.[23] Bils and Klenow (2004) show that, after accounting for product substitution, the frequency of price adjustments for durable goods falls between that of nondurables and services. Similarly, Nakamura and Steinsson (2008) highlight heterogeneity in durable goods' price stickiness, noting that transportation goods are relatively flexible, whereas household furniture and recreational goods rank among the stickier categories.[24] Finally, wage rigidity helps dampen overall price fluctuations and stabilizes durables' relative price. Our estimated degree of wage stickiness is consistent with Barattieri et al. (2014), who report that roughly a fifth of nominal wages adjust each quarter.

**Impulse-response analysis and decomposition** Figure 6 compares the model-implied expenditure responses with their empirical counterparts. While the framework successfully ensures sectoral comovement, it falls short of fully capturing the magnitude of consumption responses. This limitation stems primarily from the model's inability to replicate the persistence observed in the input data, particularly in the response of the real rate and, to some extent, GDP. The absence of supply-side amplification mechanisms—such as inflation persistence, production frictions, and physical investment—likely contributes to this discrepancy. Additionally, the model is not conceived to account for systematic income heterogeneity at the household level, which may itself act as an amplifier of aggregate demand shocks (see, e.g., Andreolli et al., 2024).

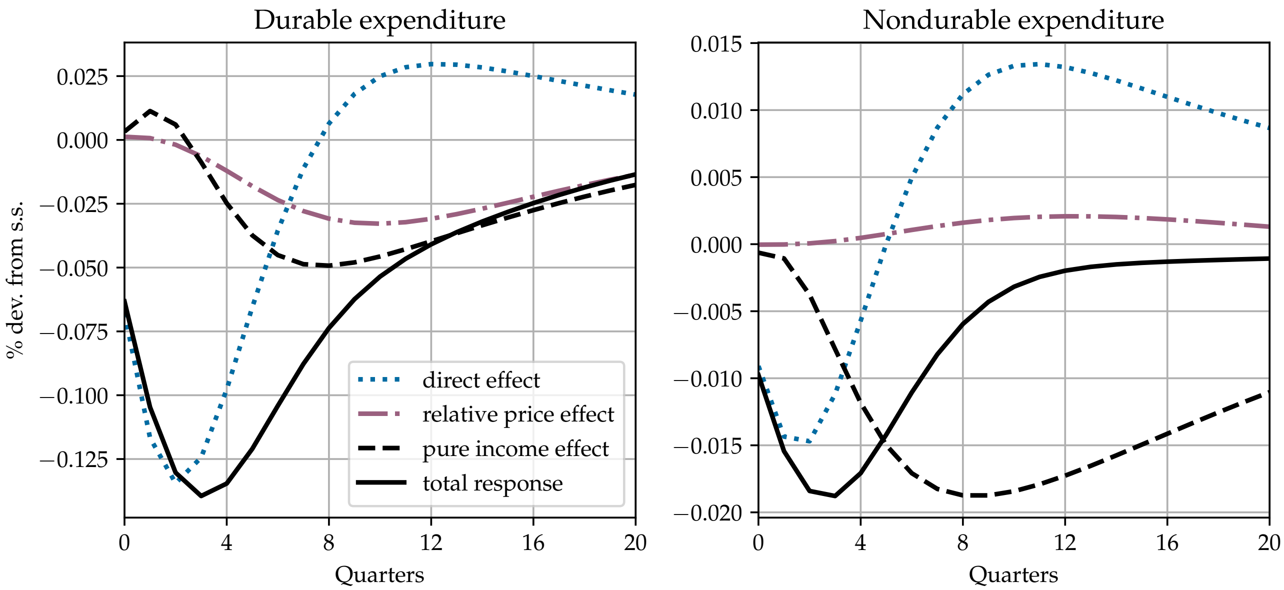
Figure 7 decomposes the key channels of monetary transmission, highlighting the distinct roles of direct and indirect effects in shaping expenditure responses. Consistent with the results in partial equilibrium, the direct effect dominates in the first year following the shock, while income effects become increasingly relevant afterward, driving the persistent comovement between durable and nondurable expenditures. This interaction between different transmission channels is crucial for replicating the sustained sectoral comovement observed in the data. Marked sensitivity of durables to intertemporal substitution implies that the response of aggregate expenditure is not overwhelmingly driven by indirect effects, which typically dominate in HANK economies with only nondurables (e.g., Kaplan et al., 2018).

Figure B.8 in Appendix B further decomposes durable and nondurable expenditure responses for savers and liquidity-constrained households. As in the model's partial equilibrium analysis, household-level comovement remains a defining feature of policy transmission.

[23] Figure B.7 in Appendix B shows that the model reproduces comovement between durable and nondurable expenditures even when durable prices are more flexible than nondurables. In this case, the relative price of durables is procyclical, yet both expenditure categories contract following a monetary tightening. This is consistent with the limited role of relative-price effects in our setting.

[24] More broadly, durable goods tend to display greater price rigidity than several nondurable categories, including food, utilities, and travel expenses. In fact, Klenow and Malin (2010) find no significant relationship between durability and price flexibility.

Figure 7: Expenditure response decomposition in HANK




Notes: Decomposition of nondurable and durable expenditure responses into direct, relative-price and pure income effects in the HANK model.

Indirect effects from income and relative price changes are stronger for liquidity-constrained households, with income effects remaining persistently contractionary. Notably, initial and peak nondurable responses are similar for both savers and liquidity-constrained households, though the latter displays a more protracted contraction in spending. This reflects an inherent property of models where liquidity-constrained households can partially rely on their durable holdings to smooth nondurable consumption. The ability to draw down these holdings—i.e., the fact durables also serve as a store of value—helps mitigate the hand-to-mouth behavior of liquidity-constrained households.[25]

## 4.2 Sectoral comovement: HANK vs. TANK

The comovement puzzle has previously been examined in TANK models with collateral constraints (e.g., Monacelli, 2009). As Sterk (2010) points out, generating positive comovement in these models—where idiosyncratic risk is absent—is challenging due to the interaction between liquidity constraints and bond market equilibrium. Following a monetary contraction, credit-constrained households reduce durable spending, tightening their borrowing capacity. In response, savers dissave to maintain bond market equilibrium, shifting their portfolios toward durables and reinforcing a positive response of aggregate durable production. In contrast, in our HANK framework incorporating idiosyncratic risk and liquidity constraints, pure

[25]The implications of this property are explored in detail in Holst Partsch et al. (2024).

income effects induce a persistent contraction in both durable and nondurable consumption. Crucially, and in line with the data, positive comovement emerges across all households, irrespective of their financial status—a feature that standard TANK models cannot accommodate.

A related perspective comes from Auclert et al. (2020), who show that comovement between aggregate (nondurable) consumption and investment can arise from income effects that disproportionately affect low-liquidity households. Instead, we highlight the necessity of both direct and income effects—albeit with different weights across sectors and household types—to reproduce the observed durable-nondurable comovement at both aggregate and disaggregate levels.

## 4.3 Macroeconomic effects of government subsidies for durable spending

As a final exercise, we examine the macroeconomic effects of a fiscal intervention designed to stimulate durable goods spending, emphasizing the role of different transmission channels.[26] Specifically, we analyze the impact of a one-period, 10% subsidy on durable expenditures, financed through debt.[27] Figure 8 presents results under two scenarios: (a) a monetary policy set in accordance with the estimated Taylor rule and (b) a fixed nominal rate of interest. We assess the policy's effectiveness by evaluating its impact on durable and nondurable spending, as well as aggregate consumption.

The results indicate that the subsidy's macroeconomic effect is limited, particularly when monetary policy responds endogenously. In this case, the interest rate increase offsets the expansionary effect induced by the the income channel, leading to a negligible aggregate impact. When nominal interest rates are held fixed, a modest, transient increase in spending is observed across all categories of spending. The accommodative monetary policy stance allows the direct effect to become expansionary, reinforcing general equilibrium forces associated with changes in disposable income (see Figure B.9 in Appendix B). To contextualize the macroeconomic effect, the peak aggregate response is roughly one-third of that of a modest monetary policy shock.[28] This is consistent with evidence from transitory "cash-for-clunkers" programs, which also demonstrate a limited macroeconomic impact of such policies (see, e.g., Mian and Sufi, 2012).

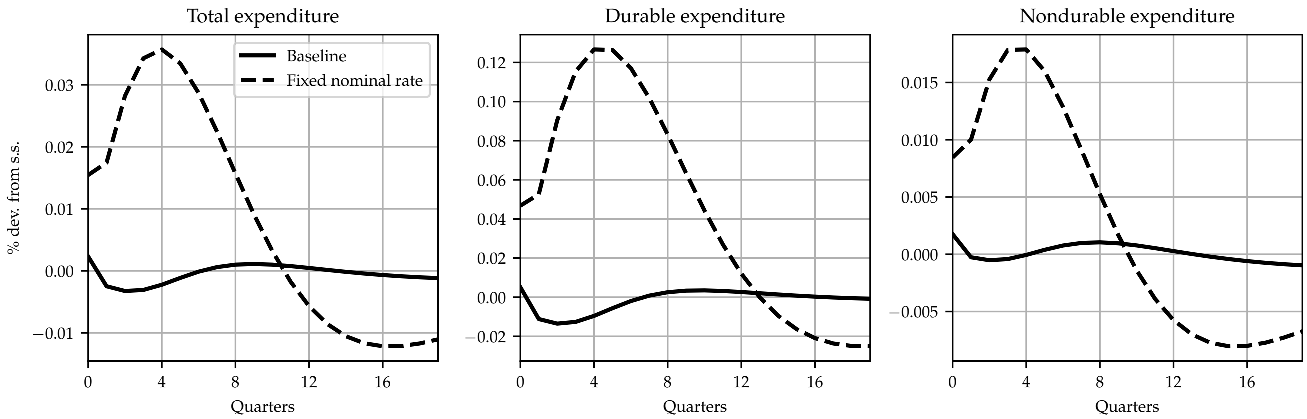
While our framework abstracts from real-world complexities—such as eligibility restrictions and the lumpy nature of durable purchases, both of which could further dampen the

[26]Such subsidies have been part of broader stimulus programs, including the U.S. Energy Star Rebate Program (2009), South Korea's Home Appliance Subsidy Program (2019), and the EU's Renovation Wave Strategy (2020).

[27]The subsidy size and duration are inspired by the U.S. Car Allowance Rebate System (July–August 2009), though our framework omits key features of "cash-for-clunkers" policies, such as their replacement nature (see, e.g., Attanasio et al., 2022).

[28]Comparing the observed responses to those in Figure 1—where the latter correspond to a 15 bp initial interest rate increase and a cumulative 100 bp—the fiscal stimulus has an effect equivalent to a monetary policy shock that raises rates by approximately 5 bp initially and 33 bp in total.

