Aggregate Demand and the Cyclical Distribution of Income*

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Abstract

I study how supply and demand shocks affect aggregate demand through the distribution of labor income and profits in a small open economy with heterogeneous households and sticky prices and wages. I show that a markup shock, which is neutral in a representative-agent model at a constant real interest rate, becomes contractionary when workers have higher marginal propensities to consume (MPCs) than firm owners. Price and wage rigidities determine the redistribution of income through markups, while differences in MPCs out of labor income and profits determine its effect on aggregate demand. This mechanism is also important for the transmission of other supply shocks, such as import price shocks, but plays a smaller role for demand shocks. The reason is that demand shocks primarily operate through the wage Phillips curve, whereas supply shocks operate through the price Phillips curve, which is typically steeper.

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1 Introduction

Changes in prices and wages not only affect the purchasing power of households but also determine how income is divided between workers and firm owners. This is particularly relevant during inflationary episodes, when consumer prices may rise considerably faster than nominal wages, shifting income away from workers and toward profits. While such changes in the distribution of income are a natural consequence of nominal rigidities, their implications for aggregate economic activity are less well understood. To what extent does the distribution of income between labor and profits matter for aggregate demand?

Standard New Keynesian models offer a useful starting point for answering this question. In the representative-agent economy, an inflationary markup shock reduces output when monetary policy raises the real interest rate in order to bring down inflation. If the real interest rate is instead held constant, the shock has no first-order effect on output. Although higher markups redistribute income from wages to profits, the representative household ultimately receives both sources of income, leaving permanent income and consumption unchanged. This neutrality result is useful precisely because it isolates a potentially important channel that is absent from the representative-agent benchmark: income accruing to different households need not generate the same spending response.

In this paper, I show that the distribution of income between workers and firm owners can be central to the transmission of aggregate shocks. When labor income accrues disproportionately to households with high marginal propensities to consume (MPCs), while profits accrue to households with low MPCs, a rise in prices relative to nominal wages shifts purchasing power toward households that spend less of an additional unit of income in the short run. Aggregate demand then falls even when the real interest rate is unchanged. Two features determine the strength of this mechanism: i) how much income is redistributed, which depends on the relative adjustment of prices and wages, and ii) how marginal spending responses differ across recipients, which depends on the distribution of income and wealth across households.

Environment. To study these mechanisms, I develop a New Keynesian small open economy model with heterogeneous households facing idiosyncratic income risk and incomplete financial markets (Bewley 1986; Imrohoroğlu 1989; Huggett 1993; Aiyagari 1994). Domestic firms use labor and intermediate inputs in production, while nominal prices and wages adjust sluggishly. Because firm profits are distributed unequally across households, changes in the division of income between wages and profits directly affect aggregate demand. I linearize the model in sequence-space (Auclert et al. 2024d; Auclert et al. 2024b), which allows me to characterize the effects of shocks in terms of the income transfers they generate and the corresponding consumption responses. The analytical results hold the real interest rate constant and assume Leontief production to isolate redistribution from intertemporal and input-substitution effects. To the best of my knowledge, this paper is the first to analytically characterize the aggregate demand effects of worker–firm redistribution in a HANK model with both sticky prices and wages. Existing analytical frameworks typically assume flexible prices and sticky wages, thus keeping markups constant and eliminating endogenous redistribution through profits (Auclert et al. 2024d), or impose an equal incidence of labor income and profits across households (Angeletos et al. 2024b), making changes in factor income shares irrelevant for aggregate demand.

By allowing both nominal rigidities and unequal income incidence, I characterize how price and wage adjustment jointly determine redistribution and its effects on aggregate demand.

Markup shocks and the MPC gap. The role of income redistribution in aggregate demand is most clearly illustrated by an aggregate markup shock. When nominal wages adjust more slowly than prices, a positive markup shock lowers real wages and raises profits, transferring income from workers to firm owners. Let $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ denote the intertemporal MPC matrices whose (t, s) entries give the date-t aggregate consumption response to a change in labor income or profits at date s (Auclert et al. 2024d). The equilibrium output response to a sequence of markup shocks $\mathrm{d}\boldsymbol{\mu}$ can then be expressed as

$$\mathrm{d}\mathbf{Y} = - \underbrace{\mathscr{M}}_{\text{GE multiplier}} \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]}_{\text{MPC gap}} \underbrace{\boldsymbol{\Theta}^P \, \mathrm{d}\boldsymbol{\mu}}_{\text{Transfer to firm owners}}. \tag{1}$$

The pass-through matrix $\boldsymbol{\Theta}^P$ captures how shocks to desired markups translate into changes in realized markups through the adjustment of prices and wages, thereby determining the transfer from workers to firm owners. Its magnitude depends on the relative slopes of the price and wage Phillips curves: greater price flexibility increases the transfer, while greater wage flexibility reduces it as nominal wages more closely track prices. With fully flexible wages, nominal wages adjust to keep real wages and realized markups unchanged, eliminating the transfer altogether. The MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ maps this transfer into aggregate spending, while the general equilibrium multiplier $\mathscr{M}$ captures the resulting income feedback. Under equal incidence ($\mathbf{M}^Z = \mathbf{M}^\Pi$), redistribution is neutral. When labor income instead accrues disproportionately to high-MPC households, a positive markup shock reduces aggregate demand and output. I provide empirical evidence for this MPC gap by combining survey-based estimates of household MPCs from Fuster et al. (2021) with detailed information on labor and capital income from the Survey of Consumer Finances. I find that capital and business income are substantially more concentrated among low-MPC households than labor income, implying a higher aggregate MPC out of labor income than profits. This finding is consistent with existing estimates of consumption responses to different income sources (Chodorow-Reich et al. 2021; Kaplan and Violante 2022; Andersen et al. 2024). Moreover, this unequal incidence of profits is a common feature of HANK models, which often assume that firm profits accrue disproportionately to wealthy households or entrepreneurs (e.g., Bayer et al. 2019).

Cumulative effects. The empirical MPC gap discussed above concerns short-run spending responses. Over longer horizons, however, the pattern can reverse: households receiving profits may initially save more of their income but spend it later, so that their MPCs eventually exceed those out of labor income. The intertemporal MPC matrices capture these differences in the timing of consumption, while the household intertemporal budget constraint implies that their discounted columns each sum to one. Redistribution therefore changes when income is spent, but not how much is spent in present-value terms. Consequently, the initial contraction in consumption following a markup shock is eventually offset by higher consumption. In the open economy, the same result extends to aggregate output: the output response has zero net present value in both RANK and HANK. Heterogeneity thus changes the timing of the response,

but not its cumulative discounted effect.[1]

The MPC gap across shocks. While the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ governs the spending effect of worker–firm redistribution across all shocks, the extent and nature of this redistribution differ across supply and demand disturbances. Other supply shocks operate through the same price pass-through channel $\boldsymbol{\Theta}^P$ as a markup shock, while also potentially involving transfers abroad or to the government. An increase in imported material prices reduces domestic income, with the adjustment of prices and wages determining how the loss is divided between workers and firm owners. This distributional effect, captured by $\boldsymbol{\Theta}^P$, accounts for about half of the first-year HANK output decline. At the same time, the transfer of resources abroad lowers the net present value of output by an amount that does not depend on domestic MPC heterogeneity. If materials are instead domestically owned, this foreign leakage disappears and the shock is equivalent to a markup shock. Imported energy, particularly oil, is a natural example of this mechanism, and these results complement other work on the direct effects of energy prices on household expenditure (Pieroni 2023; Auclert et al. 2024a) by highlighting the additional role of energy as a production input and the resulting distribution of income between workers and firm owners.

Supply and demand shocks also differ sharply in the strength and direction of worker–firm redistribution because they operate through different Phillips curves. Supply shocks tend to enter the price Phillips curve directly. When prices are more flexible than nominal wages, they thus generate a sizable transfer from workers to firm owners. Demand shocks instead affect the distribution of income indirectly as changes in economic activity move wages and realized markups. In the baseline sticky-price model, higher labor demand raises nominal wages relative to prices, transferring income toward high-MPC workers and reinforcing the expansion. Because the wage Phillips curve is typically much flatter than the price Phillips curve, however, this redistributive feedback is quantitatively modest. If markups are procyclical in response to demand shocks, as suggested by Nekarda and Ramey 2020, redistribution channel instead dampens the effect of aggregate demand shocks by shifting income toward firm owners, away from workers.

Tariffs provide a natural application of this framework, as they combine elements of both the supply and demand shock mechanisms discussed above. Like other supply shocks, tariffs on imported production inputs raise firms' marginal costs and, as prices adjust more quickly than nominal wages, redistribute income from workers to firm owners. Tariffs on imported consumer goods further reduce households' purchasing power, while tariff revenues transfer resources to the government, potentially offset by transfers to households. At the same time, tariffs generate a positive demand effect through expenditure switching toward domestic goods. The overall effect on output therefore depends on the distribution of income losses across workers and firm owners, the MPCs of households receiving government transfers, and the strength of expenditure switching. The framework thus brings together the distributional, fiscal, and expenditure-switching channels through which tariffs affect aggregate demand.

[1] The zero-NPV output result requires positive imports of final goods or materials. In the absence of both, the standard Keynesian-cross operator is not invertible in my model, and a zero-NPV redistribution shock need not imply a zero-NPV output response (see Auclert et al. 2024d; Sundram 2026).

Related literature. The paper contributes to the large literature on heterogeneous-agent New Keynesian models, which examines how household heterogeneity reshapes the transmission of aggregate shocks (e.g., Werning 2015; Kaplan et al. 2018; Auclert et al. 2020; Luetticke 2021; Auclert et al. 2024d; Angeletos et al. 2024b). Most of this work focuses on monetary or fiscal policy. I contribute by identifying endogenous factor-income redistribution as a distinct and quantitatively important channel through which aggregate shocks transmit to aggregate demand, and by showing that this channel can be characterized in closed form. Additionally, I add to the literature on small open economy HANK models, building on De Ferra et al. (2020), Hong (2020), Oskolkov (2023), Guo et al. (2023), Auclert et al. (2024c), Druedahl et al. (2025), Acharya and Challe (2025) and Druedahl et al. (2026).

On the markup and pricing side, the paper is most closely related to Bilbiie and Känzig (2024), who study whether profit-driven inflation can sustain itself through distributional channels in a TANK framework and identify a tension: procyclical profits accruing to low-MPC asset holders tend to dampen rather than amplify demand. My results complement theirs by demonstrating how factor-income redistribution operates in a full HANK model, by extending the mechanism to an open economy, and by characterizing analytically the role of nominal rigidities in shaping the strength of the channel. More broadly, the paper relates to the literature on inflationary disturbances in heterogeneous-agent models (Cravino et al. 2020; Yang 2022; Pieroni 2023; Diz et al. 2023), which has largely proceeded numerically or used two-agent models as approximations to more general HANK models.

A distinct literature studies commodity price shocks and terms-of-trade dynamics in representative-agent open-economy models (Mendoza 1995; Kose 2002; Blanchard and Gali 2007; Baqaee and Farhi 2024). These frameworks emphasize production costs and external transfers, but abstract from household heterogeneity. I show that once heterogeneity is introduced, factor-income redistribution emerges as an additional channel that is quantitatively important alongside the standard transmission mechanisms. The tariff application extends representative-agent analyses (Auclert et al. 2025b; Monacelli 2025; Bianchi and Coulibaly 2025; Werning et al. 2025) by illustrating how cost pass-through and rebate incidence affect short-run household demand.

Road map. Section 2 develops the model. Section 3 derives the markup-shock benchmark and the associated results. Section 4 extends the analysis to other aggregate shocks, while Section 5 reports the calibration of the quantitative model and provides quantitative decompositions. Section 6 concludes.

2 Model

I consider a small open economy inhabited by a continuum of households and firms. Households consume domestic and foreign tradeable goods and, because capital flows are free, may save in domestic or foreign government bonds, as in Schmitt-Grohé and Martin Uribe (2003) and Gali and Monacelli (2005), but are subject to idiosyncratic earnings risk and credit frictions as in Bewley (1986), Imrohoroğlu (1989), Huggett (1993) and Aiyagari (1994). Domestic firms produce a tradeable good using labor and materials, subject to nominal price frictions. Unions have market power and decide on the labor supply of households subject to nominal wage frictions.

There is no aggregate risk, only unanticipated aggregate shocks, which materialize at date zero, after which all agents in the economy have perfect foresight with respect to aggregate variables (MIT shocks). Time is discrete and indexed by $t \in \{0, 1, \ldots\}$, and one period corresponds to one quarter.

2.1 Households

Consumption-saving problem. While the analytical results I present are general and require little structure on the household problem, it is useful to have a baseline household model in mind for the quantitative analysis. There is a continuum of households with unit measure. Households are subject to idiosyncratic income risk e. They can save in a domestic mutual fund but cannot perfectly insure against idiosyncratic risk due to incomplete credit markets. A household with existing asset position a and idiosyncratic earnings e chooses consumption c and savings a' optimally by solving the recursive problem:

$$V_t(e,a) = \max_{c,a'} u(c) - \xi(L_t) + \beta \mathbb{E}_t V_{t+1}(e',a') \tag{2}$$

s.t.

$$c + a' = \left(1 + r_t^a\right) a + Z_t e + g(e)\,\Pi_t + T_t(e), \tag{3}$$

$$\ln e' = \bar{e} + \rho_e \ln e + \epsilon^e, \quad \epsilon^e \sim \mathcal{N}\left(0, \sigma_e^2\right), \tag{4}$$

$$a' \geq \underline{a}, \tag{5}$$

where $Z_t \equiv \frac{W_t L_t}{P_t}$ denotes real labor income (the product of the real wage W_t/P_t and labor supply L_t), r_t^a is the real return on assets, Π_t denotes real profits received from firms, and $T_t(e)$ denotes a lump sum transfer (or tax if negative) from the government. The constant $\bar{e}$ normalizes the earnings process such that $\mathbb{E}_t\, e = 1$. Profits in eq. (3) are distributed according to a function $g(e)$ which depends on earnings e and integrates to 1, $\int g(e)\,\mathrm{d}\mathscr{D}_t(e,a) = 1$, where $\mathscr{D}_t(e,a)$ denotes the time t endogenous distribution of households over states. Similarly, net transfers $T_t(e)$ are distributed according to an incidence function that integrates to one. In the quantitative baseline, I set $T_t(e) = eT_t$ so that transfers are proportional to idiosyncratic productivity. The functional forms of the utility functions are given by:

$$u(c_t) = \ln c_t, \quad \xi(L_t) = \bar{\xi}\frac{L_t^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}},$$

where $\bar{\xi}$ measures the disutility of supplying labor, and φ denotes the Frisch elasticity. Aggregates are defined by:

$$C_t = \int c_t(e,a)\,\mathrm{d}\mathscr{D}_t(e,a), \qquad A_t = \int a_t(e,a)\,\mathrm{d}\mathscr{D}_t(e,a) \tag{6}$$

Consumption basket. Consumption of goods C_t is a CES aggregate over foreign and domestic goods with elasticity of substitution η:[2]

$$C_t = \left[\alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} + (1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}.$$

The demand functions for $C_{H,t}, C_{F,t}$ are then given by:

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t, \quad C_{F,t} = \alpha\left(\frac{P_{F,t}}{P_t}\right)^{-\eta} C_t, \tag{7}$$

where $P_{H,t}, P_{F,t}$ are the prices of domestic and foreign tradeables in domestic currency units including tariffs, and the CPI (P_t) is defined by:

$$P_t = \left[(1-\alpha)P_{H,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{8}$$

I assume a law of one price such that $P_{F,t} = (1+\tau_t)\mathscr{E}_t P_{F,t}^*$, where $P_{F,t}^*$ denotes foreign export prices, τ_t is the tariff on imports, and $\mathscr{E}_t$ denotes the nominal exchange rate. Note that with this convention, an increase in $\mathscr{E}_t$ indicates a nominal *depreciation* as in Gali and Monacelli (2005).

2.2 Supply side

The supply side is mostly standard. Firms produce output Y_t using labor and imported materials subject to monopolistic competition.

Representative competitive producer. There is a representative competitive producer who aggregates the output of a continuum of monopolistically competitive firms using CES technology with elasticity of substitution ϵ^p:

$$Y_t = \left[\int_0^1 Y_t(i)^{\frac{\epsilon^p-1}{\epsilon^p}} \mathrm{d}i\right]^{\frac{\epsilon^p}{\epsilon^p-1}}.$$

Optimization implies a standard demand curve for differentiated products:

$$Y_t(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\epsilon^p} Y_t, \tag{9}$$

where $P_{H,t}$ is the price of home output.

Monopolistically competitive firms. The representative competitive producer purchases goods from a continuum of monopolistically competitive firms. In anticipation of a symmetric

[2] Since preferences are assumed to be homothetic, two-stage budgeting applies. Households can first solve the dynamic problem for individual consumption c_t (and asset holdings a_t), and subsequently allocate individual expenditure between domestic and foreign goods ($c_{H,t}$ and $c_{F,t}$). Crucially, homotheticity guarantees that aggregating individual consumption choices c_t across households yields the aggregate consumption C_t, which can then be directly plugged into the aggregate consumption basket and intratemporal allocation problems.

equilibrium, I drop the index i from here on out. The production technology of these firms is described by a CES function, where output Y_t is produced using labor L_t and materials X_t:

$$Y_t = \left[\alpha_L^{\frac{1}{\nu}} L_t^{\frac{\nu-1}{\nu}} + (1-\alpha_L)^{\frac{1}{\nu}} X_t^{\frac{\nu-1}{\nu}} \right]^{\frac{\nu}{\nu-1}}. \tag{10}$$

Labor is rented from unions at the nominal wage W_t, and materials are purchased at price $P_{X,t}$. The first-order conditions for input demands are:

$$L_t = \alpha_L \left(\frac{W_t}{MC_t} \right)^{-\nu} Y_t, \tag{11}$$

$$X_t = (1-\alpha_L) \left(\frac{P_{X,t}}{MC_t} \right)^{-\nu} Y_t, \tag{12}$$

where MC_t denotes the nominal marginal cost of producers. The material good X_t is imported from the foreign economy. The price of the imported good in foreign currency is $P^*_{X,t}$. The law of one price then implies that the domestic-currency price of the imported good is

$$P_{X,t} = (1+\tau_t)\, \mathscr{E}_t P^*_{X,t}, \tag{13}$$

where τ_t is the tariff levied on imports and $P_{X,t}$ is the price of materials including any tariffs.

Pricing friction. Firms choose prices and quantities subject to the demand function (9) and subject to a price adjustment cost à la Rotemberg (1982) given by $\frac{\theta^P}{2}\pi^2_{H,t} Y_t$. Optimization yields a New Keynesian Phillips curve relating inflation $\pi_{H,t}$ to real marginal costs $mc_t = MC_t/P_t$ and the desired markup μ_t:

$$\pi_{H,t}\left(1+\pi_{H,t}\right) = \kappa^P \left(mc_t - \frac{P_{H,t}}{P_t}\frac{1}{\mu_t} \right) + \beta \frac{Y_{t+1}}{Y_t} \pi_{H,t+1}\left(1+\pi_{H,t+1}\right), \tag{14}$$

where $\kappa^P \equiv \frac{\epsilon^p}{\theta^p}$ denotes the slope of the Phillips curve.

Profits. Real profits paid out to domestic households—measured in units of the CPI—are given by:

$$\Pi_t = \frac{P_{H,t}}{P_t} Y_t - \frac{W_t}{P_t} L_t - \frac{P_{X,t}}{P_t} X_t - \frac{\theta^P}{2} \pi^2_{H,t} Y_t. \tag{15}$$

2.3 Labor supply and wage setting

Labor supply is determined by unions as in Erceg et al. (2000) and Schmitt-Grohé and Martin Uribe (2005). There is a continuum of unions, and each household i provides $\ell^k_{i,t}$ hours of work to union k. Total labor supply of household i is then $\ell_{i,t} = \int \ell^k_{i,t} \mathrm{d}k$. Each union assembles individual labor supply to a union-specific task $L^k_t = \int e_{i,t} \ell^k_{i,t} \mathrm{d}i$, and aggregate labor supply is

assembled from these union-specific tasks using CES technology:

$$L_t = \left(\int \left(L_t^k \right)^{\frac{\epsilon^W - 1}{\epsilon^W}} \mathrm{d}k \right)^{\frac{\epsilon^W}{\epsilon^W - 1}},$$

where $\epsilon^W > 0$ is the elasticity of substitution between labor types. Union k maximizes the discounted sum of future utility of its members, less a virtual Rotemberg adjustment cost on nominal wages:

$$\sum_{t=0}^{\infty} \beta^t \left(\int \left\{ \frac{u\left(c_t\left(e,a\right)\right)}{\xi_t^{Wealth}} - \xi\left(L_t\right) \right\} \mathrm{d}\mathscr{D}_t\left(e,a\right) - \frac{\theta^W}{2} \left(\frac{W_t^k}{W_{t-1}^k} - 1 \right)^2 \right),$$

where ξ_t^{Wealth} is an endogenous preference shifter as in Galí et al. (2012), which serves the purpose of eliminating implausibly large wealth effects on labor supply.[3] The problem yields a symmetric solution such that all unions choose the same wage, and all households supply the same amount of labor within each union. The solution is characterized by the following New Keynesian wage Phillips curve:

$$\pi_t^W \left(1 + \pi_t^W\right) = \kappa^W \left\{ \frac{\xi'\left(L_t\right)}{w_t} \mu^W - 1 \right\} + \beta \pi_{t+1}^W \left(1 + \pi_{t+1}^W\right), \tag{16}$$

where the wage markup is $\mu^W \equiv \frac{\epsilon^W}{\epsilon^W - 1}$, and the slope is defined as $\kappa^W = \frac{\epsilon^W}{\theta^W}$.

2.4 Financial assets and capital flows

The assets of domestic households are administered by a mutual fund which invests in either domestic government bonds B_t or foreign bonds B_t^*, which are in infinite supply. The foreign bond pays i_t^* in foreign currency units whereas domestic bonds pay i_t, which is the nominal rate set by the domestic central bank. Free capital flows then imply a nominal uncovered interest parity (UIP) condition $1 + i_t = \left(1 + i_t^*\right) \frac{\mathscr{E}_{t+1}}{\mathscr{E}_t}$, which equalizes the expected return on foreign and domestic bonds. Using the standard definition of the real exchange rate $Q_t = \frac{\mathscr{E}_t}{P_t} P_{F,t}^*$ (Gali and Monacelli 2005), this can be rewritten as the real UIP condition:

$$1 + r_t = \left(1 + r^*\right) \frac{Q_{t+1}}{Q_t}, \tag{17}$$

where $r_t = \frac{1 + i_t}{1 + \pi_{t+1}} - 1$ is the ex-ante real interest rate and r^* is the foreign real interest rate, which I assume to be constant for the remainder of the paper. Household asset returns equal the expected real interest rate in all periods except the initial period of an MIT shock: $r_{t+1}^a = r_t$ for $t \geq 0$. In period $t = 0$, returns instead remain at the steady-state level, $r_0^a = r$, since households initially only hold real, domestic bonds, implying that surprise inflation has no effect on realized asset returns. Equilibrium in the asset market implies $A_t = B_t^* + B_t$. I define the net

[3] This device primarily matters in a counterfactual where I consider the flexible wage limit, $\theta^W \to 0$. Alternatively, one could assume Greenwood et al. (1988) preferences for households, which also eliminate the wealth effect on labor supply.

foreign asset position as the difference between domestic assets A_t and the supply of domestic bonds B_t, $NFA_t = A_t - B_t$, which also implies $NFA_t = B_t^*$.

2.5 Monetary policy

I assume that the domestic central bank controls the real interest rate r_t directly as in Holden (2024). The corresponding nominal rate can then be recovered from the Fisher relation $1 + i_t = (1 + r_t)(1 + \pi_{t+1})$.

2.6 Government

The government issues real bonds B_t and collects tariff revenues to finance interest payments and net lump-sum transfers T_t. Its budget constraint is:

$$\tau_t \left(\frac{P_{F,t}}{(1+\tau_t) P_t} C_{F,t} + \frac{\mathscr{E}_t P^*_{X,t}}{P_t} X_t \right) + B_t = (1 + r_{t-1}) B_{t-1} + T_t. \tag{18}$$

Following Auclert et al. (2020), I let lump-sum transfers adjust gradually to deviations of government debt from its steady state according to the fiscal rule:

$$T_t = T - \rho_B (B_{t-1} - B), \tag{19}$$

where ρ_B controls how fast transfers adjust to stabilize debt.

2.7 Exports

Foreign demand for domestic goods $C^*_{H,t}$ is a standard Armington demand function:

$$C^*_{H,t} = \alpha^* \left(\frac{P^*_{H,t}}{P^*_{F,t}} \right)^{-\eta} C^*_t, \tag{20}$$

where C^* denotes aggregate foreign demand and α^* is a scale parameter. I assume a law of one price such that the price faced by foreign consumers equals the domestic price of tradeable goods, converted to foreign currency $P^*_{H,t} = \frac{P_{H,t}}{\mathscr{E}_t}$. In the baseline small open economy, aggregate foreign demand is constant, $C^*_t = C^*$. In Section 4.1, I also allow C^*_t to respond to windfall income received from the domestic economy following changes in import prices (see Appendix A).

2.8 Market clearing and equilibrium

Goods market clearing in the economy is given by:

$$Y_t = C_{H,t} + C^*_{H,t} + \frac{P_t}{P_{H,t}} \frac{\theta^P}{2} \pi^2_{H,t} Y_t. \tag{21}$$

The general equilibrium of the model is defined as follows:

Definition 1 (Equilibrium in the small open economy.)**.** *Given a sequence of shocks* $\{\mu_t, P^*_{X,t}, \tau_t\}$*, an initial household distribution over assets and earnings* $\mathscr{D}_0(a, e)$*, and an initial portfolio alloc-*

ation between foreign and domestic bonds, a general equilibrium is a path of household policies $\{c_t(a,e), a_t(a,e)\}$*, distributions* $\mathscr{D}_t(a,e)$*, prices*

$$\left\{\mathscr{E}_t, Q_t, P_t, P_{H,t}, P_{F,t}, W_t, P_{X,t}, i_t, r_t\right\},$$

and quantities

$$\left\{C_t, C_{H,t}, C_{F,t}, C^*_{H,t}, A_t, Y_t, X_t, L_t, \Pi_t, T_t, NFA_t, B^*_t, B_t\right\},$$

such that households solve (2)–(5)*. Firms produce according to* (10)*, set prices according to* (14)*, and distribute profits according to* (15)*, with the material price given by* (13)*. Unions set wages according to* (16)*. The government budget* (18) *holds, foreign demand satisfies* (20)*, and the central bank sets the real rate. The real UIP condition* (17) *and goods market clearing* (21) *hold, while asset market clearing* $A_t = B^*_t + B_t$ *holds residually by Walras's law.*

2.9 Representative agent economy

I compare my results for the HANK model to those obtained with a textbook representative agent model. Here aggregate consumption follows the Euler equation:

$$u'(C_t) = \beta\left(1 + r_t - r^s_t\right) u'(C_{t+1})$$

with $\beta = \frac{1}{1+r}$ in steady state, and where $r^s_t = \left(\frac{A_t}{A}\right)^{\iota^{SGU}} - 1$ is a device, governed by ι^{SGU}, that ensures stationarity, as in Schmitt-Grohé and Martin Uribe (2003).

