Consumer Durables and Monetary Transmission in a Two-sector HANK Economy*

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Abstract

We devise a two-sector Heterogeneous Agent New Keynesian framework to examine the role of durable goods in the transmission of monetary policy on consumer spending. While durables display much stronger interest-rate sensitivity than nondurables, the indirect (general-equilibrium) effects induced by a monetary shock are the primary drivers of both sectoral expenditures' responses. In fact, pure income effects prove key in overcoming the negative-comovement force stemming from asymmetric sectoral price stickiness. When accounting for wage stickiness, the responsiveness of liquidity-constrained households and savers tends to be similar not only with respect to nondurables, but also in durable spending.

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1 Introduction

Consumer durables are essential in explaining variations in private expenditures, both at the household level and in the aggregate (see, e.g., Stock and Watson, 1999; Attanasio, 1999), despite notional durable consumption constituting a relatively small fraction of total private consumption.[1] This is notable, from a normative perspective, as macroeconomic policies typically aim to target the value of personal consumption expenditures (Laibson et al., 2022). For the sake of monetary-policy making, the distinction between durable and nondurable expenditures is particularly important, since the former are considerably more interest-rate sensitive than the latter (see, e.g., Mankiw, 1985). For this reason, consumer durables are typically seen as a significant avenue—if not the most significant—for monetary policy to influence aggregate household spending (see, e.g., Erceg and Levin, 2006). Yet, much remains to be understood about the channels through which monetary shocks effectively transmit in the aggregate, through both durable and nondurable spending.

Marked interest-rate sensitivity primarily arises from the demand for durables being directed towards a stock, so that even small changes in the latter can cause significant variation in the corresponding flow demand for newly produced goods. However, such a property need not exclusively hold in connection with the direct effect of changes in the real rate of interest, as accounted for by intertemporal substitution. Significant wealth and sectoral heterogeneity may in fact activate—and potentially amplify—indirect (general-equilibrium) effects operating through changes in labor demand. In this paper we extend the canonical one-sector Heterogeneous Agent New Keynesian (HANK) framework to accommodate the presence of an additional sector that produces consumer durables, and examine the capacity of different channels—direct and indirect—through which monetary shocks propagate to households' expenditures.

Durables are peculiar in that they have a dual functionality, being both a *consumption good*—whose user-cost behavior, as shaped by movements in the relative price and the real rate of interest, is key to expenditure allocation—and a *store of value* that (albeit subject to depreciation and adjustment frictions) can be traded on second-hand markets, a feature that may be particularly important to households constrained in the access to liquid financial assets. Both these properties characterize standard multi-sector models with durables. However, the way they combine to dictate the monetary-policy response of durable spending—and, in turn, of aggregate expenditure—is likely to be shaken by the introduction of uninsurable idiosyncratic income risk that makes the conditional behavior of households' disposable income relevant to monetary transmission (Kaplan et al., 2018).

Our HANK model retains the building blocks of standard two-sector Representative Agent

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

New Keynesian (RANK) models with asymmetric price stickiness between sectors, in the vein of Barsky et al. (2007) and Monacelli (2009), augmented to reflect uninsurable idiosyncratic risk on the household side, with some households being constrained in the access to liquid assets. We use this framework as a laboratory to decompose the responses of durable and nondurable spending to a monetary policy shock into a *direct* (or interest-rate) effect, and the *indirect* effects operating through general-equilibrium changes in households' disposable income. In turn, the latter are further decomposed into the response that can be attributed to changes in the *relative price* of durables to nondurables, and to *pure income* effects.

Not only the response of nondurables is mostly driven by pure income effects—in line with the quantitative insights from one-sector HANK economies à la Kaplan et al. (2018)—but also that of durables is predominantly affected by general-equilibrium forces. Yet, unlike nondurables, durables do display sizable interest-rate effects that, in turn, have grip on aggregate consumer spending. We also show how pure income effects are key to overcoming the relative-price force that induces consumers to substitute between durables and nondurables—whose strength depends on the relative degree of sectoral price stickiness—thus resolving the *comovement puzzle* that typically plagues otherwise standard two-sector RANK models with asymmetric sectoral price stickiness (see, e.g., Barsky et al., 2007). In this respect, decomposing consumer expenditure responses based on the holdings of liquid assets highlights some distinctive traits of different household types. In the face of a monetary shock, savers denote a the sharp reallocation of resources between their stock of durables and bond holdings, reflecting sizable capacity of the interest-rate channel. As for liquidity-constrained households, instead, they consistently display positive conditional comovement in consumption—with durables denoting much stronger reactiveness—thus making these agents' consumption habits and relative size in the total population decisive for resolving the comovement puzzle.

These findings are robust to realistic extensions to the baseline framework, such as deficit financing and nominal wage stickiness (see, e.g., Auclert et al., 2020b). In this second case, pure income effects are responsible for an even larger portion of the response of aggregate expenditure on both types of good—being relative-price effects relatively muted—while direct effects are less of a driver of the response of durables (and, in turn, of aggregate consumption), as compared with the case of flexible wages. Most notably, while displaying very different sensitivities to the direct and the indirect effects of a monetary innovation, savers and liquidity-constrained households denote remarkably similar responses, when sticky wages impair relative-price effects. This is not just the case with respect to nondurable consumption—as typically found by contributions featuring a single type of consumption good—but also for durable spending.

As durable expenditures are intrinsically more volatile, it might come as a surprise that agents with markedly different access to liquid assets denote analogous responsiveness in either spending category. We put this property to the test. To this end, we combine information from the Consumption Expenditure Survey (CEX) and the Survey of Consumer Finances (SCF) to sort households into assetholders and non-assetholders—depending their holdings of liquid financial assets—and compute their respective nondurable and durable responses to an unforecasted monetary policy innovation. The empirical analysis reveals that positive comovement between the responses of durable and nondurable expenditures to a monetary policy shock extends across different classes of households, and that their good-specific responses are quantitatively similar. Our framework rationalizes these features of the data, showing how different transmission channels play very different roles for constrained and unconstrained agents.

Our results are important as they should help us rethink the most effective channels of monetary policy transmission in HA economies, while focusing on both aggregate consumer spending and its components, characterized by different degrees of durability and price stickiness. Moreover, we provide useful insights about the exposure of households with varying levels of financial access to different channels of transmission, a topic that the existing literature has mostly emphasized in relation to nondurable spending, despite durables being dominant in shaping the responsiveness of private spending.

Related literature We relate to a burgeoning literature on monetary policy transmission in New Keynesian models with rich wealth distributions. Our work is inspired by the seminal work of Kaplan et al. (2018), who investigate the effects of monetary policy in a rich calibrated one-sector HANK model (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 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).[2] Another relevant contribution we connect to is Auclert (2019), who reports that redistribution triggered by monetary policy is key in amplifying its effects in the aggregate, and performs a back-of-the-envelope exercise showing how durables' interest-rate sensitivity may be important in quantifying the redistribution elasticity of total consumption to the real interest rate. We also relate to McKay and Wieland (2021), who devise a framework that features durable adjustment along the extensive margin.[3] In McKay and Wieland (2022), this feature is exploited due its sensitivity to the (contemporaneous) user cost, so as to address the forward guidance puzzle. We abstract from this dimension, while casting an otherwise standard

[2]When this type of models are extended to embed a saver-borrower relationship in the presence of collateralized borrowing and aggregate risk (e.g., Monacelli, 2009, designs a Two-agent New Keynesian—TANK—model), bond-market equilibrium forces are key to the sectoral allocation of consumer spending.

[3]On this modeling aspect, see also Berger and Vavra (2015) and Harmenberg and Öberg (2021).

two-sector NK model in a HA setting, so as to retain closer comparability with a long-standing tradition of studies that examine monetary transmission and sectoral comovement in multi-sector economies. More broadly, relative to the HANK literature, our contribution focuses on the drivers of monetary transmission on durable expenditure, which is typically considered key in shaping the dynamics of aggregate consumer spending, as has been empirically shown both in the aggregate and at the consumer level.

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 impairing the drop in the relative price of durables (the latter are typically assumed to display prices that are more flexible than those of nondurables), following a monetary tightening. Among these, we recall non-separable preferences between a composite of sectoral consumption goods and labor supply (see, e.g., Dey and Tsai, 2017; Katayama and Kim, 2013), and sticky prices of the production inputs: in this respect, Carlstrom and Fuerst (2010) assume sticky wages, while Sudo (2012) and Petrella et al. (2019) both allow for input-output interactions. Other remedies have placed emphasis on the importance of financial frictions. Specifically, Tsai (2016) stresses the role of working capital, along with habits in nondurable consumption. Monacelli (2009), instead, emphasizes the importance of households' collateralized borrowing to disrupt quasi-constancy in the shadow value of durables, which implies diverging responses of sectoral production, in the presence of asymmetric sectoral price stickiness.[4] Our framework takes a different route, highlighting the role of transitory income movements in the presence of market incompleteness.

It might be argued that HANK models involving a two-asset structure—one asset being liquid and the other one relatively illiquid (e.g., Auclert et al., 2020b)—appear to bear a structure similar to that of our dual-good model. Two important *caveat*s are in order, in response to this. First, our focus is on how monetary policy may heterogeneously affect inherently different components of households' consumption basket, one of which is particularly interest-rate sensitive and drives most of the unconditional volatility of aggregate expenditure. Such distinction is certainly important in the aggregate, but even more so for households characterized by different holdings of liquid assets, given that liquidity-constrained agents may rely on durables as a self-insurance device (Cerletti and Pijoan-Mas, 2012; Asdrubali et al., 2020; Holst Partsch et al., 2023). Second, we know investment may represent a powerful propagator of shocks to monetary policy (see, e.g., Smets and Wouters, 2003). This is particularly true in the presence of idiosyncratic risk, so that sizable complementarity with private consumption obtains, which would not otherwise be present in a standard RANK setting (Auclert et al., 2020b). By contrast, standard RANK economies with two sectors of consumption-good production struggle to re-

[4]See also Sterk (2010), on the actual role of collateralized borrowing in solving the comovement puzzle within a two-sector, two-agent model.

produce positive sectoral conditional comovement, in the presence of asymmetric sectoral price stickiness—the above mentioned *comovement puzzle*. In the extreme case of perfect price flexibility characterizing durable goods—a setting that most closely resembles the one involving physical capital in the presence of adjustment costs—[5] negative-comovement forces stemming from the response of the relative price are, in fact, particularly strong (Barsky et al., 2007). In this respect, relative price effects play an important role, in our analysis.

Structure The paper is structured as follows: Section 2 details the baseline two-sector HANK model. Section 3 details the calibration and the solution of the stationary steady state. In Section 4 we perform various decompositions of aggregate and household-level responses to a monetary tightening. In Section 5 we devise two extensios to the baseline framework, so as to account for deficit financing and sticky wages. Section 6 reports the empirical evidence on the responses of assetholders' and non-assetholders' consumption of nondurables and durables to a monetary policy shock. Section 7 concludes.

2 A two-sector HANK model with durables

The economy is populated by households with preferences over durable and nondurable goods, as well as labor hours that are supplied to intermediate-goods firms operating in a regime of monopolistic competition. Households are subject to idiosyncratic productivity shocks, and face a borrowing constraint. Intermediate-goods firms sell their products to firms operating in a perfectly-competitive final-goods sector. The government pursues monetary policy, while balancing its budget on a period-by-period basis. The remainder of this section details the key blocks of the model, as well as how equilibrium obtains.

2.1 Households

We assume a continuum of households, indexed by $s \in [0, 1]$. Consumer preferences are defined over (a Cobb-Douglas aggregator of) nondurable consumption and the stock of durables—$C_{n,t}(s)$ and $D_t(s)$, respectively—[6] as well as over labor hours, $\mathcal{N}_t(s)$. Households' intertemporal utility reads as

[5] Adjustment costs are necessary to observe conditional variation in Tobin's q. Should this be constant, instead, symmetric price stickiness would be required in the two-sector economy for isomorphism to the framework with capital investment, in which case nondurables would display little or no variation (Barsky et al., 2007).

[6] Concerning the implications for the transmission of monetary impulses through movements in the relative price, the assumption of Cobb-Douglas preferences is rather conservative, as the empirical estimates of the substitution elasticities between durables and nondurables range from below to around one; see Ogaki and Reinhart (1998), Davis and Ortalo-Magné (2011), Pakos (2011) and Albouy et al. (2016). We stand at the high end of the range of these estimates.

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

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

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

where $B_{t+1}(s)$ denotes bond holdings, Q_t is the price of durables relative to that of nondurables, $w_{n,t}$ is the real wage rate,[7] α scales the adjustment cost on durables, $\delta \in [0,1]$ is the depreciation rate and $e_t(s)$ is an idiosyncratic productivity shock with unit 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, κ, when $B_t(s) < 0$ (see Kaplan et al., 2018). Households pay taxes, τ_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.[8] Households face the following borrowing constraint:

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

where Y is steady-state total output, and ψ is a scaling parameter. We assume that all households supply labor according to the solution in the RA representation of the model (see, e.g., Debortoli and Galí, 2021) under perfect labor mobility between sectors, that is:

$$w_{n,t} = \psi_N N_t^{\varphi} \frac{1}{\theta} \left(C_{n,t}^{\theta} D_t^{1-\theta} \right)^{\sigma} \left(\frac{C_{n,t}}{D_t} \right)^{1-\theta}, \tag{4}$$

where $C_{n,t} \equiv \int_0^1 C_{n,t}(s) ds$ and $N_t = \mathcal{N}_t(s)$ for all s.[9]

2.2 Production

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 $i \in [0,1]$,

[7] 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.

[8] In Section 4 we discuss a robustness analysis based on an idiosyncratic income process à la Kaplan et al. (2018)—whereby log-earnings involve a temporary and a permanent component—as well as on a uniform dividend-redistribution scheme.

[9] Taking a representative-agent stand on labor supply allows us to dampen wealth effects for low liquidity households, as in Auclert et al. (2020a).

