Aggregate Demand and the Cyclical Distribution of Income*

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Abstract

I study the effects of cost-push shocks on aggregate demand in a heterogeneous agent New Keynesian model with sticky prices and wages. Using a sequence-space approach, I show that factor income redistribution via variable markups makes supply-side inflation contractionary even under a neutral monetary policy rule. When prices rise, real wages fall due to nominal rigidities, shifting income from workers to firm owners. This reduces aggregate demand whenever the marginal propensity to consume (MPC) out of labor income exceeds the MPC out of profits. The model provides a unified framework for the analysis of different cost-push shocks. I establish a link between markup and cost-push shocks governed by whether the economy is effectively a net importer or exporter of the affected input: shocks are most contractionary when payments flow abroad. Markup shocks are less contractionary because income remains domestic, though redistributed to low-MPC households. When intermediate inputs are entirely domestically owned, the shock is isomorphic to a markup shock. Tariff shocks lie in between, depending on how tariff revenue is spent.

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Keywords: Heterogeneous agents, cost-push shocks, sticky wages, marginal propensity to consume, factor income distribution

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1 Introduction

Sharp increases in the price of energy or imported materials lead to a contraction in real incomes as firms pass costs through to consumers. Because nominal wages typically adjust more slowly than prices, the immediate incidence of the shock falls largely on labor through a reduction in real wages. Whether this shift in the distribution of income between profits and wages matters for aggregate demand depends on a dimension of household heterogeneity that standard models are not designed to capture: The extent to which marginal propensities to consume (MPCs) differ across income sources.

I develop a New Keynesian small open economy model with incomplete markets and heterogeneous households (Bewley 1986; Imrohoroğlu 1989; Huggett 1993; Aiyagari 1994) in which nominal wages and prices are sticky. Using the sequence-space approach on both the household side (Auclert et al. 2024d) and the firm side (Auclert et al. 2024b), I derive closed-form characterizations of how various inflationary shocks transmit to aggregate demand. A key object that emerges is a sequence-space pass-through matrix, shaped jointly by price and wage stickiness, that governs how inflationary disturbances translate into markups. In general equilibrium, the effect on aggregate demand from inflationary shocks is jointly determined by this pass-through matrix and the distribution of MPCs out of labor income and profits across households.

Markup shocks provide the clearest illustration of these dynamics. Under a constant real interest rate rule where the conventional monetary transmission is turned off, the representative-agent model implies no output response (Bodenstein et al. 2013). In a heterogeneous-agent economy, however, the same shock is contractionary in the short run if the marginal propensity to consume (MPC) out of labor income exceeds that out of profit income. Because markups reallocate real income from workers to firm owners, aggregate demand falls when workers possess higher MPCs. This contraction vanishes only when the two MPCs are equalized-recovering the representative-agent benchmark as a special case-or when prices are perfectly rigid or wages perfectly flexible. Drawing on Fuster et al. (2021), I present empirical evidence that MPCs are significantly higher among households that rely primarily on labor income (as opposed to capital and business income), suggesting that such a contraction is likely. This is consistent with a growing literature documenting that MPCs differ systematically across income sources and wealth levels (Kaplan and Violante 2022; Chodorow-Reich et al. 2021; Andersen et al. 2024).

Foreign cost-push shocks, modeled as increases in the price of imported intermediate inputs, share the same transmission channel but with an additional dimension. Unlike markup shocks, these transfer resources abroad and are therefore contractionary even in (stationary) representative-agent models. Nonetheless, for empirically relevant calibrations, the dominant transmission channel remains domestic factor income redistribution: The indirect effect through real wages is several times larger than the direct terms-of-trade transfer, as the latter effect is proportional to the MPC out of profits, which is generally low in the model. When the imported input is domestically owned - as with an oil endowment - the shock becomes isomorphic to a markup shock and the analytical condition for contraction carries over exactly. These results complement the energy-shock HANK literature, which emphasizes direct expenditure effects when energy enters the consumption basket (Auclert et al. 2024a; Pieroni 2022). I extend this framework to a setting in which the imported good enters production rather than the consumption basket, and where markups are endogenous. In this case, redistribution of factor income - rather than direct expenditure effects - becomes the primary transmission mechanism, and amplification comes partly from complementarity between labor and materials in production.

Finally, I analyse an increase in tariffs on imported goods. Tariff shocks raise costs for firms and compress real wages through the same channel as described above, but with two key differences: The revenue accrues to the government rather than to firms or foreigners, and tariffs generate an expenditure-switching effect on net exports whose magnitude depends on trade elasticities. The fiscal treatment of tariff revenue is an open question in the literature, but recent studies utilizing models that feature Ricardian equivalence are unable to address it (Monacelli 2025; Bianchi and Coulibaly 2025; Guerrieri et al. 2025). I show that the recycling of this revenue is central to the aggregate demand response. With immediate revenue rebating to households, expenditure switching dominates and the tariff is expansionary; conversely, with debt-financed retention and a low trade elasticity, both domestic consumption and GDP may contract. If the expenditure-switching effect is zero and the government rebates revenue to wealthy firm owners, the shock is equivalent to a markup shock.

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). Most of this work focuses on monetary or fiscal policy. I contribute by identifying endogenous income redistribution as a distinct and quantitatively important channel through which supply-side shocks transmit to aggregate demand, and by showing that this channel can be characterized in closed form across a unified family of inflationary shocks. The open economy dimension builds on De Ferra et al. (2020), Auclert et al. (2024c), and Druedahl et al. (2025), extending their frameworks to cost-push shocks.

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 2022; Diz et al. 2023), which has largely proceeded numerically, or by using two-agent models as approximations.

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 can quantitatively dominate the standard transmission mechanisms. Most directly, recent New Keynesian analyses of tariff shocks (Auclert et al. 2025; Monacelli 2025; Bianchi and Coulibaly 2025; Guerrieri et al. 2025) abstract from household heterogeneity. In a HANK environment, I show that the distributional effects of tariff-induced inflation are first order for aggregate demand, and that the fiscal treatment of tariff revenues is central for determining the sign and magnitude of the output response.

Roadmap. The rest of this paper is organized as follows. Section 2 develops the HANK model which is the central framework for the majority of the paper. Section 3 shows how markup shocks transmit in the heterogeneous agent environment, and establishes analytically when heterogeneity amplifies the effects of the shock. Section 4 studies more general cost-push shocks and Section 5 studies tariff shocks. 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 may save in foreign or domestic government bonds due to free capital flows similar to Obstfeld and Rogoff (2000) 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 $t \in \{0, 1, \dots\}$.

2.1 Households

Consumption-saving problem. While the analytical results I present are general and require almost no structure on the household problem, it is useful to have a baseline household model in mind for the numerical examples and the quantitative analysis. The economy consists of 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 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:

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

$$\text{s.t.}$$

$$c + a' = (1 + r_t^a) a + Z_t e + g(e) \Pi_t - T_t(e), \tag{2}$$

$$\ln e' = \bar{e} + \rho_e \ln e + \epsilon^e, \quad \epsilon^e \sim \mathcal{N}\left(0, \sigma_e^2\right), \tag{3}$$

$$a' \geq \underline{a}, \tag{4}$$

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 $T_t(e)$ denote a lump sum tax raised by the government. Profits in eq. (2) are distributed according to a function $g(e)$ which depends on earnings e and integrates to 1, $\int g(e)\, \mathrm{d}\mathscr{D}_t = 1$, where $\mathscr{D}_t$ denotes the time t endogenous distribution of households over states.[1] 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:

$$C_t = \int c_t(e,a)\, \mathrm{d}\mathscr{D}_t(e,a), \qquad A_t = \int a_t(e,a)\, \mathrm{d}\mathscr{D}_t(e,a) \tag{5}$$

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

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

[1]In Section 3 I will vary the distributional rule $g(\bullet)$ to illustrate the role of profit incidence in the model.