3 Aggregate demand effects of income redistribution

I start by analyzing a markup shock, which corresponds to a shock to the Phillips curve in the standard New Keynesian model. The markup shock is the canonical case of the paper: it raises prices relative to nominal wages and transfers income from workers to firm owners, while leaving total domestic income unchanged for a given level of output. The main result of this section, Proposition 2, characterizes the equilibrium output response through three objects: the pass-through matrix $\mathbf{\Theta}^P$, which determines how much income is transferred from workers to firm owners, the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$, which determines how this transfer affects spending, and a general equilibrium multiplier $\mathscr{M}$. In Section 4 I extend the analysis to input-price shocks, demand shocks, and tariffs.

Assumptions on substitution effects. My analytical results build on two central assumptions that rule out substitution effects, allowing me to isolate the role of distributional income effects in aggregate demand. The first is assumption 1, under which the real interest rate is constant at the steady-state level, $r_t = r$ (Auclert et al. 2024d; Angeletos et al. 2024a).[4] In the standard 3-equation New Keynesian model the entire transmission of markup shocks to the real economy

[4] In the standard NK model a real rate rule of this kind results in indeterminacy. Following Auclert et al. (2024d) determinacy can be restored by assuming that the central bank switches to an active Taylor rule sufficiently far out in the future.

derives from the response of the central bank to inflation.[5] This is because the domestic demand effect is driven entirely by intertemporal substitution, or what Kaplan et al. (2018) call the "direct effect" of monetary policy. Hence the assumption of a constant real rate eliminates the main transmission channel present in the standard NK model to more clearly highlight the distributional dynamics which are the focus here. Additionally, in the open economy a constant real rate also switches off expenditure switching effects on net exports by keeping the real exchange rate constant, $Q_t = Q$.[6]

Assumption 1 (Constant real rate.)**.** *The domestic central bank maintains a constant real interest rate* $r_t = r$.

The second assumption involves the production technology of firms. In line with empirical estimates of the elasticity of substitution between labor and materials, I assume that they are perfect complements, $\nu \to 0$, so that production is Leontief. Empirical studies usually find labor and materials to be gross complements $\nu < 1$ (Castro-Vincenzi and Kleinman 2026), and to be almost perfect complements in the short run (Boehm et al. 2019). The exact Leontief limit $\nu \to 0$ implies that there is no substitution between materials and labor in response to relative price changes.

Assumption 2 (Leontief production.)**.** *Domestic firms produce output using Leontief production technology,* $\nu \to 0$.

3.1 Income incidence and the equilibrium output response

Sequence-space representation. Linearizing goods market clearing (21) around the steady state and using Assumption 1, which holds the real exchange rate constant by (17), gives:[7]

$$\mathrm{d}Y_t = (1-\alpha)\,\mathrm{d}C_t, \tag{22}$$

where $\mathrm{d}x_t = x_t - x$ represents deviations from steady state for some variable x. Given a constant real rate the aggregate consumption function $\mathscr{C}_t(\bullet)$ depends only on the sequences of real labor income $\{Z_s\}_{s=0}^{\infty} = \left\{\frac{W_s}{P_s}L_s\right\}_{s=0}^{\infty}$ and profits $\{\Pi_s\}_{s=0}^{\infty}$, i.e. $C_t = \mathscr{C}_t\left(\{Z_s, \Pi_s\}_{s=0}^{\infty}\right)$. Stacking variables in vectors $\mathrm{d}\mathbf{C} = (\mathrm{d}C_0, \mathrm{d}C_1, \ldots)$ the linearized consumption function can be written as $\mathrm{d}\mathbf{C} = \mathbf{M}^Z \mathrm{d}\mathbf{Z} + \mathbf{M}^\Pi \mathrm{d}\mathbf{\Pi}$ where $\mathbf{M}^Z, \mathbf{M}^\Pi$ are the sequence-space Jacobians of aggregate consumption with respect to labor income and profits respectively:[8]

$$\mathbf{M}^Z = \begin{bmatrix} \frac{\partial C_0}{\partial Z_0} & \frac{\partial C_0}{\partial Z_1} & \cdots \\ \frac{\partial C_1}{\partial Z_0} & \frac{\partial C_1}{\partial Z_1} & \cdots \\ \vdots & \vdots & \ddots \end{bmatrix}, \quad \mathbf{M}^\Pi = \begin{bmatrix} \frac{\partial C_0}{\partial \Pi_0} & \frac{\partial C_0}{\partial \Pi_1} & \cdots \\ \frac{\partial C_1}{\partial \Pi_0} & \frac{\partial C_1}{\partial \Pi_1} & \cdots \\ \vdots & \vdots & \ddots \end{bmatrix}.$$

[5] This is true at first order. At second-order or higher, inflation generates a resource loss from adjustment costs (Rotemberg) or misallocation (Calvo) depending on the specification of the pricing friction, which affects the equilibrium allocation.

[6] Even with $Q_t = Q$ expenditure switching effects can still occur in response to tariff shocks, see Section 4.3.

[7] See Appendix B.1 for the derivation.

[8] See Auclert et al. (2024d) for more details on the existence of the consumption function, and the sequence-space Jacobians.

Here the entry $M^Z_{0,0}$ corresponds to the quarterly MPC out of labor income and so forth. I discuss the empirical counterparts of $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ in Section 3.2.

Income. For a markup shock, domestic value added is split between workers and firm owners. With imported materials, linearizing the definitions of labor income and profits gives (appendix B.2):

$$d\mathbf{Z} + d\mathbf{\Pi} = \alpha_L d\mathbf{Y}. \tag{23}$$

Conditional on a path of output (and thus domestic income $\alpha_L d\mathbf{Y}$), every unit of income gained by firm owners is a unit of income lost by workers. The markup shock is thus a pure transfer between two domestic groups, and its effect on aggregate demand depends on whether the two groups spend the transfer differently. Substituting (23) into the consumption function and goods market clearing yields the following proposition:[9]

Proposition 1 (Equilibrium relationship between output and profits)**.** *Given a sequence of markup shocks* $\{\mu_s\}_{s=0}^{\infty}$*, the equilibrium relation between output and profits is given by:*

$$\frac{1}{1-\alpha} d\mathbf{Y} = \underbrace{\alpha_L \mathbf{M}^Z d\mathbf{Y}}_{\textit{Multiplier}} - \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] d\mathbf{\Pi}}_{\textit{Distributional channel}} \tag{24}$$

Proof: Appendix B.2.

Given a constant real rate, the distributional channel is the only source of propagation following the shock. With a representative agent, which features $\mathbf{M}^Z = \mathbf{M}^\Pi$, the distributional term is zero and the solution to (24) is $d\mathbf{Y} = \mathbf{0}$. This is why a markup shock has no effect on output in the basic NK model besides the direct effect of the monetary policy response. The same holds in HANK models with an equal incidence of labor income and profits across the population: short-run MPCs may be large and Ricardian equivalence violated, but if MPCs out of the two sources of income are equal, redistribution between them is neutral in the aggregate.

Corollary 1. *If the model features an equal incidence of labor income and profits, and therefore delivers equal marginal propensities to consume out of labor income and profits,* $\mathbf{M}^Z = \mathbf{M}^\Pi$*, markup shocks have no effect on real output,* $d\mathbf{Y} = \mathbf{0}$.

The endogenous response of profits: price and wage pass-through. Proposition 1 takes the response of profits $d\mathbf{\Pi}$ as given. To determine this response endogenously, I combine the price and wage Phillips curves, which govern how shocks and changes in employment are transmitted to prices, wages, and ultimately profits. Writing the New Keynesian Phillips curve (14) and wage Phillips curve (16) in sequence-space gives

$$d\mathbf{P_H} = \boldsymbol{\kappa}^P \left(d\mathbf{mc} + d\boldsymbol{\mu}\right), \tag{25}$$

$$d\mathbf{W} = \boldsymbol{\kappa}^W \left(\frac{W}{\varphi} d\mathbf{L} - d\mathbf{w}\right), \tag{26}$$

[9] Appendix B.2 records the more general ownership algebra, and the main text specializes to imported materials.

where $\boldsymbol{\kappa}^P$ and $\boldsymbol{\kappa}^W$ are the sequence-space pass-through matrices associated with the respective Phillips curves (Auclert et al. 2024b).[10] Both matrices are proportional to the corresponding scalar Phillips curve slopes, so that $\boldsymbol{\kappa}^P \to \mathbf{0}$ as $\kappa^P \to 0$, and similarly for wages.

Solving the two Phillips curves jointly with the production technology determines how changes in desired markups and employment affect realized markups, and hence the division of income between workers and firm owners. I summarize these equilibrium responses using two pass-through matrices. The first, $\boldsymbol{\Theta}^P$, measures the effect of changes in desired markups (or marginal costs) on realized markups through price adjustment and the resulting wage response. The second, $\boldsymbol{\Theta}^W$, captures how changes in employment affect markups through nominal wage adjustment. Formally:

Definition 2. *The pass-through matrix of markup shocks to realized markups is*

$$\boldsymbol{\Theta}^P \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W \boldsymbol{\kappa}^P\right]^{-1} W \boldsymbol{\kappa}^P. \tag{27}$$

The pass-through matrix of employment to realized markups is

$$\boldsymbol{\Theta}^W \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W \boldsymbol{\kappa}^P\right]^{-1} \frac{W \alpha_L}{\varphi} \boldsymbol{\kappa}^W. \tag{28}$$

Here, α_L is the labor share in production, φ is the Frisch elasticity, and W is the steady-state wage rate.

The economic intuition is particularly clear in a static economy with labor as the only input. In this case, the pass-through of a markup shock is $\frac{W\kappa^P}{1+\kappa^W+W\kappa^P}$. The numerator reflects the direct price response to the shock, while the denominator captures the interaction between price and wage adjustment. Higher prices reduce real wages, inducing unions to raise nominal wages, which in turn increases marginal costs and feeds back into prices. With fully flexible prices, the pass-through converges to α_L^{-1}, whereas with fully flexible wages it approaches zero.[11] The employment pass-through matrix $\boldsymbol{\Theta}^W$ captures the corresponding effect of labor demand operating through the wage Phillips curve: higher employment puts upward pressure on nominal wages, thereby increasing marginal costs and reducing realized markups when prices are sticky.

Using these matrices, the two Phillips curves and Leontief production imply the following equilibrium response of profits (Appendix B.4, eq. (A.7)):

$$\mathrm{d}\boldsymbol{\Pi} = \boldsymbol{\Theta}^P \mathrm{d}\boldsymbol{\mu} + \left[\frac{\mu - 1}{\mu}\mathbf{I} - \boldsymbol{\Theta}^W\right] \mathrm{d}\mathbf{Y}. \tag{29}$$

The first term captures the redistribution to firm owners induced directly by the markup shock, matched one-for-one by a loss of labor income through (23). The same pass-through matrix $\boldsymbol{\Theta}^P$ also governs the redistribution arising from increases in firms' marginal costs, such as imported-material price shocks considered in Section 4.1. The second term captures the endogenous

[10] If the discount factors in the Phillips curves equal zero, these matrices simplify to $\boldsymbol{\kappa}^P = \kappa^P \mathbf{U}$ and $\boldsymbol{\kappa}^W = \kappa^W \mathbf{U}$, where $\mathbf{U}$ is a lower-triangular matrix with ones on and below the diagonal, and zeroes above. The general expressions are derived in Appendix B.3. Markup shocks $\mathrm{d}\boldsymbol{\mu} = (\mathrm{d}\mu_0, \mathrm{d}\mu_1, \ldots)$ use the scaling $\mathrm{d}\mu_t = (\mu_t - \mu)/\mu^2$ to ease notation.

[11] In the labor-only static example, $\alpha_L = 1$, so the flexible-price limit is one.

response of profits to output, combining the direct effect of higher production on profits with the offsetting effect of higher wages on realized markups.

Equilibrium output. Substituting (29) into Proposition 1 gives the main result of this section:

Proposition 2 (Equilibrium output response to a markup shock)**.** *The equilibrium response of output* $\mathrm{d}\mathbf{Y}$ *to a markup shock is:*

$$\mathrm{d}\mathbf{Y} = - \underbrace{\mathscr{M}}_{\text{GE multiplier}} \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]}_{\text{MPC gap}} \underbrace{\boldsymbol{\Theta}^P \, \mathrm{d}\boldsymbol{\mu}}_{\text{Transfer to firm owners}}, \tag{30}$$

where the Keynesian general equilibrium multiplier $\mathscr{M}$ *is:*

$$\mathscr{M} \equiv \left[\frac{1}{1-\alpha}\mathbf{I} - \alpha_L \mathbf{M}^Z - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\left[\boldsymbol{\Theta}^W - \frac{\mu - 1}{\mu}\mathbf{I}\right]\right]^{-1}$$

Proof: Appendix B.4.

Proposition 2 separates the three ingredients of the transmission mechanism. Nominal rigidities, through $\boldsymbol{\Theta}^P$, determine how much income is transferred from workers to firm owners. The MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ determines how this transfer changes aggregate spending. The multiplier $\mathscr{M}$ propagates the resulting change in demand through labor income and profits. If either the pass-through or the MPC gap is zero, the markup shock has no effect on output.

To see the sign, consider first the static case where the MPCs are scalars, as in undergraduate textbooks. If the MPC out of labor income exceeds that out of profits, a markup increase that raises profits at the expense of labor income redistributes resources toward lower-MPC households, which reduces aggregate demand and output. In the dynamic model this comparison need not hold uniformly across horizons, because $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ are matrices. I return to this in Section 3.3. The short-run intuition from the static case nevertheless carries over.

The role of nominal rigidities. Because nominal rigidities enter the output response only through $\boldsymbol{\Theta}^P$ and the multiplier, the limiting cases of price and wage flexibility can be read off directly from Definition 2:

Proposition 3 (Implications of price and wage flexibility)**.** *Consider the response of aggregate output* (30) *to a markup shock. Suppose the equilibrium multiplier* $\mathscr{M}$ *remains bounded and converges in each limit, with all other parameters held fixed. Let* $\mathscr{M}^{\kappa^P \to \infty} \equiv \lim_{\kappa^P \to \infty} \mathscr{M}$.

(i) In the limit with completely rigid prices, $\boldsymbol{\Theta}^P = \mathbf{0}$*, and the general equilibrium response of output is zero:*

$$\lim_{\kappa^P \to 0} \mathrm{d}\mathbf{Y} = \mathbf{0} \times \mathrm{d}\boldsymbol{\mu}.$$

With fully flexible prices the pass-through matrix $\boldsymbol{\Theta}^P$ *converges to* $\alpha_L^{-1}\mathbf{I}$*, and the response of output is:*

$$\lim_{\kappa^P \to \infty} \mathrm{d}\mathbf{Y} = -\mathscr{M}^{\kappa^P \to \infty}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \alpha_L^{-1} \, \mathrm{d}\boldsymbol{\mu}.$$

(ii) If prices are not completely flexible, $\kappa^P < \infty$, then in the limit with completely flexible wages, $\boldsymbol{\Theta}^P = \mathbf{0}$, and the general equilibrium response of output is zero:

$$\lim_{\kappa^W \to \infty} d\mathbf{Y} = \mathbf{0} \times d\boldsymbol{\mu}.$$

Proof: Appendix B.5.

With rigid prices, the shock does not raise prices and no income is transferred. With flexible wages, nominal wages keep pace with prices and the real wage is unchanged. In both cases workers bear none of the shock and the distributional channel is shut off. A markup shock is therefore contractionary only if (i) workers have a higher short-run MPC than firm owners, and (ii) nominal rigidities are such that prices rise faster than nominal wages.

3.2 Evidence on the MPC gap

Proposition 2 shows that the sign of the output response depends on the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$. I now discipline this object using evidence on consumption responses to different sources of income, and using microdata on the joint distribution of MPCs and income sources.

MPCs out of labor income and profits. The conventional MPC estimated in the literature is the change in consumption given a one-time unexpected lump-sum transfer (e.g. Shapiro and Slemrod 2003; Johnson et al. 2006; Fuster et al. 2021; Fagereng et al. 2021). The aggregate labor income and profit MPCs differ from the lump-sum MPC because labor income and profits are not uniformly distributed across the population of households. With an equal distribution all three MPCs would coincide in the present model.[12] As emphasized by Auclert et al. (2024d), studies exploiting exogenous lump-sum transfers or survey-based spending responses are informative about the impact element of the iMPC Jacobians. The corresponding impact MPCs are usually estimated to lie between 0.15 and 0.25 in the first quarter (Auclert et al. 2025a), and are typically larger at an annual frequency due to the persistence of the consumption response.

Direct estimates of MPCs out of profits or business income are generally much smaller. Using US data, Chodorow-Reich et al. (2021) estimate an annual MPC out of stock market returns of 3.2%, while Andersen et al. (2024) estimate an annual MPC of approximately 4% using Danish data.[13]

Estimating the MPC out of labor income is more difficult because exogenous variation in labor income is typically accompanied by endogenous labor-supply responses and selection. I therefore calibrate the household block using the discount factor β to match the MPC out of lump-sum transfers estimated by Fagereng et al. (2021), who find a point estimate of 0.51 over the first year (panel (a) in Figure 1). Combined with the model's distribution of labor income, which I assume to be proportional to idiosyncratic productivity e, as is standard in the HANK

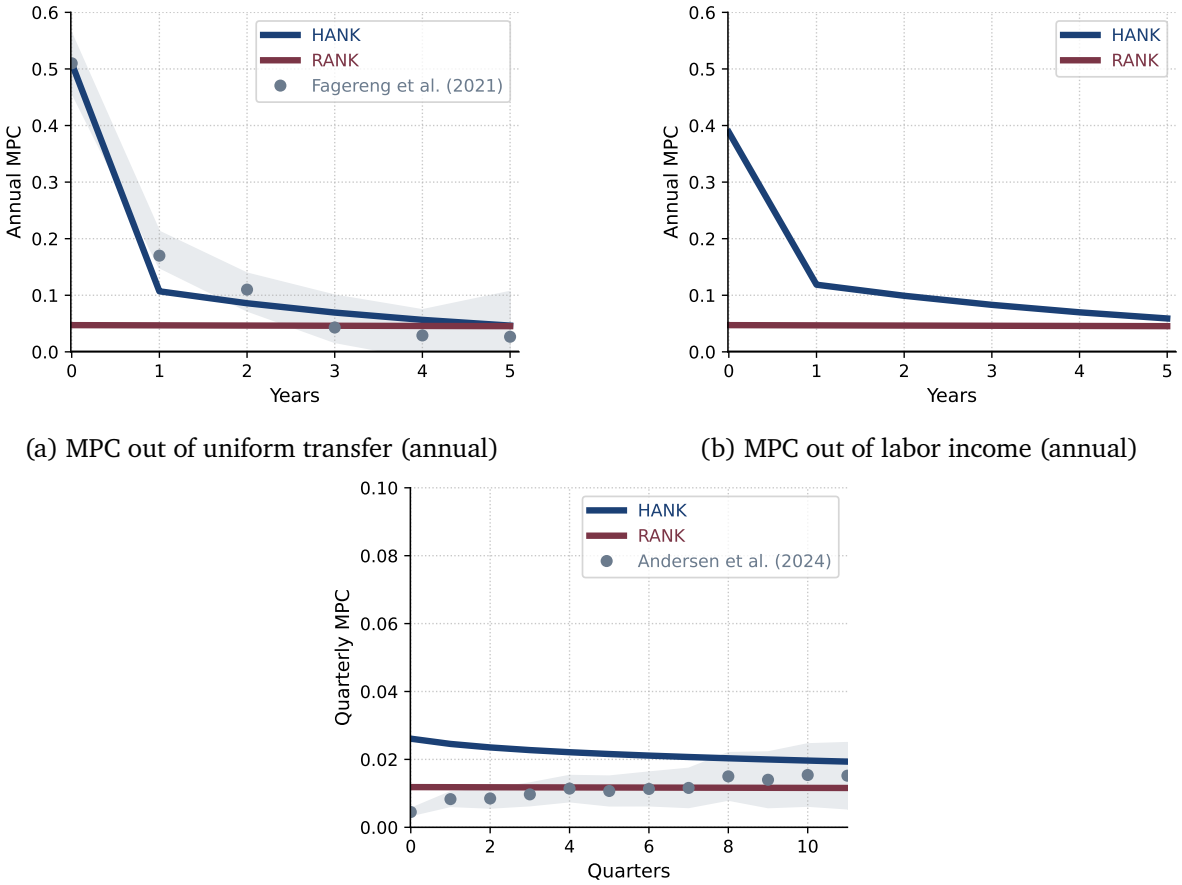
[12] This rests on the assumption that labor income and profits do not affect other parts of household behavior - for instance through heterogeneous wealth effects on labor supply at the micro level.

[13] The model speaks to the MPC out of profits, whereas the empirical evidence concerns the MPC out of stock market wealth. However, for a one-period unexpected profit shock, the period-0 MPC out of profits coincides with the MPC out of stock market wealth. Assume equity satisfies the arbitrage condition $p_t^D = (\Pi_{t+1} + p_{t+1}^D)/(1+r_t)$. If only Π_0 changes unexpectedly while future profits and interest rates are unchanged, $dp_0^D = 0$. The unexpected period-0 equity payoff is $d(\Pi_0 + p_0^D - p_{-1}^D) = d\Pi_0$. Thus, per unit of unexpected stock market payoff, $dC_0/d(\Pi_0 + p_0^D - p_{-1}^D) = dC_0/d\Pi_0$, so the MPC out of stock market wealth equals the MPC out of profits.

literature, this generates an aggregate MPC out of labor income of around 0.4 over the first year (panel (b) in Figure 1). For profits, I target an annual MPC of 4%, calibrated using the distribution of profits in the population $g(e)$.[14]

Panel (c) of Figure 1 compares the resulting quarterly MPC out of a one-time increase in profits with the dynamic estimates of Andersen et al. (2024). The model response is relatively flat because firm profits accrue primarily to wealthy households, whose consumption responds little to transitory fluctuations in income. Overall, the model matches the empirical evidence well, although its short-run response is somewhat larger than the estimates, potentially pointing to a role for illiquidity in delaying the consumption response to capital gains.

A caveat of this approach is that the available empirical evidence cannot discipline the full intertemporal MPC Jacobians $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$. Instead, it identifies only selected elements of individual columns, corresponding to the dynamic consumption response to particular unanticipated income shocks. I therefore use these moments as calibration targets and let the structural household model extrapolate from them to construct the remaining elements of the Jacobians.



(a) MPC out of uniform transfer (annual)

(b) MPC out of labor income (annual)

(c) MPC out of profits (quarterly)

Figure 1: Marginal propensities to consume in the calibrated model

[14]For the distributional rule for profits I use the functional form

$$g(e) = \frac{e^{\vartheta}}{\int e^{\vartheta} \mathrm{d}\mathscr{D}_t(e,a)}$$

where ϑ determines how much profit income accrues to high-earning households, and the denominator ensures that $g(e)$ integrates to 1. The calibration yields $\vartheta = 15$.

MPCs across the population. The MPC gap can be related directly to the cross-sectional distribution of MPCs and income sources:[15]

$$\mathbf{M}^Z - \mathbf{M}^\Pi = \mathbb{C}\text{ov}\big(\mathbf{M}(e,a), e\big) - \mathbb{C}\text{ov}\big(\mathbf{M}(e,a), g(e)\big), \tag{31}$$

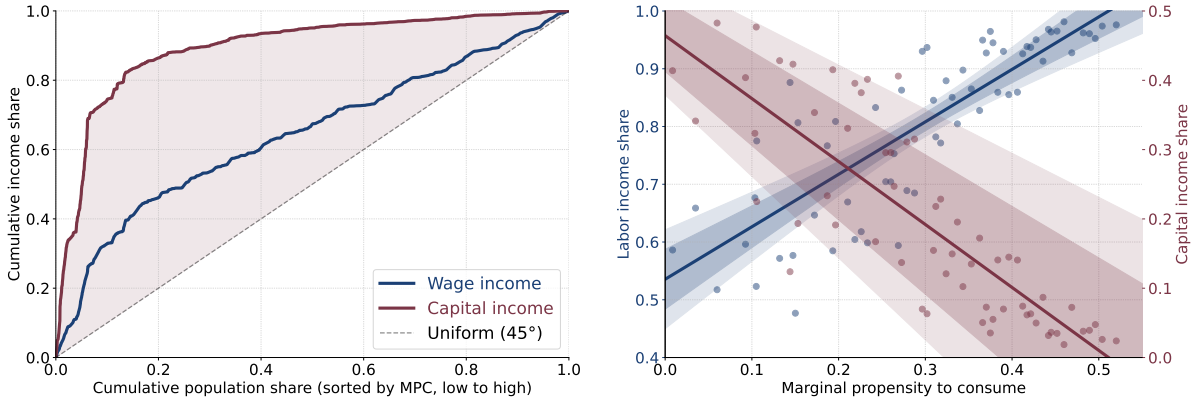
where $M_{t,s}(e,a)$ is the date-t consumption response to a date-s lump-sum transfer for a household in state (e,a) at the time of the transfer s.[16] The MPC gap is thus the difference between two covariances: the population covariance between intertemporal MPCs $\mathbf{M}(e,a)$ and idiosyncratic income e, and the covariance between intertemporal MPCs and the profit incidence function $g(e)$. If profits are distributed toward low-MPC households more so than labor earnings, an increase in profits at the expense of labor income has contractionary short-run effects.