Figure 8: Expenditure responses to a one-off government subsidy to durable purchases




Notes: Expenditure responses to a one-period, 10% subsidy to durable goods purchases, financed through debt. *Dashed line:* active monetary policy as in the baseline model. *Solid line*: counterfactual economy where the nominal rate of interest is kept fixed.

macroeconomic effect—our findings suggest that, even in an idealized setting, durable goods subsidies have limited impact. If anything, their effectiveness depends on monetary policy and is non-negligible only when the latter is constrained, such as at the zero lower bound.

# 5 Concluding remarks

We have introduced durable goods into an otherwise standard New Keynesian model with heterogeneous households subject to idiosyncratic income risk and constrained access to liquid assets. Our findings underscore the crucial role of both direct and indirect effects in shaping the response of durable and nondurable expenditures. While durable spending is primarily driven by intertemporal substitution, income effects sustain persistent comovement across spending categories. In line with the data, both savers and liquidity-constrained households display positive comovement between different spending categories. This suggests that incorporating heterogeneous households is essential for accurately capturing sectoral expenditure dynamics in monetary models.

Our results highlight the important interaction between direct and income effects, and the differential roles they play in shaping the transmission of aggregate shocks across different sectors and households in the economy. In analyzing the effectiveness of government subsidies to durable spending, we highlight the interplay with the monetary policy stance, and how it shapes the macroeconomic impact of such policies.

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# A Data

We outline the construction of the aggregate and survey data employed in the analysis.

## A.1 Aggregate data

Aggregate data are constructed from the the St. Louis Fed FRED database. Below, we provide a list of the variables used along with their corresponding FRED mnemonics:

- Personal Consumption Expenditures: Durable Goods (PCDG)
- Personal Consumption Expenditures: Nondurable Goods (PCEND)
- Personal Consumption Expenditures: Services (PCES)
- Personal Consumption Expenditures: Housing Services (DHSGRC0)
- Durable Goods Price Index (DDURRD3Q086SBEA)
- Nondurable Goods Price Index (DNDGRG3M086SBEA)
- Services Price Index (DSERRG3M086SBEA)
- Housing Services Price Index (DHUTRG3Q086SBEA)
- Disposable Income (DSPI)
- Personal Income Receipts on Assets: Personal Interest Income (PII)
- Interest payments (B069RC1)
- Fed Fund Rate (FEDFUNDS)
- Real GDP (GDPC1)
- Population (B230RC0Q173SBEA)

Monthly nominal data on expenditure and income are aggregated to quarterly levels by summing all monthly values within the quarter. For prices, we instead take the average of the values within the quarter.

Nondurable and services expenditures, along with their corresponding price index, are constructed by aggregating nondurable goods and services, excluding housing services. Total consumption expenditures and their price index are then obtained by combining nondurables, services, and durable expenditure components.

To construct aggregate real expenditure data from disaggregated components, we follow McKay and Wieland (2021). The process involves two components of nominal expenditure, $X_{1t}$ and $X_{2t}$, such that aggregate nominal spending obtains as $Y_t = X_{1t} + X_{2t}$. Thus, we define the share of good 1 in nominal expenditure as $s_{1t} \equiv X_{1t}/Y_t$. Both components of nominal expenditure have an associated price index, $P_{1t}$ and $P_{2t}$, and our goal is to derive the aggregate price index $P_t$ for $Y_t$. To this end, we first compute the growth rate of nominal spending as $y_t = \ln(Y_t) - \ln(Y_{t-1})$. The growth rate of the aggregate price index is then computed as $p_t = s_{1t-1}p_{1t} + (1 - s_{1t-1})p_{2t}$. From this, we derive $P_t$ and the growth rate of real expenditure, $y_t - p_t$, from which aggregate real expenditure is obtained. When subtracting a given component from an expenditure aggregate, we follow the same procedure. For instance, we subtract the housing services component, yielding $Y_t = X_{2t} - X_{1t}$, with the share of housing services in nondurable expenditure now given by $s_{1t} = -X_{1t}/Y_t$. With these adjustments, real expenditure and the price index are computed.

The relative price series for durables is defined as the price of durables divided by the price of nondurables and services. The real interest rate, expressed in terms of nondurables, is the Federal Funds Rate net of realized nondurable inflation over the next four quarters. For the counterfactual decomposition in Section 3.1, we compute disposable income net of interest income and interest payments on assets. This is used to normalize income (net of interest) for each assetholding group of interest (see Appendix A.2).

All variables are converted to per-capita terms dividing by population size.

## A.2 Household data

This section outlines the procedure for constructing expenditure series for household groups classified by their holdings of liquid financial assets.[29] Following Mankiw and Zeldes (1991), we classify liquidity-constrained households as those with total liquid assets (including liquid accounts) below \$1,000.

To estimate consumption expenditure in durables and nondurables for different household groups, we use data from the CEX for the 1980–2017 period, complemented by SCF data available over the 1989–2016 time span.[30] While the CEX records whether a household holds "stocks, bonds, mutual funds, and other such securities" along with checking and savings accounts, it does not capture indirect asset holdings, potentially underestimating households' participation in financial markets. To address this shortcoming, we implement an imputation

[29]For a detailed description of the dataset and the restrictions applied to the original sample, see Gaudio et al. (2023).

[30]The CEX, produced by the Bureau of Labor Statistics (BLS), is an annual U.S. survey providing household-level data on consumption expenditure, income, and financial and demographic characteristics, representing the non-institutionalized civilian population. The SCF, conducted triennially by the Federal Reserve, collects detailed information on income and wealth holdings but does not include consumption expenditure.

procedure along the lines of Attanasio et al. (2002) and Malloy et al. (2009). Using SCF data, we estimate a probit model for the probability of a household holding assets, based on observable characteristics available in both the SCF and CEX. These characteristics include age, education (and their interaction), race (white or non-white), year dummies, log income, and a dummy indicating financial income (dividends plus interest income). The assetholding status is captured by a dummy equal to 1 if total (direct or indirect) holdings of stocks, bonds, and liquid accounts exceed \$1,000. The coefficients from the model estimated on SCF data are then used to derive assetholding probabilities for comparable households in the CEX.[31]

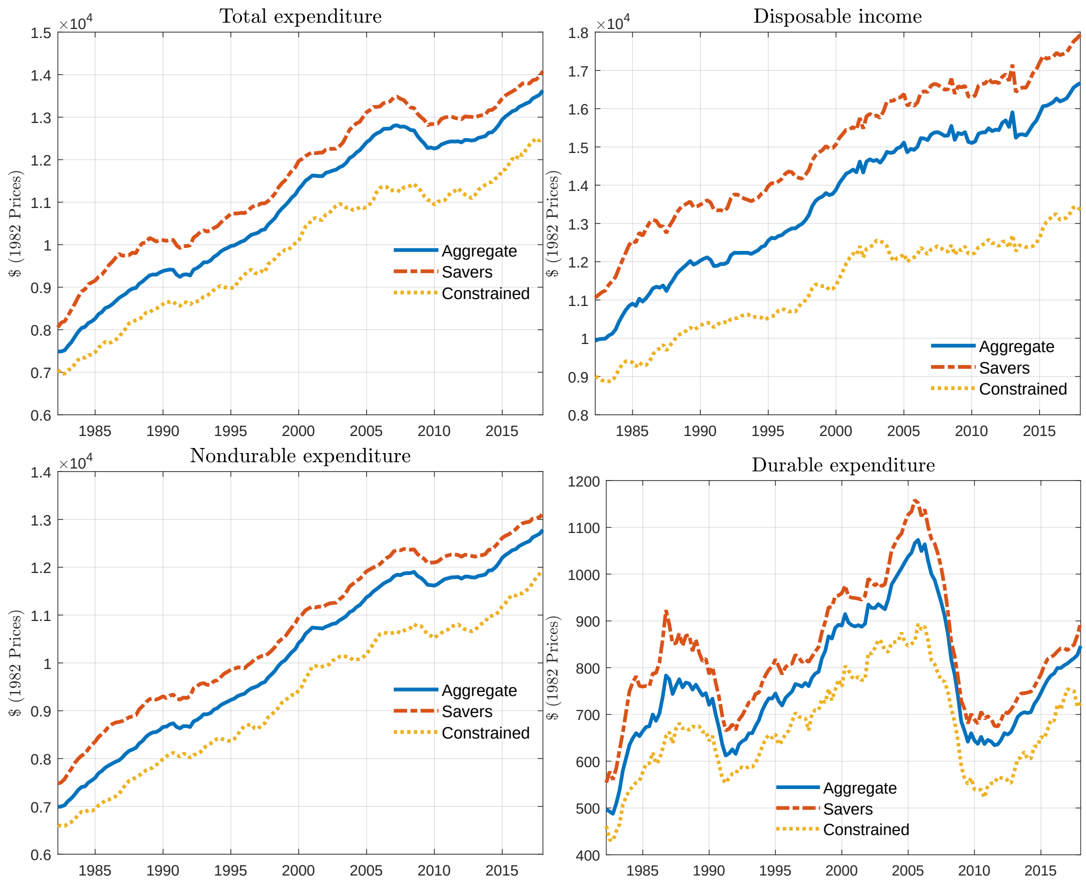
We then construct representative-household expenditure series for nondurable goods and services, as well as durable goods. The nondurables and services category includes food, alcoholic beverages, apparel and services, gasoline and motor oil, household operations, utilities, tobacco, public transportation, fees and admissions, personal care products, reading, other vehicle expenses, and other entertainment-related expenditures. Durable goods expenditures include purchases of vehicles, household furnishings, and TV and audio equipment.

Savers' raw per-capita expenditures (in each good category) are obtained by weighting each household's population-weighted consumption by the estimated probability of holding assets above the \$1,000 threshold, then dividing by the total population of savers and the Consumer Price Index (CPI). Non-savers' expenditure is computed symmetrically, using the complement to one of the imputed assetholding probability. The resulting series are smoothed using a backward-looking moving average over four quarters (including the current and previous three) to address seasonal adjustment issues and the noise inherent in survey data. The group-level series are then scaled to match National Income and Product Accounts (NIPA) aggregates. Specifically, we adjust for total nondurable and services expenditures and durable goods expenditures using the methodology detailed in Appendix A.1. Income series for both household groups are constructed in a similar fashion.

To achieve a finer discretization of the assetholding status, we employing a similar methodology. The main difference consists of using SCF data to estimate a multinomial logit model to determine the probability of belonging to a specific wealth group. The resulting probabilities are then used to classify CEX respondents, thus constructing synthetic expenditure series for four assetholding groups: (a) below \$1,000; (b) between \$1,000 and \$10,000; (c) between \$10,000 and \$20,000; and (d) above \$20,000. Figures A.1 and A.2 report the series resulting from our computation.