[2]Since preferences are assumed to be homothetic, the household problem can be separated into a intertemporal problem where households first chose c, a, and a intratemporal problem where they afterwards choose c_F, c_H using two-stage budgeting.

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

$$C_{H,t} = (1-\alpha)\left(\frac{P_{H,t}}{P_t}\right)^{-\eta} C_t, \quad C_{F,t} = \alpha\left(\frac{(1+\tau_t)\,P_{F,t}}{P_t}\right)^{-\eta} C_t, \tag{6}$$

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

$$P_t = \left[(1-\alpha)P_{H,t}^{1-\eta} + \alpha\left((1+\tau_t)\,P_{F,t}\right)^{1-\eta}\right]^{\frac{1}{1-\eta}}. \tag{7}$$

I assume a law of one price such that $P_{F,t} = \mathscr{E}_t P^*_{F,t}$, where $P^*_{F,t}$ denotes foreign exports prices and $\mathscr{E}$ denotes the nominal exchange rate. Note that with this convention, an increase in $\mathscr{E}$ 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 materials subject to monopolistic competition. Materials may be either purchased domestically or imported from abroad.

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:

$$Y_t\,(i) = \left(\frac{P_{H,t}\,(i)}{P_{H,t}}\right)^{-\epsilon^p} Y_t, \tag{8}$$

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 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:

$$Y_t = \left[\alpha_L^{\frac{1}{\nu}} L_t^{\frac{\nu-1}{\nu}} + (1-\alpha_L)^{\frac{1}{\nu}} X_t^{\frac{\nu-1}{\nu}}\right]^{\frac{\nu}{\nu-1}}. \tag{9}$$

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:

$$L_t = \alpha_L \left(\frac{W_t}{MC_t}\right)^{-\nu} Y_t, \tag{10}$$

$$X_t = (1 - \alpha_L) \left(\frac{P_{X,t}}{MC_t}\right)^{-\nu} Y_t, \tag{11}$$

where MC_t denotes the nominal marginal cost of producers. The material good X_t can come from either a domestic endowment owned by households (share ω) or be imported from the foreign economy (share $1-\omega$). 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

$$P_{X,t} = (1 + \tau_t)\, \mathscr{E}_t P^*_{X,t}, \tag{12}$$

where τ_t is the tariff levied on imports. Section 4 studies a shock to the price $P^*_{X,t}$ as a source of cost-push shocks.

Pricing friction. Firms choose prices and quantities subject to the demand function (8) 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 markups:

$$\pi_{H,t}\left(1 + \pi_{H,t}\right) = \kappa^P \left(mc_t - \frac{P_{H,t}}{P_t}\frac{1}{\mu}\right) + \beta \frac{Y_{t+1}}{Y_t}\pi_{H,t+1}\left(1 + \pi_{H,t+1}\right), \tag{13}$$

where $\kappa^P \equiv \frac{\epsilon^P}{\theta^P}$ denotes the slope of the Phillips-curve, and μ is the steady state markup.

Profits. Profits maximized by domestic firms—measured in units of the CPI—are given by:

$$\widetilde{\Pi}_t = \frac{P_{H,t}}{P_t}Y_t - \frac{W_t}{P_t}L_t - \frac{P_{X,t}}{P_t}X_t - \frac{\theta^P}{2}\pi^2_{H,t}Y_t \tag{14}$$

whereas total dividends paid out to domestic households are given by

$$\Pi_t = \widetilde{\Pi}_t + \omega\left(\frac{P_{X,t}}{P_t}X_t - \frac{\bar{P}_X}{\bar{P}}\bar{X}\right) \tag{15}$$

where variables with bars denote steady-state values, and ω determines the share of material goods owned by domestic households.[3]

[3]This specification isolates ω as a purely cyclical parameter, allowing me to study the redistribution of material costs without shifting the steady state.

2.3 Labor supply and wage setting

Labor supply is determined by unions as in Erceg et al. (2000), Schmitt-Grohé and Martin Uribe (2005). There is a continuum of unions, and each household i provides $\ell_{i,t}^{k}$ hours of work to union k. Total labor supply of household i is then $\ell_{i,t} = \int \ell_{i,t}^{k} \mathrm{d}k$. Each union assembles individual labor supply to a union-specific task $L_t^k = \int e_{i,t} \ell_{i,t}^{k} \mathrm{d}i$, and aggregate labor supply is assembled from these union-specific tasks using a 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.[4] 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 sector. 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 administrated by a mutual fund which invests in either government domestic bonds B in fixed supply or foreign bonds B^* 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 implies a nominal UIP condition $1 + i_t = (1 + i_t^*) \frac{\mathscr{E}_{t+1}}{\mathscr{E}_t}$. Defining the real exchange rate $Q_t = \frac{\mathscr{E}_t}{P_t}$ we may rewrite this as the real UIP condition:

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

[4] This device primarily matters in counterfactuals where I consider the flexible wage limit, $\theta^W \to 0$.

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. Household asset returns equal the expected real interest rate in all periods except the initial period of an MIT shock: $r^a_{t+1} = r_t$ for $t > 0$. In period $t = 0$, returns instead remain at the steady-state level, $r^a_0 = r$, since households initially only hold real bonds, implying that surprise inflation has no effect on realized asset returns. Note that equilibrium in the asset market implies $A_t = B^*_t + B$. I define the net foreign asset position as the difference between domestic asset A_t and the supply of domestic bonds B, $NFA_t = A_t - B$, which also implies $NFA_t = B^*_t$.

2.5 Monetary policy

The domestic central bank controls the nominal interest rate i_t, which is related to the ex-ante real interest rate through the Fisher relation $1 + r_t = \frac{1+i_t}{1+\pi_{t+1}}$. In the baseline analysis I assume a neutral monetary policy stance which aims to keep the domestic ex-ante real rate constant, $r_t = r$. This may be interpreted as a Taylor rule with coefficient 1 on expected inflation.[5]

2.6 Government

The government supplies bonds B and raise revenues from import tariffs τ_t and lump-sum taxes T_t to pay interest on issued bonds. The budget constraint is given by:

$$\tau_t \left(\frac{P_{F,t}}{P_t} C_{F,t} + \frac{P_{X,t}}{P_t} (1-\omega) X_t \right) + T_t + B_t = (1 + r_t) B_{t-1}$$

Unless otherwise specified I mainly focus on the case where the government adjusts lump-sum taxes to satisfy the constraint, while keeping debt fixed.

2.7 Exports

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

$$C^*_{H,t} = \alpha^* \left(\frac{P^*_{H,t}}{P^*_{F,t}} \right)^{-\eta}. \tag{18}$$

I assume a law of one price such that $P^*_{H,t} = \frac{P_{H,t}}{\mathcal{E}_t}$.

[5] Woodford (2011), Auclert et al. (2024d) and Angeletos et al. (2024b) use a similar constant real rate rule to simplify analytical exposition, and discuss the issue of local determinacy.