$y_{j,t}(i)$ (with price $p_{j,t}(i)$), in accordance with the CES technology

$$Y_{j,t} = \left(\int_0^1 y(i)_{jt}^{\frac{\epsilon_j - 1}{\epsilon_j}} \, di \right)^{\frac{\epsilon_j}{\epsilon_j - 1}}, \tag{5}$$

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

$$y(i)_{j,t} = y\left(p(i)_{j,t}; P_{j,t}, Y_{j,t}\right) = \left(\frac{p(i)_{j,t}}{P_{j,t}} \right)^{-\epsilon} Y_{j,t}, \tag{6}$$

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

$$P_{j,t} = \left(\int_0^1 p(i)_{jt}^{1-\epsilon_j} di \right)^{\frac{1}{1-\epsilon_j}}. \tag{7}$$

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

$$Y_{j,t}(i) = A_j N_{j,t}(i), \tag{8}$$

where A_j represents total factor productivity, assumed to be common to all firms in sector j. Price setting in each sector is 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

$$V_{j,t}\left(p(i)_{j,t-1}\right) \equiv \max_{p(i)_{j,t}} \frac{p(i)_{j,t}}{P_{j,t}} y\left(p(i)_{j,t}; P_{j,t}, Y_{j,t}\right) - w_{j,t} N_{j,t} - \frac{\xi_j}{2} \left(\frac{p(i)_{j,t}}{p(i)_{j,t-1}} - 1 \right)^2 Y_{j,t} + \beta V_{j,t+1}\left(p(i)_{j,t}\right). \tag{9}$$

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

$$(1-\epsilon_j) + \epsilon_j w_{j,t}/A_j - \xi_j \left(\Pi_{j,t} - 1\right) \Pi_{j,t} + \beta \xi_j \left(\Pi_{j,t+1} - 1\right) \Pi_{j,t+1} \frac{Y_{j,t+1}}{Y_{j,t}} = 0, \tag{10}$$

while total real dividends (deflated by $P_{n,t}$) are

$$Div_t = \sum_j Div_{j,t} = Y_{n,t} - w_{n,t} N_{n,t} + Q_t \left(Y_{d,t} - w_{d,t} N_{d,t}\right). \tag{11}$$

2.3 Policy

Monetary policy Monetary policy sets the nominal rate according to a Taylor rule that features a non-systematic component, u_t^r:

$$i_t = \phi_{\tilde{\pi}} \tilde{\pi}_t + u_t^r, \tag{12}$$

where $\tilde{\pi}$ is the net (aggregate) rate of inflation, with $\tilde{\Pi}_t \equiv \Pi_{n,t}^{1-\gamma} \Pi_{d,t}^{\gamma}, \gamma \in [0,1]$.

Fiscal policy The fiscal authority issues one-period nominal bonds, B^g, maintaining this constant in fulfillment of the steady-state bond-to-output ratio, and adjusts the level of lump-sum taxes, τ_t, to balance its budget period-by-period:

$$\tau_t = r_t B^g. \tag{13}$$

2.4 Equilibrium

Market clearing Bonds market clearing obtains as

$$B_t = \int_0^1 B_t(s) ds = B_g. \tag{14}$$

Aggregate labor hours are given by

$$N_t = \sum_j \int_0^1 N_{j,t}(i) di = \sum_j Y_{j,t}/A_j, \tag{15}$$

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

$$Y_{d,t} = C_{d,t}, \tag{16}$$

and

$$Y_{n,t} = C_{n,t} + \chi_t + \kappa \int \max(-B_t(s), 0) ds, \tag{17}$$

where the last two terms of (17) respectively capture the costs of adjusting the stock of durables and that of borrowing, respectively. It follows from equations (16) and (17) that the market for aggregate goods clears in accordance with

$$Y_t = Q_t Y_{d,t} + Y_{n,t} = Q_t C_{d,t} + C_{n,t} + \chi_t + \kappa \int \max(-B_t(s), 0) ds. \tag{18}$$

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 $\{w_{n,t}, w_{d,t}\}_{t\geqslant 0}$ 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 schedule, (4), conditional on perfect sectoral mobility, as captured by $Q_t w_{d,t} = w_{n,t}$;
4. The government budget constraint, (13), is satisfied;
5. Bonds, labor, nondurable and durable goods markets clear;
6. Distributions fulfill consistency requirements.

3 Calibration

An overview of our calibration is reported in Table 1. Each period in the model corresponds to a quarter. We calibrate the discount factor, β, so as to obtain a steady-state annual real risk-free rate is 3 percent. The coefficient of relative risk aversion, σ, and the inverse Frisch elasticity of labor supply, φ, are set to 1. The utility weight on nondurables, θ, is set to 0.7, so as to match the 60 percent steady-state ratio of nondurables to total consumption; a value in the middle of the range provided in Beraja and Wolf (2021). Durables' depreciation, δ, is set to 0.054, in line with the Fixed Assets and Consumer Durable Goods data from the BEA.[10] The idiosyncratic income parameters, σ_e and ρ_e, are set to 0.1928 and 0.9777, respectively, following McKay et al. (2016) and Auclert (2019). On the supply side, we set ϵ_n and ϵ_d to 6, as in Monacelli (2009). As for the policy parameters, the steady-state government debt-to-output ratio is set to 0.26, as in Kaplan et al. (2018). The reaction parameter in the Taylor rule, ϕ_π, is set to 1.5. The weight on durables in the monetary authority's inflation index, γ, is set to the steady-state share of durable consumption to total consumption, 0.4. We implement the simulated method of moments (SMM), using α and ξ_n, ξ_d to target: *i*) the relative volatility of durable to nondurable ex-

[10] This calibration reflects our focus on consumer durables, excluding (illiquid) housing. As such, the parameter value is in line with the existing studies (see, e.g., Baxter, 1996; Laibson et al., 2022).

penditure, calculated using HP-filtered log-data;[11] *ii*) the stickiness of durable and nondurable prices. As for the latter, Nakamura and Steinsson (2008) report a median price duration of 8-11 months (with one of the most prominent types of durables, *transportation goods*, exhibiting a price duration of 2.7 months; see their Table II). We target Calvo probabilities $\theta_n^{Calvo} = 0.75$ and $\theta_d^{Calvo} = 0.25$, thus imposing durables to be more price-flexible than nondurables (see, e.g., Klenow and Malin, 2010).[12] Finally, the remaining parameters are residually obtained from the computation of the steady state, as described in Section 3.1 and Appendix B.

Table 1: Baseline model calibration

Parameter	Value	Target/Source
Household parameters		
β	0.967	Steady-state adjustment
σ	1	Std. business-cycle literature value
φ	1	Std. business-cycle literature value
θ	0.7	$\frac{C_n}{C_n+C_d}$; Beraja and Wolf (2021)
α	0.112	SMM target volatility of C_d/C_n (3.572, BEA)
δ	0.054	BEA; Baxter (1996) and Laibson et al. (2022)
ψ_N	0.753	Steady-state adjustment
ψ	0.833	Borrowing limit based on earnings
κ	0.044	Steady-state share of households with $B(s) = 0$; Kaplan et al. (2018)
ρ_e	0.9777	McKay et al. (2016) and Auclert (2019)
σ_e	0.1928	McKay et al. (2016) and Auclert (2019)
r	0.03/4	Debortoli and Galí (2021)
Supply-side paramaters		
ϵ_n, ϵ_d	6	Monacelli (2009)
ξ_n	23.53	SMM target Calvo probability of 0.75; Nakamura and Steinsson (2008)
ξ_d	5.43	SMM target Calvo probability of 0.25; Nakamura and Steinsson (2008)
A_n	1.0	Steady-state adjustment
A_d	2.26	Steady-state adjustment
Policy parameters		
B^g/Y	0.26	Liquid assets/GDP; Kaplan et al. (2018)
ϕ_π	1.5	Taylor (1993)
γ	0.40	$C_d/(C_n + C_d)$

[11] Relative volatility is computed from *on-impact* responses to a 0.25% innovation to the non-systematic component of the Taylor rule, assuming this is an AR(1) process with an autoregressive coefficient equal to 0.5, as in Kaplan et al. (2018).

[12] The coefficient θ_j^{Calvo} is defined as the probability for a firm in sector j of not being able to adjust prices in a given quarter. From our calibration exercise, we obtain $\theta_n^{Calvo} = 0.64$ and $\theta_d^{Calvo} = 0.40$—corresponding to median price durations of 7 and 5 months, respectively—and a on-impact relative volatility of 3.563. This value is in line with the evidence of Erceg and Levin (2006) and Sterk and Tenreyro (2018), among others. To determine sector-specific Rotemberg adjustment costs, we rely on their mapping with the Calvo probabilities, as implied by $\xi_j = \theta_j^{Calvo}\left(\epsilon_j - 1\right)/((1-\theta_j^{Calvo})(1-\beta\theta_j^{Calvo}))$.

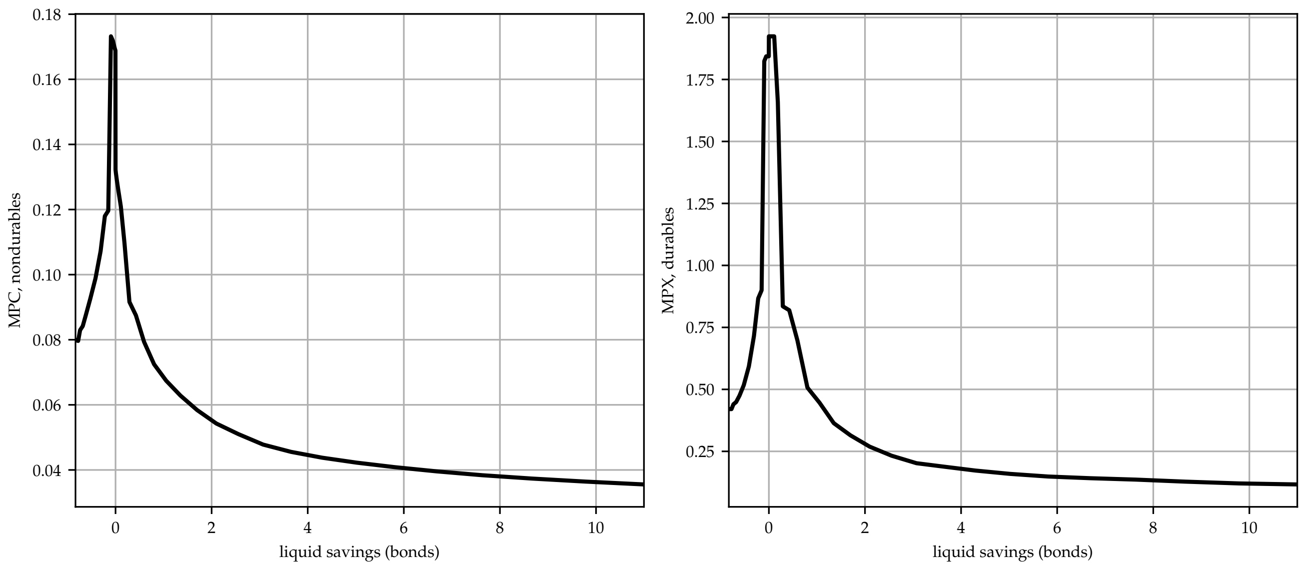
3.1 Stationary steady state

Let a generic variable x_t be denoted by x in the steady state. When solving for the steady state, we use a multi-dimensional root finder to guess on β, Q, N_d and target: *i*) bonds market clearing; *ii*) durable goods market clearing; *iii*) total employment ($N = 1$). Given bonds and durable goods market clearing, the nondurable goods market clears by Walras's law. The household solution is obtained using the endogenous grid method algorithm (EGM) of Auclert et al. (2021) in two dimensions; see Appendix A for details. The steady-state household distribution is retrieved by relying on the deterministic histogram method of Young (2010). Given guesses for β, Q, N_d, we can solve for equilibrium quantities, both at the aggregate and at the household level, as described in Appendix B.

We obtain a steady-state skewness of the durable stock over nondurable consumption of 0.863, which is remarkably in line with the microeconomic evidence of Bertola et al. (2005) (see the density in Figure F1, Appendix F), especially if we consider that the present framework does not feature any adjustment along the extensive margin. The marginal propensities to consume (MPC) and spend (MPX) are empirically realistic:[13] in quarterly terms, the MPC is 11.6% for nondurables, while the MPX for durables amounts to 151.9%. As for total expenditure, the MPX amounts to 78.7%. Thus, the MPC for nondurables is slightly below the empirical estimates in the 15-25% interval, while the total MPX is well within the 50-90% range of the available estimates (Laibson et al., 2022). Figure 1 reports the steady-state marginal propensities to consume/spend, for both classes of goods, as a function of the steady-state holdings of liquid assets. Both metrics peak at the point bond holdings are nil due to the borrowing wedge, κ. As for nondurables, Kaplan et al. (2014) estimate a MPC of 0.3 for wealthy hand-to-mouth households, slightly above the one we obtain at the peak. The reason we take this type of agents as a benchmark is that we compute our graph conditional on median holdings of durables, which in our environment can be regarded as a form of (partially) illiquid asset. In fact, even if durables may serve as a self-insurance device, their stock adjustment is subject to a cost. This specific feature of durables also explains why, according to the right panel of Figure 1, the marginal propensities to spend are relatively large across households with different holdings of bonds, and not just for those who are constrained in the access to liquid assets.

[13] As remarked by Laibson et al. (2022), the relationship between notional consumption and consumption expenditure is complex. The two measures are identical for goods with no durability, for which the MPC and the MPX correspond, but they may be very dissimilar for durables.

Figure 1: Marginal propensities to spend as functions of liquid savings



Note: We fix the idiosyncratic income shock, $e(s)$, as well as the stock of durables, $D(s)$, at their median steady-state values.