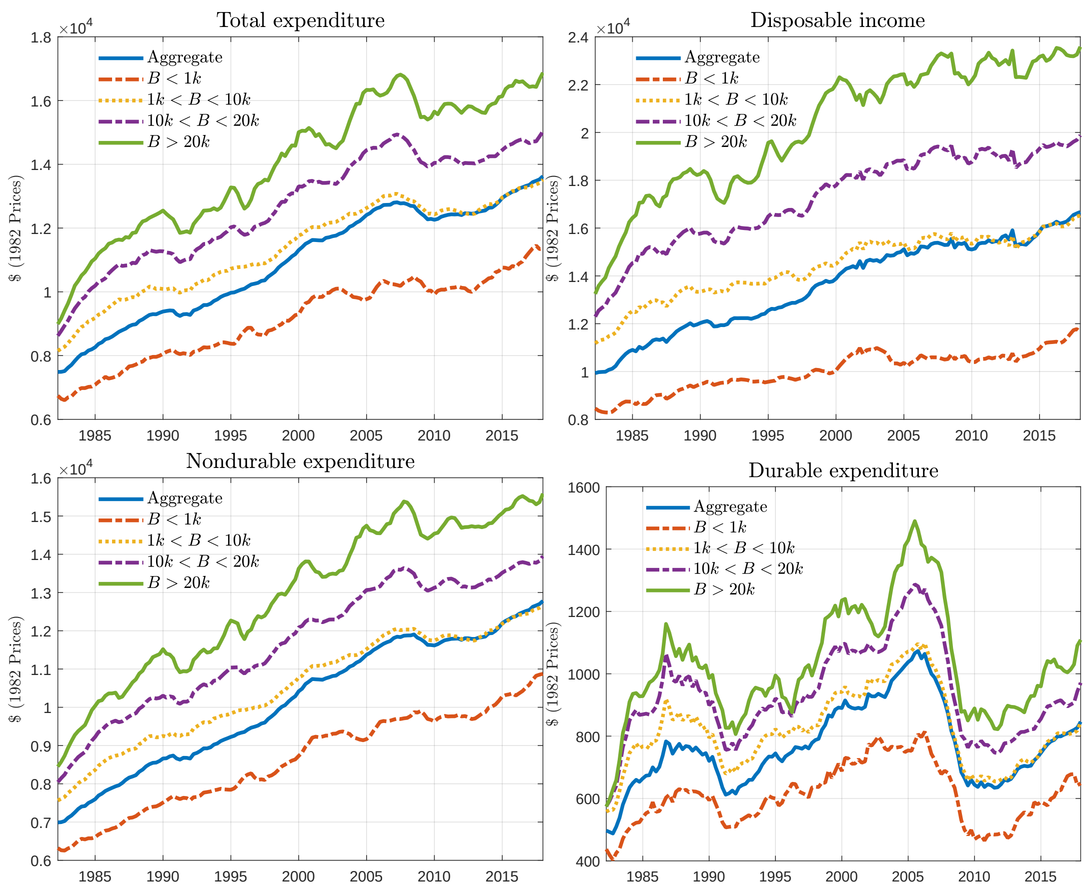
[31] Households missing responses to any variable used in the regression are assigned an assetholding probability of zero.

Figure A.1: Aggregate and household-level income and expenditure series




Notes: Quarterly expenditures and income for the representative household from the NIPA (blue line), alongside the representative saver (red line) and the representative liquidity-constrained household (yellow line), estimated through the probability-weighted assetholding status in the CEX.

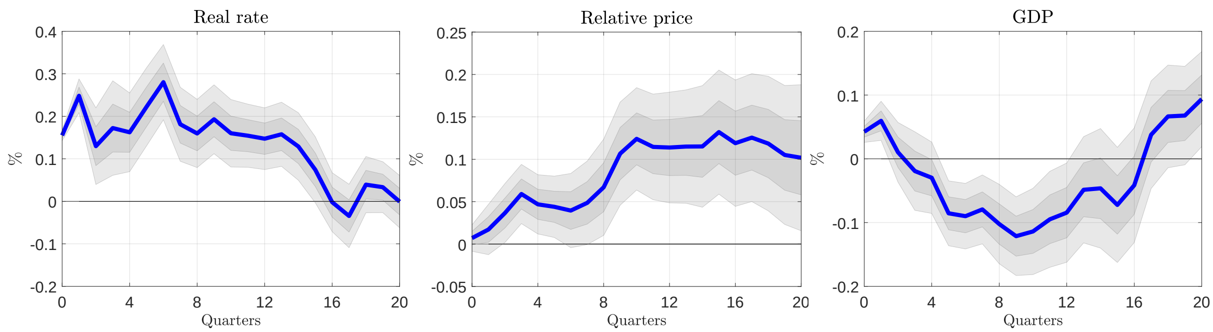
Figure A.2: Aggregate and household-level income and expenditure series: finer discretization




Notes: Quarterly expenditures and income for the representative household from the NIPA (blue line), alongside representative households with different levels of liquid wealth, $B$, as estimated through the probability-weighted assetholding status in the CEX.

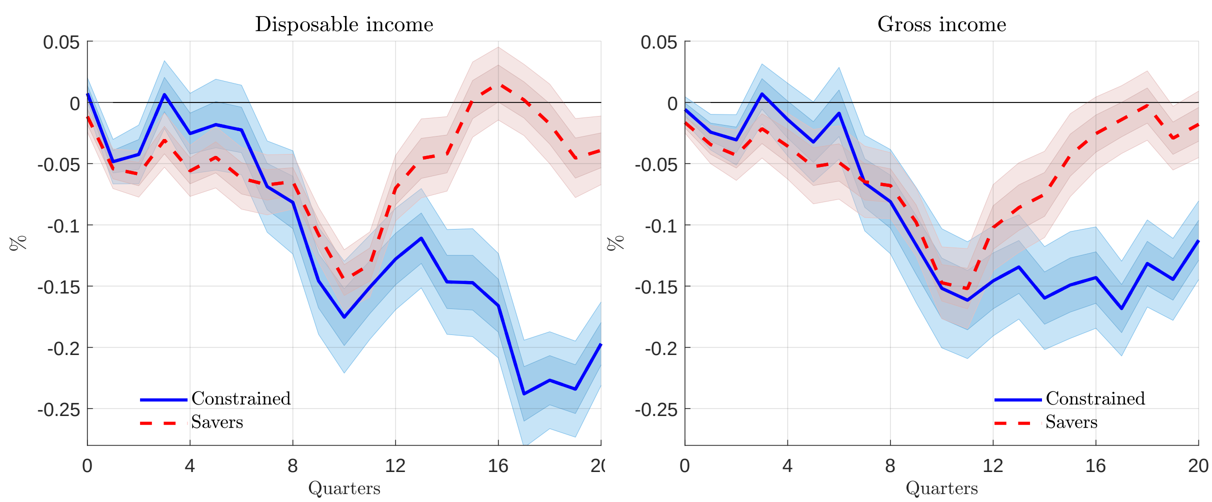
# B Additional figures and tables

Figure B.1: Aggregate responses to a monetary policy shock



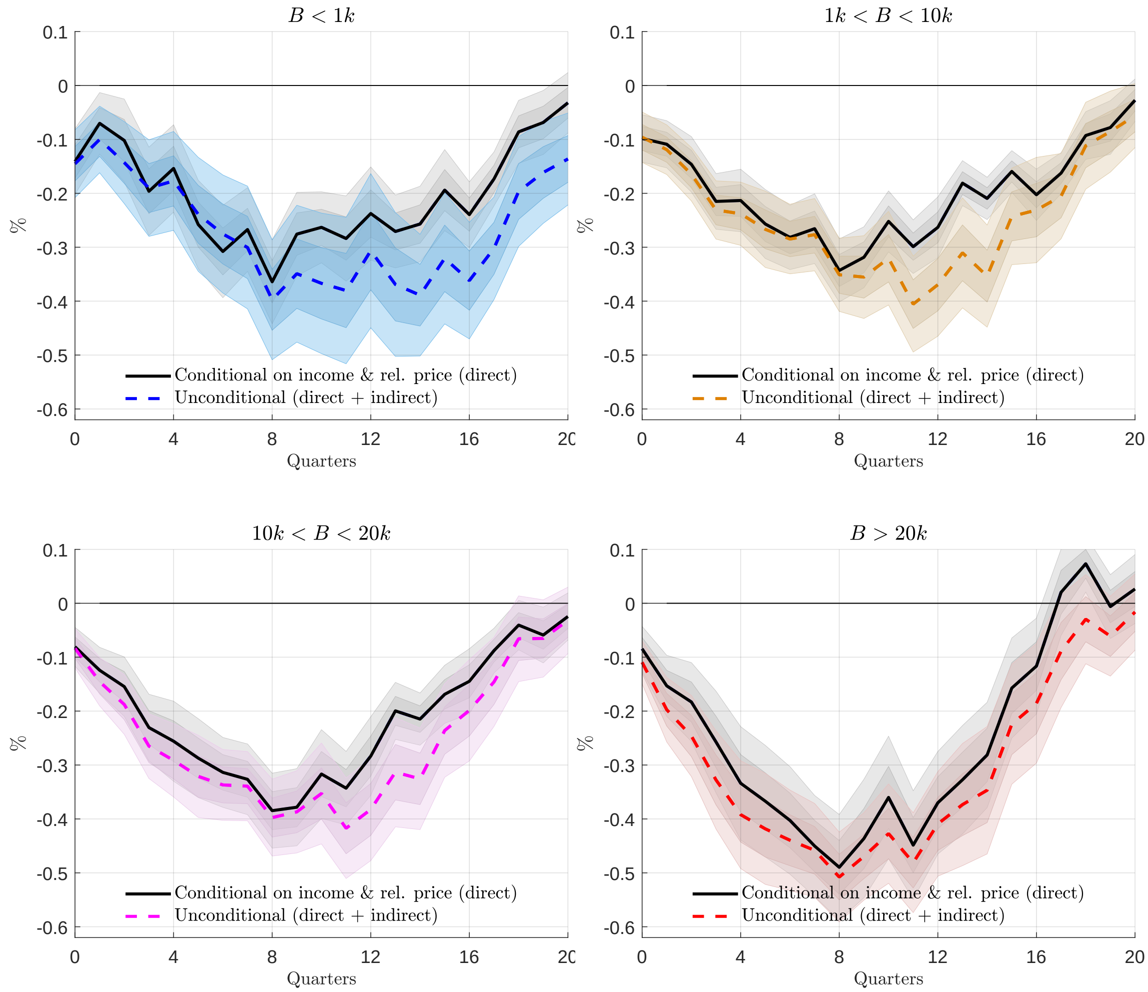

Notes: IRFs of the real interest rate, the relative price of durables and GDP in response to a monetary policy shock inducing a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years. Dark and light shaded areas represent the 68% and 95% confidence intervals, respectively.