2.8 Market clearing and equilibrium

Market clearing in the economy is given by:

$$Y_t = C_{H,t} + C^*_{H,t} + \frac{P_t}{P_{H,t}} \frac{\theta^P}{2} \pi^2_{H,t} Y_t. \tag{19}$$

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 allocation between foreign and domestic bonds, a competitive equilibrium in the domestic economy is a path of household policies* $\{c_t(a, e), a_t(a, e)\}$*, distributions* $\mathscr{D}_t(a, e)$*, prices:*

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

and quantities:

$$\{C_t, C_{H,t}, C_{F,t}, A_t, Y_t, X_t, L_t, \Pi_t, NFA_t, B^*_t\}$$

such that all households and firms optimize, the central bank sets monetary policy according to the chosen rule, and the goods market clearing condition eq. (19) *holds, while the asset market clearing condition* $A_t = B^*_t + B_t$ *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:

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

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 which insures stationarity governed by the parameter ι^{SGU} as in Schmitt-Grohé and Martin Uribe (2003).

2.10 Calibration

I calibrate the model to the average small open economy in the OECD.[6] Table 1 displays the calibration.

Households. For the household block the Frisch elasticity of labor supply is set to a standard value of 0.5, and I calibrate the disutility of labor $\bar{\xi}$ such that steady state labor supply equals

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

1, $L = 1$. 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 discount factor β is calibrated to match an aggregate MPC out of a uniform lump sum transfer of 0.51 following Fagereng et al. (2021) at an annual steady state real interest rate of 4%. In Figure 1a I plot the dynamic MPCs in the model following a one time unexpected transfer against the estimated MPCs from Fagereng et al. (2021). The model overall replicates the empirical evidence well. In Figure 1b I plot the corresponding dynamic MPCs following an increase in aggregate *real labor income* Z. The first-year MPC is somewhat lower than the transfer-MPC at 0.38 because Z loads more on rich households who have lower MPCs. The MPC out of labor income will be a central object in the analysis in the remainder of the paper. For the profits incidence function I assume a simple function form:

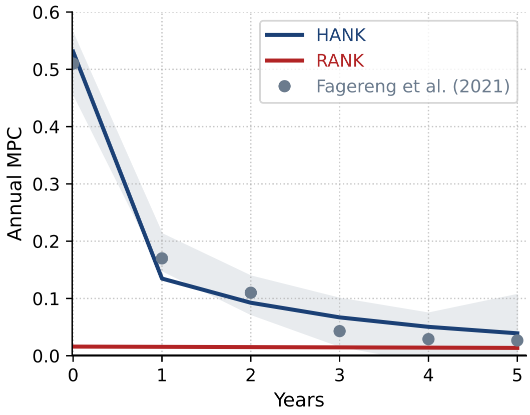
$$g(e_{i,t}) = \frac{e_{i,t}^{\vartheta}}{\int e_{i,t}^{\vartheta} \mathrm{d}\mathscr{D}_t} \tag{20}$$

I calibrate the parameter ϑ, which determines how skewed the distribution of profits is in the population, to match an aggregate, annual MPC out of profits of 4%. Chodorow-Reich et al. (2021) estimate an annual MPC out of stock returns of 3.2% using US data, while Andersen et al. (2024) estimate an annual MPC of 4% using Danish data. Calibrating to 4% gives $\vartheta = 15$. Figure 1c plots the aggregate quarterly MPC out of a one-time increase in profits against the estimated, dynamic response from Andersen et al. (2024). The overall response is relatively flat because rich households - who are the ones that have claims on firm profits - act as permanent income households, and thus smooth consumption extensively. Overall, this fits the empirical evidence well, though the short run response in the HANK model is slightly larger than the empirical estimates, suggesting that the model may need a degree of illiquidity of capital gains to match the evidence. For the RANK model 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 stationary.

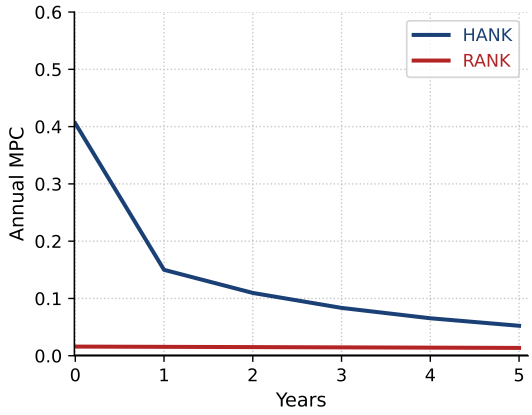
Regarding the tax function $T_t(e)$ I posit that households are taxed in proportion to individual productivity:

$$T_t(e) = \frac{e}{\int e \mathrm{d}\mathscr{D}_t} T_t.$$

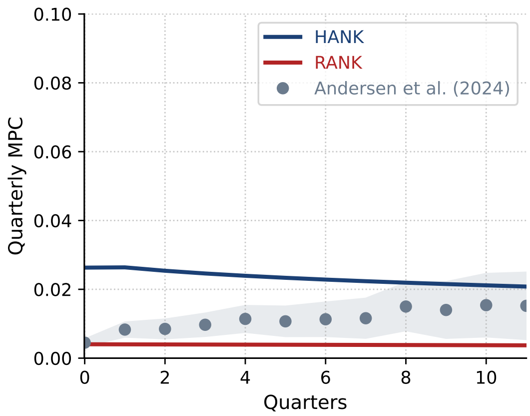
I calibrate the amount of steady state government bonds B to equal assets demanded by households A and steady state taxes T then clears the government budget.



(a) MPC out of uniform transfer



(b) MPC out of labor income



(c) MPC out of profits

Figure 1: Marginal propensities in the calibrated model

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 therefore 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 $\kappa^P \approx 0.17$ with $\frac{1}{1+r} = 0.99$. For the elasticity of substitution in production, I set $\nu = 0$ as my baseline specification. This choice provides a tractable benchmark that closely approximates the short-run estimates in Boehm et al. (2019), who find a value of 0.03. While other studies find slightly higher elasticities, typically ranging between 0.2 and 0.4 (Atalay 2017; Peter and Ruane 2025), 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). I later show that the model's core mechanisms remain robust when considering these higher empirical estimates. Regarding the cost-structure I calibrate the input share of labor α_L to match the average cost-share of labor in the sample OECD countries. This yields residually spending on total materials X_t.

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 Christiano et al. (2005) calibrate substantial nominal wage rigidities that imply a low wage Phillips curve slope. 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 size of foreign economy α^* such that steady state exports amounts 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 household's consumption basket at 25%, $\alpha = 0.25$ following Christiano et al. (2011). The share of imported materials by firms is then calculated residually such that aggregate imports constitute 42% of GDP. This yields $\alpha_L = 0.77$. The trade elasticities only matter for the effects of the tariff shock studied in Section 5. Here I follow Auclert et al. (2025) who calibrate the short-run export and import elasticities to 1.5 and 1.15 respectively. For simplicity I assume these to be equal and set it to the average of the two, $\eta = 1.3$.

Government. I set $B = A$ to clear the asset market, and calibrate the lump sum tax to satisfy the government budget constraint in steady state. Tariffs are zero in the initial steady state.