Investigating this empirically requires microdata on income and MPCs. I follow the general strategy of Patterson (2023) and Bellifemine et al. (2026), who estimate MPCs in separate datasets (the PSID and Fuster et al. 2021's version of the NY Fed's Survey of Consumer Expectations, respectively) and apply these estimates to other datasets using fitted relationships based on observable characteristics. I obtain MPC estimates from Fuster et al. (2021), specifically from the \$500-loss treatment, in which respondents in the Survey of Consumer Expectations are asked how much of an unexpected \$500 expense they would finance through reduced spending. I fit the reported MPCs as a function of various observables (labor income, age, education, homeownership, race, net wealth, and gender) and use the fitted relationship to predict MPCs in the 2013 wave of the Survey of Consumer Finances (SCF), which contains detailed household-level data on labor, capital, and business income.

The left panel of Figure 2 plots Lorenz-style concentration curves using these data: the cumulative income shares of profits and labor income as functions of the cumulative population share, sorted from lowest to highest predicted MPC. A curve above the 45° diagonal indicates that the corresponding income type is concentrated among low-MPC households. Both labor income and "profits" (capital and business income) are disproportionately concentrated among low-MPC households, though profits are substantially more skewed, implying $\mathbb{C}\text{ov}\left(\mathbf{M}(e,a), e\right) > \mathbb{C}\text{ov}\left(\mathbf{M}(e,a), g\left(e\right)\right)$.

[15] See appendix B.6 for the derivation.

[16] For the purpose of exposition, I assume that the covariance operator $\mathbb{C}\text{ov}\left(\mathbf{X}(e,a), y(e)\right)$ in (31) takes a matrix $\mathbf{X}(e,a)$ and a scalar $y(e)$ as input, and gives as output a matrix of element-by-element covariances between $\mathbf{X}(e,a)$ and $y(e)$. Each element-by-element covariance is computed over the cross section of the population using the stationary distribution $\mathscr{D}(e,a)$ across states (e,a) at the date of the income perturbation.



(a) Distribution of income

(b) MPCs against labor and profit income shares

Figure 2: Empirical evidence on labor income and profit MPCs

Left panel: Concentration curves showing the cumulative share of wage income and capital income (business, dividend, and capital gains income) as a function of the cumulative population share, sorted by predicted MPC from low to high. A curve above the 45° diagonal indicates that the income type is concentrated among low-MPC households. Right panel: Weighted binned observations and fitted relationships between MPCs and labor income shares (left axis) and capital income shares (right axis). Predicted MPCs are estimated following Patterson (2023) using the \$500-loss treatment from Fuster et al. (2021) and individual-level income data from the 2013 Survey of Consumer Finances.

The right panel shows a scatter plot of the share of each income type received by households (labor income share on the left y-axis, profit income share on the right) against the estimated MPCs. The plot shows a clear positive correlation between MPCs and labor income shares and a negative relation between profit income shares and MPCs. Both the calibrated iMPCs and the cross-sectional evidence therefore indicate that the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ is positive at short horizons, so that by Proposition 2 a markup shock is contractionary in the short run.

3.3 Role of dynamic MPCs

Proposition 2 may seem to suggest that a higher MPC out of labor income than out of profits necessarily implies a negative output response, $d\mathbf{Y} < 0$. However, this intuition overlooks the intertemporal nature of MPCs. The household intertemporal budget constraint implies that each column of the MPC Jacobians must have a present value of one,

$$\sum_{t=0}^{\infty} \frac{M^j_{t,s}}{(1+r)^{t-s}} = 1, \qquad j \in \{Z, \Pi\},$$

since every additional dollar of income must eventually be spent. Defining the discount vector $\mathbf{q}' \equiv \left(1, (1+r)^{-1}, (1+r)^{-2}, \ldots\right)$, where r is the steady-state interest rate, this implies

$$\mathbf{q}'\mathbf{M}^j = \mathbf{q}' \quad \text{for } j \in \{Z, \Pi\}, \tag{32}$$

which I refer to as the present-value condition. The condition implies that differences in MPCs across income sources reflect the timing rather than the present value of consumption responses. Larger MPCs out of labor income at short horizons must therefore be offset by smaller MPCs at longer horizons, once appropriately discounted. As a result, the empirical MPC profiles in Figure 1 can generate a substantial short-run decline in output following a markup shock, which is eventually offset by a small but persistent positive response. Indeed, the net present value of

the output response, $\mathbf{q}'d\mathbf{Y}$, is zero for all $\mathbf{M}^Z, \mathbf{M}^\Pi$ satisfying (32), since $\mathbf{q}'\mathbf{M}^Z - \mathbf{q}'\mathbf{M}^\Pi = \mathbf{0}$.[17] This result is summarized in Corollary 2.

Corollary 2 (Net present value of markup shock)**.** *Assume positive imports of final goods or materials, $\alpha > 0$ or $\alpha_L < 1$, so that the Keynesian-cross operator is invertible, and that $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ satisfy the present-value condition* (32)*. Then the net present value of the output response to a markup shock is zero, $\mathbf{q}'d\mathbf{Y} = 0$, regardless of $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$.*

3.4 Numerical illustration

I now illustrate the three objects in Proposition 2 numerically. I emphasize qualitative features here and relegate the quantitative evaluation to Section 5. The calibration is described in Section 5.1. In brief, trade openness (import and export shares of GDP) is 42% of GDP in steady state, with imported final consumption goods accounting for 25% of the household consumption basket and imported materials constituting the remaining share, implying $\alpha_L \approx 0.855$. The price Phillips curve slope is $\kappa^P = 0.17$ given a markup of $\mu = 1.2$, corresponding to an average price duration of three quarters, and the wage Phillips curve is substantially flatter with $\kappa^W = 0.01$ (Auclert et al. 2020). In the figures I report gross output Y_t. For a markup shock, the response of real GDP, defined as CPI-deflated value added $\mathscr{Y}_t = \frac{P_{H,t}}{P_t} Y_t - \frac{P_{X,t}}{P_t} X_t$, is proportional to that of output, $d\mathscr{Y}_t = \alpha_L dY_t$, and therefore the same in percent deviations from steady state.

The MPC gap. Figure 3 displays the responses to a markup shock scaled to increase inflation by 1% on impact in a baseline RANK, permanent-income type model ($\mathbf{M}^Z = \mathbf{M}^\Pi$), with the same shock amplitude applied to the HANK model with unequal incidence. In both models the increase in desired markups causes firms to raise prices further above marginal costs, generating inflation. Given nominal wage frictions, this drives down the real wage and increases firm profits. The two models differ only in how aggregate demand responds to this transfer. In the RANK model (left panel) aggregate consumption and output do not respond since the decline in consumption from lower labor income is exactly offset by the increase from higher profits, as in Corollary 1. In the HANK model (right panel), where the short-run MPC out of labor income exceeds that out of profits, the redistribution is not demand-neutral and output falls, i.e. stagflation.

[17] The present-value claim requires that the Keynesian Cross in eq. (24) is invertible, $(1-\alpha)\alpha_L < 1$. In the imported-materials baseline, this holds when households import final goods ($\alpha > 0$) or firms import materials ($\alpha_L < 1$). The singularity when both import shares are zero is discussed by Auclert et al. (2024d) and Sundram (2026).

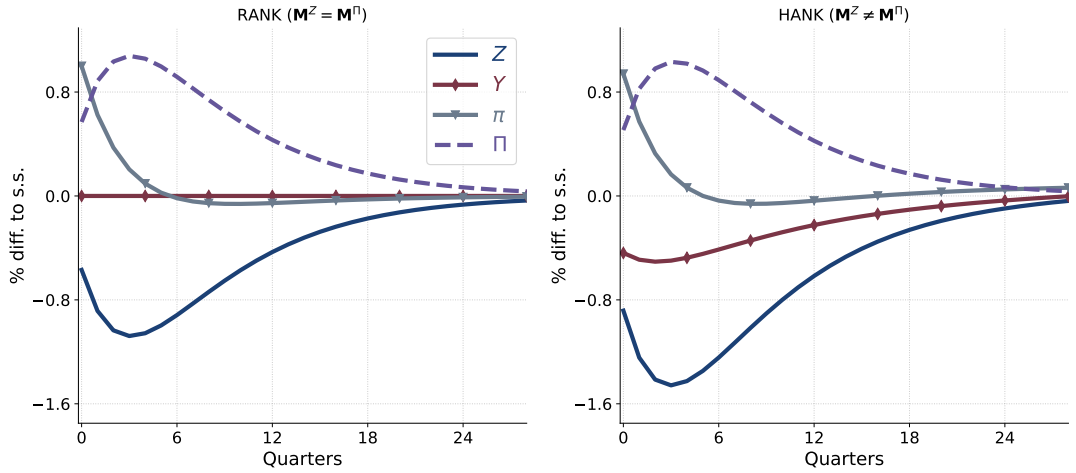


Figure 3: Effect of markup shock in RANK and HANK

Note: Impulse responses to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact in RANK. The same shock amplitude is applied to HANK. The figure reports domestic output Y (pct. change, $100 \times \mathrm{d}Y_t/Y$), together with CPI inflation π (pct. points change, $100 \times \mathrm{d}\pi_t$), real labor income Z (pct. change, $100 \times \mathrm{d}Z_t/Y$), and real profits Π (pct. change, $100 \times \mathrm{d}\Pi_t/Y$). The responses of labor income and profits are scaled by steady-state output.

Figure 4 varies the MPC gap directly by changing the profit incidence function $g(e)$, or equivalently the covariance gap in (31). As profits become more equally distributed in the population the gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ shrinks, and the contractionary effect on consumption becomes smaller, converging to zero when $\mathbf{M}^Z = \mathbf{M}^\Pi$ as stated in Corollary 1.

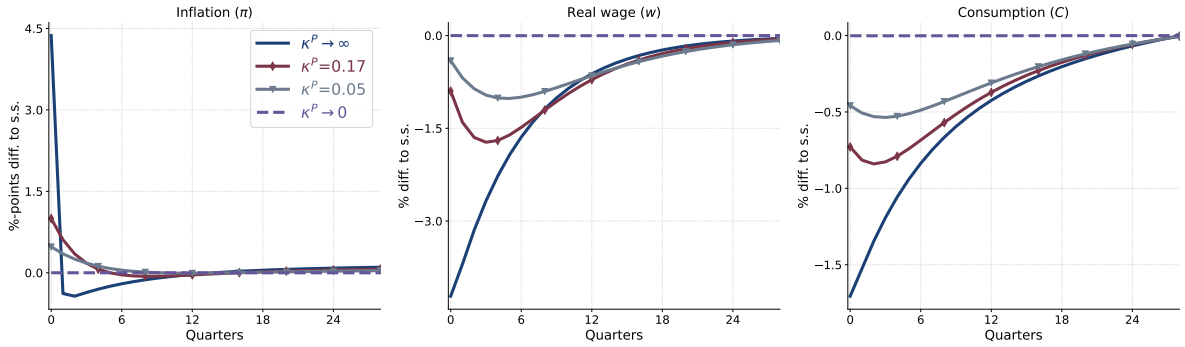


Figure 4: Responses to a markup shock with varying profit distribution across the population

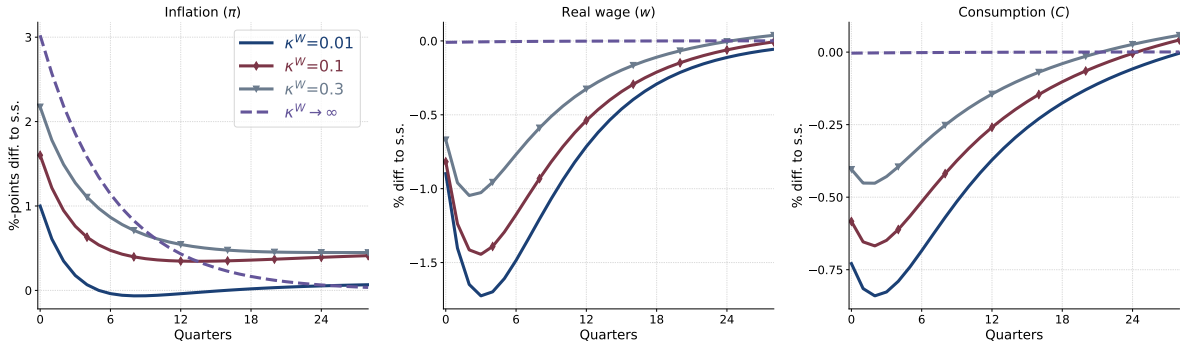
Note: Impulse responses in the HANK model to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact. The figure reports CPI inflation (pct. points change, $100 \times \mathrm{d}\pi_t$), real wages (pct. change, $100 \times \mathrm{d}w_t/w$), and aggregate consumption (pct. change, $100 \times \mathrm{d}C_t/C$) while varying ϑ, which determines the population distribution $g(e) = \frac{e^\vartheta}{\int e^\vartheta \mathrm{d}\mathscr{D}_t(e,a)}$ of profits.

Price pass-through. In Figure 5 I illustrate the implications of changing the degree of price and wage stickiness, which affect aggregate demand through the pass-through matrix $\mathbf{\Theta}^P$. Panel (a) shows that a lower degree of price stickiness amplifies the markup shock by generating a larger inflation response, which for given nominal wages generates a larger real wage drop. Price flexibility thus enlarges the transfer from workers to firm owners and the resulting fall in demand. With completely rigid prices, inflation does not move and the shock has no effect, consistent with Proposition 3. Panel (b) correspondingly shows that a larger degree of wage flexibility attenuates the response to the shock. In the limit with completely flexible wages real wages remain unchanged even though the equilibrium outcome features a larger inflation

response. Since real wages are unchanged, workers bear none of the shock and the effect on aggregate demand is neutralized.



(a) Price flexibility



(b) Wage flexibility

Figure 5: Markup-shock transmission under varying price and wage flexibility

Note: HANK impulse responses to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact in the baseline calibration. Each row reports CPI inflation (pct. points change, $100 \times d\pi_t$), real wages (pct. change, $100 \times dw_t/w$), and aggregate consumption (pct. change, $100 \times dC_t/C$). Panel (a) varies price stickiness, and panel (b) varies wage stickiness.

4 Transmission of supply and demand shocks

For the transmission of markup shocks, the pass-through matrix $\boldsymbol{\Theta}^P$ and the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ are sufficient statistics in shaping the effect on aggregate output. I now show how these same forces shape the transmission of aggregate supply and demand shocks more broadly. The distinction between the two can be understood from the response of real wages, where I now allow for changes in the price of imported materials:

$$d\mathbf{w} = \boldsymbol{\Theta}^W d\mathbf{Y} - \boldsymbol{\Theta}^P \left[d\boldsymbol{\mu} + (1 - \alpha_L) d\mathbf{P}_\mathbf{X}^* \right]. \tag{33}$$

where the pass-through matrices $\boldsymbol{\Theta}^P$ and $\boldsymbol{\Theta}^W$ are defined in (27) and (28), respectively. Substituting this response into household spending and goods-market clearing isolates the two redistribution terms in aggregate demand:

$$\begin{aligned} d\mathbf{Y} = {} & \left(1 - \alpha\right) \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \boldsymbol{\Theta}^W d\mathbf{Y} \\ & - \left(1 - \alpha\right) \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \boldsymbol{\Theta}^P \left[d\boldsymbol{\mu} + \left(1 - \alpha_L\right) d\mathbf{P}_\mathbf{X}^* \right] + \boldsymbol{\epsilon} \end{aligned} \tag{34}$$

where $\boldsymbol{\epsilon}$ collects the standard multiplier effect and any direct effects (foreign leakage, fiscal spending or expenditure switching) which depend on the specific aggregate shock under consideration.

The first term in (34) captures endogenous redistribution through $\boldsymbol{\Theta}^W \mathrm{d}\mathbf{Y}$. Higher output raises labor demand and nominal wages through the wage Phillips curve. With sticky prices, this raises real wages and transfers income from firm owners to workers, stimulating spending when workers have higher MPCs. The second term captures redistribution induced directly by markup or input-price shocks through $\boldsymbol{\Theta}^P$. Higher prices reduce real wages and transfer income in the opposite direction. Both spending effects depend on the same MPC gap, $\mathbf{M}^Z - \mathbf{M}^\Pi$.

For demand shocks redistribution operates through the first term, whereas supply shocks also function through the second. The two pass-through matrices reflect different Phillips-curve slopes: $\boldsymbol{\Theta}^W$ scales with κ^W, while $\boldsymbol{\Theta}^P$ scales with κ^P. Since nominal wages are often found to be considerably stickier than prices empirically, demand-induced real-wage adjustment is weaker. With fully rigid nominal wages, $\boldsymbol{\Theta}^W = \mathbf{0}$, while $\boldsymbol{\Theta}^P$ remains nonzero. I next discuss the specifics of supply shocks and their relation to the markup shock from Section 3, before turning to demand shocks.

4.1 Aggregate cost-push shocks

As the benchmark supply-side shock, I consider a cost-push shock driven by an increase in the price of foreign materials, $P^*_{X,t}$.[18] In Proposition 4 I present the equilibrium response of output, analogous to 1.

Proposition 4 (Equilibrium output response to cost-push shocks)**.** *The equilibrium response of output to a sequence of cost-push shocks* $\left\{\mathrm{d}P^*_{X,s}\right\}_{s=0}^{\infty}$ *is:*

$$\begin{aligned}\mathrm{d}\mathbf{Y} = & \overbrace{-\mathscr{M}\ \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]}_{\text{Distributional channel}}\ \left(1-\alpha_L\right)\boldsymbol{\Theta}^P\,\mathrm{d}\mathbf{P}^*_{\mathbf{X}}}^{} \\ & \underbrace{-\mathscr{M}\ \mathbf{M}^\Pi\ \frac{1-\alpha_L}{\alpha_L}\,\mathrm{d}\mathbf{P}^*_{\mathbf{X}}}_{\text{Foreign income leakage}}\end{aligned} \tag{35}$$

where $\mathscr{M}$ is the multiplier in Proposition 2. Proof: Appendix C.2.

Unlike the markup shock, the overall output response is the sum of two terms. The first term mirrors the markup-shock response in Proposition 2 and operates through $\boldsymbol{\Theta}^P$: higher material costs induce price adjustment, reducing real labor income relative to income received by firm owners. Its spending effect depends on the gap $\mathbf{M}^Z - \mathbf{M}^\Pi$. The second term captures the demand effect of a transfer of resources from the domestic economy to foreign suppliers. Because this operates through firm profits, it is proportional to the MPC out of profits.

Figure 6 shows that this foreign leakage effect causes a small, persistent output contraction in the RANK model, unlike the markup shock which produces a null-effect. The HANK model

[18] I hold foreign consumer prices fixed in this scenario, $\mathrm{d}P^*_{F,t} = 0$, to isolate the effect of higher foreign input prices. Under the constant real interest rate rule, a proportional increase in both foreign input and consumer prices would otherwise be fully offset by an adjustment in the nominal exchange rate, leaving the domestic economy unaffected. See Appendix C.1.

additionally features the worker–owner redistribution channel and a different consumption feedback, and therefore produces a larger contraction. It is worth noting that the response of output in the RANK model is smaller than the HANK response, but very persistent and flat, due to the permanent-income type behavior embedded in $\mathbf{M}^{\Pi}$.

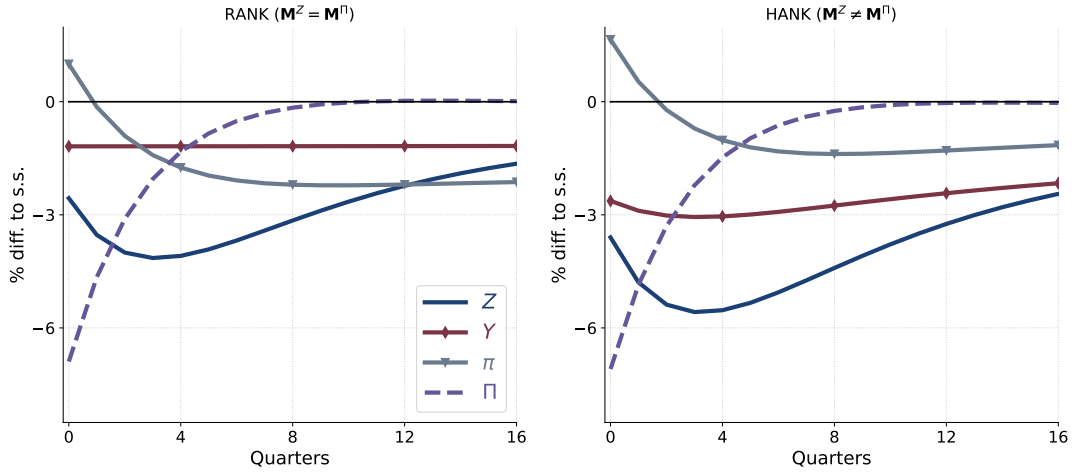


Figure 6: Effect of a cost-push shock in RANK and HANK

Note: Impulse responses to an AR(1) import-price cost-push shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact in RANK. The same shock amplitude is applied to HANK. The figure reports domestic output Y (pct. change, $100 \times \mathrm{d}Y_t/Y$), together with CPI inflation π (pct. points change, $100 \times \mathrm{d}\pi_t$), real labor income Z (pct. change, $100 \times \mathrm{d}Z_t/Y$), and real profits Π (pct. change, $100 \times \mathrm{d}\Pi_t/Y$). The responses of labor income and profits are scaled by steady-state output.

Relation to markup shock. The cost-push shock maps cleanly into the markup shock from Section 3 under a simple extension. Assume a share $\omega \in [0, 1]$ of the material input is a domestic endowment owned by domestic households. The foreign-leakage term is then scaled by $1 - \omega$, and when materials are entirely domestically owned $\omega = 1$, leakage disappears and the shock is isomorphic to a markup shock:

Proposition 5 (Markup shock equivalence)**.** *Assume that the material input X_t is entirely owned by domestic households, $\omega = 1$. Then markup shocks $\mathrm{d}\boldsymbol{\mu}$ and cost-push shocks $\mathrm{d}\mathbf{P}_{\mathbf{X}}^*$ are equivalent up to a constant scaling factor given by $1 - \alpha_L$.*

Proof. See Appendix C.2. □

This mapping makes the factor-income redistribution channel more relevant when domestic households own the affected inputs. It also gives a structural interpretation of a markup shock as a proxy for an input-price disturbance whose revenues remain in the domestic economy. The equivalence in Proposition 5 relies on Leontief production: when firms can substitute labor for materials, the two shocks need not have the same output response. I discuss this in Section 5.

Cumulative effects. Under condition (32), differences between workers' and firm owners' MPCs change the timing of spending but have no effect on the net present value of output. This implies that the first term in (4) is zero, but not the second term: An increase in import prices constitute a transfer of resources to the foreign economy, and under the small open economy assumption where foreign demand does not respond to this resource inflow, the cumulative output effect is negative.[19]

[19] See Corollary 4 in Appendix C.3.

4.2 Demand shocks

I now turn to demand shocks. The effect of worker–firm redistribution on aggregate demand is likely to be smaller following demand shocks than following supply shocks. Supply shocks directly affect firms' marginal costs, whereas demand shocks affect them through the wage Phillips curve, which has weaker pass-through. I show this for government spending shocks, whose properties are well understood in both closed and open economies (Auclert et al. 2024d; Druedahl et al. 2025), but the overall intuition carries over to other demand shocks such as monetary policy shocks.

4.2.1 Government spending

I introduce government spending G_t into the model, assuming that the government only purchases domestic final goods, and that $G = 0$ in the original steady state. Goods-market clearing then becomes:

$$d\mathbf{Y} = (1-\alpha)d\mathbf{C} + d\mathbf{G}. \tag{36}$$

The financing of purchases is summarized by $d\mathbf{T} = -\mathbf{F}^G d\mathbf{G}$, where $\mathbf{F}^G$ maps spending $\mathbf{G}$ into reductions in net transfers. Under the fiscal debt rule (19), a purchase raises debt on impact and reduces net transfers from the following period, so $\mathbf{F}^G = \rho_B \mathbf{L}[\mathbf{I} - (1 + r - \rho_B)\mathbf{L}]^{-1}$, where $\mathbf{L}$ is the lag operator. The balanced-budget case instead has $\mathbf{F}^G = \mathbf{I}$. The consumption response to transfer changes is governed by $\mathbf{M}^T$, which depends on the cross-sectional incidence of net transfers.[20] I summarize the effect on aggregate output following the shock in Proposition 6.

Proposition 6 (Equilibrium output response to government spending shocks)**.** *Assume that initial markups are small, $\mu \approx 1$. The response of output to a sequence of government spending shocks $\{G_s\}_{s=0}^{\infty}$ satisfies:*

$$\begin{aligned}\left[\mathbf{I} - (1-\alpha)\,\alpha_L \mathbf{M}^Z\right] d\mathbf{Y} = &\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \boldsymbol{\Theta}^W (1-\alpha)\, d\mathbf{Y} \\ &+ \left[\mathbf{I} - (1-\alpha)\,\mathbf{M}^T \mathbf{F}^G\right] d\mathbf{G}\end{aligned} \tag{37}$$

The full solution is:

$$d\mathbf{Y} = \mathscr{M}\left[\frac{1}{1-\alpha}\mathbf{I} - \mathbf{M}^T\mathbf{F}^G\right] d\mathbf{G}, \tag{38}$$

where $\mathscr{M}$ is the multiplier in Proposition 2. Proof: Appendix D.

Equation (37) has the same structure as the cost-push response in eq. (35): the right-hand side contains a redistribution term depending on the MPC gap and a direct effect. The key difference is that the redistribution term here is governed by the overall demand effect $d\mathbf{Y}$ and proportional to $\boldsymbol{\Theta}^W$ instead of $\boldsymbol{\Theta}^P$. The term captures how an increase in demand from higher government spending reduces the realized markup when prices are sticky, generating a transfer from firm owners to workers that raises aggregate demand in proportion to the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$. The direct effect is standard and equals the full increase in public spending minus crowding

[20] In the baseline model transfers are proportional to individual productivity, and so $\mathbf{M}^T = \mathbf{M}^Z$.

out from lower transfers. This term may depend on the degree of deficit financing in the absence of Ricardian equivalence as seen by the appearance of $\mathbf{F}^G$.