Figure B.2: Income responses and decomposition



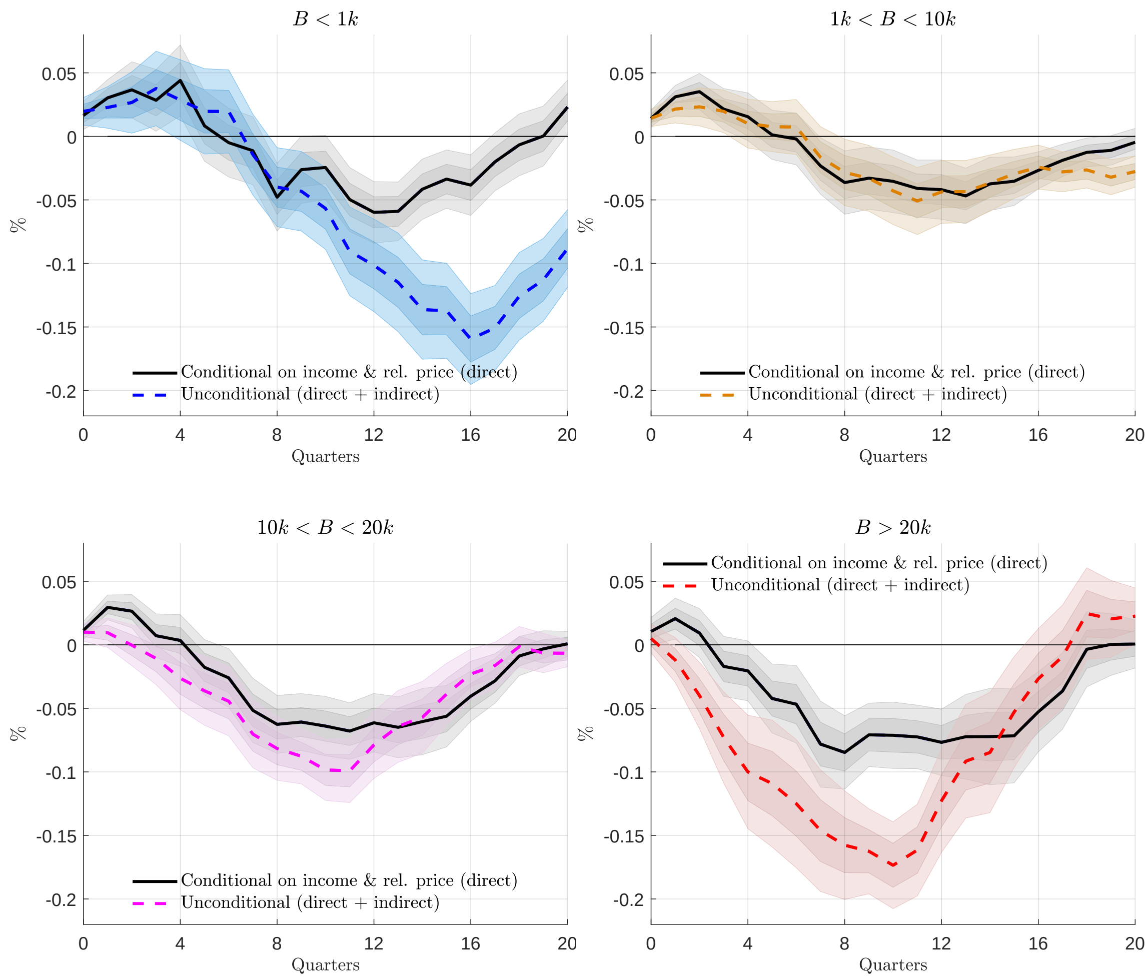

Notes: IRFs of disposable income (left panel) and gross income (right panel), for savers (dashed line) and liquidity-constrained households (solid line), to a monetary policy shock inducing a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years. Dark and light shaded areas represent the 68% and 95% confidence intervals, respectively.

Figure B.3: Assetholding status and decomposition of durable expenditure responses



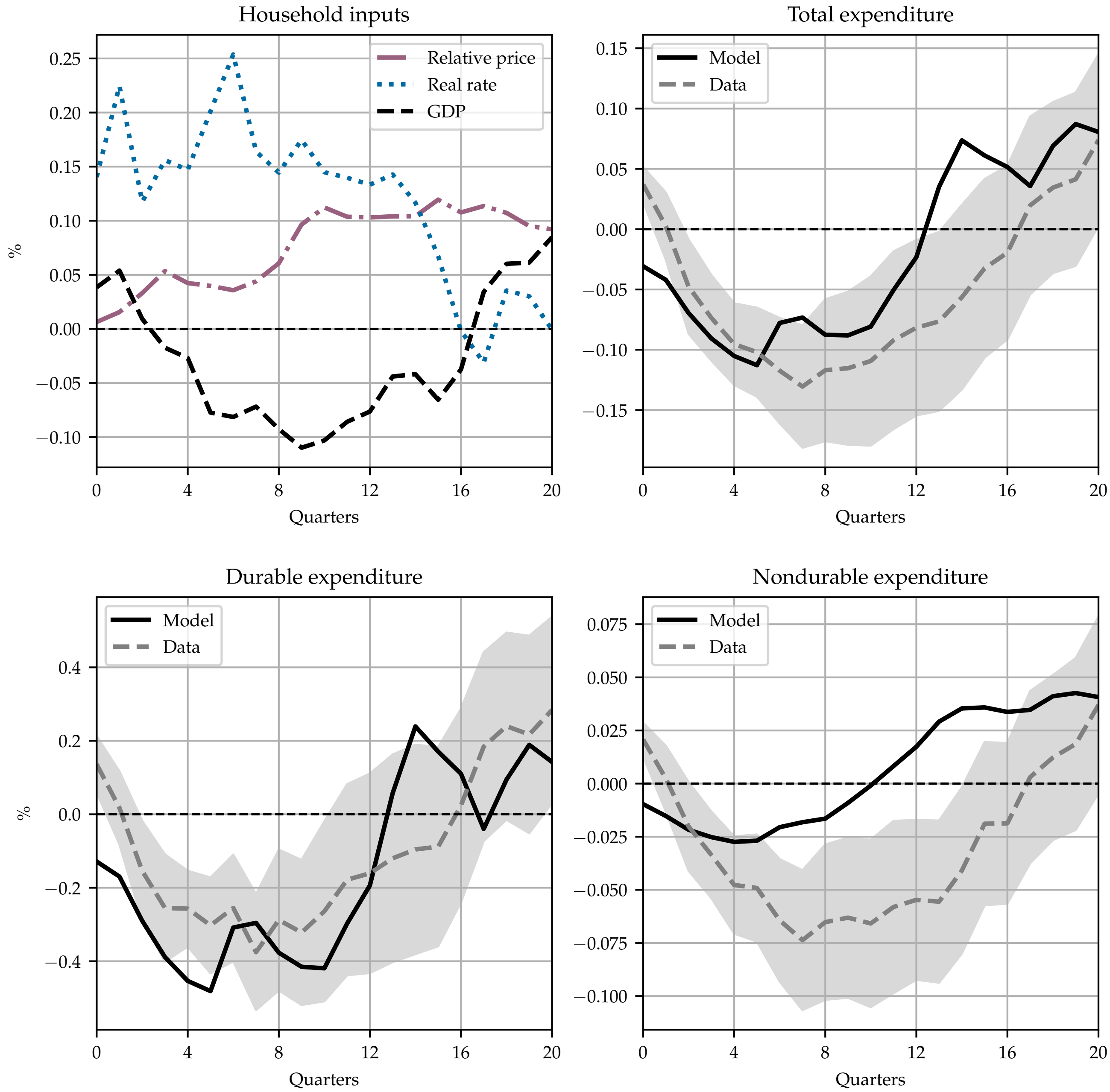

Notes: Total responses of the durable expenditures of different household groups to a monetary policy shock inducing a cumulative 100-basis-point increase in the Federal Funds Rate over five years (dashed line), alongside the responses attributable to the direct effect alone (solid line). Dark and light shaded areas represent the 68% and 95% confidence intervals, respectively. We consider households below $1,000 of liquid assets, between $1,000 and $10,000, between $10,000 and $20,000, and above $20,000.

Figure B.4: Assetholding status and decomposition of nondurable expenditure responses



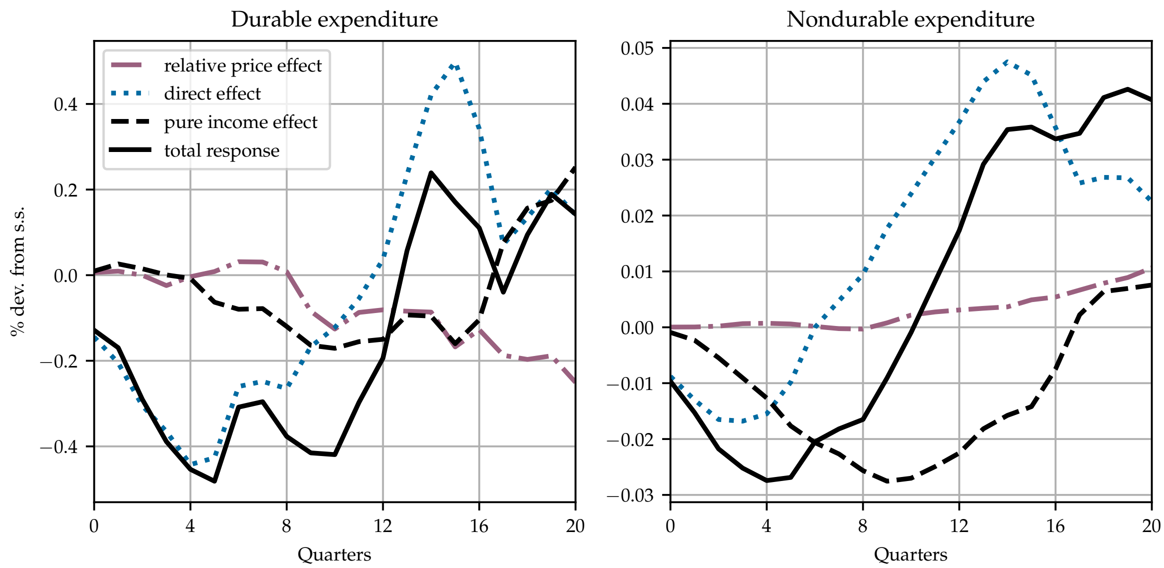

Notes: Total responses of the nondurable expenditures of different household groups to a monetary policy shock inducing a cumulative 100-basis-point increase in the Federal Funds Rate over five years (dashed line), alongside the responses attributable to the direct effect alone (solid line). Dark and light shaded areas represent the 68% and 95% confidence intervals, respectively. We consider households below $1,000 of liquid assets, between $1,000 and $10,000, between $10,000 and $20,000, and above $20,000.