Shocks. All shocks in the quantitative illustrations are modelled as AR(1) processes with quarterly persistence 0.85. The markup shock and cost-push shock are normalized such that CPI inflation increases by 1% on impact in the baseline model. The tariff shock is set to a 10% increase following Auclert et al. (2025).

3 Transmission of Markup shocks

Transmission. I start by considering a markup shock, which corresponds to a shock to the Phillips-curve in the standard New-Keynesian model. Recall that the model assumes a neutral stance of the domestic central bank such that the domestic real rate is constant (as in Auclert et al. 2024d; Angeletos et al. 2024a) at the steady state level, $r_t = r$.[7] In the standard 3-equation New-Keynesian model the entire transmission of markup shocks to the real economy derives from the response of the central bank to inflation.[8] This is because domestic demand is driven

[7]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.

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

Parameter	Description	Value	Source/Target
Households			
φ	Frisch	0.5	Chetty et al. (2011)
β	Discount factor	0.981	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	MPC out of capital gains
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	0.77	Imports = 42% of GDP (OECD average)
Trade			
α	Imports of final goods	0.25	Christiano et al. (2011)
α^*	Exports	0.42	$NX = 0$ in steady state
η	EOS between foreign and domestic goods	1.3	Auclert et al. (2025)

Table 1: Calibration

entire 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.

Sequence-space representation. The analysis is centered around the goods market clearing condition (19). Linearizing and applying the assumption of a constant real interest rate, which implies a constant real exchange rate $Q_t = Q$ by the real UIP condition (17), yields that changes in domestic output equals the change in domestic consumption spend on home goods:[9]

$$dY_t = (1-\alpha)\, dC_t, \tag{21}$$

where $dx_t = x_t - x$ represent deviations from steady state for some variable x. Given a constant real rate the aggregate consumption function $\mathscr{C}_t$ 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 $\mathrm{dC} = (dC_0, dC_1, \ldots)$ the linearized consumption function can be written as $\mathrm{dC} = \mathbf{M}^Z \mathrm{d}\mathbf{Z} + \mathbf{M}^{\Pi} \mathrm{d}\mathbf{\Pi}$ where $\mathbf{M}^Z, \mathbf{M}^{\Pi}$ are the sequence-space Jacobians of aggregate consumption

[9]See appendix A.1 for the derivation.

w.r.t labor income and profits respectively:[10]

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

Here the entry $M^Z_{0,0}$ corresponds to the quarterly MPC out of labor income and so forth. Note that 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.[11] As we shall see the relative level of $\mathbf{M}^Z, \mathbf{M}^\Pi$ will have important implications for the transmission of cost-push shocks.

Keynesian cross. Combining the linearized consumption function with the definition of profits and goods market clearing I obtain the following proposition:

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:*

$$\frac{1}{1-\alpha}\mathrm{dY} = \underbrace{\mathbf{M}^Z \mathrm{dY}}_{Multiplier} - \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \mathrm{d\Pi}}_{Distributional\ channel} \tag{22}$$

Proof: appendix A.2.

Proposition 1 implies that the response of output to a markup shock depends on a multiplier term and a distributional term relating to changes in profits. Given a constant real rate the distribution effects are the fundamental source of propagation following the shock. In particular, with a representative agent - which typically features $\mathbf{M}^Z = \mathbf{M}^\Pi$ - the distributional effect is zero, and the solution to (22) is $\mathrm{dY} = \mathbf{0}$. Hence the proposition highlights exactly why a markup shock has no effects (besides the effect through monetary policy) in the basic NK model featuring a representative agent. The same insight holds in more general HANK models which features an equal incidence of labor income and profits across the population. In this case the marginal propensities may be positive $\mathbf{M}^Z > 0, \mathbf{M}^\Pi > 0$ but to the extent that they are equal, $\mathbf{M}^Z = \mathbf{M}^\Pi$, redistribution is neutral in the aggregate, and the markup shock has no effect on aggregate demand. This is summarized in corollary 1:

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

[11] This rests on the assumption that labor income and profits do not affect other parts of household behaviour by inducing substitution effects, as for instance through endogenous labor supply.

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,* $\mathbf{M}^Z = \mathbf{M}^\Pi$*, the markup shocks have no effect on real output,* $\mathrm{d}\mathbf{Y} = \mathbf{0}$*, under a neutral monetary policy stance,* $\mathrm{d}\mathbf{r} = \mathbf{0}$.

Moving onto the more general case where $\mathbf{M}^Z \neq \mathbf{M}^\Pi$, we see that if the MPC out of labor income is greater than that of profits, as the data suggests, $\mathbf{M}^Z > \mathbf{M}^\Pi$, an increase in firm markups, which increase profits $\mathrm{d}\mathbf{\Pi} > 0$, will suppress aggregate demand and generate a contraction in terms of domestic output, $\mathrm{d}\mathbf{Y} < 0$.

Figure 2 displays the responses to a markup shock that increases inflation by 1% on impact in a baseline RANK, permanent-income type model ($\mathbf{M}^Z = \mathbf{M}^\Pi$) model, and a HANK model with unequal incidence (the baseline model - $\mathbf{M}^Z > \mathbf{M}^\Pi$). Specifically, the Figure plots the responses of real labor income Z, aggregate output Y, inflation π and real profits Π. For both the RA and HA model the increase in desired markups causes firms to raise prices further above marginal costs hence generating inflation. Given nominal wage frictions, this drives down the real wage and increases firm profits. The two models then differ in how aggregate demand and output respond to these changes. In the RA model (left panel) with a neutral monetary policy stance aggregate consumption and output does not respond since the MPC out of transitory income changes is zero. If we consider the empirically realistic case where the aggregate MPC out of labor income is greater than that of profits (right panel) the redistribution caused by inflation is not demand-neutral and the model therefore delivers a significant drop in domestic demand and output, i.e. stagflation.

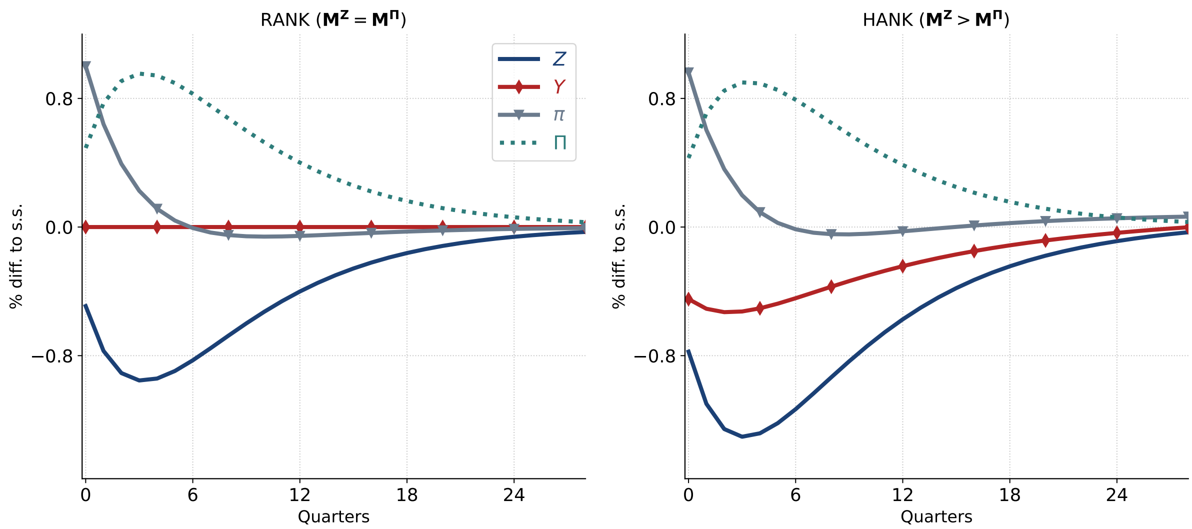


Figure 2: Effect of markup shock in RANK and HANK

Note: Impulse responses to an AR(1) shock to the domestic markup with persistence 0.8. The shock is normalized such that inflation increase 1% on impact. The Figure shows real labor income Z (red), real output Y (dark blue), CPI inflation π (grey) and real profits Π (orange).