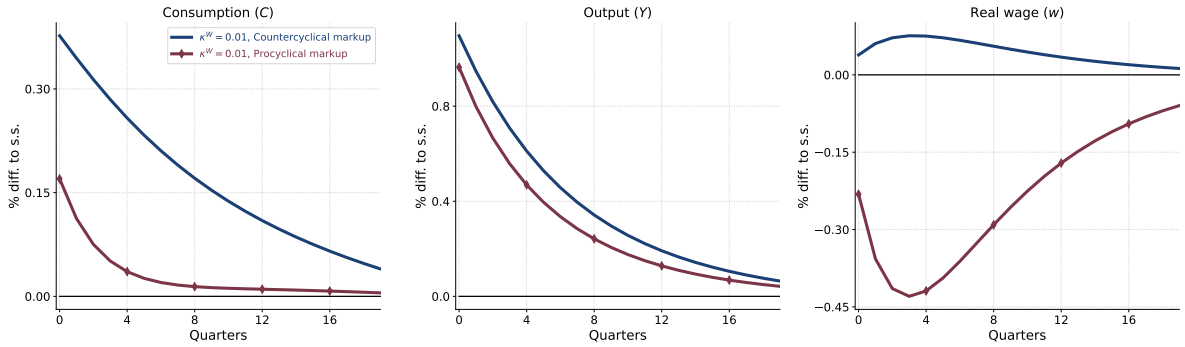
Cyclicality of markups and wage flexibility. Since $\boldsymbol{\Theta}^W$ contains $\boldsymbol{\kappa}^W$ in its numerator, a flat wage Phillips curve limits the effect of the redistribution channel for demand shocks, suggesting mild amplification in the baseline model. Two empirical considerations qualify this prediction. First, Nekarda and Ramey (2020) find that realized markups rise following expansionary monetary-policy and government-spending shocks. This contrasts with the countercyclical markups generated by the textbook sticky-price mechanism. If markups rise with demand, redistribution can instead dampen a demand shock.[21] Second, empirical evidence supports downward nominal wage rigidity (Grigsby et al. 2021; Born et al. 2024). Although wage adjustment may be relatively rigid on average (i.e. a low $\boldsymbol{\kappa}^W$), wages may respond more flexibly to positive demand shocks. In that case, $\boldsymbol{\Theta}^W$ is larger, and the redistribution term may matter more for the transmission.

I illustrate these considerations by allowing for procyclical markups by extending the price Phillips curve (14) with a demand-dependent term, $\lambda_\mu \mathrm{d}\log Y_t$, where $\lambda_\mu = 0$ recovers the standard specification. One possible microfoundation is non-homothetic preferences, which can generate an elasticity of demand that decreases with household income, as discussed in Appendix D. I calibrate λ_μ to match the baseline estimate of a fiscal-shock markup elasticity of 0.67 reported in Table 2 of Nekarda and Ramey (2020). Following their definition, this elasticity measures the cumulative response of the realized price-cost markup relative to the cumulative output response over 20 quarters. I do this separately for the baseline sticky wage model ($\kappa^W = 0.01$), but also consider the case of more flexible wages ($\kappa^W = 0.2$). The calibration yields $\lambda_\mu \approx 0.96$ and $\lambda_\mu \approx 4.19$, respectively.

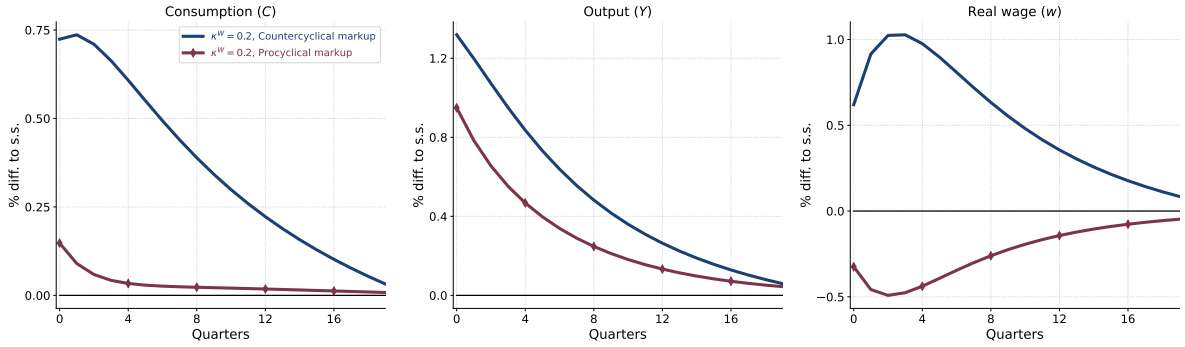
Figure 7 illustrates the aggregate effects of a government spending shock in the HANK model. Unlike the immediate-financing benchmark above, the plotted exercise uses lagged-debt feedback and reductions in net transfers distributed in proportion to household productivity. Panel (a) considers sticky wages, comparing countercyclical markups (the baseline model) with the calibrated procyclical-markup specification. In the baseline, the limited rise in real wages produces little redistribution toward workers. With procyclical markups, real wages instead fall, redistributing income toward low-MPC firm owners and dampening private consumption and output.

Panel (b) repeats the exercise with more flexible wages, as could, for instance, be the case under downward nominal wage rigidity (DNWR). With countercyclical markups, the output response is larger than in panel (a), as the greater increase in wages redistributes income from low-MPC firm owners to high-MPC workers, thereby stimulating consumption and output. With procyclical markups, redistribution operates in the opposite direction. Holding the cumulative markup elasticity fixed at 0.67, consumption and output respond similarly across the two wage slopes, and the greater amplification under countercyclical markups disappears.

[21] Evidence on markup cyclicality is mixed and depends on measurement and the shocks considered. For example, Bils et al. (2018) find evidence consistent with countercyclical price markups. The simulations below illustrate the consequences of alternative markup responses rather than taking either sign as settled.



(a) Sticky wages ($\kappa^W = 0.01$)



(b) More flexible wages ($\kappa^W = 0.2$)

Figure 7: Government spending and markup cyclicality under different degrees of wage rigidity

Note: HANK impulse responses to an AR(1) increase in government purchases with quarterly persistence 0.85 and an impact increase of 1% of steady-state GDP. The fiscal rule has $\rho_B \approx 0.02$, with reductions in net transfers distributed in proportion to household productivity e. The countercyclical-markup case has $\lambda_\mu = 0$ in both panels. The procyclical-markup case has $\lambda_\mu \approx 0.96$ in panel (a) and 4.19 in panel (b), targeting a 20-quarter cumulative realized-markup elasticity to output of 0.67 in both panels, following Nekarda and Ramey (2020). Private consumption C, output Y, and the real wage w are percentage deviations from their respective steady states.

4.2.2 Monetary policy shocks

In Appendix E, I consider monetary policy shocks as an alternative demand disturbance. The results there corroborate the overall intuition regarding demand shocks: procyclical realized markups dampen the increases in consumption and output at both wage slopes, as with fiscal shocks. In the closed economy the effects are more or less identical. In the open economy the monetary policy shock has an additional supply-side effect because it moves the exchange rate, which affects import prices and firms' marginal costs, entering the price Phillips curve directly.

4.3 Application to tariffs

As a final illustration of my main mechanism I consider an aggregate shock to tariffs on imports by domestic households and firms. Motivated by the tariffs imposed by the United States in 2025, a growing literature examines the short-run macroeconomic effects of such policies (Auclert et al. 2025b; Monacelli 2025; Bianchi and Coulibaly 2025; Werning et al. 2025; Schmitt-Grohé and Martín Uribe 2025; Barnichon and Singh 2025). In the present model, tariffs illustrate how the distributional mechanism operates when a shock combines supply and demand effects.

At its core, a tariff combines an income effect and a substitution effect. By raising import prices, tariffs reduce the real income of domestic households and firms, transferring purchasing power to the government. This resembles an adverse supply shock, whose effect on aggregate demand depends on how the income loss is distributed and how tariff revenues are rebated. At the same time, tariffs induce expenditure switching toward domestic goods, generating a positive demand effect. The overall output response depends on the relative strength of these forces.

At the zero-tariff steady state, a tariff $\mathrm{d}\boldsymbol{\tau}$ raises government revenue by $m\mathrm{d}\boldsymbol{\tau}$, where $m \equiv 1/\alpha_L - (1-\alpha)$ denotes steady-state total imports. As in Section 4.2.1, revenues are rebated through net transfers according to $\mathrm{d}\mathbf{T} = m\mathbf{F}^G\mathrm{d}\boldsymbol{\tau}$ (with $\mathbf{F}^G = \mathbf{I}$ under a balanced-budget policy), which affects consumption through $\mathbf{M}^T$. The following proposition decomposes the equilibrium output response into the real-wage redistribution effect, the net income effect, and expenditure switching.

Proposition 7 (Equilibrium output response to tariffs)**.** *At a zero initial tariff, consider a sequence of tariff changes* $\{\mathrm{d}\tau_s\}_{s=0}^{\infty}$*. Suppose tariff revenue is rebated at constant government debt (a balanced budget policy) or through the debt-stabilizing fiscal rule* (19)*. The equilibrium response of output is:*

$$\mathrm{d}\mathbf{Y} = \underbrace{-\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\left\{\overbrace{\left(1-\alpha_L+\frac{\alpha}{\mu(1-\alpha)}\right)\boldsymbol{\Theta}^P}^{\text{Firm price pass-through}} + \overbrace{\frac{\alpha}{1-\alpha}\left[\mathbf{I}+\boldsymbol{\kappa}^W+\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}W}^{\text{Direct CPI effect}}\right\}\mathrm{d}\boldsymbol{\tau}}_{\text{Real wage effect}}$$
$$+\underbrace{\mathscr{M}m\left[\mathbf{M}^T\mathbf{F}^G - \frac{1}{1-\alpha}\mathbf{M}^\Pi\right]\mathrm{d}\boldsymbol{\tau}}_{\text{Revenue rebate and income loss}} \quad + \quad \underbrace{\mathscr{M}\frac{\alpha}{1-\alpha}\eta\left(1+\frac{\alpha^*}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau}}_{\text{Expenditure switching}}, \tag{39}$$

where $\boldsymbol{\Theta}^P$ *and* $\mathscr{M}$ *are the pass-through matrix and multiplier in Proposition 2. The proof is in Appendix F.*

The first two terms in eq. (39) describe how the tariff-induced income loss affects aggregate demand. At a given level of output, total real private income $\mathrm{d}\mathbf{Z}+\mathrm{d}\boldsymbol{\Pi}$ falls by $\frac{m}{1-\alpha}\mathrm{d}\boldsymbol{\tau}$. This reflects both the higher cost of imported materials, $\frac{1-\alpha_L}{\alpha_L}\mathrm{d}\boldsymbol{\tau}$, and the decline in the real value of domestic sales, $Y\,\mathrm{d}(P_{H,t}/P_t) = -\frac{1}{\alpha_L}\frac{\alpha}{1-\alpha}\mathrm{d}\boldsymbol{\tau}$, as consumer tariffs raise the CPI relative to domestic producer prices. Since profits absorb changes in revenue net of materials and wages, firm owners bear the entire loss if real wages remain unchanged. The second term therefore evaluates this income loss at the profit MPC, while accounting for the offsetting demand generated by government rebates through $\mathbf{M}^T\mathbf{F}^G$.

Nominal rigidities determine how this income loss is instead shared between workers and firm owners. A decline in real wages transfers income from workers to firm owners relative to the fixed-wage benchmark, affecting demand through the MPC gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ in the first term of eq. (39). Real wages decline through two channels: the pass-through of higher marginal costs into domestic producer prices, captured by $\boldsymbol{\Theta}^P$, and the direct increase in consumer prices relative to domestic producer prices. Both reduce real labor income relative to profits, with the

magnitude of redistribution depending on nominal wage adjustment. Finally, the third term captures the offsetting demand stimulus from expenditure switching toward domestic goods.

Figure 8 illustrates the balance of these channels. At a low trade elasticity, household consumption falls on impact when rebates are delayed because cost pass-through and higher import prices lower real wages while the offsetting fiscal transfer arrives only gradually, even though expenditure switching raises domestic output initially. Immediate balanced-budget rebates sustain consumption and substantially strengthen the short-run output expansion in HANK, whereas the timing of rebates has almost no effect in RANK. A higher trade elasticity strengthens expenditure switching toward domestic goods, raising both output and consumption across financing rules. Rebate timing therefore shapes the magnitude of the output expansion and can flip the short-run sign of aggregate consumption. Section 5.2 reports the quantitative decompositions. Under the present-value conditions in Corollary 5, domestic MPC heterogeneity alters the timing of the adjustment rather than the NPV of output.

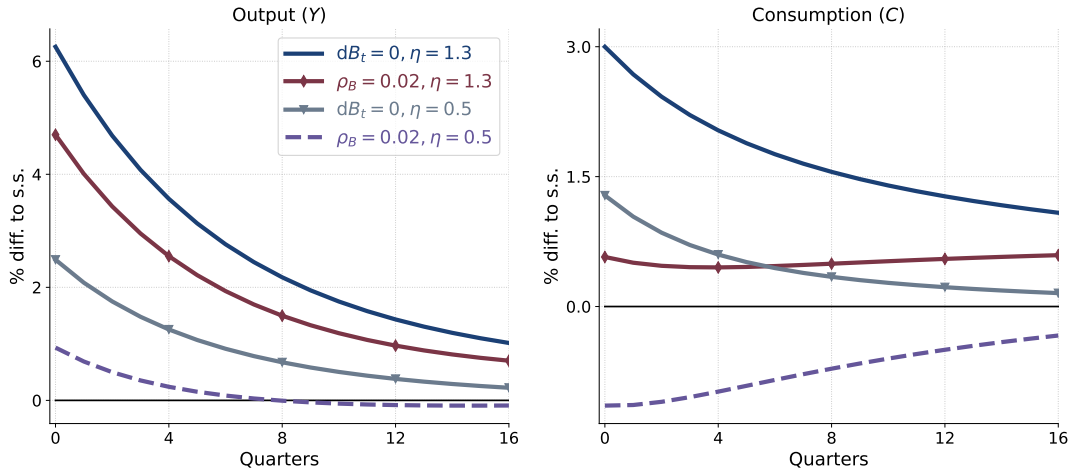


Figure 8: Tariff shock with varying financing and trade elasticity

Note: Impulse responses in the HANK model to a 10 percentage point AR(1) tariff shock with quarterly persistence 0.85. The figure reports domestic output Y (pct. change, $100 \times dY_t/Y$) and aggregate consumption C (pct. change, $100 \times dC_t/C$). Tariff revenue is either rebated immediately to households ($dB_t = 0$) or largely used for temporary debt reduction ($\rho_B = 0.02$), with trade elasticities $\eta = 0.5$ and $\eta = 1.3$.

5 Quantitative model

This section highlights the empirical relevance of the main results. I present my preferred calibration of the quantitative model (which I foreshadowed in Section 3.2), and discuss various extensions and policy implications.

5.1 Calibration

I calibrate the model to the average small open economy in the OECD.[22] Table 1 displays the calibration.

Households. I set the Frisch elasticity of labor supply to a standard value of 0.5 (Chetty et al. 2011), and I calibrate the disutility of labor $\bar{\xi}$ such that steady-state labor supply equals

[22]The small open economies constitute all OECD countries except the G7, see Druedahl et al. (2026) for more details on the sample.

$L = 1$. In the idiosyncratic income process, I fix the standard deviation of innovations (σ_e) to 0.13, and the persistence (ρ_e) to 0.966, following the estimates in Floden and Lindé (2001). This yields an income process which is similar to the ones commonly used in the HANK literature (e.g., McKay et al. 2016; Guerrieri and Lorenzoni 2017). The MPCs are calibrated as discussed in Section 3.2: I calibrate the discount factor β to match a lump-sum transfer MPC of 0.51 as in Fagereng et al. (2021), which yields $\beta \approx 0.979$, and the distribution of profits to match an annual MPC out of profits of 0.04 (Chodorow-Reich et al. 2021; Andersen et al. 2024). For the RANK model the discount factor follows from the steady-state interest rate, $\beta = \frac{1}{1+r}$, and I set its aggregate wealth-to-GDP ratio to match the HANK model's calibrated ratio of approximately 10.8. I calibrate the parameter ι^{SGU} to match the MPC out of profits from Andersen et al. (2024), which yields $\iota^{SGU} = 0.0003$. This is also sufficiently large to ensure stationarity. As specified in Section 2, net transfers are proportional to individual productivity, $T_t(e) = eT_t$.

Firms. On the supply side, I fix the steady-state markup at 20%, a standard value in the literature. For the slope of the price Phillips curve, I exploit that, to first order, Rotemberg pricing delivers the same New Keynesian Phillips curve as Calvo pricing. I then target an average price duration of three quarters, which corresponds to a Calvo probability of not adjusting prices of $\theta = 2/3$ (see, e.g., Christiano et al. 2005; Galí 2015). This implies a Phillips curve slope of $\kappa^P \approx 0.17$. For the elasticity of substitution in production, I set $\nu = 0$ as my baseline specification. This choice preserves the exact sequence-space decomposition from Sections 3–4 while closely approximating the short-run estimate of 0.03 in Boehm et al. (2019), which delivers nearly identical quantitative impulse responses (see Section 5.3 and Appendix Figure A.3). Other evidence also points to complementarity: Castro-Vincenzi and Kleinman (2026) estimate elasticities between materials and primary inputs ranging from 0.04 to 0.33. The assumption of near-perfect complementarity is consistent with recent work on inflationary shocks where substitution between materials and primary inputs is highly constrained (Auclert et al. 2024a; Chan et al. 2024).

Unions. For the unions, I assume a relatively flat wage Phillips curve with slope $\kappa^W = 0.01$, consistent with estimates in the literature. In particular, Auclert et al. (2020) obtain a value of $\kappa^W \approx 0.008$ in an estimated heterogeneous-agent New Keynesian model, while Galí (2011) find substantial nominal wage rigidities, which imply slopes between 0.001 and 0.01. More broadly, estimated medium-scale DSGE models such as Smets and Wouters (2007) typically imply values of κ^W in the range of 0.01–0.05. Taken together, these estimates support the use of a relatively flat wage Phillips curve in quantitative models. The wage markup is set equal to the markup of firms (20%) as in Smets and Wouters (2007).

Trade. The remaining parameters of the model concern trade. I calibrate the scale of foreign demand α^* such that steady-state exports amount to 42% of GDP. I assume the net-foreign asset position (and net exports) are 0 in steady state. I fix the share of imports in domestic households' consumption basket at 25%, $\alpha = 0.25$ following Christiano et al. (2011). Under the steady-state normalization (GDP = 1), total imports as a share of GDP satisfy $m = 1/\alpha_L - (1-\alpha)$. The labor share α_L (and thus the share of imported materials by firms) is then calculated residually such that aggregate imports constitute 42% of GDP, which yields $\alpha_L = 1/(0.42 + 0.75) \approx 0.855$.

For the trade elasticity η I follow Auclert et al. (2025b) who calibrate the short-run export and import elasticities to 1.5 and 1.15, respectively. For simplicity, I impose a common elasticity and set it to the average of the two, $\eta = 1.3$.

Government. I fix the tariff rate at zero in the initial steady state. I let government debt adjust such that $A = B$, implying a zero NFA. Net transfers follow from the government's budget constraint. For the fiscal rule I translate the annualized tax-rate feedback coefficient in Auclert et al. (2020) of 0.1 into a quarterly response of net transfers to lagged debt. Their rule adjusts the labor-income tax rate in response to debt relative to GDP. Converting this to quarterly frequency and multiplying by the steady-state labor-income tax base gives

$$\rho_B = \frac{0.1}{4}\frac{Z}{\text{GDP}} = 0.02.$$

Aggregate shocks. All aggregate shocks follow AR(1) processes with quarterly persistence 0.85. In the RANK–HANK comparison figures in Sections 3 and 4, the markup and cost-push shocks are scaled to raise CPI inflation by 1% on impact in RANK. The same shock amplitude is applied to HANK. The tariff shock is a 10 percentage point increase following Auclert et al. (2025b). Government purchases rise by 1% of steady-state GDP on impact. The monetary-policy experiment reduces the ex-ante real rate by 0.1 percentage point on impact (Section 4.2.2).

Parameter	Description	Value	Source/Target
Households			
φ	Frisch	0.5	Chetty et al. (2011)
β	Discount factor	0.979	MPC = 0.51 (Fagereng et al. (2021))
ρ^e	Persistence of idiosyncratic shocks	0.966	Floden and Lindé (2001)
σ^e	Std. dev of idiosyncratic shocks	0.13	Floden and Lindé (2001)
$\underline{a}$	Borrowing limit	0	Standard value
ϑ	Distribution of profits	15	Andersen et al. (2024)
Firms			
μ	Firm markup	1.2	Standard value
μ^W	Wage markup	1.2	Standard value
κ^P	Slope of Phillips curve	0.17	Galí (2015)
κ^W	Slope of wage Phillips curve	0.01	Auclert et al. (2020)
ν	EOS between labor and materials	0	Boehm et al. (2019)
α_L	Spending on labor	0.855	Imports = 42% of GDP (OECD average)
Trade			
α	Imports of final goods	0.25	Christiano et al. (2011)
α^*	Foreign demand scale	0.42	Exports = 42% of GDP
η	EOS between foreign and domestic goods	1.3	Auclert et al. (2025b)

Table 1: Calibration

5.2 Quantitative decomposition

Table 2 quantifies the contributions of price and wage pass-through to the output responses across the shock experiments. Following Propositions 2, 4, 7, and 6, I separate the first-year response into price pass-through, $\boldsymbol{\Theta}^P$, wage feedback, $\boldsymbol{\Theta}^W$, the remaining income-feedback multiplier, and direct effects unrelated to worker–firm redistribution. The final column reports the discounted output response.

Table 2: First-year decomposition and present-value output effects across shocks and models

Model	Variant	First-year effect					Present value
		Total (% of Y)	Θ^P (%)	Θ^W (%)	Multiplier (%)	Direct (%)	NPV output (% of Y)
Markup							
RANK	**Baseline**	0	0	0	0	0	0
	Closed economy	0	0	0	0	0	0
HANK	**Baseline**	−0.34	67	2	31	0	0
	Closed economy	−0.88	32	5	64	0	−6.22
Cost-push							
RANK	**Baseline**	−0.33	0	0	60	40	−7.67
HANK	**Baseline**	−0.80	33	4	43	19	−7.67
Tariff							
RANK	**Baseline**	3.78	0	0	11	89	15.10
	$dB_t = 0, \eta = 1.3$	3.80	0	0	11	89	15.10
	$\rho_B = 0.02, \eta = 1.3$	3.78	0	0	11	89	15.10
	$dB_t = 0, \eta = 0.5$	1.36	0	0	7	93	3.38
	$\rho_B = 0.02, \eta = 0.5$	1.34	0	0	7	93	3.38
HANK	**Baseline**	3.77	−19	2	29	88	15.10
	$dB_t = 0, \eta = 1.3$	5.10	−14	2	29	83	15.10
	$\rho_B = 0.02, \eta = 1.3$	3.77	−19	2	29	88	15.10
	$dB_t = 0, \eta = 0.5$	1.95	−37	2	27	108	3.38
	$\rho_B = 0.02, \eta = 0.5$	0.62	−116	1	23	192	3.38
Government spending							
HANK	**Baseline** ($\kappa^W = 0.01,\ \lambda_\mu = 0$)	0.89	0	2	27	72	0.94
	$\kappa^W = 0.01,\ \lambda_\mu \approx 0.96$	0.75	−13	2	26	86	0.94
	$\kappa^W = 0.2,\ \lambda_\mu = 0$	1.14	0	17	27	56	0.94
	$\kappa^W = 0.2,\ \lambda_\mu \approx 4.19$	0.74	−30	17	26	87	0.94

Notes: Total is mean output over the first four quarters relative to quarterly steady-state output. NPV output is the discounted quarterly sum relative to four times quarterly steady-state output. The four first-year channels are additive shares of the total response. Θ^P is shock-induced price or markup pass-through, and Θ^W is wage feedback to output. For tariffs, the price column combines firm price pass-through through $\boldsymbol{\Theta}^P$ and the direct consumer-price effect in eq. (39). Multiplier is the remaining endogenous income feedback through $\mathbf{M}^Z$ and the MPC gap. Direct includes purchases and tax financing for government spending, foreign leakage for cost-push shocks, and tariff rebates, the associated private-income loss, and expenditure switching. The markup rows use an AR(1) price-setting shock with $\epsilon_0^\pi = 0.02$ and quarterly persistence 0.85. The same shock path is used in the closed-economy rows, without the figure normalization to 1% impact CPI inflation. The material-price shock has an impact increase of 16% and quarterly persistence 0.85. The tariff rises by 10 percentage points on impact, and government purchases rise by 1% of steady-state GDP on impact. Both shocks have quarterly persistence 0.85. The baseline has zero foreign spending feedback, trade elasticity $\eta = 1.3$, and lagged-debt feedback $\rho_B \approx 0.02$. The procyclical fiscal cases target a 20-quarter cumulative markup/output elasticity of 0.67 (Section 4.2.1). $dB_t = 0$ denotes balanced budget policy. Entries may not sum exactly because of rounding.

The decomposition confirms that the redistribution channel operates primarily through price pass-through following supply shocks, whereas wage feedback is more important for demand shocks. For a markup shock, price pass-through accounts for 67% of the first-year HANK contraction, with income feedback accounting for most of the remainder. Imported-material price shocks operate through the same mechanism, but also transfer resources abroad. The source-

based decomposition in Appendix Figure A.1 attributes approximately half of the HANK contraction to domestic redistribution and half to foreign leakage, including their feedback effects. In contrast, government spending raises labor demand and shifts income toward workers through wage adjustment. This channel is weak under the baseline flat wage Phillips curve, accounting for only 2% of the first-year expansion, but rises to 17% with a steeper wage curve. Moreover, procyclical markups introduce an opposing price-pass-through effect, reducing the first-year fiscal expansion from 0.89% to 0.75% with flat wages and from 1.14% to 0.74% with steeper wages (Figure 7).[23] Tariffs combine these supply and demand forces: higher prices reduce real wages, while expenditure switching and rebates stimulate demand. Although the baseline HANK and RANK responses are similar, the HANK expansion increases from 3.77% to 5.10% with immediate rebates and falls to 0.62% when the trade elasticity is reduced under delayed rebates.