4 Monetary transmission

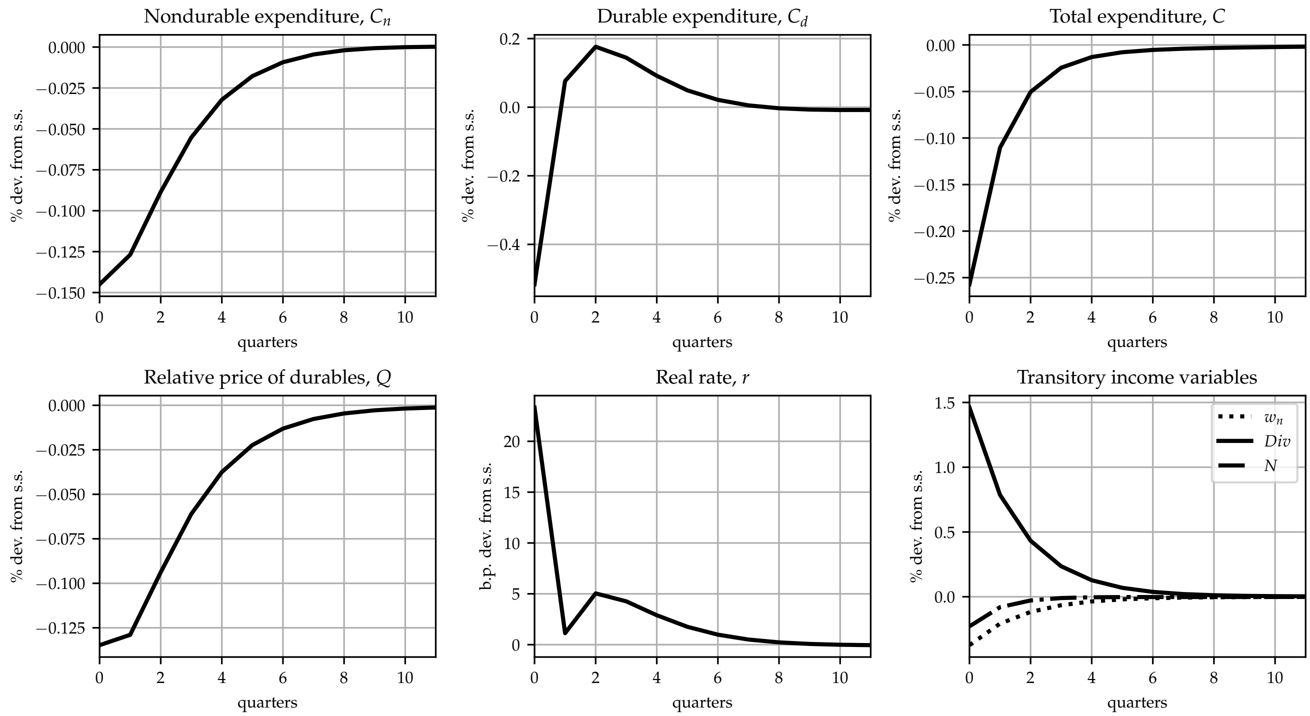
We are now ready to study monetary transmission, with a special focus on how the response of different types of expenditure, both at the aggregate and at the household level, can be decomposed into direct and (different) indirect effects. We then test the robustness of our main insights by accounting for realistic extensions to the original framework.

4.1 Impulse responses to a monetary policy shock

We consider a monetary policy shock at time $t = 0$. As in Kaplan et al. (2018), we take a quarterly innovation of -0.25%, while the shock-persistence parameter is set to 0.5. To obtain general-equilibrium impulse responses, we solve the model by approximating it to the first order around the stationary steady state, using the sequence-space method described in Auclert et al. (2021).[14]

[14] For the sequence-space formulation of the model, we refer the reader to Appendix C.

Figure 2: Impulse responses to a contractionary monetary policy shock



Note: We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

The results of the experiment are presented in Figure 2. We may readily notice how the monetary shock pushes both expenditures down, with the durable one featuring a relatively deeper drop, followed by a hump-shaped recovery, as it has typically been shown in both theoretical and empirical settings (see, e.g., Beraja and Wolf, 2021). Notably, the correlation between durable and nondurable expenditure, measured over 10 quarters, amounts to 0.420, which is remarkably in line with the analogous computed with NIPA HP-filtered data (0.422). Also the drop in the relative price is consistent with what expected on *a priori* grounds, given that durables feature relatively more flexible prices. Nevertheless, the magnitude of the relative price response is relatively modest, as reported by McKay and Wieland (2021), among others.[15] The main scope of the subsequent analysis is to study the channels shaping the overall response of both types of expenditure, as well as their relative capacity.

4.2 Response decomposition

Following Kaplan et al. (2018), we decompose the response of different expenditures as of $t = 0$ into *direct* (i.e., interest-rate) and *indirect* (i.e., general-equilibrium or transitory income) effects, by total differentiation of the impulse-response path of $\{C_{j,t}\}_{t \geqslant 0}$, for $j = \{n, d\}$:

[15] Calibrating the volatility of the monetary policy shock to match the variance of the real interest rate, we obtain that the volatility of the relative price aligns closely with that of its (detrended) empirical counterpart.

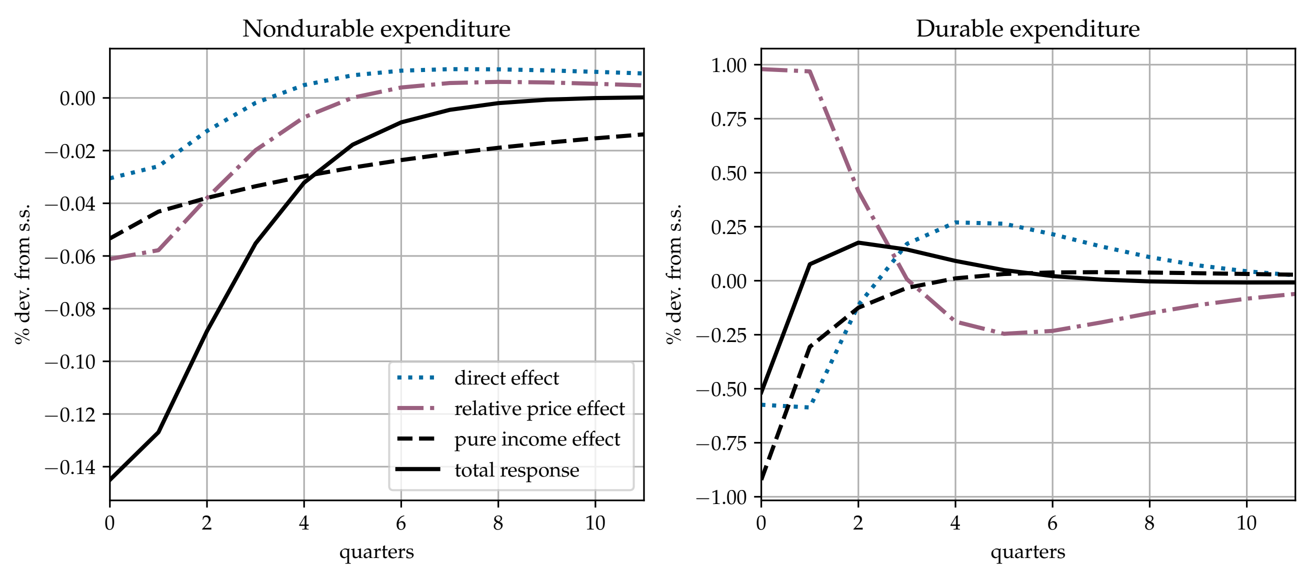
$$dC_{j,0} = \underbrace{\sum_{t=0}^{\infty} \frac{\partial C_{j,0}}{\partial r_t} dr_t}_{\text{direct effect}} + \underbrace{\sum_{t=0}^{\infty} \left(\underbrace{\frac{\partial C_{j,0}}{\partial Q_t} dQ_t}_{\text{relative-price effect}} + \underbrace{\frac{\partial C_{j,0}}{\partial N_t} dN_t + \frac{\partial C_{j,0}}{\partial w_{n,t}} dw_{n,t} + \frac{\partial C_{j,0}}{\partial Div_t} dDiv_t + \frac{\partial C_{j,0}}{\partial \tau_t} d\tau_t}_{\text{pure income effects}} \right)}_{\text{indirect effects}}. \tag{19}$$

Each effect is computed by moving only the variable with respect to which the partial differential is taken. For example, the direct effect is a partial-equilibrium one, whereby all variables other than the real rate are kept fixed. As we are in a two-sector setting, indirect effects can be further grouped into a *relative-price* effect—which embodies both income and substitution effects—and terms that exclusively exert *pure income* effects. Numerically, we calculate the partial-equilibrium household paths by varying only the relevant inputs, while keeping the remaining terms fixed. For example, in the case of the direct effect on nondurable consumption, we compute

$$\sum_{t=0}^{\infty} \frac{\partial C_{n,0}}{\partial r_t} dr_t = \sum_{t=0}^{\infty} \left(\int \frac{\partial C_{n,0}\left(e_t(s), B_t(s), D_t(s); \{r_t, Q, w_n, N, Div, \tau\}_{t>0}\right)}{\partial r_t} ds \right) dr_t. \tag{20}$$

In practice, this is accomplished by varying one input at a time, given the general-equilibrium path computed through household Jacobians, which are calculated when tackling the sequence-space solution of the impulse-response functions.

Figure 3: Expenditure response decomposition



Note: Decomposition of the response of nondurable and durable expenditure into direct, relative-price and pure income effects. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

Figure 3 reports our baseline expenditure response decomposition. This shows how direct and pure income effects push both durables and nondurables down. By contrast, the fall in the relative price would *per se* lead to substitute nondurables for durables, potentially yielding an empirically counterfactual negative comovement. In fact, summing the relative-price to the direct effect would still imply negative comovement between durable and nondurable expenditure, as the intratemporal substitution motive—which is driven by the drop in Q_t—is way more powerful than intertemporal substitution, as is typically the case in standard two-sector RANK models with sticky prices. Thus, pure income effects prove key to generating positive comovement.

From a quantitative viewpoint, the on-impact interest-rate effect amounts to -0.03 percentage-point deviation from steady state (pp) for nondurables, while pure income and relative-price effects amount to -0.05 pp and -0.06 pp, respectively. As for durables, the corresponding figures are -0.57 pp, -0.92 pp and 0.97 pp, respectively. The corresponding annualized figures are reported in Table 2. From this, we infer a relative contribution of the direct effect of about 17% for nondurables. To establish a term of comparison, in Kaplan et al. (2018) the specific contribution of the direct effect to (nondurable) expenditure amounts to about 20% over the year after the shock. We even reduce our model to a one-sector economy, to allow for closer comparability: all else equal, the direct effect contributes by 22.7% of the consumption response over the year after the shock.

Table 2: Annualized effects (pp)

	Direct	Pure income	Relative price
Nondurable	-0.055	-0.130	-0.137
Durable	-0.552	-0.693	1.185
Aggregate	-0.299	-0.437	0.294

Note: Effects of different monetary-transmission channels on different types of expenditure over the year after a 0.25% monetary-policy innovation.

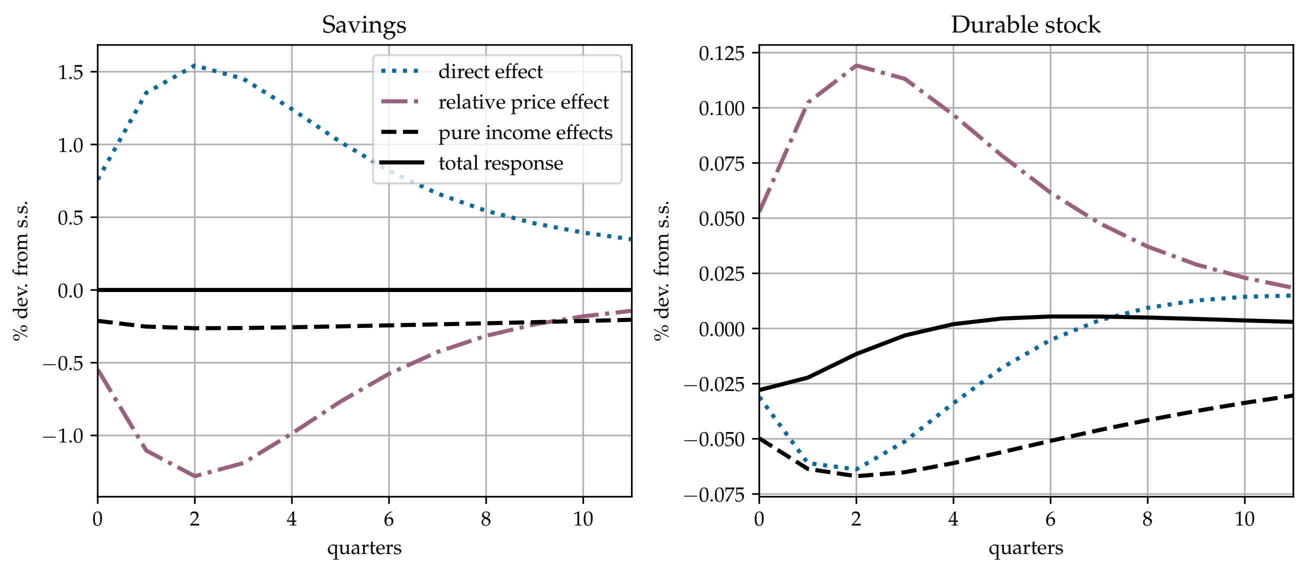
Our figures imply a large negative contribution of the relative price to the response of durable expenditure that is qualitatively in line with what we would expect to see from a standard two-sector RANK model (e.g., Barsky et al., 2007), given asymmetry in sectoral price stickiness. Nevertheless, the sum of direct and pure income effects decisively outweighs any negative contribution, driving durable expenditure in tandem with nondurable expenditure, so that aggregate expenditure contracts.[16] This is a defining feature of our framework, which

[16]Notably, this property survives two robustness checks: one based on assuming a process for log-earnings à la Kaplan et al. (2018)—where a temporary and a persistent component are considered—and one involving a uniform dividend-redistribution scheme (see Figures F5 and F6 in Appendix F).

will be subject to further discussion when examining more closely the role of household heterogeneity for sectoral comovement. Finally, turning to the response of aggregate expenditure, it is important to stress that monetary transmission through intertemporal substitution has sizable grip, relative to comparable sticky-price one-sector HANK economies.

A finer decomposition of the indirect effects reveals that the brunt of the negative force exerted from the income components arises from labor-related variables (i.e., N and w_n; see Appendix F, Figure F2). Taxes account for a smaller share of the overall negative push. This can be explained upon taxes being imposed based on productivity, so that low-income households—who are more sensitive to transitory income shocks—are partially insulated from fiscal propagation. From Kaplan et al. (2018), it is well known that the exact assumptions about how the government budget constraint adjusts outside the steady state matter when budgets are balanced period-by-period. In Section 5.1 we show that our results still hold in the presence of deficit financing. Moreover, one should recall that dividends are expansionary in the present scenario, as is typically the case in New Keynesian economies featuring rigid prices. In light of this, we argue that "positive-comovement" forces would be even stronger in a similar model where dividends are procyclical. Introducing sticky wages in Section 5.2 makes it possible to test such conjecture.