Figure B.5: IRF matching under lower IES



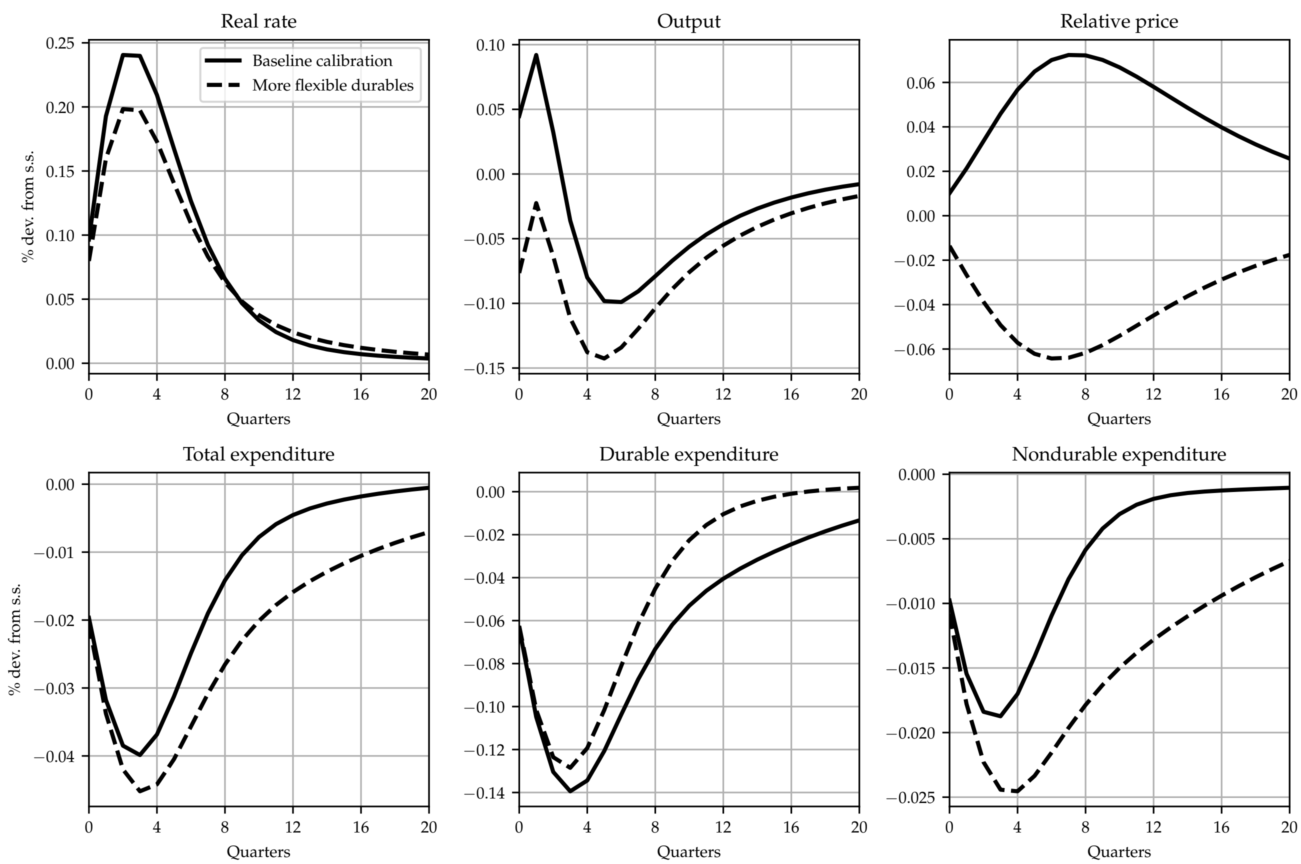

Notes: The top-left panel reports the IRFs of the real interest rate, GDP, and the relative price of durables in response to a monetary policy shock that results in a cumulative 100-basis-point increase in the Federal Funds Rate over 5 years. The remaining panels report the IRFs of aggreage and sectoral expenditures triggered by the same shock (dashed line; the shaded area indicates the 95% confidence interval), against the IRFs of their counterparts from a model where we set $\alpha = 1$ and $\sigma = 3.2$, and re-calibrating the share of liquidity constrained households and total liquid wealth holdings results in $\beta = 0.88, \kappa = 0.08$ (solid line), holding all other parameters at their baseline values.

Figure B.6: IRF decomposition under lower IES



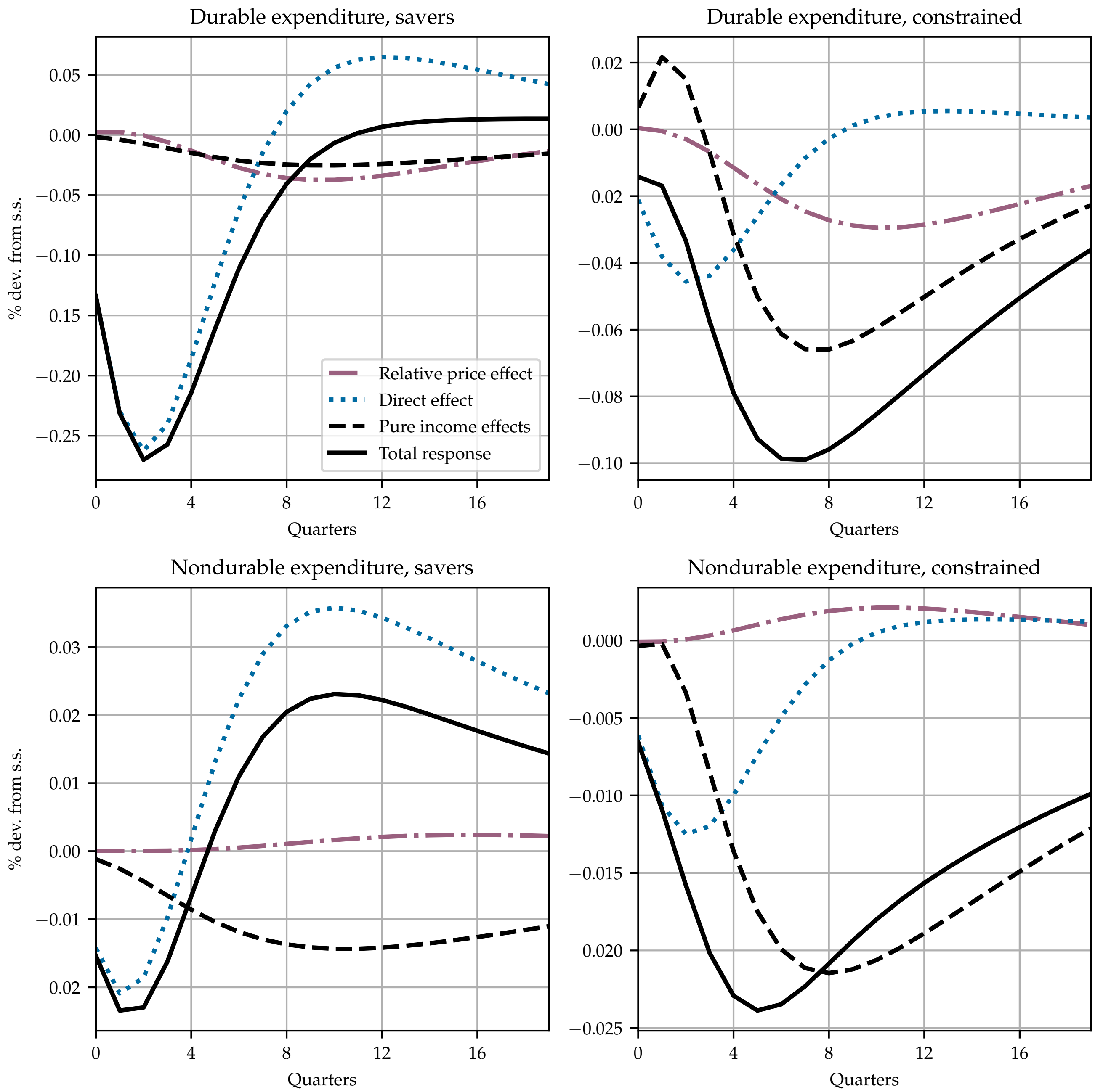

Notes: In this model iteration, we set $\alpha = 1$ and $\sigma = 3.2$—while re-calibrating the share of liquidity constrained households and total liquid wealth holdings results in $\beta = 0.88$, $\kappa = 0.08$ (holding all other parameters at their baseline values)—and decompose the response of expenditures into direct, relative-price and pure income effects.

Figure B.7: Robustness: baseline calibration vs. stickier prices of nondurable goods



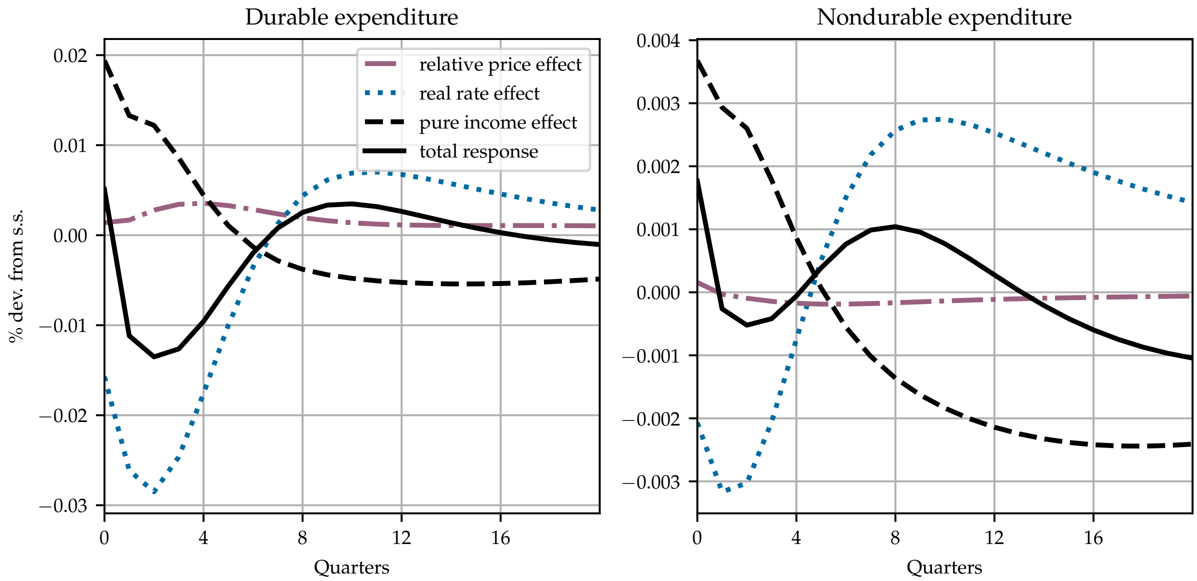

Notes: Comparison between the model's responses to a monetary policy shock under our baseline calibration (solid line)—where nominal frictions are stronger in the durable-goods sector—with an alternative calibration in which durables have more flexible prices than nondurables. All other model parameters remain unchanged.