Despite these differences in short-run transmission, the discounted output responses are largely governed by the present-value condition (32). In the small open economy, domestic redistribution changes the timing of spending without affecting its present value. Consequently, markup shocks have zero NPV in both HANK and RANK, while imported-material price shocks generate the same negative NPV in both models because of foreign leakage. Tariff NPVs are likewise identical across models at a given trade elasticity, and the four HANK fiscal experiments have the same NPV despite their different first-year responses. The fully closed markup experiment is an exception: stronger domestic income feedback produces an NPV of -6.22% in HANK, compared with zero in RANK. I note that even a small positive import share restores the zero-NPV result, making the fully closed economy a limiting case.

5.3 Extensions

The baseline model abstracts from several features that may affect the transmission of supply shocks. In this section, I examine the robustness of the main results to relaxing these assumptions. I first consider whether nominal debt revaluation or the inclusion of capital and investment can offset the contraction following a markup shock. I then allow substitution between labor and intermediate inputs to examine how the effects of an input-price shock depend on their degree of complementarity.

Fisher effects. The baseline model assumes that households save in real assets, thus sidestepping the debt-revaluation channel that arises when nominal debt contracts are present (Fisher 1933; Doepke and Schneider 2006; Auclert 2019; Brunnermeier et al. 2025). Shocks that directly raise marginal costs and inflation can generate large absolute demand effects through worker–owner redistribution. Surprise inflation can also activate Fisher effects. Evaluating their joint effect on aggregate demand is therefore important. In this exercise I relax the baseline zero borrowing limit to $\underline{a} = -Z_{ss}$, allowing households to hold debt. In Appendix G.1 I introduce nominal, long-term government bonds such that surprise inflation affects returns in the first

[23] I omit the RANK model from the fiscal rows for brevity. Its zero MPC gap eliminates worker–firm redistribution, and Ricardian equivalence makes private demand insensitive to the timing of tax financing.

period of the shock. With bonds of one-period maturity, the change in aggregate consumption is given by:

$$d\mathbf{C} = \underbrace{\mathbf{M}^{Z} d\mathbf{Z}}_{\text{Labor income}} + \underbrace{\mathbf{M}^{\Pi} d\mathbf{\Pi}}_{\text{Profits}} - \underbrace{\mathbf{M}^{r_0} \theta^{n} d\pi_0}_{\text{Fisher effects}}$$

where $\mathbf{M}^{r_0}$ is a vector capturing the effect on aggregate consumption $d\mathbf{C}$ following a change in the realized real rate of return on assets at time 0, dr_0^a, and θ^n is the share of nominal bonds.[24] The vector $\mathbf{M}^{r_0}$ can be written as the sum of an average effect and a covariance:

$$\mathbf{M}^{r_0} = \mathbf{M}_0 \times A + \mathbb{C}\text{ov}\big(\mathbf{M}_0(e,a), a\big)$$

stating that the effect on consumption from a surprise change in the rate of return is the sum of (i) the MPC out of a lump-sum transfer at time $t = 0$ ($\mathbf{M}_0$) times the aggregate net asset position A and (ii) the covariance between MPCs in the population and net asset positions. Since borrowers in the model are more likely to be credit constrained, this covariance tends to be negative. Figure A.6a shows the effects of the markup shock with the Fisher effect active. On impact, the redistribution from creditors to debtors dampens the demand contraction, since impact MPCs of debtors exceed those of creditors, $\mathbb{C}\text{ov}\big(\mathbf{M}_0(e,a), a\big) < 0$. However, because creditors have larger intertemporal MPCs (i.e. they smooth consumption more), the negative consumption response is amplified in subsequent periods as the initial redistributional effect subsides and savers reduce consumption persistently. For a realistic covariance between MPCs and net nominal positions (Auclert 2019) the overall impact of these Fisher effects is minor.

Investment. The baseline model abstracts from investment. This assumption may matter for the transmission of aggregate shocks because a low MPC out of profits implies a high marginal propensity to invest. In the baseline model these profits flow into unproductive bonds, and therefore do not directly affect production and income. To see the implications of this assumption, I introduce investment into the model. I consider two versions: one in which firms pay for investment subject to an adjustment cost, and another with financial frictions in which a fraction s of operating surplus is used to finance investment (Lian and Ma 2021; Drechsel 2023). In both cases total output Y is produced with Cobb-Douglas technology using capital and the CES aggregate containing L and X (see appendix G.2 for details).

Appendix Figure A.8 shows the results. With unconstrained investment there is a mild contraction in output in the RANK model, while the response of the HANK model is largely unchanged. In both models investment declines since a higher firm markup reduces the marginal product of capital. With financial constraints the overall surplus of firms instead determines the investment response. In this case the RANK model predicts an increase in output following the markup shock as the increase in profits flows into investment. The HANK model still predicts a decline due to the negative effect on consumption from lower real wages, though this can be overturned if the financial friction effect on investment is sufficiently strong since the markup shock directly increases profits and relaxes the financial constraint. Overall, whether the inclu-

[24] Only the date-0 realized return r_0^a is affected by surprise inflation, since monetary policy keeps the ex-ante real rate constant ($dr_t = 0$ for all $t \geq 0$), which implies $dr_{t+1}^a = 0$ for $t \geq 0$.

sion of investment amplifies or dampens the shock depends on firms' marginal propensity to invest, as highlighted in Winberry et al. (2025).

Substitution in production. The baseline model assumes Leontief production (assumption 2, $\nu \to 0$), ruling out substitution between labor and intermediate inputs. In Appendix C.4 (Figure A.3) I relax this assumption and compare the responses to a markup shock and a cost-push shock as the elasticity of substitution ν increases, holding materials domestically owned ($\omega = 1$) so the two shocks coincide in the Leontief limit (Proposition 5). For the markup shock, varying ν has only a minor effect because the shock raises price markups without directly altering the relative price of materials and labor. For the cost-push shock, a higher elasticity of substitution ν causes firms to substitute away from more expensive materials toward labor, whose nominal cost is sticky. This substitution raises labor demand and employment, thus stabilizing real labor income and dampening the fall in aggregate demand and output. Amplification of an input-price shock through worker–firm redistribution therefore requires complementarity between labor and materials in addition to sticky nominal wages and a positive MPC gap (see also Lorenzoni and Werning 2023; Auclert et al. 2024a), although an implausibly large short-run elasticity is needed to overturn the output contraction.

5.4 Stabilization policy

The main focus of this paper is the *positive* description of the transmission of aggregate shocks in the presence of heterogeneous agents. In this final section I briefly consider the implications for stabilization policy in the present environment, where demand shortages are caused by heterogeneous MPCs.

Fiscal transfers. A targeted government transfer to poorer households financed by higher taxes on wealthier households can fully neutralize the markup shock since this is a pure redistributive shock. However, in practice governments that paid out stimulus to alleviate cost-of-living issues during the 2021–2023 inflation surge often did so using deficit financing (Dao et al. 2023; Langot et al. 2023). To investigate this, I consider a policy of this kind. I assume that the government provides a uniform transfer $\mathrm{d}U_t$ that is exactly enough to stabilize the income loss from lower real wages from the markup shock, and that this transfer is financed by reductions in net transfers to rich households (i.e. proportional to the profit incidence function $g(e)$). The transfer rule (19) applies with no purchase or tariff shock. The balanced-budget benchmark offsets the discretionary outlays contemporaneously with reductions in net transfers to rich households. Under lagged-debt feedback, a smaller positive ρ_B delays these reductions, subject to debt stability.

Appendix Figure A.9 shows the results for different positive values of ρ_B in the baseline HANK model. With a fully balanced budget, fiscal policy can perfectly stabilize consumption without causing excess inflation (i.e. inflation beyond the effects of the underlying markup shock). Under lagged-debt transfer feedback, the discretionary outlay is initially deficit financed. Slower transfer adjustment (a smaller ρ_B) raises private consumption because real labor income is stabilized while the offsetting reductions in net transfers to rich households occur later. This also raises inflation beyond the effect of the underlying markup shock.

Monetary policy. The baseline model features "passive" monetary policy ($dr_t = 0$), which implies that the markup shock has no effects in the representative agent model. Whether monetary policy should tighten or loosen is not obvious with a stagflationary supply shock when the central bank has a dual mandate, though historically the Fed has tightened in response to oil shocks (Bernanke et al. 1997), as has the ECB, which focuses on inflation stabilization. I investigate the implications of a tighter monetary policy response by adding a Taylor rule $di_t = \phi^\pi d\pi_{t+1}$ where $\phi^\pi = 1$ recovers the baseline where the ex-ante real rate is constant. Here I vary the response to a markup shock. Section 4.2.2 instead introduces an expansionary policy wedge at $\phi^\pi = 1$.

Appendix Figure A.10 shows the first-year response of real labor income, real wages and employment as a function of ϕ^π. Aggregate real labor income Z declines more as the monetary policy response becomes more aggressive since this decreases aggregate demand through intertemporal substitution. Notably the *driver* of this decline in real income changes with the monetary policy response: For a low ϕ^π, the decline is caused by higher inflation lowering real wages. As ϕ^π becomes larger inflation declines, real wages fall less, but overall employment declines more. The latter effect dominates, so total real labor income ultimately declines more with a more aggressive policy. This can potentially have important implications in models with a more realistic labor market where not all households are equally affected by changes in real wages vs. employment (see e.g. Alves and Violante 2023).

Wage indexation. Proposition 3 highlights the importance of real wage dynamics for the transmission of markup shocks in models with distributional effects. A natural structural remedy is to index nominal wages to CPI inflation (Fischer 1976). In Appendix H.3 I solve the model with wage indexation, which modifies both pass-through matrices $\mathbf{\Theta}^P$ and $\mathbf{\Theta}^W$ (and therefore the general-equilibrium multiplier $\mathscr{M}$), and demonstrate that a higher degree of indexation dampens the output effects of the markup shock. Full indexation gives $\mathbf{\Theta}^P = \mathbf{0}$ and perfectly neutralizes the shock's aggregate demand effects, analogously to the flexible-wage case in Proposition 3.

6 Conclusion

This paper has analytically characterized the transmission of inflationary supply and demand shocks in a heterogeneous-agent New Keynesian model, emphasizing changes in factor income as a channel through which shocks redistribute income from workers to firm owners. Using the sequence-space Jacobian framework, I derive closed-form expressions relating the output response to the cross-sectional distribution of marginal propensities to consume across income sources and to the degree of nominal price and wage rigidities. The mechanism is particularly strong for supply shocks which operate through the price Philips curve, but weaker for demand shock which operate through the wage Philips curve.

For tractability, the model in the paper is deliberately kept largely standard. Future research could extend the framework to settings in which the inflation burden is not shared uniformly across workers—for instance, through heterogeneous consumption baskets or labor supply schedules—to more realistic forms of firm price setting, such as menu costs, which are known to generate non-linear effects in response to large shocks, and to incorporate aggregate

uncertainty, which is often present when significant inflationary episodes are driven by oil price shocks.

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Appendix

A Details on foreign demand

I assume that foreign demand for domestic goods C_t^* can potentially depend on the net income received by foreign households from the domestic economy. Let foreign households' revenue be $R_t^* = P_{X,t}^* (1-\omega) X_t + P_{F,t}^* C_{F,t}$, and assume that foreign export prices satisfy $P_{X,t}^* = MC_{X,t}^* + \tau_{X,t}^*, P_{F,t}^* = MC_{F,t}^* + \tau_{F,t}^*$ where $\tau_{X,t}^*, \tau_{F,t}^*$ potentially represent taxes, markups or iceberg trading costs. Net income $\mathcal{N}_t^*$ is:

$$\begin{aligned}\mathcal{N}_t^* =& R_t^* - MC_{X,t}^* (1-\omega) X_t - MC_{F,t}^* C_{F,t} \\ =& \tau_{X,t}^* (1-\omega) X_t + \tau_{F,t}^* C_{F,t}\end{aligned}$$

To first order, with initially small $\tau_{X,t}^*, \tau_{F,t}^*$, this yields the change in net income:

$$\mathrm{d}\mathcal{N}_t^* = (1-\omega) X \mathrm{d}P_{X,t}^* + C_F \mathrm{d}P_{F,t}^*$$

B Derivations and proofs for markup shocks

Initial steady state. For all the linearized derivations and proofs I assume that in the initial steady state net exports and the NFA are 0 (balanced trade) and that aggregate consumption C is normalized to 1. Steady-state output is then $\frac{1}{\alpha_L} > 1$, labor is $L = 1$, and material use is $\frac{1-\alpha_L}{\alpha_L}$. Prices are normalized to 1 except for the wage rate which is $W = \frac{\frac{1}{\mu} - (1-\alpha_L)}{\alpha_L}$. For future use, total imports are $\frac{1}{\alpha_L} - (1-\alpha)$.

B.1 Derivation of eq. (22)

Starting from goods market clearing condition (21) and linearizing around the zero-inflation steady state gives:

$$\mathrm{d}Y_t = \mathrm{d}C_{H,t} + \mathrm{d}C_{H,t}^*$$

Substituting in for $\mathrm{d}C_{H,t}^*$ from (20), including the foreign price-windfall demand term $\mathrm{d}C_{H,t}^{*,F}$:

$$\mathrm{d}Y_t = \mathrm{d}C_{H,t} - \eta\alpha^* \left(\mathrm{d}P_{H,t}^* - \mathrm{d}P_{F,t}^*\right) + \mathrm{d}C_{H,t}^{*,F}$$

Using the law of one price $\mathrm{d}P_{H,t}^* + \mathrm{d}\mathscr{E}_t = \mathrm{d}P_{H,t}, \mathrm{d}P_{F,t} = \mathrm{d}\mathscr{E}_t + \mathrm{d}P_{F,t}^*$ and the definition of the CPI $\mathrm{d}P_t = \alpha\left(\mathrm{d}P_{F,t} + \mathrm{d}\tau_t\right) + (1-\alpha)\mathrm{d}P_{H,t}$ one gets:

$$\begin{aligned}\mathrm{d}Y_t &= \mathrm{d}C_{H,t} - \frac{1}{(1-\alpha)}\eta\alpha^* \left(\mathrm{d}P_t - \mathrm{d}\mathscr{E}_t - \mathrm{d}P_{F,t}^* - \alpha\mathrm{d}\tau_t\right) + \mathrm{d}C_{H,t}^{*,F} \\ \Leftrightarrow \mathrm{d}Y_t &= \mathrm{d}C_{H,t} + \frac{1}{(1-\alpha)}\eta\alpha^*\mathrm{d}Q_t + \frac{\alpha}{(1-\alpha)}\eta\alpha^*\mathrm{d}\tau_t + \mathrm{d}C_{H,t}^{*,F}\end{aligned}$$

where the second line uses the definition of the real exchange rate $Q_t = \frac{\mathscr{E}_t P_{F,t}^*}{P_t}$. In this linearization $P_{F,t}$ is the pre-tariff price, whereas in the main text $P_{F,t} = (1+\tau_t)\mathscr{E}_t P_{F,t}^*$ is tariff-inclusive

and the CPI in (8) therefore has no separate tariff term. Since the real UIP condition (17) implies $dQ_t = 0$ under a constant real rate policy we have:

$$dY_t = dC_{H,t} + \frac{\alpha}{(1-\alpha)}\eta\alpha^* d\tau_t + dC^{*,F}_{H,t}$$

Linearizing demand for domestic goods in (7) gives:

$$dC_{H,t} = (1-\alpha)\, dC_t - \eta\,(1-\alpha)\left(dP_{H,t} - dP_t\right)$$

Next, using the law of one price and the definition of the real exchange rate $dP_{H,t} - dP_t$ can be written as:

$$\begin{aligned} dP_{H,t} - dP_t &= \frac{1}{(1-\alpha)} dP_t - \frac{\alpha}{(1-\alpha)}\left(dP_{F,t} + d\tau_t\right) - dP_t \\ &= -\frac{\alpha}{(1-\alpha)} dP_{F,t} + \frac{\alpha}{(1-\alpha)} dP_t - \frac{\alpha}{(1-\alpha)} d\tau_t \\ &= -\frac{\alpha}{(1-\alpha)}\left(d\mathscr{E}_t + dP^*_{F,t}\right) + \frac{\alpha}{(1-\alpha)} dP_t - \frac{\alpha}{(1-\alpha)} d\tau_t \\ &= -\frac{\alpha}{(1-\alpha)} dQ_t - \frac{\alpha}{(1-\alpha)} d\tau_t \end{aligned}$$

With a constant real exchange rate we thus have:

$$dY_t = (1-\alpha)\, dC_t + \alpha\eta\left(1 + \frac{\alpha^*}{1-\alpha}\right) d\tau_t + dC^{*,F}_{H,t}$$

I define $\mathbf{M}^F$ as the sequence-space Jacobian of foreign demand C^* with respect to foreign net income $\mathbf{F}^P$:

$$d\mathbf{C}^* = \mathbf{M}^F d\mathbf{F}^P. \tag{A.1}$$

At constant relative prices the induced demand for domestic goods is $d\mathbf{C}^{*,F}_H = \alpha^* d\mathbf{C}^*$, hence $d\mathbf{C}^{*,F}_H = \alpha^* \mathbf{M}^F d\mathbf{F}^P$. Further assuming constant tariffs gives equation (22). In the markup section $d\mathbf{F}^P = \mathbf{0}$, so this reduces to $d\mathbf{Y} = (1-\alpha) d\mathbf{C}$.

B.2 Proof of Proposition 1

The appendix derivations retain a domestic ownership share $\omega \in [0,1]$ of materials. Main-text Propositions 1–2 specialize to imported materials, $\omega = 0$. Proposition 5 uses the domestically owned case $\omega = 1$. First note that under a constant-r rule the consumption function $\mathscr{C}_t$ depends only on the aggregate sequence of labor income, profits and transfers, i.e.:

$$C_t = \mathscr{C}_t\left(\{Z_s, \Pi_s, T_s\}_{s=0}^{\infty}\right)$$

or, written in sequence space: $\mathbf{C} = \mathscr{C}\left(\{\mathbf{Z}, \mathbf{\Pi}, \mathbf{T}\}\right)$. Linearizing and substituting this into (22) gives:

$$\mathrm{d}\mathbf{Y} = (1-\alpha)\left[\mathbf{M}^{Z}\mathrm{d}\mathbf{Z} + \mathbf{M}^{\Pi}\mathrm{d}\mathbf{\Pi} + \mathbf{M}\mathrm{d}\mathbf{T}\right] + \alpha^{*}\mathbf{M}^{F}\mathrm{d}\mathbf{F}^{P} + \alpha\eta\left(1 + \frac{\alpha^{*}}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau} \tag{A.2}$$

To derive Proposition 1 we need to derive an expression for labor income $\mathrm{d}\mathbf{Z}$. Start from operating profits (15) and, when $\omega > 0$, add the cyclical material-ownership income $\omega\left(\frac{\mathscr{E}_t P^{*}_{X,t}}{P_t}X_t - \frac{\mathscr{E}P^{*}_{X}}{P}X\right)$ paid to domestic households (subtracting the steady-state material cost so that ω does not alter the initial steady state). Using $\nu \to 0$, so that $X_t = (1-\alpha_L)Y_t$, and $\frac{\mathscr{E}_t P^{*}_{X,t}}{P_t} = P^{*}_{X,t}$ at a constant real exchange rate, total profits are:

$$\begin{aligned}\Pi_t &= \frac{P_{H,t}}{P_t}Y_t - Z_t - \frac{(1+\tau_t)\mathscr{E}_t P^{*}_{X,t}}{P_t}Y_t(1-\alpha_L) + \omega(1-\alpha_L)\left(\frac{\mathscr{E}_t P^{*}_{X,t}}{P_t}Y_t - \frac{\mathscr{E}P^{*}_{X}}{P}Y\right) - \frac{\theta^{P}}{2}\pi^{2}_{H,t}Y_t \\ &= \left[\frac{P_{H,t}}{P_t} - (1+\tau_t-\omega)P^{*}_{X,t}(1-\alpha_L) - \frac{\theta^{P}}{2}\pi^{2}_{H,t}\right]Y_t - \omega(1-\alpha_L)P^{*}_{X}Y - Z_t.\end{aligned}$$

Linearizing gives:

$$\begin{aligned}\mathrm{d}\Pi_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t + Y\mathrm{d}\left(\frac{P_{H,t}}{P_t}\right) \\ &\quad - Y(1-\omega)(1-\alpha_L)\mathrm{d}P^{*}_{X,t} - Y(1-\alpha_L)\mathrm{d}\tau_t - \mathrm{d}Z_t \\ \Leftrightarrow \mathrm{d}\Pi_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t - Y\frac{\alpha}{(1-\alpha)}\mathrm{d}\tau_t \\ &\quad - Y(1-\omega)(1-\alpha_L)\mathrm{d}P^{*}_{X,t} - Y(1-\alpha_L)\mathrm{d}\tau_t - \mathrm{d}Z_t \\ \Leftrightarrow \mathrm{d}Z_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t - \frac{1}{\alpha_L}\frac{\alpha}{(1-\alpha)}\mathrm{d}\tau_t \\ &\quad - (1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}P^{*}_{X,t} - \frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}\tau_t - \mathrm{d}\Pi_t\end{aligned} \tag{A.3}$$

Assume that we are only interested in a markup shock so $\mathrm{d}\tau_t = 0$, and $\mathrm{d}\mathbf{P}^{*}_{X} = \mathbf{0}, \mathrm{d}\mathbf{F}^{P} = 0$. Writing (A.3) in sequence-space and substituting into (A.2) gives:

$$\begin{aligned}\mathrm{d}\mathbf{Y} &= (1-\alpha)\left[\mathbf{M}^{Z}\left[\left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}\mathbf{Y} - \mathrm{d}\mathbf{\Pi}\right] + \mathbf{M}^{\Pi}\mathrm{d}\mathbf{\Pi} + \mathbf{M}\mathrm{d}\mathbf{T}\right] \\ \Leftrightarrow \frac{1}{1-\alpha}\mathrm{d}\mathbf{Y} &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathbf{M}^{Z}\mathrm{d}\mathbf{Y} - \left[\mathbf{M}^{Z} - \mathbf{M}^{\Pi}\right]\mathrm{d}\mathbf{\Pi} + \mathbf{M}\mathrm{d}\mathbf{T}\end{aligned}$$

Using the assumption $\mathrm{d}\mathbf{B} = 0$, which implies $\mathrm{d}\mathbf{T} = 0$, and specializing to imported materials ($\omega = 0$) yields eq. (24) in the main text.

B.3 Phillips curve pass-through matrices

This section derives the expressions for the pass-through matrices $\boldsymbol{\kappa}^{P}, \boldsymbol{\kappa}^{W}$ appearing in eqs. (25) and (26). The baseline analysis assumes a price Phillips curve of the form in (14). Retaining

the relative price $P_{H,t}/P_t$, this is

$$\pi_{H,t}\left(1+\pi_{H,t}\right) = \kappa^P\left(mc_t - \frac{P_{H,t}}{P_t}\frac{1}{\mu_t}\right) + \beta\pi_{H,t+1}\left(1+\pi_{H,t+1}\right),$$

where the desired markup μ_t equals μ in steady state. Linearizing around the zero-inflation steady state and writing $\mathrm{d}\mu_t = (\mu_t - \mu)/\mu^2$ gives:

$$\mathrm{d}\pi_{H,t} = \kappa^P\left[\mathrm{d}mc_t + \mathrm{d}\mu_t - \frac{1}{\mu}\mathrm{d}\left(\frac{P_{H,t}}{P_t}\right)\right] + \beta\mathrm{d}\pi_{H,t+1} \tag{A.4}$$

For markup and material-price shocks at fixed tariffs and a constant real exchange rate, $\mathrm{d}(P_{H,t}/P_t) = 0$. Under a tariff shock, however, $\mathrm{d}(P_{H,t}/P_t) = -\alpha\mathrm{d}\tau_t/(1-\alpha)$, so the relative-price term must be retained. Imposing the terminal inflation condition gives

$$\mathrm{d}\pi_{H,t} = \kappa^P\sum_{s=0}^{\infty}\beta^s\left[\mathrm{d}mc_{t+s} + \mathrm{d}\mu_{t+s} - \frac{1}{\mu}\mathrm{d}\left(\frac{P_{H,t+s}}{P_{t+s}}\right)\right].$$

In sequence space this is

$$\mathrm{d}\boldsymbol{\pi}_H = \kappa^P\boldsymbol{\Psi}\left[\mathrm{d}\mathbf{mc} + \mathrm{d}\boldsymbol{\mu} - \frac{1}{\mu}\mathrm{d}\left(\frac{\mathbf{P}_H}{\mathbf{P}}\right)\right], \tag{A.5}$$

where:

$$\boldsymbol{\Psi} = \begin{bmatrix} 1 & \beta & \beta^2 & \beta^3 & \cdots \\ 0 & 1 & \beta & \beta^2 & \cdots \\ 0 & 0 & 1 & \beta & \cdots \\ 0 & 0 & 0 & 1 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

The final step is to rewrite the equation in terms of price levels instead of inflation. This yields:

$$\mathrm{d}\mathbf{P}_H = \boldsymbol{\kappa}^P\left[\mathrm{d}\mathbf{mc} + \mathrm{d}\boldsymbol{\mu} - \frac{1}{\mu}\mathrm{d}\left(\frac{\mathbf{P}_H}{\mathbf{P}}\right)\right]$$

where $\boldsymbol{\kappa}^P = \kappa^P\mathbf{U}\boldsymbol{\Psi}$ and:

$$\mathbf{U} = \begin{bmatrix} 1 & 0 & 0 & 0 & \cdots \\ 1 & 1 & 0 & 0 & \cdots \\ 1 & 1 & 1 & 0 & \cdots \\ 1 & 1 & 1 & 1 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

is a lower triangular matrix. $\boldsymbol{\kappa}^P$ has the following form:

$$\boldsymbol{\kappa}^P = \kappa^P \begin{bmatrix} 1 & \beta & \beta^2 & \beta^3 & \cdots \\ 1 & 1+\beta & \beta+\beta^2 & \beta^2+\beta^3 & \cdots \\ 1 & 1+\beta & 1+\beta+\beta^2 & \beta+\beta^2+\beta^3 & \cdots \\ 1 & 1+\beta & 1+\beta+\beta^2 & 1+\beta+\beta^2+\beta^3 & \cdots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix}$$

With a non-forward-looking Phillips curve, $\beta = 0$, $\boldsymbol{\kappa}^P = \kappa^P \mathbf{U}$.
Regarding the New Keynesian wage Phillips curve we have that the linearized NKWPC is:

$$\mathrm{d}\pi_t^W = \kappa^W \left(\frac{1}{\varphi} \frac{\bar{\xi}}{w} \mu^w L^{\frac{1}{\varphi}-1} \mathrm{d}L_t - \frac{\bar{\xi}}{w^2} \mu^w \mathrm{d}w_t \right) + \beta \mathrm{d}\pi_{t+1}^W$$

Using that in steady state $\bar{\xi} = \frac{w}{\mu^w}$ we get:

$$\mathrm{d}\pi_t^W = \kappa^W \left(\frac{1}{\varphi} \mathrm{d}L_t - \frac{1}{W} \mathrm{d}w_t \right) + \beta \mathrm{d}\pi_{t+1}^W$$

Then, using the definition of $\boldsymbol{\Psi}$ above:

$$\mathrm{d}\boldsymbol{\pi}^W = \kappa^W \boldsymbol{\Psi} \left(\frac{1}{\varphi} \mathrm{d}\mathbf{L} - \frac{1}{W} \mathrm{d}\mathbf{w} \right)$$

To express the equation in wage levels, I multiply by steady-state wages using the defined $\mathbf{U}$ matrix above (for the NKPC, this step is implicit because $P_H = 1$ in steady state):

$$\begin{aligned} \mathrm{d}\mathbf{W} &= \kappa^W \mathbf{U}\boldsymbol{\Psi} \left(\frac{1}{\varphi} W \mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w} \right) \\ &= \boldsymbol{\kappa}^W \left(\frac{1}{\varphi} W \mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w} \right) \end{aligned}$$

with $\boldsymbol{\kappa}^W \equiv \kappa^W \mathbf{U}\boldsymbol{\Psi}$.