Figure 4: Portfolio-based response decomposition



Note: Decomposition of the response of liquid savings and the durable stock into direct, relative-price and pure income effects. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

A portfolio-based view We should elaborate further on the specifics and implications of durables displaying marked interest-rate sensitivity. A useful perspective to examine this issue consists of considering that, being a store of value, durables are implicitly part of a two-asset portfolio, together with bonds (whenever agents have access to financial investment). Therefore, we consider a response decomposition of the economy-wide *portfolio* featuring bonds and the stock of durables (see Figure 4). Focusing first on the direct effects of the monetary tightening, we report a conditional negative comovement between the holdings of the two assets. As the return on liquid assets increases, households who are not liquidity-constrained are progressively induced to tilt their portfolio towards bonds. On the other hand, intertemporal substitution has limited grip on the response of the stock of durables.[17] This is both because durables' adjustment is frictional—applying to all households, albeit to different extents, based on their durable holdings and purchases—and because liquidity-constrained consumers are predominantly affected by pure income effects, as we will soon see in detail. As for the force emanating from the contraction in the relative price, this would *per se* induce households to increase their holdings of durables, while reducing bond holdings. Pure income effects, instead, are inevitably contractionary with respect to both types of asset, being substantially stronger for bonds. All in all, the sum of these effects is nil for liquid assets, for they are in a fixed supply, whereas the stock of durables contracts, with pure income effects being primarily responsible for this. Based on this evidence, the next step in the analysis consists of understanding to which extent the reaction of the durable-nondurable mix changes depending on households' holdings of liquid assets, and whether different channels assume different importance when accounting for a liquidity-based household-sorting criterion.

A decomposition based on holdings of liquid assets The first row of Figure 5 breaks down the response of durable expenditure, both for liquidity-constrained households (i.e., households with zero or negative bond holdings), and for savers (i.e., households with positive bond holdings).[18] Confirming the portfolio-based analysis, we see that savers' durable expenditure is very interest-rate sensitive, given their motive to re-balance the portfolio of assets away from durables and towards bonds. In spite of this, changes in the relative price are the main driver of their durable expenditure, to the extent that the joint (contractionary) forces exerted by intertemporal substitution and other income effects are overcome. As for liquidity-constrained households, the reaction to interest-rate changes is notably subdued, reflective of their hand-to-mouth consumption behavior. Similarly, shifts in the relative price exert a muted influence on their durable goods spending, compared with savers. Predominantly, hand-to-mouth households absorb the shock through pure income effects, underscoring the minimal impact of interest-rate and relative-price movements on their expenditure behavior. Shifting the focus to nondurable expenditure, all forces are contractionary, with the peculiarity that pure income and relative-price effects are very similar, at least on impact, for both types

[17] More generally, the aggregate holdings of durables denote much weaker responsiveness than bond holdings, when examined from any channel-specific standpoint.

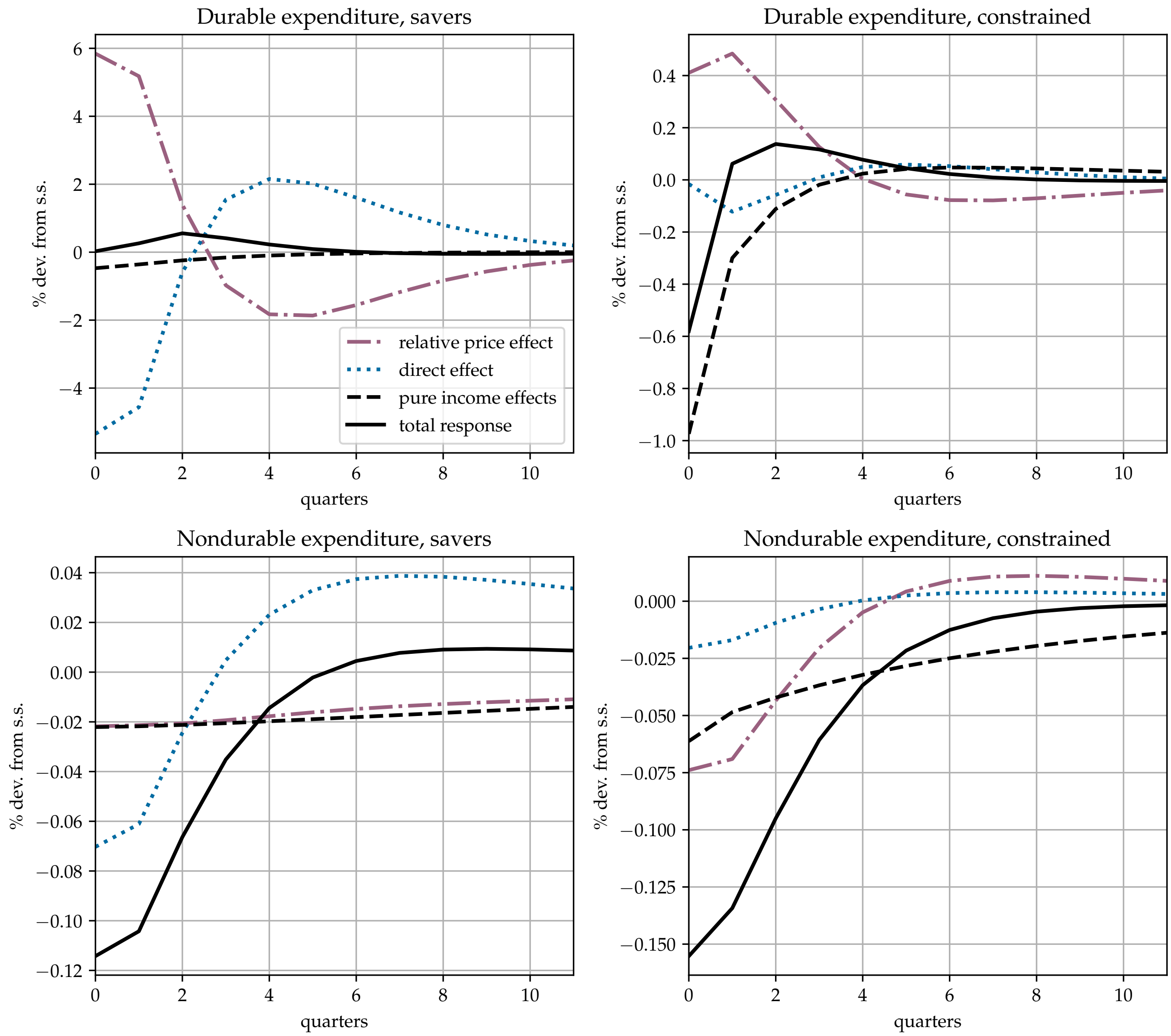
[18] We opt for a standard sorting of households into liquidity-constrained and savers, based on the holdings of liquid assets (see, e.g., Kaplan et al., 2014, 2018).

of consumer. The overall picture emerging from these "household-level" decompositions is that negative comovement between durable and nondurable expenditure appears as a distinctive trait of savers' consumption response in the face of a monetary disturbance, at least in this model featuring flexible wages and asymmetric sectoral price stickiness.[19] By contrast, liquidity-constrained households display positive conditional comovement through marked pure income effects, a property that renders these agents and their consumption habits decisive for resolving the comovement puzzle in the HANK model with asymmetrically sticky sectoral prices.

Sectoral comovement It is worth elucidating the connection between the (positive) sectoral comovement property of our framework, and how the comovement puzzle has formerly been addressed, either explicitly (e.g., in the two-sector TANK of Monacelli, 2009), or implicitly, in alternative two-sector HANK settings. As noted by Sterk (2010), the difficulty in generating positive comovement in TANK models with no idiosyncratic risk rests on the fact that, following a monetary contraction, credit constrained households' drop in durable expenditure implies a diminished capacity to borrow—via a binding collateral constraint—so that savers dissave to ensure equilibrium in the bond market (absent government-provided liquidity). On the other hand, savers may buy durables as an alternative mean of saving, thus facilitating a positive response of aggregate durable production, and more so as durables display relatively flexible prices. In fact, Sterk (2010) shows that, for any degree of durable price-stickiness, removing the financial constraint attenuates the negative comovement problem. Turning back to our setting, idiosyncratic risk implies a more muted (positive) response of durable purchases for the savers, compared to what would occur if their financial status remained unchanged (i.e., should households invariantly be savers or liquidity-constrained). In fact, the *negative* influence of general equilibrium forces on savers' durable purchases is conspicuous, and decisive in limiting the expansionary effect brought by the drop in the relative price. Furthermore, introducing sticky wages—thus toning relative price changes down—will flip savers' response to a contractionary shock into the negative territory, so that positive comovement also applies at the household level (see Section 5.2). On a side note, we stress that adding some source of non-convexity in the presence of modest adjustment of the relative price would not break the positive-comovement property by impairing general-equilibrium forces shaping liquidity-constrained agents' expenditure (see, e.g., McKay and Wieland, 2021, 2022, who consider a fixed cost of durable adjustment).

[19] In Section 5.2 we show how also savers display positive comovement in their sectoral expenditures, due to sticky wages limiting movements in the relative price.

Figure 5: Expenditure response decomposition by steady-state bond holdings



Note: 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 (bonds). Liquidity-constrained consumers are defined as households with zero or less liquid assets. Savers are defined as households holding above zero liquid assets. The effects are calculated by subtracting either expenditure—conditional on the holdings of assets on either side of a the ergodic distribution with respect to the truncation rule—from the shock-response counterpart. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

5 Extensions

We now consider two extensions to the baseline model—namely, deficit financing and sticky wages—so as to account for potential criticalities in the way fiscal policy and wage dynamics may affect the conditional behavior of aggregate and household-level expenditure.

5.1 Deficit financing

It is well known that the specific assumptions about how the government budget constraint adjusts outside the steady state matter in HANK economies, especially when governments balance their budget period-by-period. As mentioned in Section 4.2, part of the positive consumption comovement accomplished through pure income effects is driven by the tax increase. Thus, to test the robustness of this result, we neutralize movements in taxes by replacing equation (13) with (21), as in Auclert et al. (2020b):

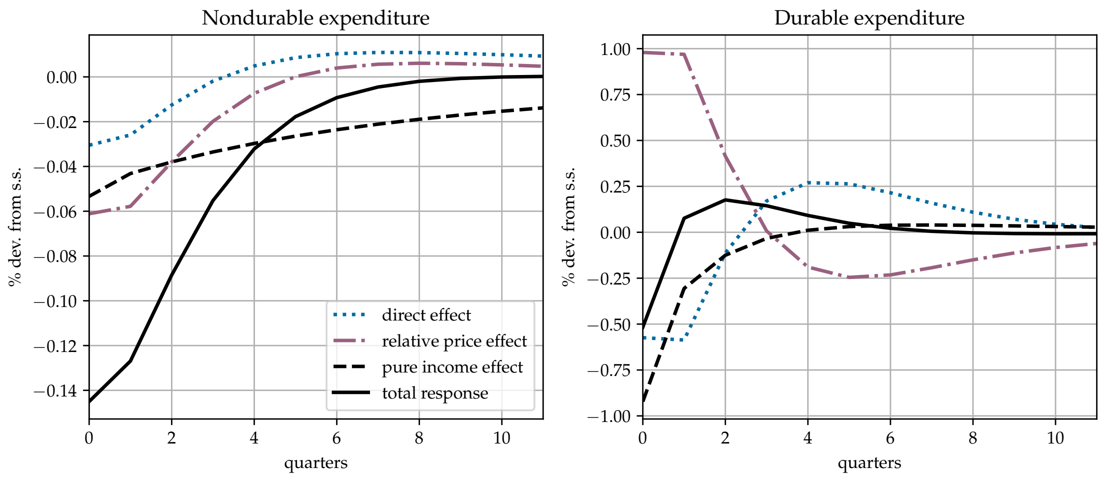
$$\begin{aligned} (1 + r_t)\, B^g_{t-1} &= \tau_t + B^g_t, \\ \tau_t &= \tau + \phi_\tau \left(B^g_{t-1} - B^g \right), \end{aligned} \tag{21}$$

where τ and B^g denote steady-state taxes and government bonds, respectively, while ϕ_τ 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 D for further details.

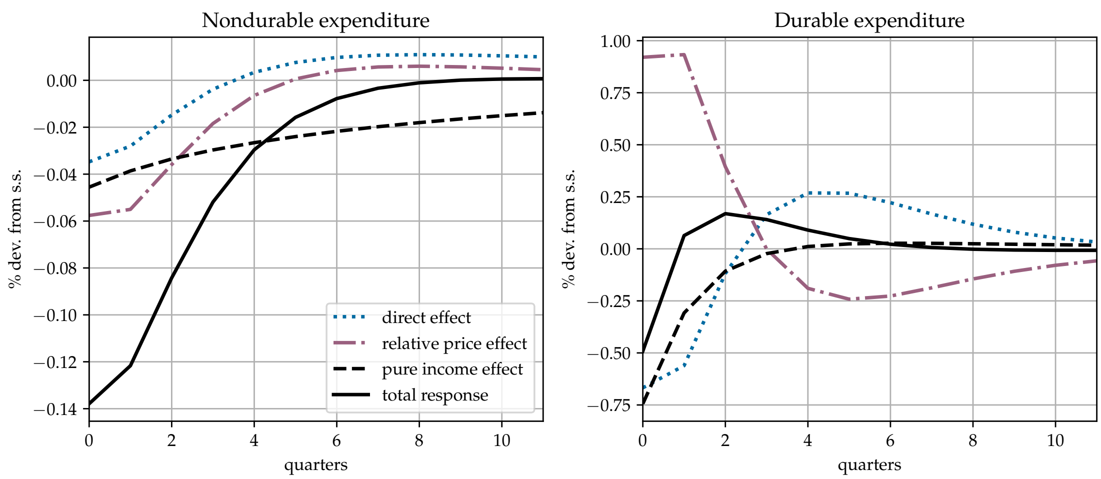
Re-calibration We briefly present the parameter values that change to accommodate the calibration of the economy under deficit financing. We set ϕ_τ to 0.1, as in Auclert et al. (2020b). We also need to re-perform our SMM calibration exercise to determine a value of the scaling parameters in the adjustment cost of durables and the sectoral price-adjustment costs, while targeting the volatility of durables to nondurables. Doing so results in $\alpha = 0.111$, while the Calvo probability for nondurables is set to 0.63, which maps into $\xi_n = 22.43$. The implied total factor productivity for durable production is 2.26, while the scaling parameter for labor disutility, ψ_N, is set to 0.753. The resulting volatility of durable-to-nondurable consumption is 3.564.

Decomposition of consumption responses The second row of Figure 6 contains a consumption decomposition of the effects induced by a monetary tightening in this model extension, in line with the analogous decomposition for the baseline model in Section 4.2 (which has been reproduced in the first row of the figure, to enhance comparability). Even with fiscal deficit financing, pure income effects drive the brunt of the response of both durables and nondurables. For a more disaggregated overview, we refer the reader to Figure F3 in Appendix F. As expected, taxes barely move in the presence of deficit financing.