Two-agent model. The transmission occurring through factor income redistribution is very clear in the case of a two-agent model à la Galí et al. (2004) where the matrices $\mathbf{M}^Z, \mathbf{M}^\Pi$ have closed form solutions. Assume that a share λ of households are financially constrained with the remaining $1-\lambda$ share being permanent-income type households (implying an aggregate MPC of λ). Constrained households receive a share δ of aggregate profits such that $\delta = \lambda$ implies an equal incidence of profits across the population. These assumptions imply $\mathbf{M}^Z = \lambda\mathbf{I}$ and $\mathbf{M}^\Pi = \frac{\delta}{\lambda}\lambda\mathbf{I} = \delta\mathbf{I}$. Equation (22) then takes the simple form:

$$\frac{1}{1-\alpha}\mathrm{d}\mathbf{Y} = \lambda\mathrm{d}\mathbf{Y} - [\lambda - \delta]\,\mathrm{d}\mathbf{\Pi},$$

from which it is evident that $\lambda = \delta$ yields $\mathrm{d}\mathbf{Y} = 0$ and $\lambda > \delta$ implies $\mathrm{d}\mathbf{Y} < 0$ for $\mathrm{d}\mathbf{\Pi} > 0$.

Dynamic MPCs. Returning to the full HANK model with general MPC matrices, $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$, equation (22) may suggest that a HANK model with a high MPC out of labor income and a low MPC out of profits necessarily implies $\mathrm{d}\mathbf{Y} < 0$. However, this intuition is generally incorrect because $\mathbf{M}^Z$ and $\mathbf{M}^\Pi$ are Jacobians—that is, matrices rather than scalars—so that $\mathbf{M}^Z\mathrm{d}\mathbf{\Pi}$ and $\mathbf{M}^\Pi\mathrm{d}\mathbf{\Pi}$ are vectors describing the dynamic response over time. In particular, due to the intertemporal budget constraint, the columns of these Jacobians have present value 1, $\sum_{t=0}^{\infty}\frac{M_{t,s}^Z}{(1+r)^{t-s}} = 1$, since every additional dollar received must eventually be spent. As a result, a HANK model that features larger MPCs at short horizons (e.g., in the first few quarters after a transfer) must necessarily exhibit smaller MPCs at longer horizons. Consequently, for a given path of $\mathrm{d}\mathbf{\Pi}$, the sign and magnitude of $\mathbf{M}^Z\mathrm{d}\mathbf{\Pi}$ and $\mathbf{M}^\Pi\mathrm{d}\mathbf{\Pi}$ can vary over time.

MPCs across the population. Additional intuition for the mechanisms present in eq. (22) can be provided by re-writing the distributional term in terms of covariances as follows:[12]

$$\frac{1}{1-\alpha}\mathrm{d}\mathbf{Y} = \mathbf{M}^Z\mathrm{d}\mathbf{Y} - \left[\mathbb{C}\mathrm{ov}_i\left(\mathbf{M}_i, e_i\right) - \mathbb{C}\mathrm{ov}_i\left(\mathbf{M}_i, g\left(e_i\right)\right)\right]\mathrm{d}\mathbf{\Pi}, \tag{23}$$

where $\mathbf{M}_i$ is the Jacobian of consumption w.r.t a uniform lump-sum transfer for individual i in the population.[13]

Each of the the terms in eq. (23) corresponds exactly to the terms in (22). Focusing on the second term on the right-hand side, eq. (23) shows that the differential $\mathbf{M}^Z - \mathbf{M}^\Pi$ corresponds exactly to the differential of two covariances: The population covariance between intertemporal MPCs $\mathbf{M}_i$ and idiosyncratic income e_i and the covariance between intertemporal MPCs $\mathbf{M}_i$ and the profit incidence function $g(e_i)$, since e_i and $g(e_i)$ determines the distribution of aggregate labor income and profits in the population. If profits tend to be distributed towards

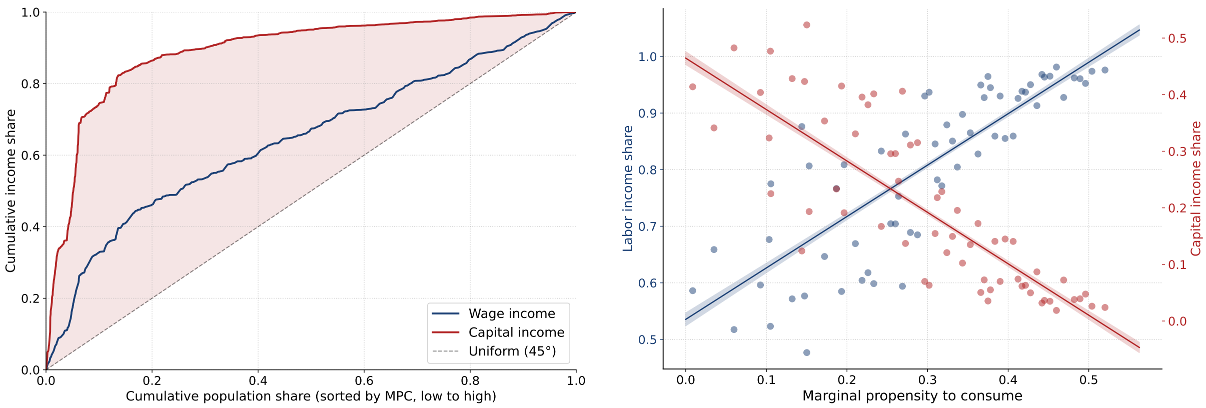
[12]See appendix A.3 for the derivation.

[13]For the purpose of exposition, I assume that the covariance operator $\mathbb{C}\mathrm{ov}\left(\mathbf{X}, y\right)$ in (23) takes a matrix $\mathbf{X}$ and a scalar y as input, and gives as output a matrix which is simply the element-by-element covariances between $\mathbf{X}$ and y.

low MPC households more so than labor earnings, then eq. (23) implies that an increase in profits 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. (2025), who estimate MPCs in one dataset (the PSID and the NY Fed's Survey of Consumer Expectations; Fuster et al. 2021) and apply these estimates to other datasets using the fitted relationships based on observable characteristics. I obtain MPC estimates from Fuster et al. (2021), specifically from the $500-loss treatment, in which respondents are asked how much of an unexpected $500 expense they would finance through reduced spending. I fit 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 3 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 $\mathbb{C}\mathrm{ov}_i(\mathbf{M}i, ei) > \mathbb{C}\mathrm{ov}_i(\mathbf{M}i, g(ei))$.