B.4 Proof of Proposition 2

As in Appendix B.2, the algebra retains general ω. The main-text statement of Proposition 2 is the specialization $\omega = 0$. The proof involves solving for $\mathrm{d}\boldsymbol{\Pi}$ as a function of the price shock and output. Starting from the equation:

$$\begin{aligned} \mathrm{d}\Pi_t = &\left[1 - (1-\omega)(1-\alpha_L)\right] \mathrm{d}Y_t - (1-\omega) \frac{(1-\alpha_L)}{\alpha_L} \mathrm{d}P_{X,t}^* \\ &- \left[(1-\alpha_L) + \frac{\alpha}{(1-\alpha)} \right] \frac{1}{\alpha_L} \mathrm{d}\tau_t - \mathrm{d}Z_t \end{aligned}$$

Using the expression derived in Appendix B.2 and Leontief production gives:

$$\begin{aligned}
\mathrm{d}\Pi_t &= \left[1-(1-\omega)(1-\alpha_L)-w\alpha_L\right]\mathrm{d}Y_t-(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}P^*_{X,t}\\
&\quad-\left[(1-\alpha_L)+\frac{\alpha}{(1-\alpha)}\right]\frac{1}{\alpha_L}\mathrm{d}\tau_t-\mathrm{d}w_t\\
\mathrm{d}\Pi_t &= \left[\frac{\mu-1}{\mu}+\omega(1-\alpha_L)\right]\mathrm{d}Y_t-(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}P^*_{X,t}\\
&\quad-\left[(1-\alpha_L)+\frac{\alpha}{(1-\alpha)}\right]\frac{1}{\alpha_L}\mathrm{d}\tau_t-\mathrm{d}w_t
\end{aligned}$$

Then using the definition of real marginal costs $mc_t = \alpha_L w_t + (1-\alpha_L)P^*_{X,t}(1+\tau_t)$ (which in steady state equals $\frac{1}{\mu}$):

$$\mathrm{d}\Pi_t = \left[\frac{\mu-1}{\mu}+\omega(1-\alpha_L)\right]\mathrm{d}Y_t-\frac{1}{\alpha_L}\frac{\alpha}{(1-\alpha)}\mathrm{d}\tau_t+\omega\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}P^*_{X,t}-\frac{1}{\alpha_L}\mathrm{d}mc_t$$

To combine the two Phillips curves, use $\mathrm{d}\mathbf{P} = \mathrm{d}\mathbf{P}_H + \alpha\mathrm{d}\boldsymbol{\tau}/(1-\alpha)$ and retain the tariff-induced relative-price term in the NKPC. Subtracting price changes from nominal wage changes gives

$$\mathrm{d}\mathbf{w} = \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L}-\mathrm{d}\mathbf{w}\right)-W\boldsymbol{\kappa}^P\left[\mathrm{d}\mathbf{mc}+\mathrm{d}\boldsymbol{\mu}+\frac{\alpha}{\mu(1-\alpha)}\mathrm{d}\boldsymbol{\tau}\right]-\frac{W\alpha}{1-\alpha}\mathrm{d}\boldsymbol{\tau}.$$

Substitute $\mathrm{d}\mathbf{L} = \alpha_L\mathrm{d}\mathbf{Y}$ and $\mathrm{d}\mathbf{mc} = \alpha_L\mathrm{d}\mathbf{w} + (1-\alpha_L)(\mathrm{d}\mathbf{P}^*_{\mathbf{X}} + \mathrm{d}\boldsymbol{\tau})$. Together with the definitions of $\boldsymbol{\Theta}^P$ and $\boldsymbol{\Theta}^W$ in the main text, this yields

$$\begin{aligned}
\mathrm{d}\mathbf{w} &= \boldsymbol{\Theta}^W\mathrm{d}\mathbf{Y}-\boldsymbol{\Theta}^P\left[(1-\alpha_L)\mathrm{d}\mathbf{P}^*_{\mathbf{X}}+\mathrm{d}\boldsymbol{\mu}\right]\\
&\quad-\left\{\left(1-\alpha_L+\frac{\alpha}{\mu(1-\alpha)}\right)\boldsymbol{\Theta}^P+\frac{\alpha}{1-\alpha}\left[\mathbf{I}+\boldsymbol{\kappa}^W+\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}W\right\}\mathrm{d}\boldsymbol{\tau}. \qquad \text{(A.6)}
\end{aligned}$$

Substituting into profits gives

$$\begin{aligned}
\mathrm{d}\boldsymbol{\Pi} &= \left[\left(\frac{\mu-1}{\mu}+\omega(1-\alpha_L)\right)\mathbf{I}-\boldsymbol{\Theta}^W\right]\mathrm{d}\mathbf{Y}\\
&\quad+\left\{\left(1-\alpha_L+\frac{\alpha}{\mu(1-\alpha)}\right)\boldsymbol{\Theta}^P+\frac{\alpha}{1-\alpha}\left[\mathbf{I}+\boldsymbol{\kappa}^W+\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}W\right.\\
&\quad\left.-\frac{1}{\alpha_L}\left(\frac{\alpha}{1-\alpha}+1-\alpha_L\right)\mathbf{I}\right\}\mathrm{d}\boldsymbol{\tau}\\
&\quad-(1-\alpha_L)\left[\frac{1-\omega}{\alpha_L}\mathbf{I}-\boldsymbol{\Theta}^P\right]\mathrm{d}\mathbf{P}^*_{\mathbf{X}}+\boldsymbol{\Theta}^P\mathrm{d}\boldsymbol{\mu}. \qquad \text{(A.7)}
\end{aligned}$$

Focusing on the markup shock ($d\boldsymbol{\tau} = 0, d\mathbf{P}_{\mathbf{X}}^{*} = 0$), and combining (A.2), (A.3), and (A.7):

$$\begin{aligned}\frac{1}{1-\alpha}d\mathbf{Y} = \mathbf{M}^{Z}\left(1-\left(1-\omega\right)\left(1-\alpha_{L}\right)\right)d\mathbf{Y} \\ -\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\left\{\left[\frac{\mu-1}{\mu}+\omega\left(1-\alpha_{L}\right)-\boldsymbol{\Theta}^{W}\right]d\mathbf{Y}+\boldsymbol{\Theta}^{P}d\boldsymbol{\mu}\right\}\end{aligned}$$

Defining:

$$\mathscr{M} \equiv \left\{\frac{\mathbf{I}}{1-\alpha}-\mathbf{M}^{Z}\left(1-\left(1-\omega\right)\left(1-\alpha_{L}\right)\right)-\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\left[\boldsymbol{\Theta}^{W}-\frac{\mu-1}{\mu}\mathbf{I}-\omega\left(1-\alpha_{L}\right)\mathbf{I}\right]\right\}^{-1}$$

Specializing to $\omega = 0$ yields Proposition 2:

$$d\mathbf{Y} = -\mathscr{M}\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\times\boldsymbol{\Theta}^{P}\times d\boldsymbol{\mu}$$

with $\mathscr{M} = \left\{\frac{\mathbf{I}}{1-\alpha}-\alpha_{L}\mathbf{M}^{Z}-\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\left[\boldsymbol{\Theta}^{W}-\frac{\mu-1}{\mu}\mathbf{I}\right]\right\}^{-1}$.

B.5 Proof of Proposition 3

For expositional ease, define the objects:

$$\mathbf{K} = W\boldsymbol{\kappa}^{P}, \quad \mathbf{R} = \mathbf{I}+\boldsymbol{\kappa}^{W}+\alpha_{L}W\boldsymbol{\kappa}^{P}$$

so that $\boldsymbol{\Theta}^{P} = \mathbf{R}^{-1}\mathbf{K}$ and $\boldsymbol{\Theta}^{W} = \mathbf{R}^{-1}\frac{W\alpha_{L}}{\varphi}\boldsymbol{\kappa}^{W}$. From Proposition 2, the markup-shock output response is:

$$d\mathbf{Y} = -\mathscr{M}\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\boldsymbol{\Theta}^{P}d\boldsymbol{\mu}.$$

Under the proposition's assumption that the multiplier remains bounded and converges in each limit, when prices are completely rigid, $\boldsymbol{\kappa}^{P} \to \mathbf{0}$ and therefore $\mathbf{K} \to \mathbf{0}$. Hence:

$$\lim_{\kappa^{P}\to 0}\boldsymbol{\Theta}^{P} = \mathbf{0},$$

which implies:

$$\lim_{\kappa^{P}\to 0}d\mathbf{Y} = \mathbf{0}\times d\boldsymbol{\mu}.$$

When prices are fully flexible, $\kappa^{P} \to \infty$. Using the definition in (27), the pass-through matrix converges to:

$$\lim_{\kappa^{P}\to\infty}\boldsymbol{\Theta}^{P} = \frac{1}{\alpha_{L}}\mathbf{I},$$

so the output response becomes:

$$\lim_{\kappa^{P}\to\infty}d\mathbf{Y} = -\mathscr{M}^{P\infty}\left[\mathbf{M}^{Z}-\mathbf{M}^{\Pi}\right]\alpha_{L}^{-1}d\boldsymbol{\mu},$$

Finally, when wages become fully flexible, $\kappa^W \to \infty$ while $\kappa^P < \infty$, the wage response offsets the price-induced real wage movement, and:

$$\lim_{\kappa^W \to \infty} \boldsymbol{\Theta}^P = \mathbf{0}.$$

Thus:

$$\lim_{\kappa^W \to \infty} \mathrm{d}\mathbf{Y} = \mathbf{0} \times \mathrm{d}\boldsymbol{\mu}.$$

B.6 Derivation of eq. (31)

Start by writing out eq. (24) at time t:

$$\frac{1}{1-\alpha}\mathrm{d}Y_t = \alpha_L \sum_{s=0}^{\infty} M^Z_{t,s}\mathrm{d}Y_s - \sum_{s=0}^{\infty}\left[M^Z_{t,s} - M^\Pi_{t,s}\right]\mathrm{d}\Pi_s.$$

Consider a date-s income perturbation announced at date 0, evaluated around the stationary distribution $\mathscr{D}(e,a)$. In the household budget constraint at date s, an aggregate perturbation $\mathrm{d}Z_s$ changes the date-s resources of a household in date-s state $(e_s, a_s) = (e,a)$ by $e\,\mathrm{d}Z_s$, while an aggregate perturbation $\mathrm{d}\Pi_s$ changes its date-s resources by $g(e)\,\mathrm{d}\Pi_s$.

Let $M_{t,s}(e,a)$ denote the date-t consumption response to a unit lump-sum transfer received at date s by a household that is in state (e,a) at date s. For $t < s$, $M_{t,s}(e,a)$ captures the anticipatory consumption response at date t of households that will be in state (e,a) at date s. For $t \geq s$, it captures the expected date-t consumption response of the cohort in state (e,a) at date s, propagating through the endogenous evolution of asset holdings and the Markov transition of productivity between dates s and t (equivalent to the Fréchet derivative of aggregate date-t consumption with respect to a date-s transfer targeted to state (e,a), normalized by the stationary density $\mathscr{D}(e,a)$).

Because labor income and profits at date s enter the date-s budget constraint in the same manner as a date-s transfer, with incidence e and $g(e)$ across date-s states (e,a), the chain rule implies that the date-t responses to date-s perturbations in Z_s and Π_s conditional on the date-s state (e,a) are

$$M^Z_{t,s}(e,a) = M_{t,s}(e,a)e, \qquad M^\Pi_{t,s}(e,a) = M_{t,s}(e,a)g(e).$$

Integrating across the date-s cross section under the stationary distribution $\mathscr{D}(e,a)$ yields the (t,s) entries of the aggregate sequence-space Jacobians:

$$M^Z_{t,s} = \int M_{t,s}(e,a)e\,\mathrm{d}\mathscr{D}(e,a), \qquad M^\Pi_{t,s} = \int M_{t,s}(e,a)g(e)\,\mathrm{d}\mathscr{D}(e,a).$$

Hence, the difference between the two aggregate Jacobians at any horizon (t,s) can be written as

$$M^Z_{t,s} - M^\Pi_{t,s} = \int M_{t,s}(e,a)\left[e - g(e)\right]\mathrm{d}\mathscr{D}(e,a).$$

To rewrite this difference in terms of cross-sectional covariances, define the average uniform-transfer Jacobian entry

$$\overline{M}_{t,s} \equiv \int M_{t,s}(e,a)\mathrm{d}\mathscr{D}(e,a),$$

and the stationary cross-sectional means

$$\bar{e} \equiv \int e\,\mathrm{d}\mathscr{D}(e,a), \qquad \overline{g(e)} \equiv \int g(e)\,\mathrm{d}\mathscr{D}(e,a).$$

Using the identity $\mathbb{E}[XY] = \mathbb{E}[X]\mathbb{E}[Y] + \mathbb{C}\mathrm{ov}(X,Y)$ under $\mathscr{D}(e,a)$, we have

$$\int M_{t,s}(e,a)e\,\mathrm{d}\mathscr{D}(e,a) = \overline{M}_{t,s}\,\bar{e} + \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), e\Big),$$

and, analogously,

$$\int M_{t,s}(e,a)g(e)\,\mathrm{d}\mathscr{D}(e,a) = \overline{M}_{t,s}\,\overline{g(e)} + \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), g(e)\Big).$$

Inserting these expressions gives

$$\begin{aligned} M^Z_{t,s} - M^\Pi_{t,s} = \overline{M}_{t,s}\Big(\bar{e} - \overline{g(e)}\Big) \\ + \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), e\Big) - \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), g(e)\Big). \end{aligned}$$

Since the stationary distribution of e is normalized to have mean one, $\bar{e} = 1$, and $g(e)$ is normalized such that $\overline{g(e)} = 1$, the mean term cancels, leaving

$$M^Z_{t,s} - M^\Pi_{t,s} = \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), e\Big) - \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), g(e)\Big).$$

Equivalently, by linearity of covariance,

$$M^Z_{t,s} - M^\Pi_{t,s} = \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), e - g(e)\Big).$$

Substituting this expression into eq. (24) gives

$$\frac{1}{1-\alpha}\mathrm{d}Y_t = \alpha_L \sum_{s=0}^{\infty} M^Z_{t,s}\mathrm{d}Y_s - \sum_{s=0}^{\infty}\Big[\mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), e\Big) - \mathbb{C}\mathrm{ov}\Big(M_{t,s}(e,a), g(e)\Big)\Big]\mathrm{d}\Pi_s.$$

The covariance identity above yields eq. (31) in the main text. Substituting it into eq. (24) gives the corresponding output relationship in sequence space:

$$\frac{1}{1-\alpha}\mathrm{d}\mathbf{Y} = \alpha_L \mathbf{M}^Z\mathrm{d}\mathbf{Y} - \big[\mathbb{C}\mathrm{ov}\big(\mathbf{M}(e,a), e\big) - \mathbb{C}\mathrm{ov}\big(\mathbf{M}(e,a), g(e)\big)\big]\,\mathrm{d}\boldsymbol{\Pi}.$$

C Cost-push shocks

C.1 Neutrality of Cost-push shocks when $dP^*_{F,t} = dP^*_{X,t}$

Define $p_{X,t} = \frac{P_{X,t}}{P_t}$ as the price of imported materials in domestic CPI units. If $dp_{X,t} = 0$ then the shock has no real effects on the domestic economy. To see when this case arises, consider the linearized versions of $p_{X,t}$ and Q_t under the law of one price:

$$\begin{aligned} dp_{X,t} &= d\mathcal{E}_t + dP^*_{X,t} - dP_t \\ dQ_t &= d\mathcal{E}_t + dP^*_{F,t} - dP_t \end{aligned}$$

With a constant real rate and a UIP condition we have $dQ_t = 0$. Clearly if $dP^*_{X,t} = dP^*_{F,t}$ then $dp_{X,t} = 0$ and the shock to import prices has no effect on the domestic economy. Note that a constant real rate does not neutralize the relative price effects of a tariff, only the exchange rate movements.[25]

C.2 Proof of Proposition 4 and ownership equivalence

The main-text cost-push formula (35) follows from the general expression derived here with imported materials ($\omega = 0$) and fixed foreign demand ($\mathbf{M}^F = \mathbf{0}$). The same expression also gives the foreign-demand extension discussed in the main text. Setting $\omega = 1$ eliminates the leakage term and delivers Proposition 5. Substituting (A.3) into the generalized goods-market equation (A.2) with $d\mathbf{T} = d\boldsymbol{\tau} = 0$ and $d\mathbf{F}^P = (1-\omega)\frac{1-\alpha_L}{\alpha_L} d\mathbf{P}^*_{\mathbf{X}}$ gives:

$$\begin{aligned} \frac{1}{1-\alpha} d\mathbf{Y} = \mathbf{M}^Z \left[1 - (1-\omega)(1-\alpha_L)\right] d\mathbf{Y} \\ - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] d\boldsymbol{\Pi} - \left[\mathbf{M}^Z - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right](1-\omega)\frac{(1-\alpha_L)}{\alpha_L} d\mathbf{P}^*_{\mathbf{X}} \end{aligned}$$

To derive the general response, use (A.7):

$$\begin{aligned} \frac{1}{1-\alpha} d\mathbf{Y} = \left\{ \mathbf{M}^Z \left(1 - (1-\omega)(1-\alpha_L)\right) - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \left[\frac{\mu-1}{\mu} + \omega(1-\alpha_L) - \boldsymbol{\Theta}^W\right] \right\} d\mathbf{Y} \\ - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right](1-\alpha_L)\boldsymbol{\Theta}^P d\mathbf{P}^*_{\mathbf{X}} - \left[\mathbf{M}^\Pi - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right](1-\omega)\frac{(1-\alpha_L)}{\alpha_L} d\mathbf{P}^*_{\mathbf{X}} \end{aligned}$$

Solving for output one obtains:

$$d\mathbf{Y} = -\mathcal{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right](1-\alpha_L)\boldsymbol{\Theta}^P d\mathbf{P}^*_{\mathbf{X}} - \mathcal{M}\left[\mathbf{M}^\Pi - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right](1-\omega)\frac{(1-\alpha_L)}{\alpha_L} d\mathbf{P}^*_{\mathbf{X}}$$

where:

$$\mathcal{M} \equiv \left\{ \frac{\mathbf{I}}{1-\alpha} - \mathbf{M}^Z \left(1 - (1-\omega)(1-\alpha_L)\right) - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \left[\boldsymbol{\Theta}^W - \frac{\mu-1}{\mu}\mathbf{I} - \omega(1-\alpha_L)\mathbf{I}\right] \right\}^{-1}$$

[25] Of course monetary policy could be chosen to neutralize any relative price movements even in the presence of tariffs, but this would induce an additional effect on household consumption through intertemporal substitution.

At $\omega = 1$, foreign leakage vanishes, and the cost-push response equals the markup-shock response under the same ownership structure when $d\boldsymbol{\mu} = (1-\alpha_L)d\mathbf{P}_{\mathbf{X}}^*$. Both responses then use the $\omega = 1$ multiplier above, which differs from the imported-materials benchmark multiplier.

C.3 Additional results on income incidence and ownership

The proposition corresponding to 1 for markup shocks is given in Proposition 8 for cost-push shocks.

Proposition 8 (Equilibrium relationship between output and profits with cost-push shocks)**.** *For a general ownership share $\omega \in [0,1]$, given a sequence of material price shocks $\left\{dP_{X,s}^*\right\}_{s=0}^{\infty}$, the equilibrium relation between output and profits is given by:*

$$\frac{1}{1-\alpha}d\mathbf{Y} = \underbrace{\left[1-(1-\omega)(1-\alpha_L)\right]\mathbf{M}^Z d\mathbf{Y}}_{\textit{Multiplier}} - \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]d\boldsymbol{\Pi}}_{\textit{Distributional channel}} \\ \underbrace{-(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\left[\mathbf{M}^Z - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right]d\mathbf{P}_{\mathbf{X}}^*}_{\textit{Direct effect}} \tag{A.8}$$

where $\mathbf{M}^F$ is the sequence-space Jacobian of foreign demand C_t^* with respect to foreign net income. Proof: Appendix C.2.

Corollary 3. *If there is equal incidence of labor income and profits, $\mathbf{M}^\Pi = \mathbf{M}^Z$, then the output response to a cost-push shock is:*

$$d\mathbf{Y} = -\left[\frac{1}{1-\alpha}\mathbf{I} - \left[1-(1-\omega)(1-\alpha_L)\right]\mathbf{M}^\Pi\right]^{-1}(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\left[\mathbf{M}^\Pi - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right]d\mathbf{P}_{\mathbf{X}}^*$$

Cumulative effect. The net present value of the output response follows from (A.8) and the present-value condition (32), as shown in Corollary 4. Unlike the markup shock, a foreign cost-push shock can have a non-zero net present value because it involves a transfer of resources to the foreign economy. With fixed foreign demand, the NPV is negative for a shock with positive discounted value when the foreign transfer is nonzero. If foreign demand responds and foreign behavior satisfies $\mathbf{q}'\mathbf{M}^F = \mathbf{q}'$, the net present value is negative when home bias is sufficiently strong that $1-\alpha > \alpha^*$, and positive when $1-\alpha < \alpha^*$.

Corollary 4 (Net present value of cost-push shock)**.** *Assume that the economy is open ($\alpha > 0$ or $\omega < 1, \alpha_L < 1$), and that $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ satisfy the present-value condition (32). Then the net present value of the output response to a cost-push shock is given by*

$$\mathbf{q}'d\mathbf{Y} = -\frac{(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}}{\frac{1}{1-\alpha} - \left[1-(1-\omega)(1-\alpha_L)\right]}\mathbf{q}'\left[\mathbf{I} - \frac{\alpha^*}{1-\alpha}\mathbf{M}^F\right]d\mathbf{P}_{\mathbf{X}}^*, \tag{A.9}$$

and is therefore independent of $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$. The foreign Jacobian $\mathbf{M}^F$ enters only through the leakage term. If it also satisfies $\mathbf{q}'\mathbf{M}^F = \mathbf{q}'$, the bracket reduces to $\left(1-\frac{\alpha^*}{1-\alpha}\right)\mathbf{q}'$.

Importantly, relaxing the fixed-foreign-demand assumption by allowing for foreign feedback does not necessarily eliminate the net present value of the cost-push shock, even if $\mathbf{M}^F$ satisfies

the present-value condition (32). This contrasts with the markup shock, for which the net present value is zero under the baseline assumptions. The difference arises because domestic and foreign consumers may have different marginal propensities to spend on domestic goods. If the two groups devote the same share of spending to domestic goods, such that $\frac{\alpha^*}{1-\alpha} = 1$, the net present value is exactly zero.

This observation also highlights that the zero net present value of the markup shock (Corollary 2) relies on workers and firm owners having the same present-value marginal propensity to consume *domestic* goods. If workers differ from firm owners in this aspect, the net present value of the markup shock will generally be non-zero.[26]

Real GDP. It is worth noting that a shock to import prices P_X^* decouples the responses of output and real GDP $\mathscr{Y}_t$ compared to the markup shock, $\mathrm{d}\mathscr{Y}_t = \mathrm{d}Y_t - (1-\omega)(1-\alpha_L)\left[\mathrm{d}Y_t + Y\,\mathrm{d}P_{X,t}^*\right]$, implying that real GDP may decline persistently in both models due to the *mechanical effect* of higher material prices, $\mathrm{d}P_X^*$. I focus primarily on the response of output Y_t as a measure of *internal propagation*.[27]

Domestic redistribution and foreign leakage. Figure A.1 plots the source attribution summarized in Section 5.2. I evaluate the two terms in Proposition 4 separately, applying the same baseline multiplier $\mathscr{M}$ to each. Each contribution includes its own general-equilibrium feedback, and their sum gives the total output response. Domestic redistribution and foreign leakage contribute approximately equally to the first-year HANK contraction. The HANK–RANK difference does not isolate domestic redistribution because the multiplier applied to foreign leakage also differs across models. The domestic HANK contribution eventually changes sign and has zero net present value under the maintained present-value condition, while foreign leakage accounts for the nonzero present-value contraction.

[26] For illustration, suppose that households at the 25th percentile of the earnings distribution have an import share 10 percentage points higher than households at the 75th percentile, implying a positive correlation between MPCs and import shares. In this case, the net present value of the output response to the markup shock is positive because a resource transfer to firm owners raises overall, cumulative spending on domestic goods, with a resulting NPV of approximately 1.7%.

[27] A similar measure is domestic employment, which is often used by the Federal Reserve as an indicator of the business cycle.