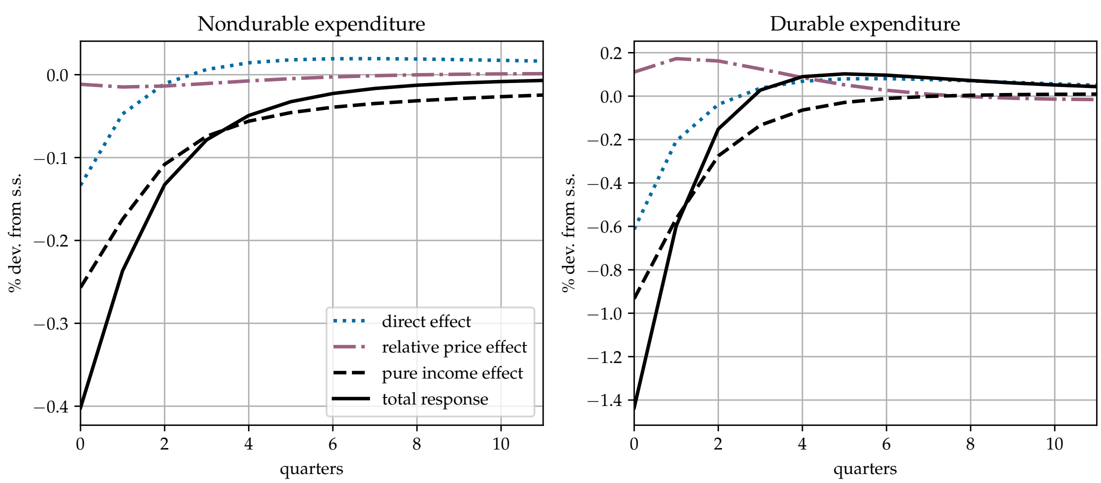
Figure 6: Expenditure response decomposition, robustness to different model alterations



(a) Baseline model



(b) Deficit financing



(c) Sticky wages

Note: Decomposition of the response of nondurable and durable expenditure into direct, relative-price and pure income effects. Top panel: baseline model; middle panel: model with deficit financing; bottom panel: model with sticky wages. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

5.2 Sticky wages

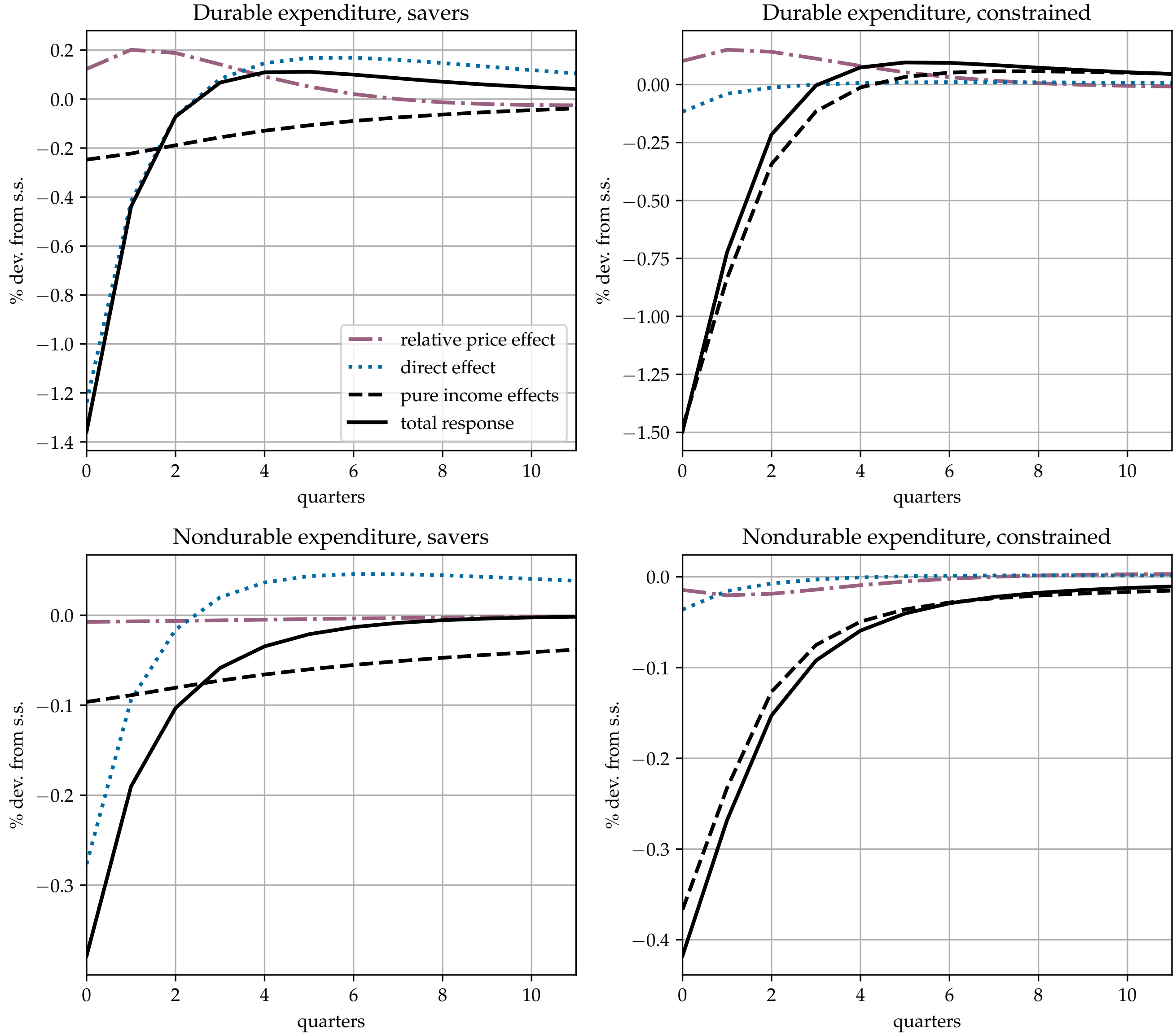
In the presence of price stickiness and flexible nominal wages, firm profits are countercyclical in both sectors of our model economy. However, it is well understood that the specific source of nominal rigidity—prices vs. wages—and the ensuing profit cyclicality may imply wide variation in the emergence of redistributional and aggregate effects (see, e.g., Christiano et al., 1997; Broer et al., 2020). Thus, we want to test to which extent the qualitative and quantitative properties highlighted so far hold when acting on this front. Thus, we introduce sticky wages, so as to induce profits to be condionally procyclical. Incidentally, sticky wages reinforce comovement between durable and nondurable expenditure, as they dampen relative-price changes (see Carlstrom and Fuerst, 2010).

The modelling twist consists of replacing the wage schedule equation, (4), with a wage Phillips curve. To this end, we adapt the wage-setting block of Erceg et al. (2000), following closely the approach of Hagedorn et al. (2019). We assume that each household provides some (perfectly competitive) labor packers with differentiated labor services, so as to be transformed into aggregate effective labor. 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. In doing so, the union sets the nominal wage for one effective labor unit subject to virtual Rotemberg adjustment costs. Further analytical details about the modeling approach are reported in Appendix G.

Re-calibration Given this extended structure, we need to re-calibrate some parameters. We set $\xi_n = 54.42$ and $\xi_d = 2.20$, such that the corresponding Calvo probabilities for prices are right on target (i.e, 0.75 and 0.25, respectively). As for wage stickiness, we set $\xi_w = 54.42$ to target a Calvo probability of 0.75, yielding an implied duration of wage contracts of one year, in line with the estimates of Smets and Wouters (2003) and Levin et al. (2005). We re-calibrate the parameter scaling the adjustment of durables, α, to 1.522, so as to target the relative (on-impact) volatility of $C_{d,t}$ to $C_{n,t}$. The model can now hit that target of 3.572 with precision. The borrowing wedge, κ, is re-calibrated to 0.0341, to target a 30% steady-state share of liquidity-constrained households. The discount factor, β, is now 0.965. The scaling factor applying to labor disutility, ψ_N, is 0.627. Finally, the implied steady-state total factor productivity in each sector are $A_n = 1$ and $A_d = 2.63$, while the steady-state nondurable-to-total consumption ratio equals 0.61 (so that $\gamma = 0.39$). Finally, we set labor unions' market power in line with the value characterizing the two intermediate-goods markets (i.e., $\epsilon_w = 6$).

Decomposition of expenditure responses The last row of Figure 6 reports the expenditure response decomposition for the model with sticky wages. In this case, pure income effects make up an even larger part of the response of both durables and nondurables. This is because

Figure 7: Expenditure response decomposition by steady-state bond holdings (with sticky wages)



Note: 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 (bonds). Liquidity-constrained consumers are defined as households with zero or less liquid assets. Savers are defined as households holding above zero liquid assets. The effects are calculated using the (initially) truncated distributions relative to a simulation of the relevant truncated distribution conditional on all input variables being at their steady-state values. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

prices inherit some stickiness from wages, causing relative-price movements to be smaller.[20]

It should also be stressed that durables still display higher interest-rate sensitivity, though the gap of responsiveness with respect to nondurables along this dimension is heavily reduced, mostly because the durable figure is an order of magnitude lower, relative to its flexible-wage benchmark: over a year, the relative contribution of interest rate changes to the drop of private spending in either sector is 21% for nondurables and 38% for durables. The corresponding

[20]For a detailed account, see Appendix F, Figure F4.

figures for pure income effects are 72% and 89%, respectively, while the relative-price effect alone accounts for 6% and -27% of either expenditure's total response, respectively. As for the response of total consumption, we record a contribution of 27%, 75% and -0.02% from direct, pure income and relative-price effects, respectively.

The main takeaways from the liquidity-based decomposition in Section 4.2 carry over to the present setting, as implied by Figure 7: *i*) the aggregate relevance of pure income effects is mostly to be reconducted to the hand-to-mouth behavior of liquidity-constrained households, whose expenditures in either type of good comove positively; *ii*) interest-rate effects have strong grip on savers' expenditure in both types of good. In connection with this last observation, savers display positive comovement between durable and nondurable expenditure, in this model variation. This is because relative price movements have lost traction, due to sticky wages, and the direct channel of transmission of monetary disturbances becomes key in compressing savers' durable expenditure.

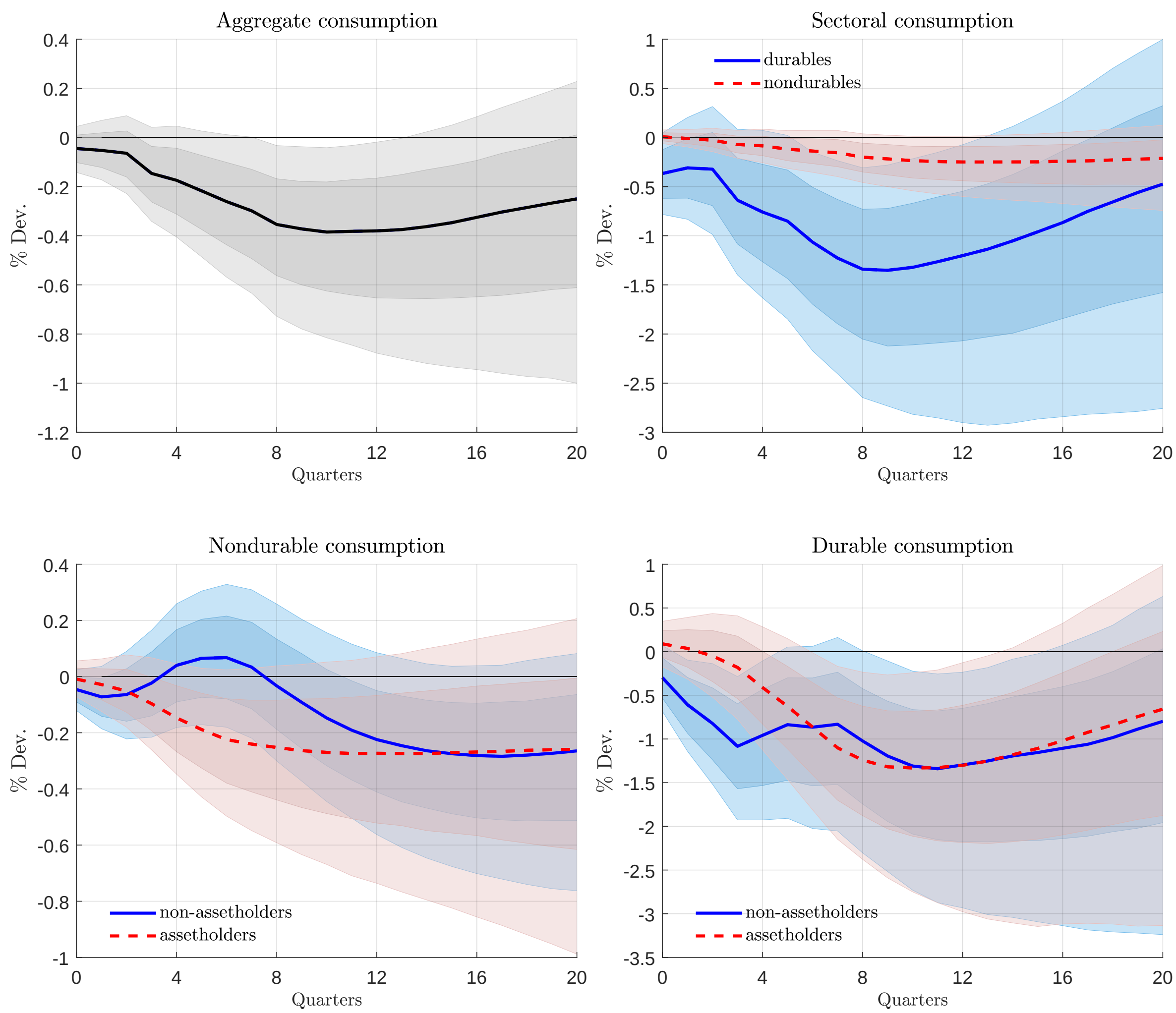
A final yet key consideration is in order. While predominantly affected by different transmission channels, savers and liquidity-constrained households exhibit remarkably similar responses (especially on impact, with savers showing a stronger tendency towards overshooting). Such similarity does not only characterize nondurable consumption, but also durable spending. While previous studies have reported analogous evidence in settings involving a single type of consumption good, as reviewed in the introduction, documenting this fact for inherently more volatile goods as durables is remarkable. The next step consists of putting this model property to the test.