Figure B.8: Expenditure response decomposition by steady-state liquid asset holdings in HANK

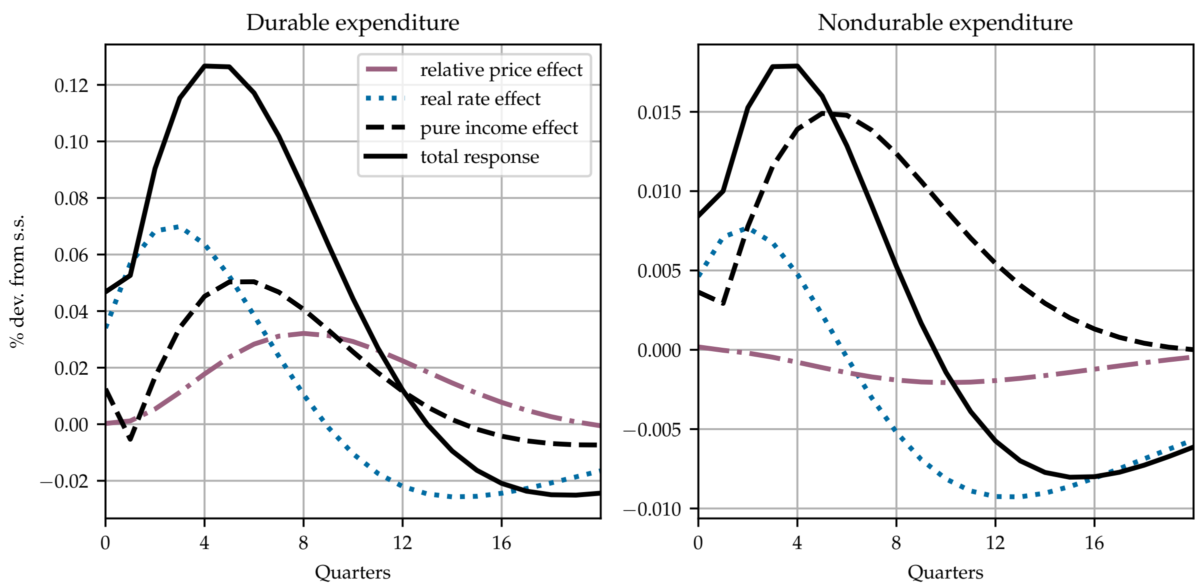



Notes: Decomposition of nondurable and durable expenditure responses into direct, relative-price and pure income effects in general equilibrium, for households differing with respect to their steady-state holdings of liquid assets. Liquidity-constrained households are defined as those holding $1,000 or less in liquid assets.

Figure B.9: Expenditure response decomposition by steady-state liquid asset holdings in HANK (fiscal shock)




(a) Active monetary policy




(b) Fixed nominal interest rate

Notes: Decomposition of nondurable and durable expenditure responses to a one-period, 10% subsidy to durable goods purchases expenditures (financed through debt) into direct, relative-price and pure income effects in the HANK model. Liquidity-constrained households are defined as those holding $1,000 or less in liquid assets.

# C General equilibrium model

We complement the household block in Section 2 by assuming households supply labor hours to intermediate-goods firms operating in a regime of monopolistic competition. Intermediate-goods firms sell their products to firms operating in a perfectly-competitive final-goods sector. The government pursues monetary and fiscal policy. The remainder of this section details the key blocks of the model, as well as how equilibrium obtains.

## C.1 Household problem

We now assume that households experience disutility from labor hours, denoted as $\mathcal{N}_t(s)$:

$$\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[ \frac{\left( C_{n,t}^{\theta}(s) D_t^{1-\theta}(s) \right)^{1-\sigma}}{1-\sigma} - \psi_N \frac{\mathcal{N}_t^{1+\varphi}(s)}{1+\varphi} \right] \right\}. \tag{7}$$

Concurrently, household $s'$s budget constraint (deflated by the price of nondurables) is given by

$$\begin{aligned} C_{n,t}(s) + Q_t C_{d,t}(s) + B_{t+1}(s) = (1 + r(B_t(s))_t)\, B_t(s) + w_{n,t} N_t(s) \exp\{e_t(s)\} \\ + Div_t \overline{Div}(s) - \tau_t \bar{\tau}(s) - \tfrac{\alpha}{2} \left( \tfrac{C_{d,t}(s)}{D_t(s)} \right)^2 D_t(s), \end{aligned} \tag{8}$$

where $w_{n,t}$ is the real wage rate,[32] and $e_t(s)$ is an idiosyncratic productivity shock with unit mean. Furthermore, households pay taxes, $\tau_t$, and receive dividends from the ownership of firms, $Div_t$, according to the incidence rules $\bar{\tau}(s)$ and $\overline{Div}(s)$, which are set so that taxes and dividends are linear functions of individual productivity. Finally, the financial constraint in equation (3) applies.

## C.2 Wage setting

We consider wage setting in the vein of Erceg et al. (2000), Erceg and Levin (2006) and Hagedorn et al. (2019). Specifically, each household provides differentiated labor services, which are transformed into aggregate effective labor, $N_t$, by perfectly competitive labor packers, using the technology

$$N_t = \left( \int_0^1 \exp\{e_t(s)\} \left(\mathcal{N}_t(s)\right)^{\frac{\epsilon_w - 1}{\epsilon_w}} ds \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}. \tag{9}$$

[32] Formally, this is indexed by "$n$", as we deflate the nominal wage by the price level of nondurables. However, it is important to recall that, as we assume perfect labor mobility, nominal wages are equalized across sectors.

A union sells labor services at the nominal wage $W_t$ (equalized across production sectors) to the labor recruiter, who minimizes costs given the aggregate demand for labor, implying

$$\mathcal{N}_t(s) = \mathcal{N}\left(W_t(s); W_t, N_t\right) = \left(\frac{W_t(s)}{W_t}\right)^{-\epsilon_w} N_t \tag{10}$$

for the $s$th household, and where the equilibrium nominal wage amounts to

$$W_t = \left(\int_0^1 \exp\{e_t(s)\} W_t(s)^{1-\epsilon_w} ds\right)^{\frac{1}{1-\epsilon_w}}. \tag{11}$$

The union sets the nominal wage for one effective labor unit, $\hat{W}_t$, such that $\hat{W}_t = W_t$ subject to virtual Rotemberg adjustment costs:

$$\mathcal{C}_w(\cdot) = \exp\left\{e_t(s)\right\} \frac{\xi_w}{2} \left(\frac{W_t(s)}{W_{t-1}(s)} - 1\right)^2 N_t, \tag{12}$$

assuming steady-state wage inflation $\Pi_w = 1$. The union's wage-setting problem maximizes

$$\begin{aligned} V_t^w\left(\hat{W}_{t-1}\right) \quad \equiv \quad & \max_{\hat{W}_t} \left(\int \frac{\exp\left\{e_t(s)\right\}(1-\tau_t)\hat{W}_t}{P_{n,t}} \mathcal{N}\left(\hat{W}_t; W_t, N_t\right) - \frac{v\left(\mathcal{N}\left(\hat{W}_t; W_t, N_t\right)\right)}{U'_{C_n}\left(C_{n,t}, D_t\right)}\right) ds \\ & - \int \exp\left\{e_t(s)\right\} \frac{\xi_w}{2} \left(\frac{\hat{W}_t}{\hat{W}_{t-1}} - 1\right)^2 N_t ds + \beta V_{t+1}^w\left(\hat{W}_t\right). \end{aligned} \tag{13}$$

This problem yields a wage Phillips curve (see Hagedorn et al. (2019)):

$$\left(1-\epsilon_w\right) w_{n,t} + \epsilon_w \frac{U'_{\mathcal{N}}\left(N_t\right)}{U'_{C_n}\left(C_{n,t}, D_t\right)} - \xi_w\left(\Pi_{w,t} - 1\right)\Pi_{w,t} + \beta\xi_w\left(\Pi_{w,t+1} - 1\right)\Pi_{w,t+1}\frac{N_{t+1}}{N_t} = 0, \tag{14}$$

where the aggregation assumptions are as in Hagedorn et al. (2019), so that one obtains the representative agent outcome when heterogeneity is turned off.

## C.3 Production

Each of the two sectors—durables and nondurables—features a two-layer production structure. final-goods producers operate under monopolistic competition and face price-setting frictions à la Rotemberg (1982). Their production technology combines intermediate goods, which are produced by intermediate-goods producers using a linear technology that relies solely on labor as an input.

**Final-goods producers** There are two sectors, indexed by $j = \{n, d\}$. Two representative sectoral final-goods producers aggregate a continuum of intermediate goods indexed by $i \in [0, 1]$, $y_{j,t}(i)$ (with price $p_{j,t}(i)$), in accordance with the CES technology

$$Y_{j,t} = \left( \int_0^1 y_{j,t}(i)^{\frac{\epsilon_j - 1}{\epsilon_j}} di \right)^{\frac{\epsilon_j}{\epsilon_j - 1}}, \tag{15}$$

where $\epsilon_j$ is the elasticity of substitution across goods of type $j$. Given $Y_{j,t}$, profit maximization for the $j$th final-goods producer implies a demand for intermediate good $i$ in the same sector:

$$y_{j,t}(i) = y\left(p_{j,t}(i); P_{j,t}, Y_{j,t}\right) = \left( \frac{p_{j,t}(i)}{P_{j,t}} \right)^{-\epsilon} Y_{j,t}, \tag{16}$$

where $P_{j,t}$ denotes the equilibrium price of the final good:

$$P_{j,t} = \left( \int_0^1 p_{j,t}(i)^{1-\epsilon_j} di \right)^{\frac{1}{1-\epsilon_j}}. \tag{17}$$

**Intermediate-goods producers** Intermediate-goods producers in either sector employ a linear production technology:

$$Y_{j,t}(i) = A_j N_{j,t}(i), \tag{18}$$

where $A_j$ represents total factor productivity (TFP), assumed to be common to all firms in sector $j$. Sectoral TFPs are used to attain a steady-state relative price of durables $Q = 1$.