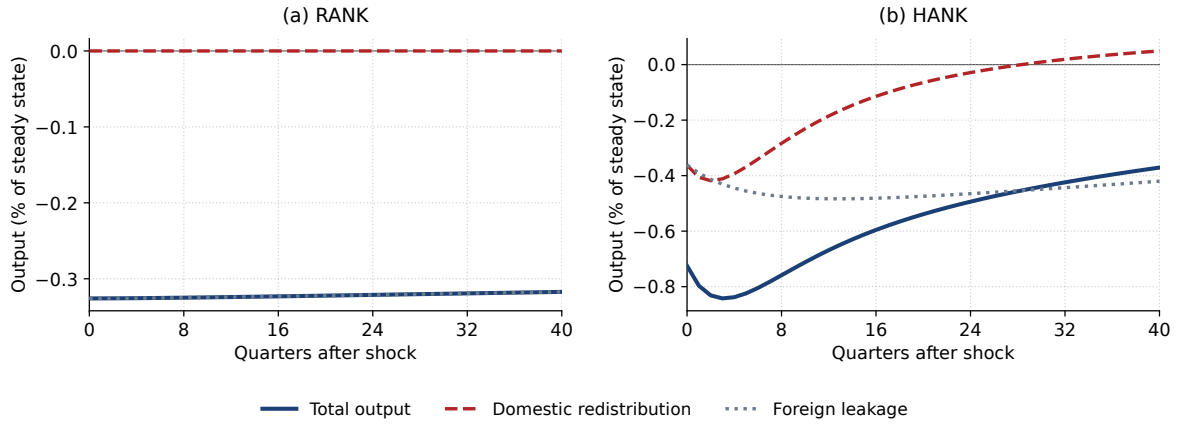


Figure A.1: Cost-push output response: domestic redistribution and foreign leakage

Note: Contributions to the response of gross output in RANK and HANK to an AR(1) foreign material-price shock with quarterly persistence 0.85 and an impact increase of 16%, matching the quantitative summary table. The same shock is applied to both models. Unlike Figure 6, the shock is not rescaled to one percentage point of impact CPI inflation. Foreign spending feedback is zero ($\mathbf{M}^F = \mathbf{0}$), and the real interest rate is constant. Each source contribution includes the baseline general-equilibrium multiplier. Series are percentage deviations from each model's steady-state gross output, $100 \times \mathrm{d}Y_t/Y$. In RANK, total output coincides with the foreign-leakage contribution.

Numerical illustration of equivalence between markup and cost-push shocks. Figure A.2 illustrates the equivalence in Proposition 5 when materials are domestically owned.

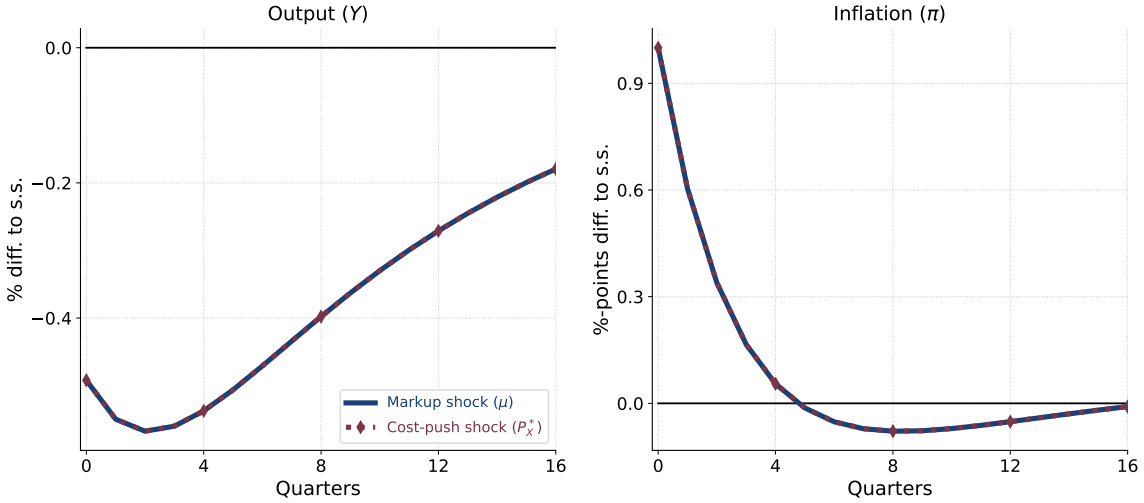


Figure A.2: Equivalence between markup shocks and cost-push shocks

Note: Impulse responses in the HANK model to an AR(1) domestic markup shock and an AR(1) import-price cost-push shock, both with quarterly persistence 0.85 and each scaled to raise CPI inflation by 1% on impact. The figure reports domestic output Y (pct. change, $100 \times \mathrm{d}Y_t/Y$), and CPI inflation (pct. points change, $100 \times \mathrm{d}\pi_t$). The material endowment is domestically owned, $\omega = 1$.

C.4 Substitution in production

The analytical results assume zero substitution between production inputs. Figure A.3 shows how the transmission of the markup shock (left panel) and cost-push shock (right panel) changes with the degree of substitutability. With an elasticity of zero the two shocks are equivalent when $\omega = 1$ (Proposition 5) and both generate a large decline in output. As the CES elasticity ν becomes larger firms respond to the increase in import prices by substituting away from materials

toward labor, which is relatively cheap due to sticky nominal wages. This increases employment, thereby stabilizing real labor income and consumption. This effect is much stronger for the cost-push shock because it directly changes the relative price of materials vis-à-vis labor. Thus a necessary condition for the amplification of the cost-push shock is the presence of heterogeneous MPCs out of profits and labor income, sticky wages *and* complementarity in factor inputs, see also Lorenzoni and Werning (2023) and Auclert et al. (2024a). Note, however, that an implausibly high degree of (short-run) substitutability is required for consumption and output to *increase* in response to the cost-push shock.

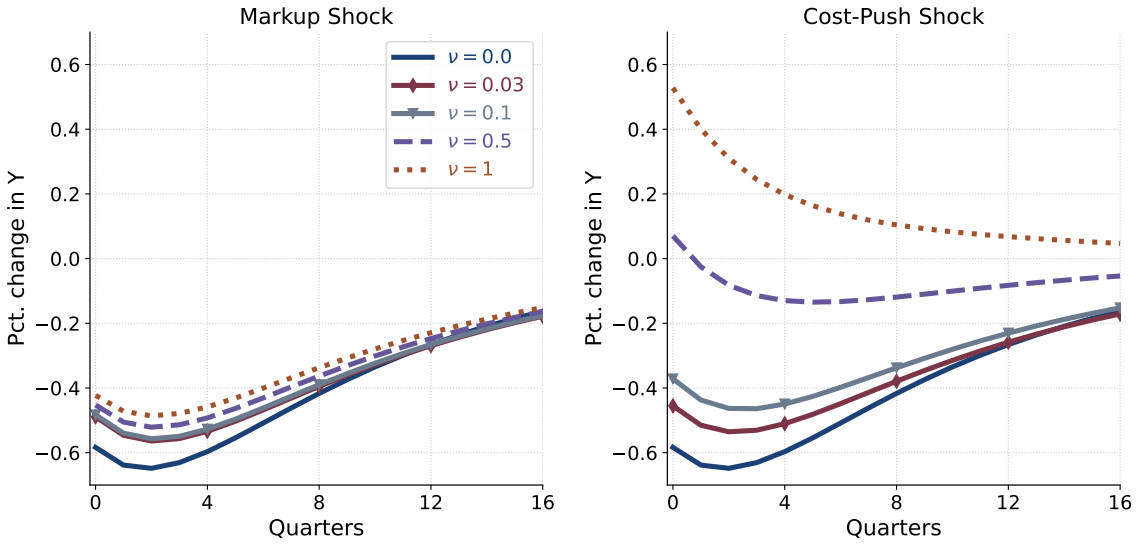


Figure A.3: Importance of labor-materials substitution

Note: Impulse responses in the HANK model to an AR(1) domestic markup shock and an AR(1) import-price cost-push shock, both with quarterly persistence 0.85 and scaled to raise CPI inflation by 1% on impact in the Leontief baseline. The figure reports domestic output Y (pct. change, $100 \times \mathrm{d}Y_t/Y$), while varying the labor-materials substitution elasticity ν. The material endowment is domestically owned, $\omega = 1$, in both shocks, meaning that they coincide at $\nu \to 0$.

D Government purchases

Purchases and financing. With fixed tariffs and a constant real interest rate, the linearized government budget constraint (18) around $G = 0$ is

$$\mathrm{d}G_t + \mathrm{d}T_t + (1+r)\mathrm{d}B_{t-1} = \mathrm{d}B_t, \qquad \mathrm{d}B_{-1} = 0, \tag{A.10}$$

where reductions in net transfers ($\mathrm{d}T_t < 0$) represent higher net taxes. Under the fiscal rule (19), net transfers adjust to lagged government debt according to $\mathrm{d}T_t = -\rho_B \mathrm{d}B_{t-1}$. Substituting this rule into (A.10) yields the debt law of motion $\mathrm{d}B_t = (1 + r - \rho_B)\mathrm{d}B_{t-1} + \mathrm{d}G_t$. Stacking sequences and letting $\mathbf{L}$ denote the lag operator ($(\mathbf{L}\mathrm{d}\mathbf{B})_t = \mathrm{d}B_{t-1}$ with $\mathrm{d}B_{-1} = 0$) gives $\mathrm{d}\mathbf{B} = \left[\mathbf{I} - (1 + r - \rho_B)\mathbf{L}\right]^{-1} \mathrm{d}\mathbf{G}$ and thus $\mathrm{d}\mathbf{T} = -\mathbf{F}^G \mathrm{d}\mathbf{G}$, where

$$\mathbf{F}^G \equiv \rho_B \mathbf{L}\left[\mathbf{I} - (1 + r - \rho_B)\mathbf{L}\right]^{-1}. \tag{A.11}$$

The operator $\mathbf{F}^G$ is strictly lower-triangular with (t, s) entry $\rho_B(1 + r - \rho_B)^{t-1-s}$ for $t > s$, capturing how deficit financing postpones the reduction in net transfers. By contrast, the balanced-

budget benchmark ($dB_t = 0$ for all t) finances purchases contemporaneously and corresponds to $\mathbf{F}^G = \mathbf{I}$. In both cases, $\mathbf{M}^T$ denotes the consumption Jacobian for a given cross-sectional transfer incidence, and purchases have no direct utility or production effect.

Proof of Proposition 6. In the baseline with imported materials ($\omega = 0$) and no change in desired markups, material prices, or tariffs, the production-income identity is $d\mathbf{Z} + d\mathbf{\Pi} = \alpha_L d\mathbf{Y}$. Purchases of the domestic final good enter goods-market clearing (36) directly. The household consumption response, including the financing of purchases, is

$$\begin{aligned} d\mathbf{C} &= \mathbf{M}^Z d\mathbf{Z} + \mathbf{M}^\Pi d\mathbf{\Pi} + \mathbf{M}^T d\mathbf{T} \\ &= \alpha_L \mathbf{M}^Z d\mathbf{Y} - [\mathbf{M}^Z - \mathbf{M}^\Pi] d\mathbf{\Pi} - \mathbf{M}^T \mathbf{F}^G d\mathbf{G}. \end{aligned}$$

The wage Phillips curve has no direct wealth effect, so fiscal financing does not add a separate term to the price–wage block. Equation (29) with $d\boldsymbol{\mu} = \mathbf{0}$ therefore gives $d\mathbf{\Pi} = \left(\frac{\mu-1}{\mu}\mathbf{I} - \mathbf{\Theta}^W\right) d\mathbf{Y}$. Substitution into (36) yields

$$\left\{ \frac{\mathbf{I}}{1-\alpha} - \alpha_L \mathbf{M}^Z + [\mathbf{M}^Z - \mathbf{M}^\Pi] \left(\frac{\mu - 1}{\mu} \mathbf{I} - \mathbf{\Theta}^W \right) \right\} d\mathbf{Y} = \left[\frac{\mathbf{I}}{1-\alpha} - \mathbf{M}^T \mathbf{F}^G \right] d\mathbf{G}.$$

Setting $\mu \approx 1$ and rearranging gives (37), while inverting the operator on the left—which is $\mathscr{M}^{-1}$ from Proposition 2—yields (38). Rearranging goods-market clearing gives the corresponding consumption response:

$$d\mathbf{C} = \frac{d\mathbf{Y} - d\mathbf{G}}{1-\alpha}. \tag{A.12}$$

For any debt-stabilizing rule ($\rho_B > r$) as well as the balanced-budget benchmark ($\mathbf{F}^G = \mathbf{I}$), the intertemporal government budget implies $\mathbf{q}'\mathbf{F}^G = \mathbf{q}'$. Finally, with constant $P_{H,t}/P_t = 1$ and fixed material prices, the realized markup $\mathfrak{m}_t \equiv P_{H,t}/MC_t = 1/mc_t$ satisfies $d\mathfrak{m} = -\mu^2 d\mathbf{mc} = -\mu^2 \alpha_L \mathbf{\Theta}^W d\mathbf{Y}$.

Non-homothetic demand and procyclical desired markups. One possible motivation for an activity-dependent desired markup is firm demand of the form $Y_{i,t} = D(P_{i,t}/P_t, C_t)$. Suppose the price elasticity $\epsilon(C_t) = -\partial \log D / \partial \log P_{i,t}$, evaluated at a symmetric allocation, falls as aggregate consumption rises. The desired markup $\mu_t^* = \epsilon(C_t)/[\epsilon(C_t) - 1]$ then increases with consumption. Around the steady state,

$$\widehat{\mu_t^*} = \phi_\mu \widehat{C}_t, \qquad \phi_\mu = -\frac{1}{\bar{\epsilon} - 1} \frac{d \log \epsilon}{d \log C} > 0. \tag{A.13}$$

The corresponding log-linear price Phillips curve has a term proportional to $\widehat{mc}_t + \phi_\mu \widehat{C}_t$. The numerical exercise instead adds $\lambda_\mu (Y_t/\bar{Y} - 1)$ to the price Phillips driving term. Section 4.2.1 calibrates its coefficient to the same 20-quarter cumulative realized-markup elasticity to output of 0.67 at each wage slope, following Nekarda and Ramey (2020). This remains a reduced-form implementation, not a structural calibration of D. Proposition 6 applies to the benchmark without this extra term.

E Monetary easing: additional impulse responses

Figures A.4 and A.5 report the monetary-policy comparison discussed in Section 4.2.2. With sticky wages, the real wage falls initially under both pricing rules and falls further with the procyclical-markup extension. With more flexible wages, it rises under the baseline rule but falls initially with the extension. Consumption and output rise less with the extension in both cases. I retain the coefficients calibrated to fiscal shocks in Section 4.2.1. I do not impose a separate elasticity target for monetary-policy shocks.

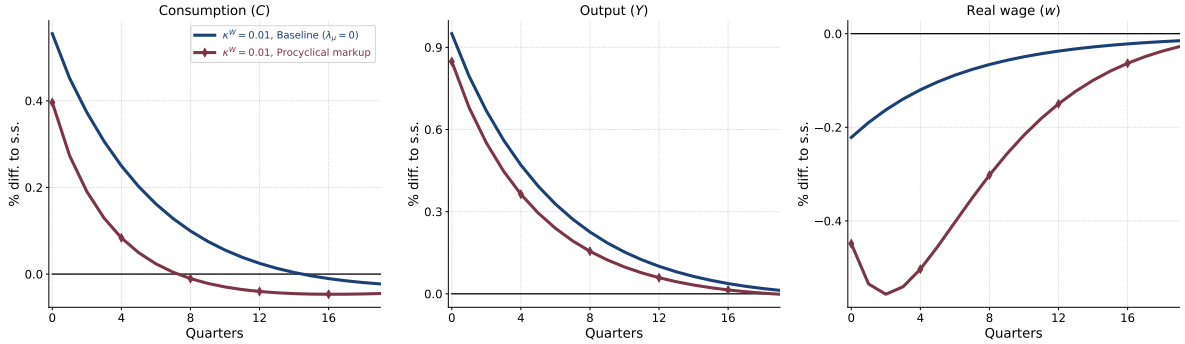


Figure A.4: Monetary easing and markup cyclicality with sticky wages

Note: HANK impulse responses to an AR(1) ex-ante real-rate shock with persistence 0.85 and an impact reduction of 0.1 percentage point, as specified in Section 4.2.2. The wage Phillips slope is $\kappa^W = 0.01$. The baseline pricing rule has $\lambda_\mu = 0$. The procyclical extension uses the fiscal-calibrated coefficient $\lambda_\mu \approx 0.96$ from Section 4.2.1. Private consumption C, output Y, and the real wage w are percentage deviations from their respective steady states.

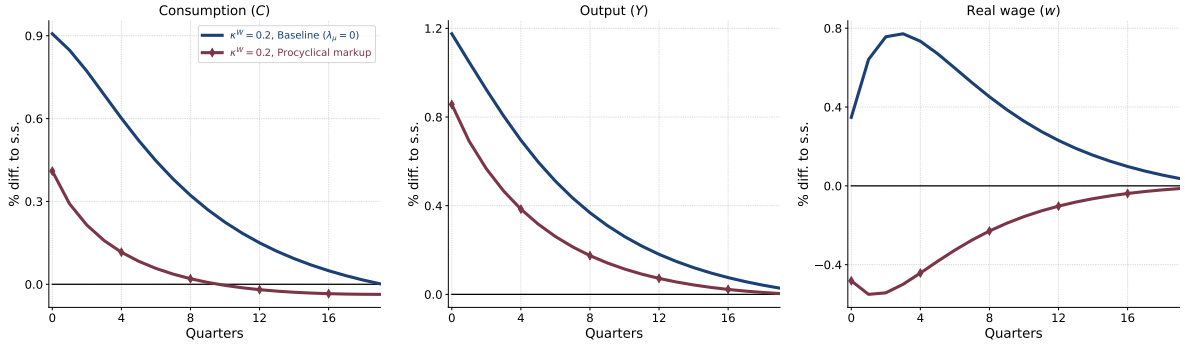


Figure A.5: Monetary easing and markup cyclicality with more flexible wages

Note: The same AR(1) ex-ante real-rate shock as in Figure A.4, with persistence 0.85 and an impact reduction of 0.1 percentage point. The wage Phillips slope is $\kappa^W = 0.2$. The baseline pricing rule has $\lambda_\mu = 0$. The fiscal-calibrated procyclical extension has $\lambda_\mu \approx 4.19$. Private consumption C, output Y, and the real wage w are percentage deviations from their respective steady states.

F Tariff shocks

Proof of Proposition 7. Let $c_\tau \equiv m/(1-\alpha) = \alpha_L^{-1}[\alpha/(1-\alpha) + 1 - \alpha_L]$. The income identity and the profit response (A.7) specialize to

$$\begin{aligned} \mathrm{d}\mathbf{Z} + \mathrm{d}\boldsymbol{\Pi} &= \alpha_L \mathrm{d}\mathbf{Y} - c_\tau \mathrm{d}\boldsymbol{\tau}, \\ \mathrm{d}\boldsymbol{\Pi} &= \left[\frac{\mu-1}{\mu}\mathbf{I} - \boldsymbol{\Theta}^W\right]\mathrm{d}\mathbf{Y} \\ &\quad + \left\{\left(1 - \alpha_L + \frac{\alpha}{\mu(1-\alpha)}\right)\boldsymbol{\Theta}^P + \frac{\alpha}{1-\alpha}\left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W \boldsymbol{\kappa}^P\right]^{-1} W \right. \\ &\quad \left. - c_\tau \mathbf{I}\right\}\mathrm{d}\boldsymbol{\tau}. \end{aligned}$$

Substituting into household spending and goods-market clearing, while allowing an arbitrary net-transfer path, gives

$$\begin{aligned} \mathscr{M}^{-1}\mathrm{d}\mathbf{Y} = &-\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\left\{\left(1 - \alpha_L + \frac{\alpha}{\mu(1-\alpha)}\right)\boldsymbol{\Theta}^P + \frac{\alpha}{1-\alpha}\left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W \boldsymbol{\kappa}^P\right]^{-1} W\right\}\mathrm{d}\boldsymbol{\tau} \\ &- c_\tau \mathbf{M}^\Pi \mathrm{d}\boldsymbol{\tau} + \mathbf{M}^T \mathrm{d}\mathbf{T} + \frac{\alpha}{1-\alpha}\eta\left(1 + \frac{\alpha^*}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau}. \end{aligned}$$

At the zero-tariff steady state, tariff revenue changes by $m\mathrm{d}\boldsymbol{\tau}$. At constant debt, the government budget implies $\mathrm{d}\mathbf{T} = m\mathrm{d}\boldsymbol{\tau}$, corresponding to $\mathbf{F}^G = \mathbf{I}$. Under the lagged-debt rule (19), debt instead follows $\mathrm{d}B_t = (1 + r - \rho_B)\mathrm{d}B_{t-1} - m\mathrm{d}\tau_t$, with $\mathrm{d}B_{-1} = 0$. Consequently, $\mathrm{d}\mathbf{T} = m\mathbf{F}^G\mathrm{d}\boldsymbol{\tau}$, where $\mathbf{F}^G$ is defined in Section 4.2.1 and derived in Appendix D. Substituting either transfer path above yields (39). In particular, rebates do not represent additional income without a corresponding loss to private agents.

Present-value response.

Corollary 5 (Net present value of tariff shock)**.** *Assume positive imports, $m > 0$, and that $\mathbf{M}^Z$, $\mathbf{M}^\Pi$, and $\mathbf{M}^T$ satisfy the present-value condition* (32)*. Under the assumptions of Proposition 7, the net present value of output is*

$$\mathbf{q}'\mathrm{d}\mathbf{Y} = \frac{\alpha}{\alpha_L}\left[\frac{\eta\left(1 + \frac{\alpha^*}{1-\alpha}\right) - m}{m}\right]\mathbf{q}'\mathrm{d}\boldsymbol{\tau}, \tag{A.14}$$

and is independent of the three domestic consumption Jacobians.

Proof. For either fiscal regime in Proposition 7, $\mathbf{q}'\mathbf{F}^G = \mathbf{q}'$. For the lagged-debt rule this follows from $\rho_B > r$. The household present-value conditions therefore imply $\mathbf{q}'\mathrm{d}\mathbf{C} = \alpha_L \mathbf{q}'\mathrm{d}\mathbf{Y} - (c_\tau - m)\mathbf{q}'\mathrm{d}\boldsymbol{\tau}$. Premultiplying goods-market clearing by $\mathbf{q}'$ therefore gives

$$\left[\frac{1}{1-\alpha} - \alpha_L\right]\mathbf{q}'\mathrm{d}\mathbf{Y} = \frac{\alpha}{1-\alpha}\left[\eta\left(1 + \frac{\alpha^*}{1-\alpha}\right) - m\right]\mathbf{q}'\mathrm{d}\boldsymbol{\tau}.$$

Use $1/(1-\alpha) - \alpha_L = \alpha_L m/(1-\alpha)$ to obtain the corollary. Delayed rebates satisfy the intertemporal government budget, $\mathbf{q}'\mathrm{d}\mathbf{T} = m\mathbf{q}'\mathrm{d}\boldsymbol{\tau}$.

Quantitative illustration. The tariff rows of Table 2 report the decomposition underlying Section 4.3. The tariff price contribution in eq. (39) is negative in every HANK case: higher firm costs passed through to prices, together with the direct consumer-import price increase, reduce real wages and spending. Rebate timing changes how much this contractionary force is offset, while higher trade elasticity strengthens expenditure switching. The immediate-rebate and delayed-rebate simulations correspond to the two fiscal regimes in Proposition 7.