6 Empirical evidence

We have shown that the overall responses of different household types are roughly similar. This is a stark prediction, which we may corroborate empirically. To this end, we employ the data organized by Gaudio et al. (2023), who rely on the U.S. CEX and the SCF to construct durable and nondurable consumption series for assetholders and non-assetholders (see also Malloy et al., 2009). Following Mankiw and Zeldes (1991), a household is defined to be an assetholder if the dollar value of held assets (namely, stocks, bonds, and mutual funds) together with liquid accounts, such as savings and checking accounts, exceeds 1000$. Further details about household data and the construction of household-specific consumption series are reported in Appendix H.

A vast body of literature has employed identified VARs to assess the reaction of aggregate macroeconomic variables to monetary policy shocks (see, e.g., Christiano et al., 1999). We formulate a 7-variable VAR model that includes detrended total expenditure, durable and nondurable expenditure, as well as assetholders' and non-assetholders' durable and nondurable

Figure 8: Consumption and monetary shocks



Note: The figure displays the responses to a monetary tightening of aggregate consumption (upper-left panel), durable and nondurable consumption (upper-right panel), assetholders' and non-assetholders' nondurable (bottom-left panel) and durable (bottom-right panel) consumption. Dark and light shaded areas represent the 68% and 90% confidence intervals, respectively.

expenditure. To identify the impact of a monetary policy innovation, we employ the Romer and Romer (2004) proxy updated by Wieland and Yang (2020) as an internal instrument within our VAR (see Plagborg-Møller and Wolf, 2021). The VAR is estimated over the 1982:Q3-2007:Q3 sample, the start date being determined by the availability of household-level data, and the end date by the availability of the monetary-policy proxy. We include 8 lags and estimate the model using Bayesian techniques with standard Minnesota priors. The impulse responses correspond to a 1-standard deviation contractionary shock to monetary policy, and are calculated from 5000 replications of the Gibbs sampler.

The shock induces a contraction in aggregate consumption, reaching a peak after 2 years (see the upper-left panel of Figure 8). In the upper-right panel, we report the response of durable expenditure and nondurable consumption. The former displays higher interest-rate sensitivity, reaching a peak response more than five times larger than that of nondurables. This is in line with previous studies employing sectoral data, such as Erceg and Levin (2006) and Monacelli (2009). In the bottom row of the figure, we depict the response of durables and nondurables for the two household groups. Apart from minor differences over the initial periods after the shock realizes, the responses of assetholders and non-assetholders are remarkably similar, in both shape and magnitude. The peak responses are in fact virtually identical for both types of expenditure. From such a viewpoint, the empirical evidence seems to be supportive of the predictions from the economy featuring nominal wage stickiness (see Figure 7). Noticeably, these results contrast with marked heterogeneity in the responses to monetary policy of households sorted based on alternative characteristics, such as housing tenure (see, e.g., Cloyne et al., 2019).[21]

Does this mean heterogeneity is irrelevant for the aggregate transmission of monetary policy shocks? Far from it. In fact, it is precisely because of household heterogeneity and how it enables various transmission channels to play significant roles for different types of households, that we are able to rationalize what would otherwise seem like a surprisingly similar response from subsets of households that are *a priori* quite distinct. Our evidence confirms that indirect effects prove crucial in bringing the overall responsiveness of liquidity-constrained agents—in terms of both durable and nondurable expenditure—in line with that of savers, who are most sensitive to the interest-rate channel.

[21] Notice that our results remain robust to controlling for housing tenure, as well as other socioeconomic characteristics, within the two groups of households (along the lines of Kehoe et al. (2020) and Gaudio et al. (2023)). This confirms that housing tenure does not necessarily map to liquidity considerations (in line with Kaplan et al., 2014).

7 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, decomposing expenditure responses to a monetary policy shock into direct (interest-rate) and indirect (general-equilibrium) effects. Indirect effects are further decomposed into the response of spending in either type of good that can be ascribed to relative-price changes, and to general-equilibrium changes in other income components. Interest-rate effects make up a sizable fraction of the response of durables and, in turn, that of aggregate consumption. However, pure income effects dominate the responses of both types of expenditure. Moreover, pure income effects are key to undoing negative comovement that would otherwise stem from changes in the relative price of the two goods.

Despite the dominance of general-equilibrium effects, it is important to recall that, even when displaying similar reactiveness with respect to their good-specific expenditures, savers and liquidity-constrained agents respond to fundamentally different *stimuli*. In fact, while the former denote a strong attitude towards intertemporal substitution, the latter are extremely sensitive to pure income effects. This aspect, in conjunction with the dominant role of durables for business-cycle volatility—as well as the transmission of monetary shocks—renders the lessons learned in this paper rather relevant for deepening our understanding of monetary transmission, both in the dynamic and the cross-sectional dimension.

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Appendix

A Endogenous grid method

A.1 Model setup

Households face the following optimization problem:

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

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. The utility and the adjustment cost functions are

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

A.2 First-order and envelope conditions

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

$$
\begin{aligned}
V_t\left(z_t, B_t, D_t\right) = \max_{B_{t+1}, D_{t+1}} \quad & u\left(z_t + \left(1 + r_t\right) B_t - Q_t\left(D_{t+1} - (1-\delta) D_t\right) - \Psi\left(D_{t+1}, D_t\right) - B_{t+1}, D_t\right) \\
& + \mu_t D_{t+1} + \lambda_t\left(B_{t+1} - \underline{B}\right) + \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right),
\end{aligned} \tag{A.3}
$$

where μ_t and λ_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

$$
\begin{aligned}
\partial_{C_t} u(C_t, D_t)\left(Q_t + \partial_{D_{t+1}} \Psi\left(D_{t+1}, D_t\right)\right) = \mu_t + \partial_{D_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right), \\
\partial_{C_t} u(C_t, D_t) = \lambda_t + \partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right).
\end{aligned} \tag{A.4}
$$

The envelope conditions are

$$\partial_{B_t} V_t\left(z_t, B_t, D_t\right)=\left(1+r_t\right) \partial_{C_t} u(C_t, D_t),$$
$$\partial_{D_t} V_t\left(z_t, B_t, D_t\right)=\partial_{D_t} u(C_t, D_t)+\partial_{C_t} u(C_t, D_t)\left[Q(1-\delta)-\partial_{D_t} \Psi\left(D_{t+1}, D_t\right)\right]. \tag{A.5}$$

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

$$W_t\left(z_t, B_{t+1}, D_{t+1}\right) \equiv \beta \mathbb{E}_t V_{t+1}\left(z_t, B_{t+1}, D_{t+1}\right). \tag{A.6}$$

A.3 Main equations of the algorithm

First, we combine the two equations in (A.4) to obtain

$$\frac{\mu_t+\partial_{D_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)}{\lambda_t+\partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)}=Q_t+\alpha\left(\frac{D_{t+1}}{D_t}-(1-\delta)\right). \tag{A.7}$$

From the F.O.C. wrt. B_{t+1} in eq. (A.4) we can pin down nondurable consumption:

$$\frac{\partial u(C_t, D_t)}{\partial C_t}=\lambda_t+\partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)$$
$$\Rightarrow C_t=\left[\frac{1}{\theta}\left(\lambda_t+\partial_{B_{t+1}} \beta \mathbb{E} V_{t+1}\left(z_{t+1}, B_{t+1}, D_{t+1}\right)\right) D_t^{(\theta-1)(1-\sigma)}\right]^{\frac{1}{\theta(1-\sigma)-1}}. \tag{A.8}$$

A.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 Π. The value functions have a common $z' \rightarrow z$ so the post-decision functions are:

$$W_B\left(z, B', D'\right)=\beta \Pi V_B\left(z', B', D'\right),$$
$$W_D\left(z, B', D'\right)=\beta \Pi V_D\left(z', B', D'\right). \tag{A.9}$$

3. Find $D'(z, B', D)$ for the *unconstrained* case using eq. (A.7):

$$\frac{W_D\left(z, B', D'\right)}{W_B\left(z, B', D'\right)}=Q+\alpha\left(\frac{D'}{D}-(1-\delta)\right). \tag{A.10}$$

4. Use $D'(z,B',D)$ to map $W_B(z,B',D')$ into $W_B(z,B',D)$ by interpolation. Then compute consumption by using eq. (A.8):

$$C(z,B',D) = \left(W_B\left(z,B',D\right) D^{\theta-1} \cdot D^{(1-\theta)\sigma}\right)^{\frac{1}{\theta(1-\sigma)-1}}. \tag{A.11}$$

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

$$B\left(z,B',D\right) = \frac{C\left(z,B',D\right) + Q\left(D'\left(z,B',D\right) - (1-\delta)\,D\right) + B' + \Psi\left(D'(z,B',D),D\right) - z}{1+r}. \tag{A.12}$$

6. Invert $B(z,B',D)$ to obtain $B'(z,B,D)$ 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 eq. (A.7). For scaling, define $\kappa \equiv \lambda / W_B(z,\underline{B},D')$. Then eq. (A.7) becomes

$$\frac{1}{1+\kappa}\frac{W_D\left(z,\underline{B},D'\right)}{W_B\left(z,\underline{B},D'\right)} = Q + \alpha\left(\frac{D'}{D} - (1-\delta)\right). \tag{A.13}$$

8. Use eq. (A.13) to solve for $D'(z,\kappa,D)$, that is over a grid of κ values. Then compute consumption as

$$C(z,\kappa,D) = \left((1+\kappa)W_B\left(z,\kappa,D\right) D^{\theta-1} \cdot D^{(1-\theta)\sigma}\right)^{\frac{1}{\theta(1-\sigma)-1}}. \tag{A.14}$$

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

$$B(z,\kappa,D) = \frac{C(z,\kappa,D) + Q\left(D'(z,\kappa,D) - (1-\delta)\,D\right) + \underline{B} + \Psi\left(D'(z,\kappa,D),D\right) - z}{1+r}. \tag{A.15}$$

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:

$$C(z,B,D) = z + (1+r)\,B - Q\left(D'(z,B,D) - (1-\delta)\,D\right) - \Psi\left(D',D\right) - B'(z,B,D). \tag{A.16}$$

12. Update $\partial_B V(z, B, D)$ and $\partial_D V(z, B, D)$ using the envelope conditions from eq. (A.5):

$$\begin{aligned} \partial_B V(z, B, D) &= (1+r)\,\partial_C u(C, D), \\ \partial_D V(z, B, D) &= \partial_D u(C, D) - \partial_C u(C, D)\left[Q(1-\delta) + \partial_D \Psi(D', D)\right]. \end{aligned} \tag{A.17}$$

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 ≈ 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 ≈ 0 (see Appendix B). Outside the steady state, one can simply simulate forward given a path length (used to obtain Jacobians).

B Stationary steady state

The distribution is obtained by relying on the deterministic histogram method of Young (2010). Given guesses for β, Q, 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. Given a calibration target for Y_d (which is set to 0.5), we pin down $A_d = Y_d/N_d$;[1]
4. We obtain $w_d = A_d \cdot \frac{\epsilon_d - 1}{\epsilon_d}$ from the durable-goods sector Phillips curve;
5. 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;
6. From the nondurable-goods sector Phillips curve we can pin down $A_n = w_n \cdot \frac{\epsilon_n}{\epsilon_n - 1}$;
7. We set $Y_n = 1 - Q \cdot Y_d$, such that total output, $Y = 1$;
8. We then obtain employment in the nondurable-goods sector as $N_n = Y_n/A_n$;
9. We get dividends from eq. (11), $Div(Y_n, Y_d, Q, w_n, w_d)$;
10. Taxes are pinned down as $\tau = r \cdot B^g$.

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

As we pin down all variables from aggregate relationships, it is then possible to solve the household problem to obtain C_n, C_d, B, and check root-finding target residuals. Thus, after root-finding, we set ψ_N given w_n, C_n, C_d and the parameters, such that the wage schedule, eq. (4), holds in the steady state.

C Sequence space formulation for impulse responses

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

$$H\left(N_{n,t}, N_{d,t}, \Pi_{n,t}, Q_t, w_{n,t}, u_t^r\right) = \begin{pmatrix} \text{Wage schedule} \\ \text{NKPC durables} \\ \text{NKPC nondurables} \\ \text{Bonds market} \\ \text{Goods market durables} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \tag{C.1}$$

Denoting the aggregate solution variables with $\mathcal{B}, \mathcal{C}_n, \mathcal{C}_d, \mathcal{D}$, the system can be reported as

$$H\left(N_{n,t}, N_{d,t}, \Pi_{n,t}, Q_t, w_{n,t}, u_t^r\right) = \begin{pmatrix} w_{n,t} - \psi_N N_t^{\varphi} \frac{1}{\theta} \left(\mathcal{C}_{n,t}^{\theta} \mathcal{D}_t^{1-\theta}\right)^{\sigma} \left(\frac{\mathcal{C}_{n,t}}{\mathcal{D}_t}\right)^{1-\theta} \\ (1-\epsilon_d) + \epsilon_d w_{d,t}/A_n - \xi_d \left(\Pi_{d,t} - 1\right) \Pi_{d,t} + \beta \xi_d \left(\Pi_{d,t+1} - 1\right) \Pi_{d,t+1} \frac{Y_{d,t+1}}{Y_{d,t}} \\ (1-\epsilon_n) + \epsilon_n w_{n,t}/A_d - \xi_n \left(\Pi_{n,t} - 1\right) \Pi_{n,t} + \beta \xi_n \left(\Pi_{n,t+1} - 1\right) \Pi_{n,t+1} \frac{Y_{n,t+1}}{Y_{n,t}} \\ \mathcal{B}_t - B^g \\ Y_{d,t} - \mathcal{C}_{d,t} \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \tag{C.2}$$

where we have

$$\Pi_{d,t} = \frac{Q_t}{Q_{t-1}} \Pi_{n,t} \tag{C.3}$$

$$Y_{n,t} = A_n N_{n,t} \tag{C.4}$$

$$Y_{d,t} = A_d N_{d,t} \tag{C.5}$$

$$N_t = N_{n,t} + N_{d,t} \tag{C.6}$$

$$w_{d,t} = Q_t^{-1} w_{n,t} \tag{C.7}$$

$$Div_t = Y_{n,t} - w_{n.t} N_{n,t} + Q_t \left[Y_{d,t} - w_{d,t} N_{d,t} \right] \tag{C.8}$$

$$\tilde{\Pi}_t = \Pi_{n,t}^{1-\gamma} \Pi_{d,t}^{\gamma} \tag{C.9}$$

$$i_t = u_t^r + \phi_{\tilde{\pi}} \tilde{\pi}_t \tag{C.10}$$

$$r_t = \frac{1 + i_{t-1}}{1 + \pi_{n,t}} - 1 \tag{C.11}$$

$$\tau_t = r_t B_g \tag{C.12}$$

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

D Sequence space formulation with deficit financing

All targets and variables stay the same as in Appendix C. The only difference is that we replace equation (C.12) with

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

where it has to hold that

$$\left(1 + r_t\right) B_{t-1}^g = \tau_t + B_t^g. \tag{D.2}$$

Thus, we use a root-finder to solve for the path of B_t^g consistent with eq. (D.2), nested in the sequence space formulation. For further details, see Appendix C.5 in Auclert et al. (2021). The model can then be solved in sequence space, as described in Appendix C.