**Price setting** Final-goods producers' price-setting decisions are subject to virtual Rotemberg adjustment costs $\mathcal{C}_j(\cdot) = \frac{\xi_j}{2}\left(\frac{p_{j,t}(i)}{p_{j,t-1}(i)} - 1\right)^2 Y_{j,t}$ (with $\xi_j > 0$) as in, e.g., Hagedorn et al. (2019). Each firm's value function in real terms reads as

$$\begin{aligned} V_{j,t}\left(p_{j,t-1}(i)\right) \equiv & \max_{p_{j,t}(i)} \frac{p_{j,t}(i)}{P_{j,t}} y\left(p_{j,t}(i); P_{j,t}, Y_{j,t}\right) - w_{j,t} N_{j,t} \\ & - \frac{\xi_j}{2} \left( \frac{p_{j,t}(i)}{p_{j,t-1}(i)} - 1 \right)^2 Y_{j,t} + \beta V_{j,t+1}\left(p_{j,t}(i)\right). \end{aligned} \tag{19}$$

This problem yields the usual New Keynesian Phillips curve(s):

$$(1 - \epsilon_j) + \epsilon_j w_{j,t}/A_j - \xi_j \left(\Pi_{j,t} - 1\right) \Pi_{j,t} + \beta \xi_j \left(\Pi_{j,t+1} - 1\right) \Pi_{j,t+1} \frac{Y_{j,t+1}}{Y_{j,t}} = 0, \tag{20}$$

where $\Pi_{j,t}$ denotes the sectoral gross rate of inflation, while total real dividends (deflated by $P_{n,t}$) are

$$Div_t = \sum_j Div_{j,t} = Y_{n,t} - w_{n,t}N_{n,t} + Q_t\left(Y_{d,t} - w_{d,t}N_{d,t}\right). \tag{21}$$

## C.4 Government

The government comprises two branches: a monetary policy authority and a fiscal policy maker.

**Monetary policy** The monetary authority adjusts the nominal interest rate, $i_t$, in response to aggregate inflation and output deviations from steady state, following a Taylor rule with interest-rate inertia:

$$1 + i_t = (1 + i_{t-1})^{\rho_i}\left(\tilde{\Pi}_t^{\phi_\pi}\left(Y_t/Y\right)^{\phi_y}\left(1 + r_t^*\right)\right)^{1-\rho_i}, \tag{22}$$

where $\rho_i \in [0, 1]$, and $r_t^*$ is an AR(1) non-systematic component of monetary policy. Aggregate inflation is defined as $\tilde{\Pi}_t \equiv \Pi_{n,t}^{1-\gamma}\Pi_{d,t}^{\gamma}$ where $\gamma$ equals the share of durable spending over total expenditure (in steady state, i.e. $\gamma = C_d/(C_n + C_d)$).

**Fiscal policy** The fiscal authority issues one-period nominal bonds, $B_t^g$, and adjusts the level of lump-sum taxes, $\tau_t$, as in Auclert et al. (2020):

$$\begin{aligned}(1 + r_t)\,B_{t-1}^g &= \tau_t + B_t^g,\\ \tau_t &= \tau + \phi_\tau\left(B_{t-1}^g - B^g\right),\end{aligned} \tag{23}$$

where $\tau$ and $B^g$ denote steady-state taxes and government bonds, respectively, while $\phi_\tau$ determines how fast deficits are closed. Note that such formulation does not affect the steady state. Outside the steady state, we determine taxes in each period conditional on the government budget constraint holding; see Appendix F for further details.

## C.5 Equilibrium

**Market clearing** Bonds market clearing obtains as

$$B_t = \int_0^1 B_t(s)ds = B_t^g. \tag{24}$$

Aggregate labor hours are given by

$$N_t = \sum_j \int_0^1 N_{j,t}(i)di = \sum_j Y_{j,t}/A_j, \tag{25}$$

and are assumed to be distributed uniformly among household types, i.e. $N_t(s) = N_t$ for all $s \in (0,1)$. The sectoral resource constraints are

$$Y_{d,t} = C_{d,t}, \tag{26}$$

and

$$Y_{n,t} = C_{n,t} + \chi_t + \kappa \int \max(-B_t(s), 0)ds, \tag{27}$$

where the last two terms of (27) respectively capture the costs of adjusting the stock of durables and that of borrowing, respectively. It follows from equations (26) and (27) that the market for aggregate goods clears in accordance with

$$Y_t = Q_t Y_{d,t} + Y_{n,t} = Q_t C_{d,t} + C_{n,t} + \chi_t + \kappa \int \max(-B_t(s), 0)ds. \tag{28}$$

**Equilibrium definition** An equilibrium in this economy is defined as paths for individual household decisions, $\{C_{n,t}(s), D_t(s), B_t(s)\}_{t\geqslant 0}$, inflation rates and relative prices, $\{\Pi_{n,t}, \Pi_{d,t}, Q_t\}_{t\geqslant 0}$, real wages, $\{w_{n,t}, w_{d,t}\}_{t\geqslant 0}$, sectoral output and employment, $\{Y_{n,t}, Y_{d,t}, N_{n,t}, N_{d,t}\}_{t\geqslant 0}$, dividends, $\{Div_t\}_{t\geqslant 0}$, interest rates, $\{i_t, r_t\}_{t\geqslant 0}$, government bond supply and taxes, $\{B_t^g, \tau_t\}_{t\geqslant 0}$, such that:

1. Households maximize their objective functions, given the $\{Q_t, r_t, w_{n,t}, N_t, Div_t, \tau_t,\}_{t\geqslant 0}$ sequences;
2. Firms in each sector maximize their profits, taking as given the $\{w_{n,t}, w_{d,t}, Q_t\}_{t\geqslant 0}$ sequences;
3. Given the $\{C_{n,t}, D_t\}_{t\geqslant 0}$ sequences, the real-wage sequences, $\{w_{n,t}\}_{t\geqslant 0}$ and $\{w_{d,t}\}_{t\geqslant 0}$, are consistent with the wage Phillips curve, (14), conditional on perfect sectoral mobility, as captured by $Q_t w_{d,t} = w_{n,t}$;
4. The government budget constraint, (23), is satisfied;
5. Bonds, labor, nondurable and durable goods markets clear;
6. Distributions fulfill consistency requirements.

**Computational details** Household policy functions are obtained by using the endogenous grid method algorithm (EGM) of Auclert et al. (2021); see Appendix D for details. To solve for the steady state, we use a multi-dimensional root finder to guess on $\beta, N_d$ and target: *i*) bonds market clearing; *ii*) durable goods market clearing. Given bonds and durable goods market clearing, the nondurable goods market clears by Walras's law; see Appendix E for further details. To obtain impulse responses, we formulate our model in sequence space; see Appendix F.

# D Endogenous grid method

## D.1 Model setup

Households face the following optimization problem:

$$\begin{aligned} V_t\left(z_t, B_t, D_t\right) &= \max_{C_t, D_{t+1}, B_{t+1}} u\left(C_t, D_t\right) + \beta \mathbb{E}_t V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right) \\ \text{s.t. } C_t + B_{t+1} + Q_t\left(D_{t+1} - (1-\delta) D_t\right) &= z_t + \left(1 + r_t\right) B_t - \Psi\left(D_{t+1}, D_t\right) \\ B_t \geqslant \underline{B}, &\quad D_t \geqslant 0, \end{aligned} \tag{29}$$

where $z_t$ denotes idiosyncratic income, $B_t$ is wealth, $D_t$ denotes the stock of durables and $Q_t$ is the price of durables relative to that of nondurables. In the general equilibrium setting, $z_t = \exp\{e_t\}\left[w_{n,t} N_t - \tau_t + Div_t\right]$. The rest, except for utility and the cost function $\Psi(\cdot)$ is standard. Note that we do not take care of sticky expectations explicitly in this algorithm, as it is possible to simply apply an appropriate matrix operation to the household Jacobians as shown in Auclert et al. (2020). The utility and the adjustment cost functions are

$$\begin{aligned} u(C_t, D_t) = \tfrac{\psi(C_t, D_t)^{1-\sigma}}{1-\sigma} \quad &\text{and} \quad \psi(C_t, D_t) = C_t^{\theta} D_t^{1-\theta}, \\ \Psi\left(D_{t+1}, D_t\right) &= \tfrac{\alpha}{2}\left(\tfrac{D_{t+1} - (1-\delta) D_t}{D_t}\right)^2 D_t. \end{aligned} \tag{30}$$

## D.2 First-order and envelope conditions

Re-write the Bellman equation by substituting out consumption using the budget constraint

$$\begin{aligned} V_t\left(z_t, B_t, D_t\right) = \max\nolimits_{B_{t+1}, D_{t+1}} \quad & u\left(z_t + \left(1 + r_t\right) B_t - Q_t\left(D_{t+1} - (1-\delta) D_t\right) - \Psi\left(D_{t+1}, D_t\right) - B_{t+1}, D_t\right) \\ & + \mu_t D_{t+1} + \lambda_t\left(B_{t+1} - \underline{B}\right) + \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right), \end{aligned} \tag{31}$$

where $\mu_t$ and $\lambda_t$ are the multipliers for the non-negativity constraint on durables and the unsecured credit-borrowing constraint, respectively.

The first-order conditions with respect to $D_{t+1}$ and $B_{t+1}$ yield

$$\begin{aligned} \partial_{C_t} u(C_t, D_t) \left(Q_t + \partial_{D_{t+1}} \Psi\left(D_{t+1}, D_t\right)\right) &= \mu_t + \partial_{D_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right), \\ \partial_{C_t} u(C_t, D_t) &= \lambda_t + \partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right). \end{aligned} \tag{32}$$

The envelope conditions are

$$\begin{aligned} &\partial_{B_t} V_t\left(z_t, B_t, D_t\right) = (1 + r_t)\, \partial_{C_t} u(C_t, D_t), \\ &\partial_{D_t} V_t\left(z_t, B_t, D_t\right) = \partial_{D_t} u(C_t, D_t) + \partial_{C_t} u(C_t, D_t)\left[Q(1-\delta) - \partial_{D_t} \Psi\left(D_{t+1}, D_t\right)\right]. \end{aligned} \tag{33}$$

For later use, it is convenient to define the post-decision value function as

$$W_t\left(z_t, B_{t+1}, D_{t+1}\right) \equiv \beta \mathbb{E}_t V_{t+1}\left(z_t, B_{t+1}, D_{t+1}\right). \tag{34}$$

## D.3 Main equations of the algorithm

First, we combine the two equations in (32) to obtain

$$\frac{\mu_t + \partial_{D_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)}{\lambda_t + \partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)} = Q_t + \alpha\left(\frac{D_{t+1}}{D_t} - (1-\delta)\right). \tag{35}$$

From the F.O.C. wrt. $B_{t+1}$ in equation (32) we can pin down nondurable consumption:

$$\begin{aligned} &\tfrac{\partial u(C_t, D_t)}{\partial C_t} = \lambda_t + \partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right) \\ \Rightarrow C_t = &\left[\tfrac{1}{\theta}\left(\lambda_t + \partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)\right) D_t^{(\theta-1)(1-\sigma)}\right]^{\frac{1}{\theta(1-\sigma)-1}}. \end{aligned} \tag{36}$$

## D.4 Algorithm

The algorithm is based on the two-asset algorithm described in Auclert et al. (2021). For a generic variable $x_t$, denote today's grid by $x$ and tomorrow's grid by $x^{'}$. Thus, according to the EGM algorithm:

1. When seeking for steady-state policies, initialize the guess on $\partial_B V\left(z, B, D\right), \partial_D V\left(z, B, D\right)$. Otherwise, start backward induction by starting from steady-state $\partial_B V\left(z, B, D\right), \partial_D V\left(z, B, D\right)$ (used when calculating household Jacobians).