G Model extensions with markup shock

G.1 Fisher effects

A mechanism often brought up in the context of large inflation surges is the redistribution that occurs between borrowers and savers when debt contracts are nominal (see e.g. Auclert 2019; Nuño and Thomas 2022; Brunnermeier et al. 2025). The baseline model assumes that households save in real assets, and thereby sidesteps this channel. To evaluate this effect I introduce a share θ^n of nominal bonds into the economy. The budget constraint of households is unchanged in real terms, but the total realized real return is then given by $r_t^a = \theta^n r_t^n + \left(1-\theta^n\right) r_{t-1}$ where r_t^n is the realized real return on nominal bonds. I assume that these bonds are potentially long term and that they pay exponentially decaying coupons. A bond purchased at time t at nominal price q_t gives a stream $\{\delta^s\}_{s=0}^{\infty}$ of nominal payments. With $\delta = 0$ standard, short-term bonds are recovered. Arbitrage implies that the bond price follows:

$$q_t = \frac{1+\delta q_{t+1}}{1+i_t},$$

such that the expected real return on nominal bonds is the same as for real bonds. The realized real return on nominal bonds is given by:

$$1 + r_t^n = \frac{1+\delta q_t}{q_{t-1}} - \pi_t,$$

which follows from the linear Fisher relation $i_t = r_t + \pi_{t+1}$ around the zero-inflation steady state. With a constant-r rule ($\mathrm{d}r_t = 0$ for all $t \geq 0$), expected returns are unchanged and the only effect on household asset returns comes from the initial revaluation of nominal bonds at time 0, $\mathrm{d}r_0^a = \theta^n \mathrm{d}r_0^n$. The consumption function therefore depends on the sequences of real labor income and profits and the date-0 realized asset return, $C_t = \mathscr{C}_t\left(\{Z_s, \Pi_s\}_{s=0}^{\infty}, r_0^a\right)$. Linearizing in sequence space and using $\mathrm{d}r_0^a = \theta^n \mathrm{d}r_0^n$ gives:

$$\mathrm{d}\mathbf{C} = \mathbf{M}^Z \mathrm{d}\mathbf{Z} + \mathbf{M}^\Pi \mathrm{d}\mathbf{\Pi} + \mathbf{M}^{r_0} \theta^n \mathrm{d}r_0^n,$$

where $\mathbf{M}^{r_0}$ is a column vector whose entries reflect the response of consumption to the initial revaluation effect at time 0. Note that at the individual household level the entries in this vector would be positive for savers and negative for borrowers. To proceed, I linearize time-0 nominal

bond returns to get:

$$\mathrm{d}r_0^n = \underbrace{\frac{\delta}{q_{ss}}\mathrm{d}q_0}_{\text{Long-term bond effect}} - \underbrace{\mathrm{d}\pi_0}_{\text{Fisher effect}} .$$

Thus the initial revaluation effect depends on two terms. With short bonds ($\delta = 0$) there is the usual Fisher effect of surprise inflation, whereby the value of nominal assets depreciates with the increase in inflation. With long-term nominal bonds ($\delta > 0$) there is an additional effect since the bond has a duration of more than one period: higher future nominal interest rates $i_s = r_s + \pi_{s+1}$ reduce the initial bond price $\mathrm{d}q_0$. Iterating the linearized bond-pricing equation forward gives:

$$\mathrm{d}q_0 = -\sum_{s=0}^{\infty} \frac{\delta^s}{(1+i_{ss})^{2+s}} (1+\delta q_{ss}) (\mathrm{d}r_s + \mathrm{d}\pi_{1+s}) .$$

High future real rates or inflation reduce the current price of the bond, with larger effects for longer-duration bonds (δ). Under a constant ex-ante real rate ($\mathrm{d}r_s = 0$), substituting $\mathrm{d}q_0$ into $\mathrm{d}r_0^n$ gives the overall effect on aggregate consumption:

$$\mathrm{d}\mathbf{C} = \underbrace{\mathbf{M}^Z \mathrm{d}\mathbf{Z}}_{\text{Labor income}} + \underbrace{\mathbf{M}^\Pi \mathrm{d}\mathbf{\Pi}}_{\text{Profits}} \underbrace{- \mathbf{M}^{r_0} \theta^n \left[\frac{\delta}{q_{ss}} \sum_{s=0}^{\infty} \frac{\delta^s}{(1+i_{ss})^{2+s}} (1+\delta q_{ss}) \mathrm{d}\pi_{1+s} + \mathrm{d}\pi_0 \right]}_{\text{Fisher effects}} .$$

As before a markup shock induces a negative effect on consumption from labor income and a positive effect from profits. If households hold nominal bonds ($\theta^n > 0$), there is an additional effect, which scales with the marginal propensity to spend out of time-0 unexpected returns $\mathbf{M}^{r_0}$. For savers this tends to be a negative effect since the real value of their bonds is reduced by inflation, thus acting as a negative income shock. Borrowers experience the opposite, and will generally increase consumption in response to this channel, leaving the overall sign of $\mathbf{M}^{r_0}$ uncertain. At the individual level, the MPC out of date-0 returns is the MPC out of a cash transfer, times the initial net asset position of the household, $mpc_i \times a_i$. Aggregating yields:

$$\mathbf{M}^{r_0} = \mathbf{M} \times A + \mathbb{C}\mathrm{ov}\left(\mathbf{M}_i, a_i\right)$$

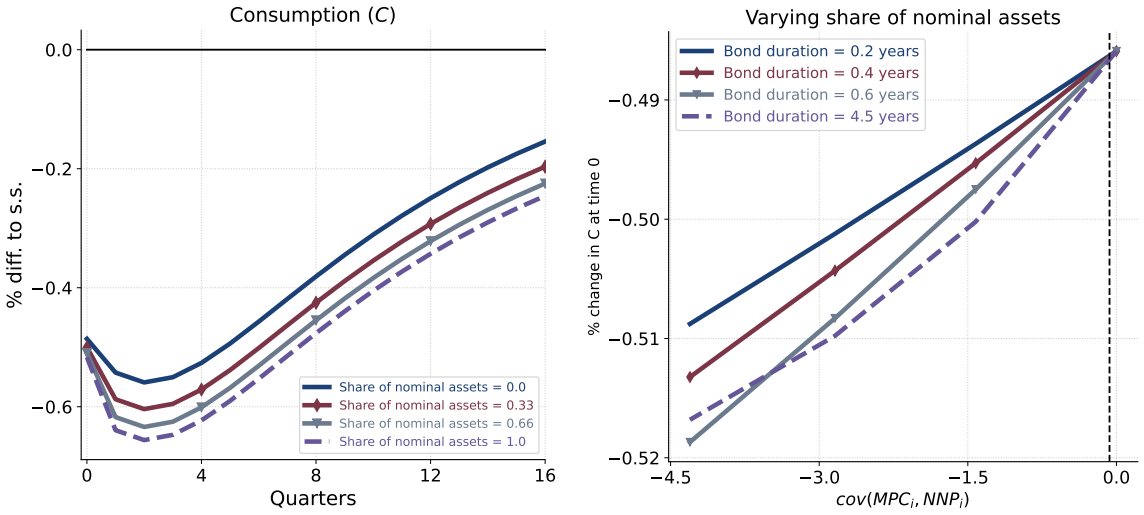
Given that the aggregate net asset position is generally positive, the first term is positive. The second term captures redistribution between borrowers and savers and is negative when borrowers have larger MPCs than savers. Auclert (2019) uses the Italian Survey of Household Income and Wealth to measure the covariance between MPCs and net nominal positions—i.e. $\mathbb{C}\mathrm{ov}\left(\mathbf{M}_i, a_i\right)$—and measures a positive, but quantitatively small effect of redistribution on consumption.

The left panel in Figure A.6 shows the effects of the markup shock on aggregate consumption for varying shares of nominal bonds, all with $\delta = 0.94$ to match an average duration of 4.5 years as in Doepke and Schneider (2006).[28] A larger share of nominal bonds implies redis-

[28]For this model exercise I set the borrowing constraint to minus one times the average quarterly steady-state labor income $\underline{a} = -Z_{ss}$ as in Kaplan et al. (2018).

tribution towards borrowers, who in this model tend to have higher MPCs than savers. With enough nominal bonds this can potentially overturn the initial decline in consumption causing the aggregate response to turn positive. The response in the following quarters, however, is amplified relative to the baseline with real bonds because savers reduce their consumption, and though their initial time 0 MPCs are smaller than the corresponding MPCs of borrowers, their intertemporal MPCs are typically larger. Figure A.7 plots the intertemporal MPCs of borrowers and savers, illustrating this point.

However, the standard incomplete markets model has a tendency to overstate the aggregate effects of the Fisher redistribution channel. The right panel in Figure A.6 shows the change in consumption at time 0 as a function of the covariance $\mathbb{C}\text{ov}\left(\mathbf{M}_i, a_i\right)$, obtained by varying the share of nominal assets θ^n. With a larger share of nominal assets the model predicts a large negative covariance, implying strong effects of redistribution. However, the size of this covariance is many times larger than the empirical estimate from Auclert (2019).[29] If I calibrate θ^n to match the empirical covariance from Auclert (2019), the Fisher effect is quantitatively small, and the effect of declining real labor income dominates, so consumption declines following a markup shock, as in the baseline model.



(a) Response of aggregate consumption to a markup shock

(b) dC_0 with varying share of nominal bonds and duration

Figure A.6: Model with Fisher debt-inflation effects

Note: Responses to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by one percentage point on impact. Consumption is expressed as a percentage deviation from aggregate steady-state consumption. The borrowing limit is minus one times quarterly steady-state labor income. The left panel varies the share of nominal assets θ^n holding bond duration fixed at 4.5 years ($\delta = 0.94$), while the right panel reports the time-0 consumption response as the covariance between net nominal positions and MPCs varies across bond durations.

[29] The model over-predicts the size of this covariance because all constrained households are up against the borrowing limit $\underline{a}$, whereas empirically there is typically bunching around the point $a = 0$, where the Fisher effect is limited. This can be remedied by introducing a borrowing premium, see Faccini et al. (2024).

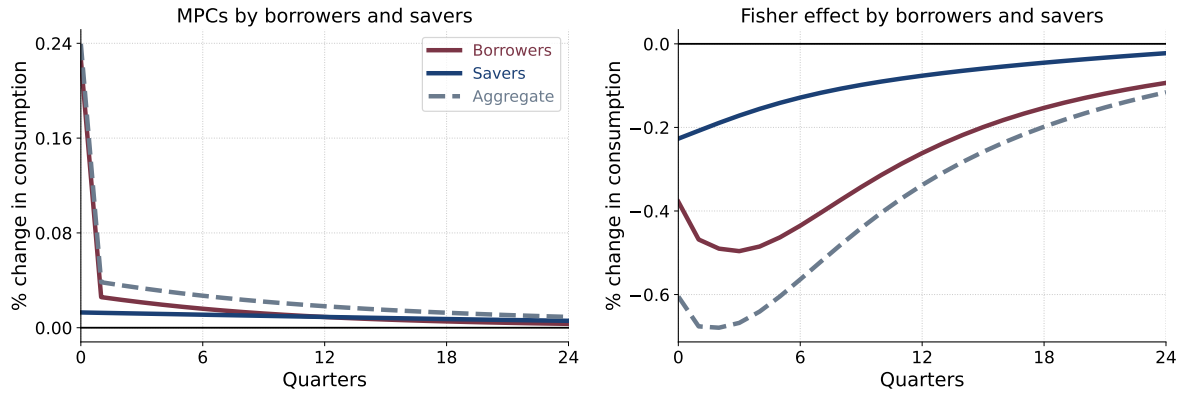


Figure A.7: Partial equilibrium responses by borrowers and savers

Note: The left panel shows partial-equilibrium consumption responses to a one-period uniform lump-sum transfer equal to 1% of steady-state labor income. The right panel shows partial-equilibrium responses using the household input paths from the AR(1) markup shock in Figure A.6, with quarterly persistence 0.85 and impact CPI inflation scaled to one percentage point. Responses are expressed as a percentage of aggregate steady-state consumption. Borrowers have nonpositive initial assets and savers have positive initial assets.

G.2 Investment

Standard model (friction-free investment). I consider two versions of the baseline model with investment and capital. In the first model, which features the standard neoclassical investment setup, production is given by a Cobb-Douglas production function:

$$Y_t = K_{t-1}^{\alpha_K} R_t^{1-\alpha_K},$$

where R_t is a CES aggregate of labor and materials. With $\alpha_K = 0$ one recovers the baseline model without capital. Firms optimize subject to a quadratic adjustment cost $\Phi(I_t, K_t) = \frac{\psi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$, where ψ governs the cost of changing the capital stock and investment follows from the law of motion $K_t = (1-\delta)K_{t-1} + I_t$. Real profits are:

$$\Pi_t = \frac{P_{H,t}}{P_t} Y_t - \frac{P_{X,t}}{P_t} X_t - Z_t - I_t - \Phi(I_t, K_t) - \frac{\theta^P}{2} \pi_{H,t}^2 Y_t.$$

The first-order conditions for capital and investment are:

$$q_t^I + \frac{\partial \Phi(I_t, K_t)}{\partial K_t} = \frac{1}{1+r_t}\left[MPK_{t+1} + (1-\delta) q_{t+1}^I\right],$$
$$\frac{I_t}{K_t} = \delta + \frac{1}{\psi}(q_t^I - 1),$$

where q_t^I is the Lagrange multiplier associated with the investment law of motion (Tobin's Q), $\frac{\partial \Phi(I_t, K_t)}{\partial K_t} = \frac{\psi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 - \psi\left(\frac{I_t}{K_t} - \delta\right)\frac{I_t}{K_t}$, and $MPK_{t+1} = \alpha_K mc_{t+1}\frac{Y_{t+1}}{K_t} = \alpha_K mc_{t+1} K_t^{\alpha_K - 1} R_{t+1}^{1-\alpha_K}$ is the date-$(t+1)$ marginal product of installed capital K_t.

Investment with financial frictions. The second version of the problem I consider contains a stylized version of a model with internal financing constraints (Lian and Ma 2021; Drechsel 2023). Production is still Cobb-Douglas, and the steady state is frictionless so that the aggregate

capital stock satisfies:

$$MPK = r + \delta,$$

and investment follows from the law of motion. Away from the steady state an earnings constraint binds, which implies that a fraction s of the change in operating surplus is used for net investment:

$$I_t - \delta K_{t-1} = s \times \mathrm{d}OS_t,$$

where:

$$OS_t = \frac{P_{H,t}}{P_t} Y_t - \frac{P_{X,t}}{P_t} X_t - Z_t - \frac{\theta^P}{2} \pi_{H,t}^2 Y_t.$$

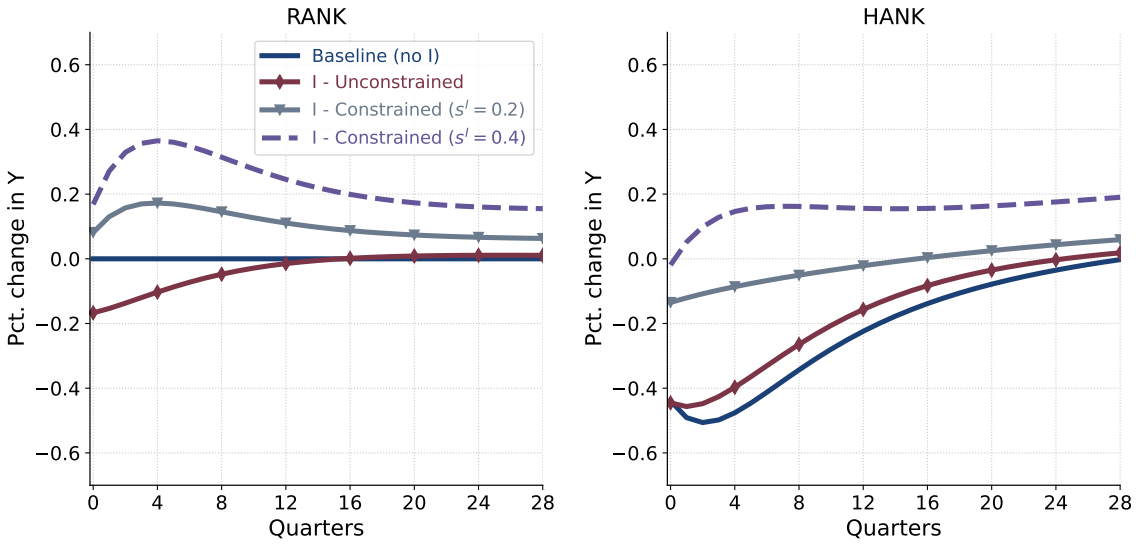


Figure A.8: Responses to a markup shock in the RANK and HANK models

Note: Impulse responses to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact. The figure reports domestic output Y (pct. change, $100 \times \mathrm{d}Y_t/Y$) in the RANK and HANK models. *Baseline* refers to the model without capital and investment, *I - Unconstrained* to investment subject only to an adjustment cost, and *I - Constrained* to investment constrained by an earnings constraint.

H Policy response to markup shock

H.1 Fiscal policy

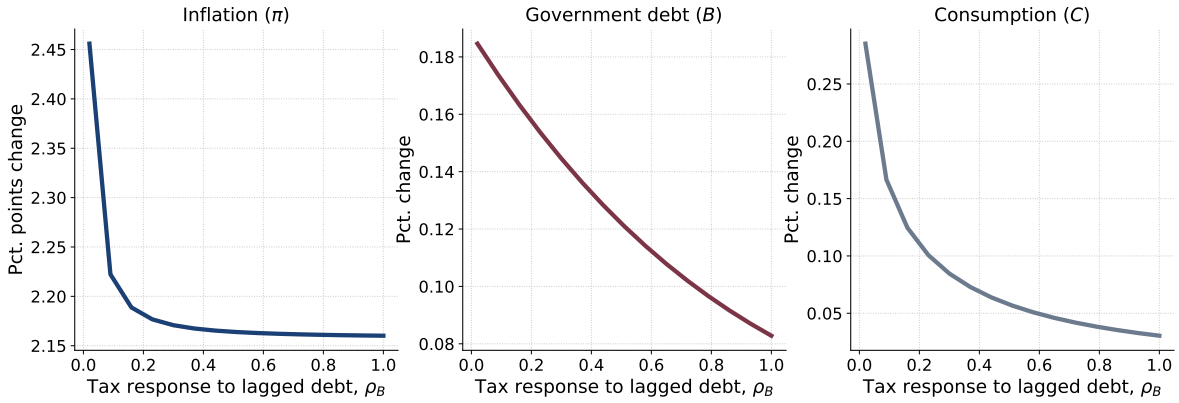


Figure A.9: First-year responses to a markup shock with discretionary transfers and debt feedback

Note: Responses to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact in the baseline. The figure reports cumulative first-year CPI inflation (pct. points), the average first-year percentage change in government bonds, and the average first-year percentage change in aggregate consumption. The discretionary transfer stabilizes the baseline real labor income loss and is financed by reductions in net transfers to rich households (proportional to $g(e)$). The horizontal axis varies the response of net transfers to lagged debt, $\rho_B \in [\bar{\rho}_B, 1]$, with $\bar{\rho}_B = 0.02$. Smaller values delay the offsetting reductions in net transfers.

H.2 Monetary policy

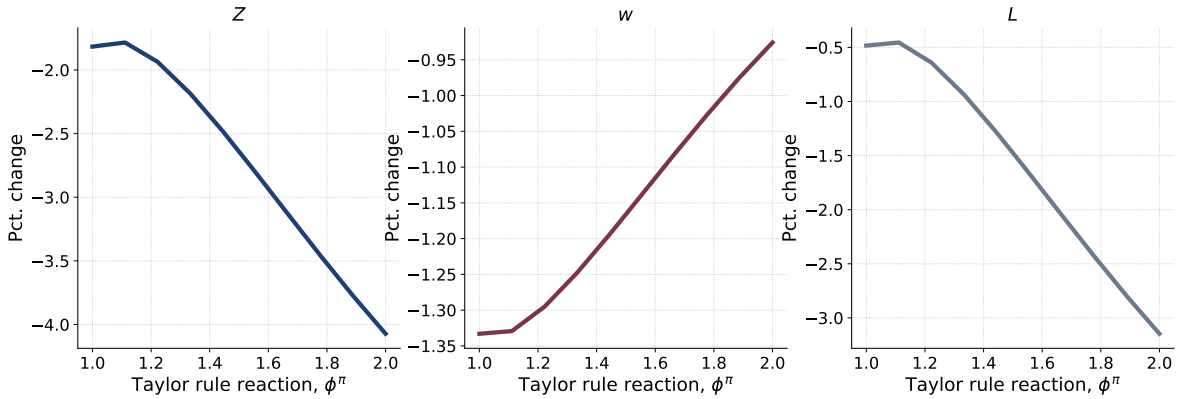


Figure A.10: Responses of real labor income, real wages, and labor to a markup shock with a varying inflation coefficient in the Taylor rule

Note: First-year responses of real labor income Z (pct. change, $100 \times \mathrm{d}Z_t/Z$), real wages w (pct. change, $100 \times \mathrm{d}w_t/w$), and employment L (pct. change, $100 \times \mathrm{d}L_t/L$) to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact. The Taylor rule is $\mathrm{d}i_t = \phi^\pi \mathrm{d}\pi_{t+1}$, where $\phi^\pi = 1$ recovers the constant real-rate baseline.

H.3 Wage indexation

Proposition 3 highlights the importance of real wage dynamics for the transmission of the shock in models with distributional effects. A natural remedy to stabilize real wages in volatile inflation environments is to index nominal wages to CPI inflation (Fischer 1976). Specifically, indexing wages to CPI inflation at rate ι modifies the Rotemberg adjustment cost on nominal wages to $\frac{\theta^W}{2}\left(\left(1+\pi_t^W\right)/\left(1+\pi_t\right)^\iota - 1\right)^2$, see Ascari et al. (2011).[30] The implied wage Phillips curve is

[30] For tractability I assume that wages are indexed to current inflation, but this is not central to my results.

then given by:

$$\left(\pi_t^W - \iota\pi_t\right)\left(1+\pi_t^W-\iota\pi_t\right) = \kappa^W\left(\frac{\xi'\left(L_t\right)}{w_t}\mu^W - 1\right) + \beta\left(\pi_{t+1}^W - \iota\pi_{t+1}\right)\left(1+\pi_{t+1}^W-\iota\pi_{t+1}\right)$$

With wage indexation in the Phillips curve, the response to a markup shock in Proposition 2 becomes:

Proposition 9. *For a general ownership share $\omega \in [0,1]$, the general equilibrium response of output $\mathrm{d}\mathbf{Y}$ to a markup shock with wage indexation is:*

$$\mathrm{d}\mathbf{Y} = -\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\boldsymbol{\Theta}^P\mathrm{d}\boldsymbol{\mu}, \tag{A.15}$$

where the pass-through matrices $\boldsymbol{\Theta}^P, \boldsymbol{\Theta}^W$, on which the multiplier $\mathscr{M}$ depends, are given by:

$$\boldsymbol{\Theta}^P \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W\left(1-\iota\right)\boldsymbol{\kappa}^P\right]^{-1} W\left(1-\iota\right)\boldsymbol{\kappa}^P. \tag{A.16}$$

$$\boldsymbol{\Theta}^W \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + (1-\iota)\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}\frac{W\alpha_L}{\varphi}\boldsymbol{\kappa}^W. \tag{A.17}$$

Proof: appendix H.4.

Inspecting (A.15)-(A.16) one finds that the presence of wage indexation modifies the response of output in a manner similar to the degree of price stickiness κ^P. This implies that a sufficient degree of wage indexation is able to dampen the effect on aggregate demand from the markup shock (Proposition 3) by stabilizing the real wage since a higher ι fundamentally ties nominal wage growth to inflation. Figure A.11 illustrates this numerically. With fully indexed wages real wages are fully stabilized, and there is zero redistribution occurring in the economy, thus leading to full demand stabilization.

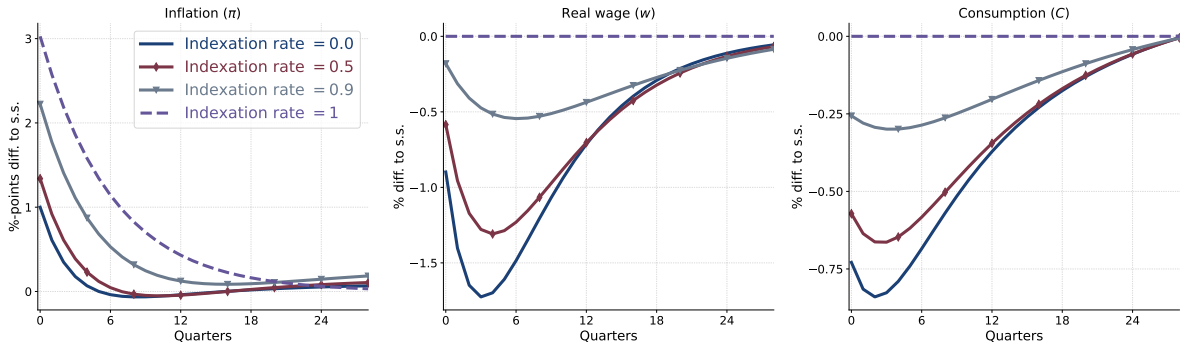


Figure A.11: Transmission of markup shock with varying degree of wage indexation

Note: Impulse responses in the HANK model to an AR(1) domestic markup shock with quarterly persistence 0.85, scaled to raise CPI inflation by 1% on impact in the no-indexation baseline. The figure reports CPI inflation (pct. points change, $100 \times \mathrm{d}\pi_t$), real wages (pct. change, $100 \times \mathrm{d}w_t/w$), and aggregate consumption (pct. change, $100 \times \mathrm{d}C_t/C$) while varying wage indexation.

H.4 Proof of Proposition 9

The output response retains the form of eq. (A.15), but wage indexation changes both $\boldsymbol{\Theta}^P$ and $\boldsymbol{\Theta}^W$, and therefore also the multiplier $\mathscr{M}$. The income-incidence accounting is unchanged. To

derive $\boldsymbol{\Theta}^P$ under wage indexation, I start by linearizing the wage Phillips curve with indexation:

$$\pi_t^W = \iota\pi_t + \kappa^W\left(\frac{\bar{\xi}L_t^{\frac{1}{\varphi}}}{w_t}\mu^W - 1\right) + \beta\left(\pi_{t+1}^W - \iota\pi_{t+1}\right)$$
$$\Rightarrow \mathrm{d}\pi_t^W = \iota\mathrm{d}\pi_t + \kappa^W\left(\frac{1}{\varphi}\mathrm{d}L_t - \frac{1}{W}\mathrm{d}w_t\right) + \beta\left(\mathrm{d}\pi_{t+1}^W - \iota\mathrm{d}\pi_{t+1}\right)$$

Then, using the definition of $\boldsymbol{\Psi}$ above we get the sequence-space representation:

$$\mathrm{d}\boldsymbol{\pi}^W - \iota\mathrm{d}\boldsymbol{\pi} = \kappa^W\boldsymbol{\Psi}\left(\frac{1}{\varphi}\mathrm{d}\mathbf{L} - \frac{1}{W}\mathrm{d}\mathbf{w}\right)$$

To write in levels instead of rates, I use $\mathbf{U}$ to get:

$$\mathrm{d}\mathbf{W} - \iota W\mathrm{d}\mathbf{P} = \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right)$$

where $\boldsymbol{\kappa}^W \equiv \kappa^W\mathbf{U}\boldsymbol{\Psi}$ as before.
To solve for $\boldsymbol{\Theta}^P$, I start by substituting the NKPC into the NKWPC:

$$\mathrm{d}\mathbf{W} - \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) = \iota W\mathrm{d}\mathbf{P}$$
$$\Leftrightarrow \mathrm{d}\mathbf{W} - W\mathrm{d}\mathbf{P} + W\mathrm{d}\mathbf{P} - \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) = W\iota\mathrm{d}\mathbf{P}$$
$$\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) = W\left(\iota - 1\right)\mathrm{d}\mathbf{P}$$
$$\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) = W\left(\iota - 1\right)\boldsymbol{\kappa}^P\left(\mathrm{d}\mathbf{mc} + \mathrm{d}\boldsymbol{\mu}\right)$$
$$\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W\left(\frac{W}{\varphi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) = W\left(\iota - 1\right)\boldsymbol{\kappa}^P\left(\alpha_L\mathrm{d}\mathbf{w} + \mathrm{d}\boldsymbol{\mu}\right).$$

Setting $\mathrm{d}\mathbf{L} = \mathbf{0}$ to isolate the direct pass-through from markup shocks gives:

$$\mathrm{d}\mathbf{w} = -\left[\mathbf{I} + \boldsymbol{\kappa}^W + W\left(1-\iota\right)\boldsymbol{\kappa}^P\alpha_L\right]^{-1}W\left(1-\iota\right)\boldsymbol{\kappa}^P\mathrm{d}\boldsymbol{\mu},$$

implying:

$$\boldsymbol{\Theta}^P \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + (1-\iota)\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}W(1-\iota)\boldsymbol{\kappa}^P,$$

which shows that introducing wage indexation is isomorphic to a proportional change in $\boldsymbol{\kappa}^P$. Similarly, the pass-through from labor to markups becomes:

$$\boldsymbol{\Theta}^W \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + (1-\iota)\alpha_L W\boldsymbol{\kappa}^P\right]^{-1}\frac{W\alpha_L}{\varphi}\boldsymbol{\kappa}^W.$$

This gives the pass-through matrices stated in the proposition.