(a) Distribution of income

(b) MPCs against labor and profit income shares

Figure 3: 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: Scatter plot of MPCs against labor income (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 plots the share of each income type received by households in each MPC decile. Both panels show that capital income is substantially more concentrated among low-MPC households than wage income, implying that redistribution from one group to the other affects aggregate demand. Figure 4 displays the effects of the markup shock in the model on inflation, real wages and consumption when varying the covariance gap in (23), or equivalently, the difference between the Jacobians $\mathbf{M}^Z - \mathbf{M}^\Pi$ by changing the profit incidence function $g(e)$. As the profits become more equally distributed in the population the gap $\mathbf{M}^Z - \mathbf{M}^\Pi$ lessens, and the contractionary effect on consumption becomes smaller, converging to zero when $\mathbf{M}^Z = \mathbf{M}^\Pi$ as per corollary 1.

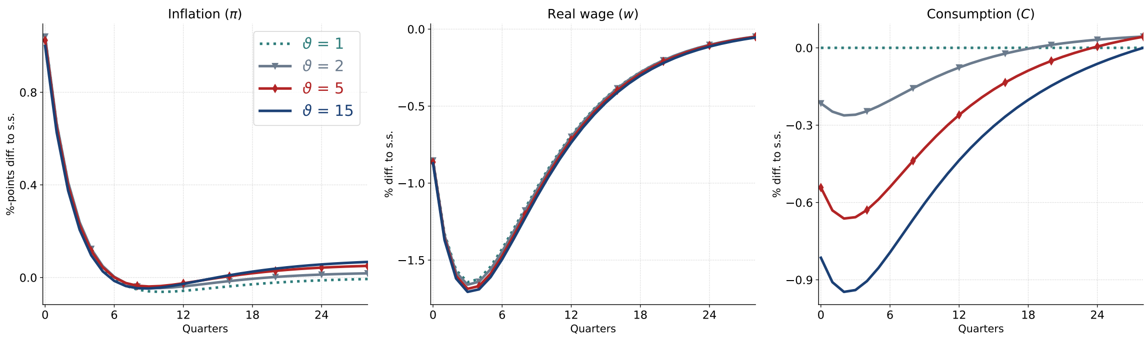


Figure 4: Responses to a markup shock with varying profit distribution across the population

The figure shows the response in the HANK model to a markup shock while varying the parameter ϑ, which determines the distribution $g(e_i)$ of profits in the population. A value of $\vartheta = 1$ implies that profits and labor income are distributed in the same way across the population, whereas $\vartheta > 1$ implies that profits are more concentrated than labor income

Real GDP. Proposition 1 focuses on the response of domestic output Y_t. Given that the model features intermediate inputs in production, domestic real GDP and output do not coincide. Defining real GDP as output net of imported materials (measured in units of the CPI) $\mathcal{Y}_t = \frac{P_{H,t}}{P_t} Y_t - \frac{P_{X,t}}{P_t} (1-\omega) X_t$, the relation between GDP and output is simply $d\mathcal{Y}_t = [1 - (1-\omega)(1-\alpha_L)] \, dY_t$, and so the impulse response of GDP is proportional to the impulse of output.

Closed economy. The analysis above carries through in a closed economy ($\alpha = 0$) with no change in the structure of the distributional channel. The only difference is that the Keynesian multiplier is larger: in the open economy, a fraction α of any increase in domestic spending falls on imported goods and therefore does not feed back into domestic output. In a closed economy this leakage vanishes and the multiplier term in Proposition 1 becomes simply $\mathbf{M}^Z \mathbf{dY}$ with the left-hand side equal to $\mathbf{I}\,\mathbf{dY}$. The distributional channel $\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \mathbf{d\Pi}$ is unchanged, and so the qualitative results on the role of MPC heterogeneity apply identically.

3.1 The role of price and wage stickiness

General equilibrium. So far I have taken the response of aggregate profits $\mathbf{d\Pi}$ as given. Solving the model for $\mathbf{d\Pi}$ and substituting into eq. (22) characterizes the full general equilibrium solution for output. This operation requires writing the New-Keynesian Phillips curve (13) and wage Phillips curve (16) in sequence-space:

$$\mathbf{dP_H} = \boldsymbol{\kappa}^P (\mathbf{dmc} + \mathbf{d}\boldsymbol{\mu}) \tag{24}$$

$$\mathbf{dW} = \boldsymbol{\kappa}^W \left(\frac{W}{\phi} \mathbf{dL} - \mathbf{dw} \right), \tag{25}$$

where the bold letters $\boldsymbol{\kappa}^P, \boldsymbol{\kappa}^W$ are the Phillips curve pass-through matrices (Auclert et al. 2024b).[14] Note that even though these are matrices, they are proportional to the slopes of the respective Phillips curves and so $\kappa^P = 0 \Rightarrow \boldsymbol{\kappa}^P = \mathbf{0}$, $\frac{\partial \boldsymbol{\kappa}^P}{\partial \kappa^P} \geq \mathbf{0}$ etc. To compactly solve for the general equilibrium response of the model it is useful to define the *pass-through matrix of markup shocks to markups* $\boldsymbol{\Theta}^\mu$ as well as the *pass-through matrix of employment to markups* $\boldsymbol{\Theta}^L$.

Definition 2. *The pass-through matrix of markup shocks to markups is defined by:*

$$\boldsymbol{\Theta}^\mu \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W \boldsymbol{\kappa}^P \right]^{-1} W \boldsymbol{\kappa}^P. \tag{26}$$

Similarly, the pass-through matrix of employment to markups is defined by:

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

where $\boldsymbol{\kappa}^P, \boldsymbol{\kappa}^W$ are the slopes of the Phillips curves (24)-(25), α_L is the share of labor used in production, ϕ is the Frisch elasticity, and W is the steady state wage rate.

The markup pass-through matrix $\boldsymbol{\Theta}^\mu$ captures the effect of an increase in desired markups μ (or equivalently, in marginal costs) on the markup (defined as prices over nominal marginal costs, $P_{H,t}/MC_t$) through the two Phillips curves (24)-(25). If we consider simple, static Phillips curves of the form $\mathrm{d}W_t = \kappa^W \left(\frac{W}{\phi} \mathrm{d}L_t - \mathrm{d}w_t \right)$, $\mathrm{d}P_t = \kappa^P (\mathrm{d}mc_t + \mathrm{d}\mu_t)$ with only labor used as input $\mathrm{d}mc_t = \mathrm{d}w_t$, then the entries in $\boldsymbol{\Theta}^\mu$ are constant and given by $\frac{W\kappa^P}{1+\kappa^W + W\kappa^P}$. The numerator captures the direct effect on markups from an increase in μ (markups increase by the shock times the pass-through to prices κ^P), while the denominator captures the feedback loop occurring through the wage Phillips curve. When prices go up due to the shock, this reduces the real wages appearing in the wage Phillips curve, thereby raising nominal wages by κ^W. This raises the marginal costs of firms, which causes firms to once again raise prices by κ^P. The fixed point of this interaction is exactly $\boldsymbol{\Theta}^\mu$. With fully flexible prices the pass-through is one, while with fully flexible wages the pass-through is zero. $\boldsymbol{\Theta}^L$ captures the same logic following an increase in labor supply.[15] An increase in labor supply puts upwards pressure

[14] If the discount factors in the Phillips-curves equal 0 then these matrices are simply given by $\boldsymbol{\kappa}^P = \kappa^P \times \mathbf{U}, \boldsymbol{\kappa}^W = \kappa^W \times \mathbf{U}$ where $\mathbf{U}$ is a lower-triangular matrix with ones on and below the diagonal, and zeros above. The more general expressions are derived in appendix A.4. Note that to simplify notation the markup shocks $\mathbf{d}\boldsymbol{\mu} = (d\mu_0, d\mu_1, \ldots)$ in (24) are defined as $d\mu_t = \frac{\mu_t - \mu}{\mu^2}$. This is just a matter of scaling given linearity.