2. Let the productivity-shock transmission matrix be notated by $\Pi$. The value functions have a common $z' \rightarrow z$ so the post-decision functions are:

$$\begin{aligned} W_B\left(z, B', D'\right) &= \beta \Pi V_B\left(z', B', D'\right), \\ W_D\left(z, B', D'\right) &= \beta \Pi V_D\left(z', B', D'\right). \end{aligned} \tag{37}$$

3. Find $D'(z,B',D)$ for the *unconstrained* case using equation (35):

$$\frac{W_D\left(z,B',D'\right)}{W_B\left(z,B',D'\right)} = Q + \alpha\left(\frac{D'}{D} - (1-\delta)\right). \tag{38}$$

4. Use $D'(z,B',D)$ to map $W_B\left(z,B',D'\right)$ into $W_B\left(z,B',D\right)$ by interpolation. Then compute consumption by using equation (36):

$$C(z,B',D) = \left(W_B\left(z,B',D\right)D^{\theta-1}\cdot D^{(1-\theta)\sigma}\right)^{\frac{1}{\theta(1-\sigma)-1}}. \tag{39}$$

5. Now it is possible to find total assets by inserting $D'(z,B',D)$ and $C(z,B',D)$ into the budget constraint:

$$B\left(z,B',D\right) = \frac{C\left(z,B',D\right) + Q\left(D'\left(z,B',D\right) - (1-\delta)D\right) + B' + \Psi\left(D'(z,B',D),D\right) - z}{1+r}. \tag{40}$$

6. Invert $B\left(z,B',D\right)$ to obtain $B'\left(z,B,D\right)$ by interpolation. Use the same interpolation weights to obtain $D'(z,B,D)$.

7. Find $D'(z,\underline{B},D)$ for the *constrained* case using equation (35). For scaling, define $\kappa \equiv \lambda/W_B\left(z,\underline{B},D'\right)$. Then equation (35) becomes

$$\frac{1}{1+\kappa}\frac{W_D\left(z,\underline{B},D'\right)}{W_B\left(z,\underline{B},D'\right)} = Q + \alpha\left(\frac{D'}{D} - (1-\delta)\right). \tag{41}$$

8. Use equation (41) to solve for $D'(z,\kappa,D)$, that is over a grid of $\kappa$ values. Then compute consumption as

$$C(z,\kappa,D) = \left((1+\kappa)W_B\left(z,\kappa,D\right)D^{\theta-1}\cdot D^{(1-\theta)\sigma}\right)^{\frac{1}{\theta(1-\sigma)-1}}. \tag{42}$$

9. Using $D'(e,\kappa,D)$, $C(e,\kappa,D)$ and the budget constraint obtain

$$B(z,\kappa,D) = \frac{C(z,\kappa,D) + Q\left(D'(z,\kappa,D) - (1-\delta)D\right) + \underline{B} + \Psi\left(D'(z,\kappa,D),D\right) - z}{1+r}. \tag{43}$$

10. Invert $B(z,\kappa,D)$ by interpolation to obtain $\kappa(z,B,D)$. The same interpolation weights can be used to map $D'(z,\kappa,D)$ into $D'(z,B,D)$. By definition, $B'(z,B,D) = \underline{B}$.

11. Combine the constrained and the unconstrained solutions of $B'(z,B,D)$ and $D'(z,B,D)$.

Then compute consumption from the budget constraint:

$$C(z,B,D) = z + (1+r)\,B - Q\left(D'(z,B,D) - (1-\delta)\,D\right) - \Psi\left(D',D\right) - B'(z,B,D). \tag{44}$$

12. Update $\partial_B V(z,B,D)$ and $\partial_D V(z,B,D)$ using the envelope conditions from equation (33):

$$\begin{aligned} \partial_B V(z,B,D) &= (1+r)\,\partial_C u(C,D), \\ \partial_D V(z,B,D) &= \partial_D u(C,D) - \partial_C u(C,D)\left[Q(1-\delta) + \partial_D \Psi\left(D',D\right)\right]. \end{aligned} \tag{45}$$

13. For the steady-state solutions: Return to step 2 and follow the same steps until the change in $\partial_B V(z,B,D)$ and $\partial_D V(z,B,D)$ between iterations is $\approx 0$. Otherwise, solve paths by backward iteration (used to obtain household Jacobians given some shock to a given household input variable).

Finally, to obtain aggregates we need to simulate the distribution of households. We use the histogram method as developed in Young (2010). In the steady state, we simulate forward until the change in the distribution between consecutive iterations is $\approx 0$ (see Appendix E). Outside the steady state, one can simply simulate forward given a path length (used to obtain Jacobians).

# E Stationary steady state

Given guesses for $\beta, N_d$, we can solve for equilibrium quantities as follows:

1. We set $P_n = 1$ as the numeraire, so that $\Pi_n = 1$;
2. We get that $\Pi_d = 1$, as $\Pi_d = \Pi_n$ in the steady state;
3. We normalize $Q = 1$;
4. Given a calibration target for $N_d$ (which is set to 1/6), we pin down $A_d = Y_d/N_d$;[33]
5. We obtain $w_d = A_d \cdot \frac{\epsilon_d - 1}{\epsilon_d}$ from the durable-goods sector Phillips curve;
6. The latter then yields real wage in the nondurable-goods sector as $w_n = Q \cdot w_d$, as the nominal wage is equalized across sectors;
7. From the nondurable-goods sector Phillips curve we can pin down $A_n = w_n \cdot \frac{\epsilon_n}{\epsilon_n - 1}$;
8. We set $Y_n = 1 - Q \cdot Y_d$, such that total output, $Y = 1$;

[33] $N_d = 0.5$ is a reasonable choice—given that $A_d N_d = Y_d = C_d$—as $C_d$ makes up a empirically plausible share of total consumption; cf. the calibration target for $C_n/(C_n + C_d)$.

9. We then obtain employment in the nondurable-goods sector as $N_n = Y_n/A_n$;

10. We get dividends from equation (21), $Div(Y_n, Y_d, Q, w_n, w_d)$;

11. Taxes are pinned down by $\tau = r \cdot B^g$.

As we pin down all variables from aggregate relationships, it is possible to solve the household problem to obtain $C_n, C_d, B$, and check root-finding target residuals. After root-finding, we set $\psi_N$ given $w_n, C_n, C_d$ and parameters, such that the wage Phillips curve, equation (14), holds in the steady state.

# F Sequence space formulation for the impulse responses

In sequence space, the model can be summarized by the equation system

$$H\left(N_{n,t}, N_{d,t}, \Pi_{n,t}, Q_t, w_{n,t}, u_t^r\right) = \begin{pmatrix} \text{Wage Phillips curve} \\ \text{Phillips curve durables} \\ \text{Phillips curve nondurables} \\ \text{Bonds market clearing} \\ \text{Durable goods market clearing} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \tag{46}$$

Using caligraphic variables $\mathcal{B}$,$\mathcal{C}_n$,$\mathcal{C}_d$,$\mathcal{D}$ to denote the aggregated household solution variables counterparts, the system reads as

$$H\left(N_{n,t}, N_{d,t}, \Pi_{n,t}, Q_t, w_{n,t}, u_t^r\right) =$$
$$\begin{pmatrix} (1-\epsilon_w)\, w_{n,t} + \epsilon_w \frac{U'_N(N_t)}{U'_{C_n}(\mathcal{C}_{n,t}, \mathcal{D}_t)} - \xi_w \left(\Pi_{w,t} - 1\right) \Pi_{w,t} + \beta \xi_w \left(\Pi_{w,t+1} - 1\right) \Pi_{w,t+1} \frac{N_{t+1}}{N_t} \\ (1-\epsilon_d) + \epsilon_d w_{d,t}/A_n - \xi_d \left(\Pi_{d,t} - 1\right) \Pi_{d,t} + \beta \xi_d \left(\Pi_{d,t+1} - 1\right) \Pi_{d,t+1} \frac{Y_{d,t+1}}{Y_{d,t}} \\ (1-\epsilon_n) + \epsilon_n w_{n,t}/A_d - \xi_n \left(\Pi_{n,t} - 1\right) \Pi_{n,t} + \beta \xi_n \left(\Pi_{n,t+1} - 1\right) \Pi_{n,t+1} \frac{Y_{n,t+1}}{Y_{n,t}} \\ \mathcal{B}_t - B_t^g \\ Y_{d,t} - \mathcal{C}_{d,t} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \tag{47}$$

where we have

$$\Pi_{d,t} = \frac{Q_t}{Q_{t-1}} \Pi_{n,t} \tag{48}$$

$$\Pi_{w,t} = \frac{w_{n,t}}{w_{n,t-1}} \cdot \Pi_{n,t} \tag{49}$$

$$Y_{n,t} = A_n N_{n,t} \tag{50}$$

$$Y_{d,t} = A_d N_{d,t} \tag{51}$$

$$N_t = N_{n,t} + N_{d,t} \tag{52}$$

$$w_{d,t} = Q_t^{-1} w_{n,t} \tag{53}$$

$$Div_t = Y_{n,t} - w_{n.t} N_{n,t} + Q_t \left[ Y_{d,t} - w_{d,t} N_{d,t} \right] \tag{54}$$

$$\tilde{\Pi}_t = \Pi_{n,t}^{1-\gamma} \Pi_{d,t}^{\gamma} \tag{55}$$

$$1 + i_t = (1 + i_{t-1})^{\rho_i} \left( \tilde{\Pi}_t^{\phi_{\tilde{\pi}}} \left( Y_t / Y \right)^{\phi_y} (1 + r_t^*) \right)^{1-\rho_i}, \tag{56}$$

$$(1 + r_t) B_{t-1}^g = \tau_t + B_t^g \tag{57}$$

$$\tau_t = \tau + \phi_\tau \left( B_{t-1}^g - B^g \right) \tag{58}$$

and where the nondurable goods market clears by Walras' law.

# Appendix References

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