E Sequence space formulation with sticky wages

In sequence space, the model with the wage Phillips curve can be summarized by the equation system

$$H\left(N_{n,t},N_{d,t},\Pi_{n,t},Q_t,w_{n,t},u_t^r\right)=\begin{pmatrix}\text{Wage Phillips curve}\\ \text{Phillips curve durables}\\ \text{Phillips curve nondurables}\\ \text{Bonds market clearing}\\ \text{Durable goods market clearing}\end{pmatrix}=\begin{pmatrix}0\\0\\0\\0\\0\end{pmatrix} \tag{E.1}$$

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

$$H\left(N_{n,t},N_{d,t},\Pi_{n,t},Q_t,w_{n,t},u_t^r\right)=$$
$$\begin{pmatrix}(1-\epsilon_w)\,w_{n,t}+\epsilon_w\frac{U'_{\mathcal{N}}(N_t)}{U'_{C_n}(\mathcal{C}_{n,t},\mathcal{D}_t)}-\xi_w\left(\Pi_{w,t}-1\right)\Pi_{w,t}+\beta\xi_w\left(\Pi_{w,t+1}-1\right)\Pi_{w,t+1}\frac{N_{t+1}}{N_t}\\ (1-\epsilon_d)+\epsilon_d w_{d,t}/A_n-\xi_d\left(\Pi_{d,t}-1\right)\Pi_{d,t}+\beta\xi_d\left(\Pi_{d,t+1}-1\right)\Pi_{d,t+1}\frac{Y_{d,t+1}}{Y_{d,t}}\\ (1-\epsilon_n)+\epsilon_n w_{n,t}/A_d-\xi_n\left(\Pi_{n,t}-1\right)\Pi_{n,t}+\beta\xi_n\left(\Pi_{n,t+1}-1\right)\Pi_{n,t+1}\frac{Y_{n,t+1}}{Y_{n,t}}\\ \mathcal{B}_t-B^g\\ Y_{d,t}-\mathcal{C}_{d,t}\end{pmatrix}=\begin{pmatrix}0\\0\\0\\0\\0\end{pmatrix} \tag{E.2}$$

where we have

$$\Pi_{d,t}=\frac{Q_t}{Q_{t-1}}\Pi_{n,t} \tag{E.3}$$

$$\Pi_{w,t}=\frac{w_{n,t}}{w_{n,t-1}}\cdot\Pi_{n,t} \tag{E.4}$$

$$Y_{n,t}=A_nN_{n,t} \tag{E.5}$$

$$Y_{d,t}=A_dN_{d,t} \tag{E.6}$$

$$N_t=N_{n,t}+N_{d,t} \tag{E.7}$$

$$w_{d,t}=Q_t^{-1}w_{n,t} \tag{E.8}$$

$$Div_t=Y_{n,t}-w_{n.t}N_{n,t}+Q_t\left[Y_{d,t}-w_{d,t}N_{d,t}\right] \tag{E.9}$$

$$\tilde{\Pi}_t = \Pi_{n,t}^{1-\gamma}\Pi_{d,t}^{\gamma} \tag{E.10}$$

$$i_t = u_t^r + \phi_{\tilde{\pi}}\tilde{\pi}_t \tag{E.11}$$

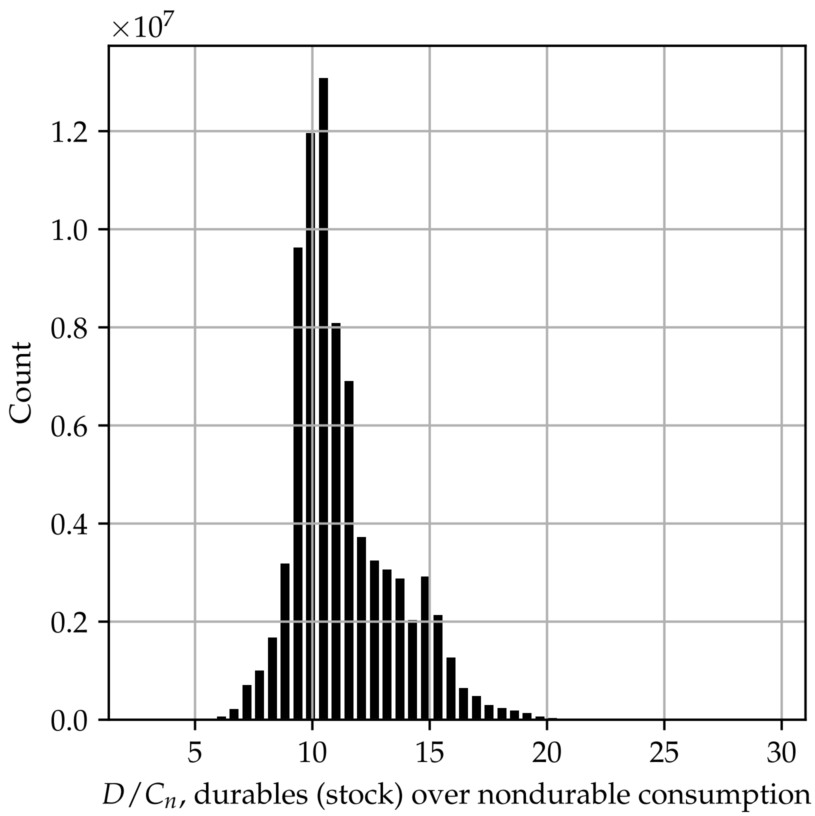
$$r_t = \frac{1+i_{t-1}}{1+\pi_{n,t}} - 1 \tag{E.12}$$

$$\tau_t = r_t B_g \tag{E.13}$$

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

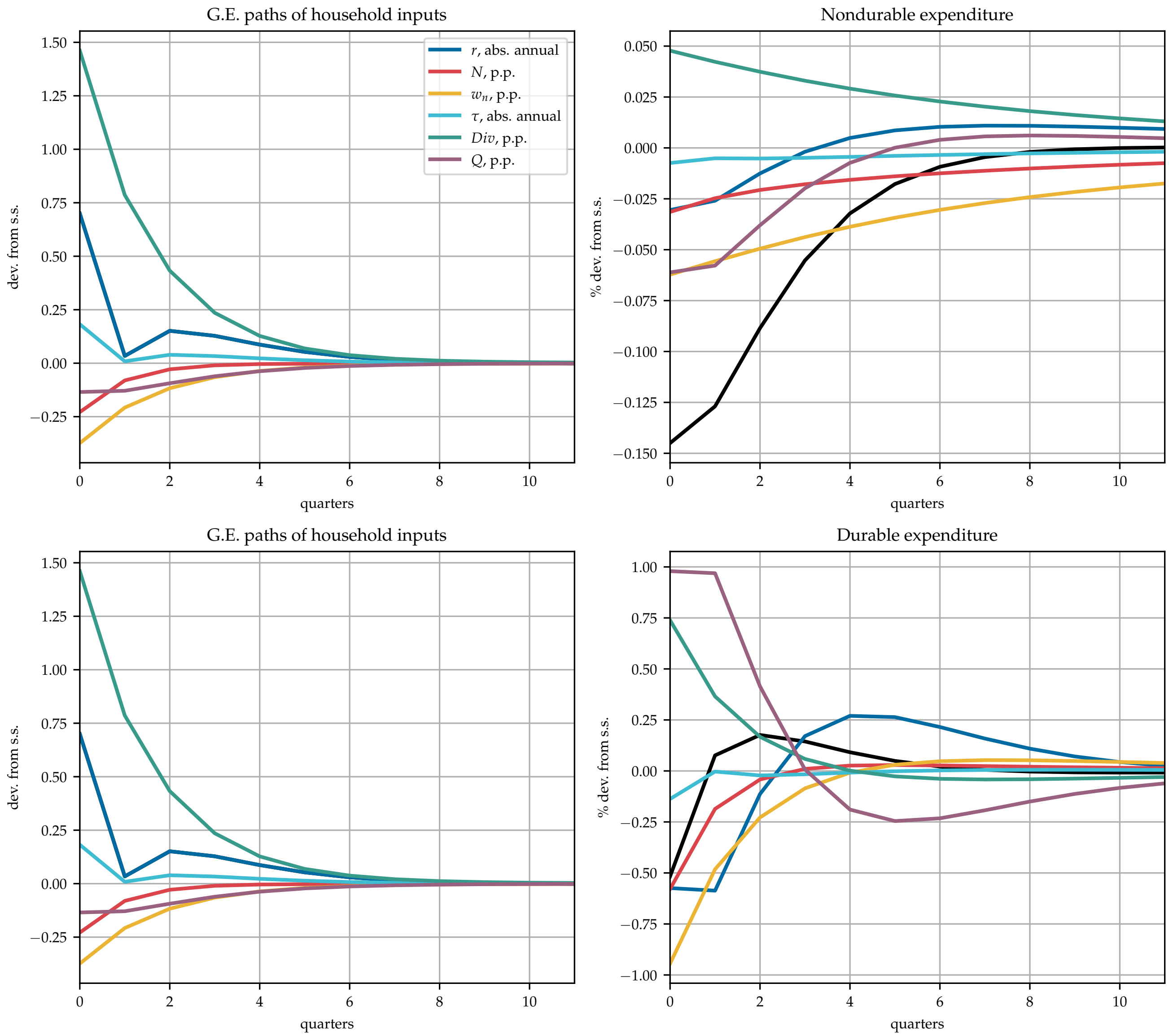
F Additional figures and tables

Figure F1: Histogram of the ratio between the steady-state stock of durables and nondurable consumption



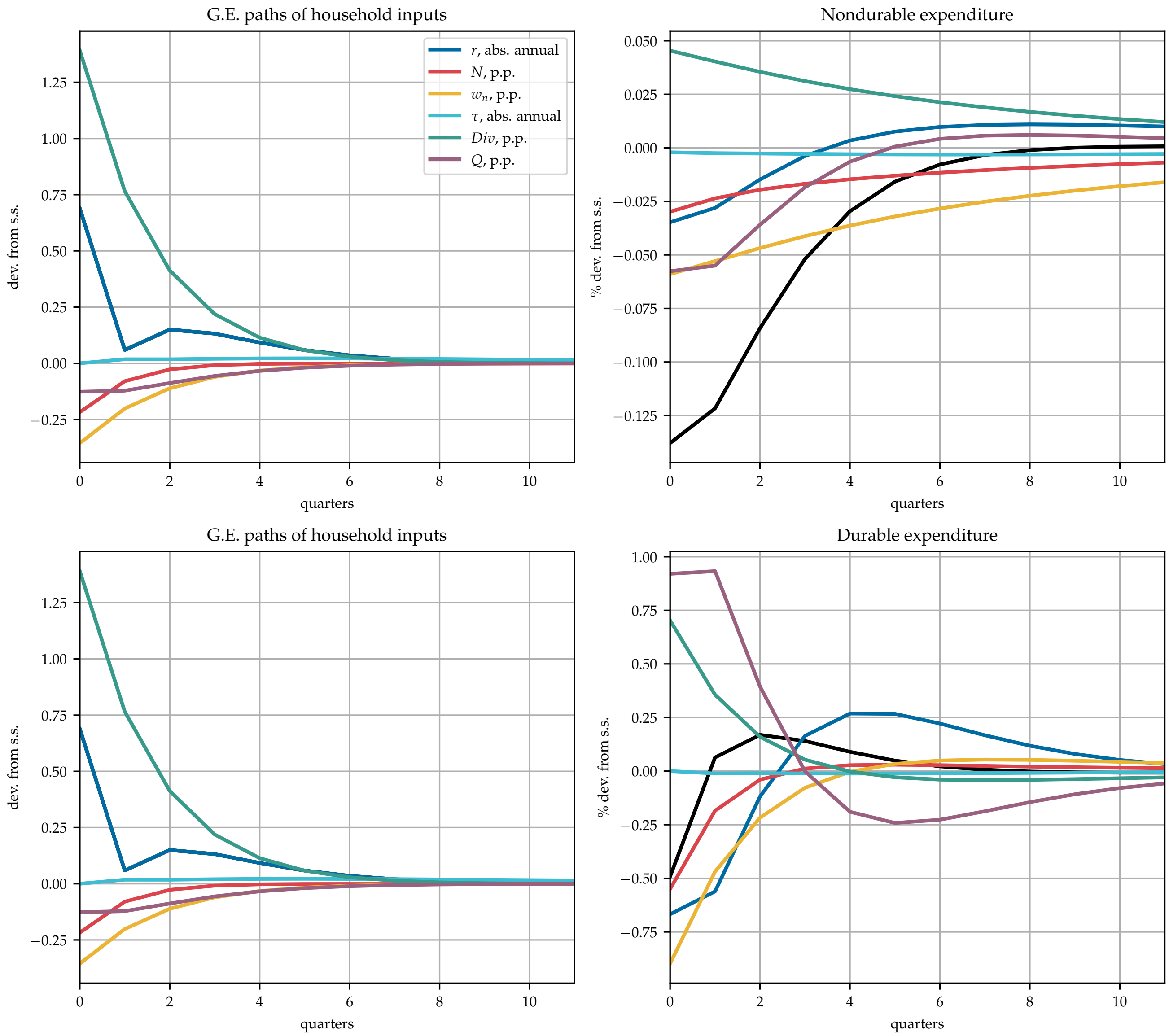
Note: To generate the histogram, we Monte Carlo simulate the steady-state household distribution using 2D linear interpolation over the policy functions. We simulate 80.000 households for 2.000 periods, and discard the first 1.000 periods. We use 50 bins for plotting.

Figure F2: Detailed expenditure response decomposition



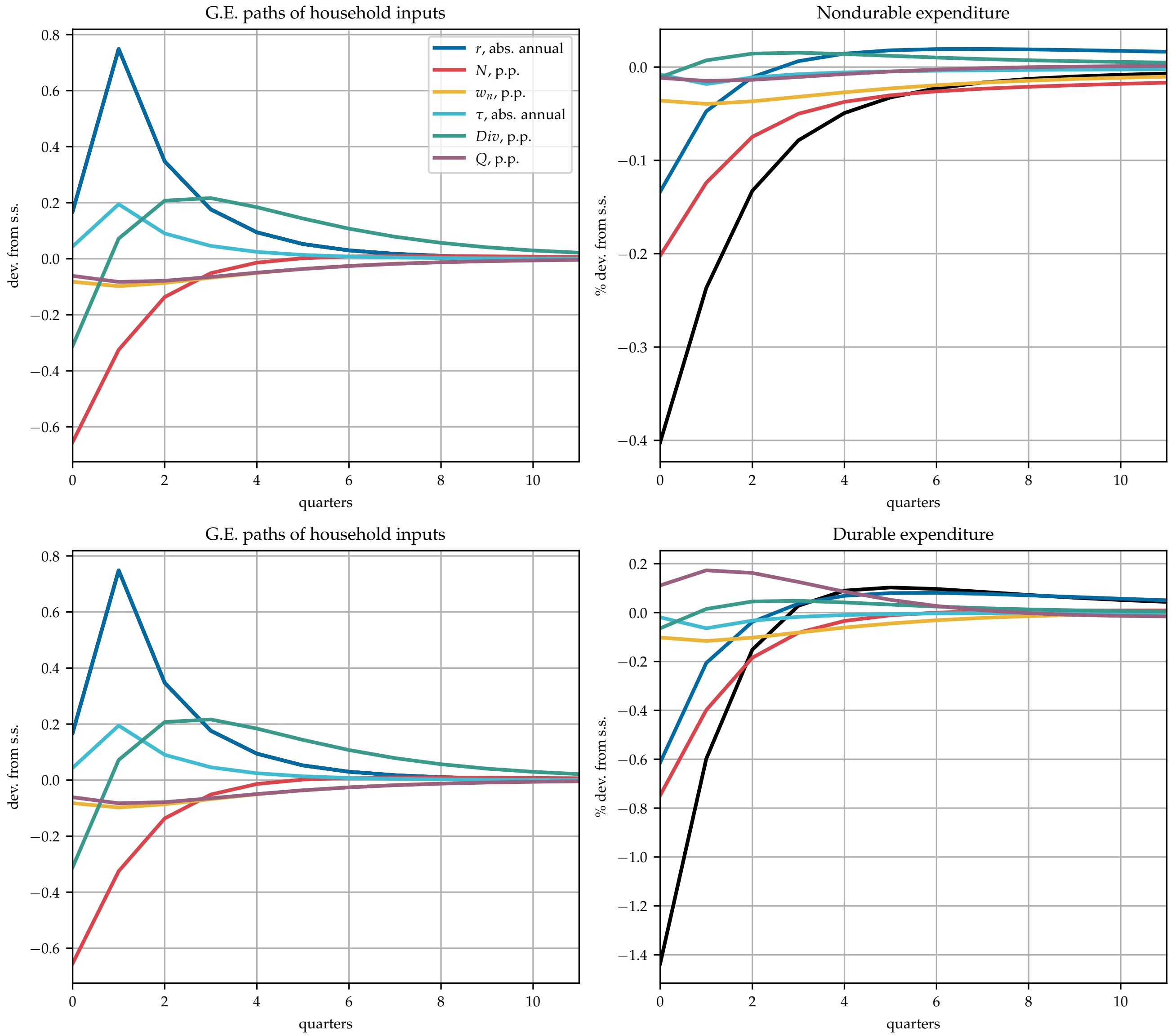
Note: Absolute annual deviations are calculated for visualization purposes.

Figure F3: Detailed expenditure response decomposition under deficit financing



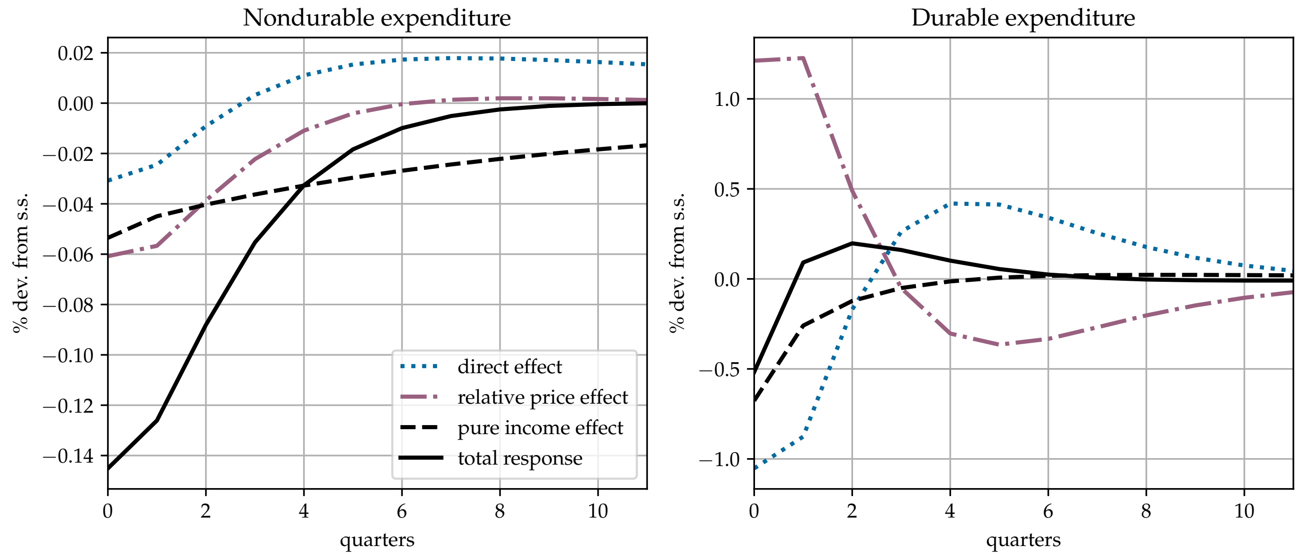
Note: Absolute annual deviations are calculated for visualization purposes.

Figure F4: Detailed expenditure response decomposition under sticky wages



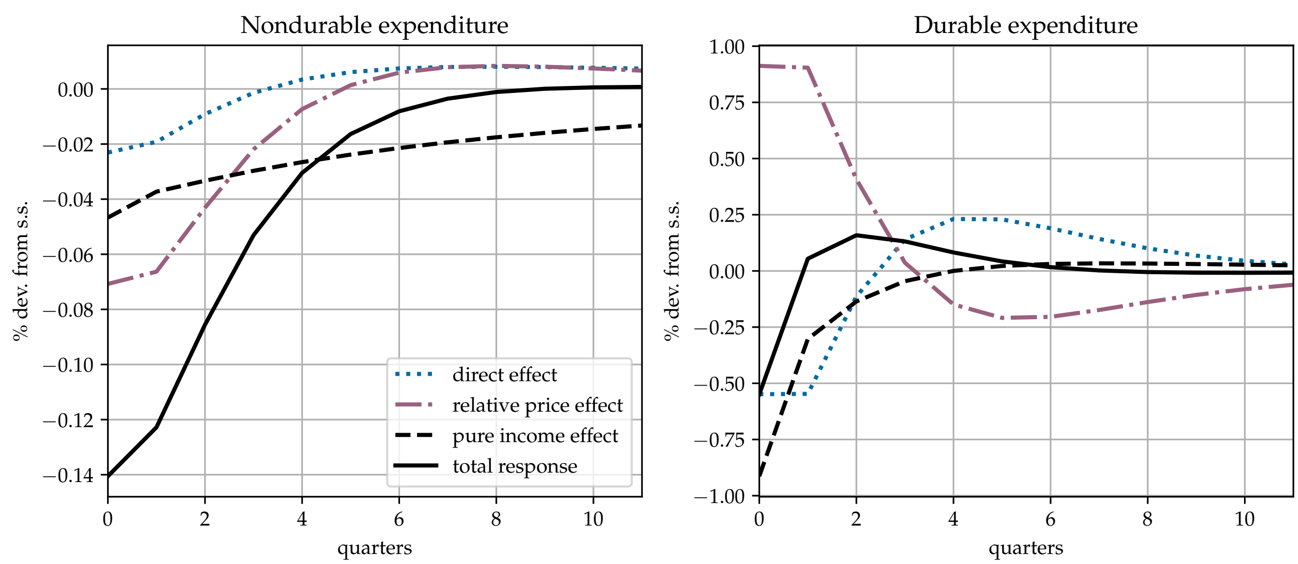
Note: Absolute annual deviations are calculated for visualization purposes.

Figure F5: Expenditure response decomposition, income process à la Kaplan et al. (2018)



Note: Decomposition of the response of nondurable and durable expenditure into direct, relative-price and pure income effects in a model based on a process for household-level productivity à la Kaplan et al. (2018)—whereby log-earnings are conceived as the sum of two independent components, one transitory and one persistent. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

Figure F6: Expenditure response decomposition, uniform redistribution scheme



Note: Decomposition of the response of nondurable and durable expenditure into direct, relative-price and pure income effects in a model based on a uniform profit-redistribution scheme. We consider a 0.25% monetary-policy innovation occurring at $t = 0$.

G Model with sticky wages

We replace the wage schedule equation, eq. (4), with a wage Phillips curve, 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

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

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

$$\mathcal{N}(s)_t = \mathcal{N}\left(W(s)_t; W_t, N_t\right) = \left(\frac{W(s)_t}{W_t}\right)^{-\epsilon_w} N_t \tag{G.2}$$

for the sth household, and where the equilibrium nominal wage amounts to

$$W_t = \left(\int_0^1 \exp\{e(s)_t\} W(s)_t^{1-\epsilon_w} ds \right)^{\frac{1}{1-\epsilon_w}}. \tag{G.3}$$

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:

$$\mathcal{C}_w(\cdot) = \exp\left\{e(s)_t\right\} \frac{\xi_w}{2} \left(\frac{W_{it}}{W_{it-1}} - 1\right)^2 N_t, \tag{G.4}$$

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

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

This problem yields a wage Phillips curve:[2]

$$(1-\epsilon_w) w_{n,t} + \epsilon_w \frac{U'_{\mathcal{N}}\left(N_t\right)}{U'_{C_n}\left(C_{n,t}, D_t\right)} - \xi_w\left(\Pi_{w,t} - 1\right)\Pi_{w,t} + \beta\xi_w\left(\Pi_{w,t+1} - 1\right)\Pi_{w,t+1}\frac{N_{t+1}}{N_t} = 0, \tag{G.5}$$

[2]See Hagedorn et al. (2019).

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

The steady state is solved as described in Appendix B: however, instead of varying ψ_N such that the wage schedule, eq. (4), holds in the steady state, we vary it to ensure that the steady-state wage Phillips curve holds. As for the dynamic solution, we refer the reader to Appendix E.

H Consumer spending data

We now describe how we retrieve the expenditure series pertaining household groups with and without holdings of liquid financial assets.[3] Non-assetholders are typically pictured as holding very little liquid financial assets. In light of this, we follow Mankiw and Zeldes (1991), and set the threshold of holdings of assets plus liquid accounts at 1000$. As extensively described in Gaudio et al. (2023), sorting protocols alternative to the one used here have been implemented, leading to no qualitatively different regression outcomes.

To estimate group-specific consumption expenditure in nondurables and durables, we complement information available from the Consumer Expenditure Survey (CEX) over the sample 1980-2017 with that available from the Survey of Consumer Finances (SFC) (sample: 1989-2016).[4] The CEX collects information on whether a household holds "stocks, bonds, mutual funds and other such securities", along with checking and savings accounts. However, it does not encompass indirect assetholdings, with the likely implication of underestimating households' participation in financial markets. To overcome such limitation, we implement an imputation procedure similar to the one employed by Attanasio et al. (2002) and Malloy et al. (2009). Using SCF data, we devise a probit model for the probability of a household holding assets, directly or indirectly, based on a set of observables that are also available through the CEX. Age and education (as well as the interaction term between the two), race (white or non-white), year dummies, (log) income, and a dummy variable capturing whether the household earns any financial income (defined as dividend plus interest income) are included. The assetholding status is captured by a dummy taking value 1 if (direct or indirect) holdings of stocks, bonds, and liquid accounts exceed the threshold of 1000$. The estimated coefficients are then used to predict the probability that a household in the CEX holds assets.[5]

[3] We refer the reader to Gaudio et al. (2023), for a detailed description of the dataset and the restrictions applied to the original sample.

[4] Produced by the Bureau of Labor Statistics (BLS), the CEX is a annual U.S. survey featuring household-level data on consumption expenditure—along with income and other financial and demographic information—on a sample that is designed to represent the non-institutionalized civilian population. The SCF, instead, is an independent triennial survey run by the Federal Reserve that collects detailed information on income and wealth holdings of U.S. households, while not including consumption expenditure.

[5] The imputation only applies to households who have valid responses to questions connected with all variables used in the regression with CEX data. If this prerequisite is not met, the household is imputed an assetholding

The next step consists of building representative-household series of expenditure in both nondurable goods and services, as well as on durable goods. Nondurables and services consist of food, alcoholic beverages, apparel and services, gasoline and motor oil, household operations, utilities, tobacco, public transportation, fees and admissions, personal care products, reading, other vehicle expenses, and other entertainment supplies, equipment, and services. Durable-good expenditure contemplates purchases of vehicles, house furnishings, and TV and audio equipment.

Gaudio et al. (2023) construct a raw measure of per-capita assetholders' consumption (of either good) by multiplying households' population-weighted consumption by the estimated probability of holding assets in amounts that exceed the 1000$ threshold, and divide this by the total population of assetholders and the Consumer Price Index (CPI). Per-capita non-assetholders' variables are constructed in a symmetric way, using the complement to one of the imputed assetholding probability. Thus, in every quarter the group-level series are adjusted by the ratio of the corresponding National Income and Product Accounts (NIPA) aggregate to the corresponding aggregate from the CEX. The adjusted series are then smoothed through a backward-looking moving average,[6] so as to deal with seasonal adjustment and the noise that typically characterizes survey data.

probability equal to zero.

[6]This includes both the current and the previous three quarters.