[15] In this stylized example the entries of $\boldsymbol{\Theta}^L$ are given by $\frac{\kappa^W W/\phi}{1+\kappa^W + W\kappa^P}$.

on nominal wage growth by exactly κ^W/ϕ. This raises marginal cost of firms, who in turn raise their prices by κ^P. This causes a decline in the real wage, whereby unions raise nominal wages again. The fixed point of this interaction is exactly $\frac{\kappa^W/W\phi}{1+\kappa^W+W\kappa^P}$. Note that this is positive; it enters the multiplier with a negative sign, reflecting that with sticky prices an increase in inputs such as labor generates temporarily lower markups.

3.1.1 General equilibrium solution

With the notation from Definition 2 in place, the following proposition characterizes the full general equilibrium solution for output:

Proposition 2. *The equilibrium response of output* dY *to a markup shock is:*

$$\mathrm{dY} = -\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \times \mathbf{\Theta}^\mu \times \mathrm{d}\boldsymbol{\mu}, \tag{28}$$

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

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

Proof: appendix A.5.

Proposition 2 highlights simultaneously the importance of the MPC differential $\mathbf{M}^Z - \mathbf{M}^\Pi$ discussed earlier as well as the importance of nominal price and wage frictions (captured in $\mathbf{\Theta}^\mu$) as they determine the response of profits $\mathrm{d}\mathbf{\Pi}$.

More flexible prices ($\kappa^P \uparrow$) will lead to a larger pass-through from markups to prices. In the presence of nominal wage frictions ($\kappa^W < \infty$) this will lead to a decline in the real wage and higher profits (larger $\mathbf{\Theta}^\mu$). The drop in real wages suppress aggregate demand and output if $\mathbf{M}^Z > \mathbf{M}^\Pi$. Similarly, more flexible wages ($\kappa^W \uparrow$) will imply a small drop in real wages as any drop in real wages will be met by larger nominal wage increases according to the wage Phillips curve (16). This will stabilize aggregate demand since $\mathbf{M}^Z > \mathbf{M}^\Pi$ and output fluctuations will be dampened. These mechanisms are summarized in the following proposition:

Proposition 3 (Price and Wage flexibility). *Consider the response of aggregate output* (28) *to a markup shock. If* $\mathbf{M}^Z \geq \mathbf{M}^\Pi$ *then:*

(i) Increasingly flexible prices amplify the output effects of the markup shock $\frac{\partial \mathrm{dY}}{\partial \kappa^P} \leq 0$*, while rigid prices dampen the shock. In the limit with completely rigid prices we have* $\mathbf{\Theta}^\mu = \mathbf{0}$*, and the general equilibrium response of output is zero:*

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

while with fully flexible prices there is full pass-through, $\mathbf{\Theta}^{\mu} = \mathbf{I}$*:*

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

(ii) If prices are not completely flexible, $\kappa^P < \infty$*, increasingly flexible wages attenuate the output effects of the markup shock* $\frac{\partial \mathrm{dY}}{\partial \kappa^W} \geq 0$*, while more rigid wages amplify the effects of the markup shock. In the limit with completely flexible wages we have* $\mathbf{\Theta}^{\mu} = \mathbf{0}$*, and the general equilibrium response of output is zero:*

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

Proof: Appendix A.6.

Figures 5 and 6 illustrate Proposition 3 numerically. Figure 5 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. Hence price flexibility amplifies the redistribution from workers to firm owners which suppresses aggregate demand. With sufficiently sticky prices, inflation does not move and the shock has no effect.

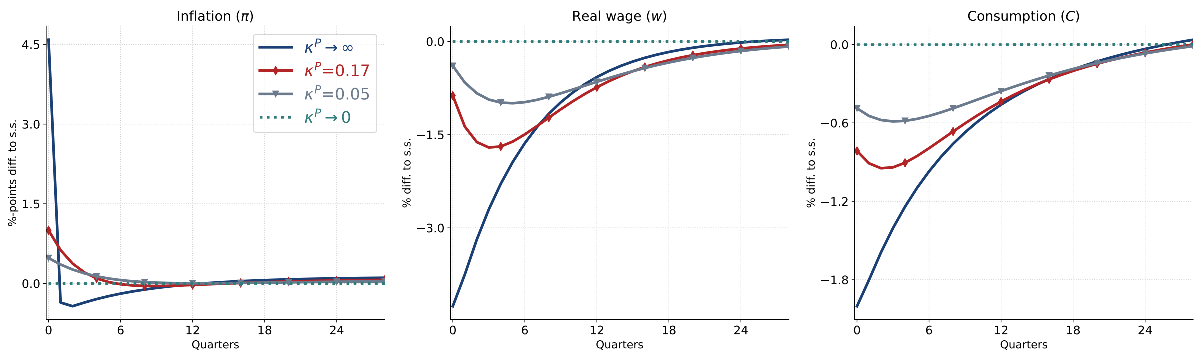


Figure 5: Transmission of markup shock with varying degree of price stickiness

Figure 6 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 the effect on aggregate demand is completely neutralized. Note that for wage flexibility to matter it is necessary that prices are not completely flexible $\kappa^P < \infty$, since in that case the change in the markup is exogenous. In this case wage flexibility cannot affect the cyclicality of markups, and even completely flexible wages will not be sufficient to stabilize the real wage.

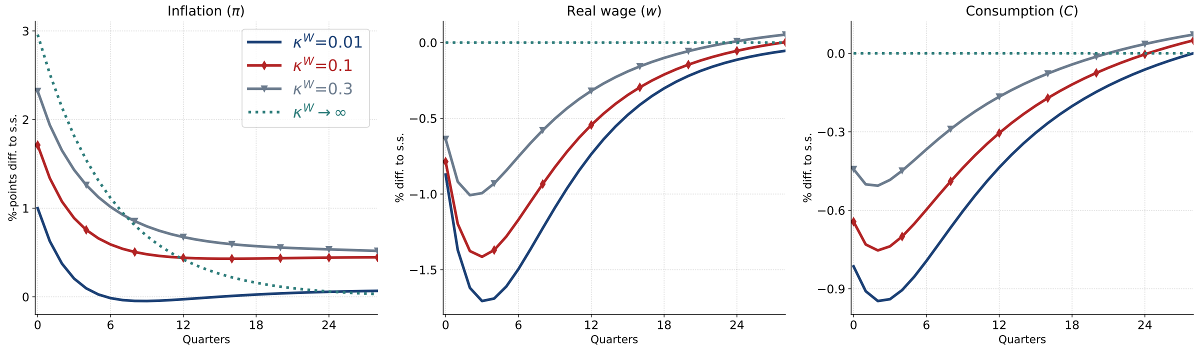


Figure 6: Transmission of markup shock with varying degree of wage stickiness

3.2 Extensions

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; M. Brunnermeier et al. 2025). In Appendix C.4 I introduce nominal, long term government bonds such that surprise inflation affects returns in the first period of the shock. In the case with 1 year maturity of bonds, the change in aggregate consumption is given by:

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

where $\mathbf{M}^{r_0}$ is a vector capturing the effect on aggregate consumption dC following a change in the real rate of return at time 0, $\mathrm{d}r_0$ and θ^n is the share of nominal bonds.[16] The vector $\mathbf{M}^{r_0}$ can be written as the sum of an average effect and a covariance:

$$\mathbf{M}^{r_0} = \mathbf{M}_0 \times A + \mathbb{C}\mathrm{ov}\left(\mathbf{M}_{i,0}, a_i\right)$$

stating that the effect on consumption from a surprise change in the rate of return is the sum of 1) MPC out of a lumpsum transfer at time $t = 0$ ($\mathbf{M}_0$) times the aggregate net asset position A, 2) 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.5a 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, $\mathbb{C}\mathrm{ov}\left(\mathbf{M}_{i,0}, a_i\right) < 0$. However, because creditors have larger intertemporal MPCs (i.e. they consumption smooth more), the negative consumption response is amplified in subsequent periods as the initial redistributional effect subsides and savers reduce consumption persistently. However, for a realistic covariance between MPCs

[16] I only need to account for the effects of a rate change at time 0 on consumption, since monetary policy keeps the ex-ante real rate constant, and so $\mathrm{d}r_t = 0$ for $t > 0$.

and net nominal positions (Auclert 2019) the overall impact of these Fisher effects are 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 imply 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: 1) A standard approach where investment is paid for by firms subject to an adjustment cost, 2) A version with financial frictions where a fraction s of operating surplus is used to finance investment (Lian and Ma 2021; Drechsel 2023). In both cases total output Y is a Cobb-Douglas with capital and the CES aggregate containing L, X (see appendix C.1 for details). Figure A.3 shows the results. With unconstrained investment there is mild contraction in output in the RANK model, while the response of the HANK model are largely unchanged. In both models investment decline since a higher firm markup reduces the marginal product of capital. With financial constraints the overall surplus of firms instead determines the response investment. In this case the RANK model predicts an increase in output following the markup shock as the increase in profits flow 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. Overall, the aggregate demand amplification in the HANK model is largely unchanged when investment is included.

3.3 Policy

Transfers. It is obvious that a targeted transfer to poorer households paid for by hiking taxes on wealthier households can fully neutralize the shock. However, in practice government which 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 transfer dT_t that is exactly enough to stabilize the income loss from real wages in the baseline shock, and that this transfer is financed by a tax on rich households. The size of the tax is determined by the degree of debt issuing:

$$\mathrm{d}B_t = \rho_B \left(\mathrm{d}B_{t-1} - \mathrm{d}T_t\right)$$

where $\rho_B = 0$ imply that the policy is perfectly balanced (i.e. the transfer equals the tax), and $\rho_B > 0$ imply that the policy is partially deficit financed. Figure A.2 shows the results for varying 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). As the policy becomes increasingly deficit financed the response of private consumption becomes positive, reflecting that overall household income is now net positive: Real labor income is fully stabilized (funded by the government), while profit income is above steady state due to the markup shock itself. This causes excess inflation, which increases in the degree of deficit financing ρ_B.

Monetary policy. The baseline models features "passive" monetary policy ($dr_t = 0$), which imply 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 if the central bank has a dual mandate, though historically the Fed has tightened in response to oil shocks, as has the ECB as they focus only on inflation stabilization. I investigate the implications of a tight monetary policy response by adding a Taylor rule $\mathrm{d}i_t = \phi^\pi \mathrm{d}\pi_{t+1}$ where $\phi^\pi = 1$ recovers the baseline where the ex-ante real rate is constant. Figure A.1 shows the 1st 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. Notably the *driver* of this decline changes with the monetary policy response: For a low ϕ^π the decline is caused by higher inflation, and lower real wages. As ϕ^π become 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 model with a more realistic modelling of the 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 cost-push shocks in models with distributional effects. A natural structural remedy is to index nominal wages to CPI inflation (Fischer 1976). In Appendix C.2 I solve the model with wage indexation and demonstrate that a higher degree of indexation dampens the output effects of the markup shock. Full indexation perfectly neutralizes the shock's aggregate demand effects, analogously to the flexible-wage case in Proposition 3.

4 General cost-push shocks

While the cost-push shock considered in Section 3 is a very direct inflationary shock, it is also special in the sense that it per construction directly distorts the distribution of factor income. In this section I consider instead a more general cost-push shock corresponding to an increase in the price of materials used in production ($P^*_{X,t}$ in equation (12)). This shock resembles more closely the large inflationary shock which hit Europe in 2021-2023 through higher import prices.

Preliminaries. The baseline analysis assumes that the domestic central bank keeps the domestic real rate constant, implying that the real exchange rate is also constant given the real

UIP condition (17). It turns out that if we consider a foreign inflation shock that increases foreign CPI and the price of foreign inputs equally, $\mathrm{d}P^*_{F,t} = \mathrm{d}P^*_{X,t}$ then the assumption of a constant real rate implies that the nominal exchange rate takes the entire adjustment of the shock and the domestic economy is entirely unaffected.[17]

This result can easily be broken by considering an asymmetric shock which features a larger increase in the price of foreign inputs compared to the foreign CPI, $\mathrm{d}P^*_{X,t} > \mathrm{d}P^*_{F,t}$. In this section I consider the special case where $\mathrm{d}P^*_{F,t} = 0, \mathrm{d}P^*_{X,t} > 0$ but given linearization the shock can be interpreted as an increase import prices over and above the increase in foreign CPI.

Analysis Consider now a shock which raises the price of materials, $P^*_{X,t} > 0$. The difference between this shock and the markup shock can be seen in the following proposition, which generalizes eq. (22):

Proposition 4 (Equilibrium relationship between output and profits with cost-push shocks). *Given a sequence of material price shocks $\left\{dP^*_{X,t}\right\}_{s=0}^{\infty}$ the equilibrium relation between output and profits is given by:*

$$\frac{1}{1-\alpha}\mathrm{d}\mathbf{Y} = \underbrace{\left[1-(1-\omega)(1-\alpha_L)\right]\mathbf{M}^Z\mathrm{d}\mathbf{Y}}_{\textit{Multiplier}} - \underbrace{\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathrm{d}\mathbf{\Pi}}_{\textit{Distributional channel}} \underbrace{- (1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathbf{M}^Z\mathrm{d}\mathbf{P}^*_{\mathbf{X}}}_{\textit{Direct effect}} \tag{29}$$

Proof: appendix D.2.

Note that when the endowment is entirely domestic ($\omega = 1$), the direct effect in (29) vanishes and the multiplier term reduces to $\mathbf{M}^Z\mathrm{d}\mathbf{Y}$, recovering the same multiplier appearing in Proposition 1.

Proposition 4 shows that even with an equal incidence of labor income and profits $\mathbf{M}^\Pi = \mathbf{M}^Z$, the cost-push shock has a contractionary effect on domestic output to the extent that MPCs are positive, $\mathbf{M}^\Pi = \mathbf{M}^Z > \mathbf{0}$. In this case the dynamics of the real wage and profits do not matter because both have the same effect on aggregate demand, and one can solve for the GE output response independently of the Phillips curves:

Corollary 2. *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:*

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

and thus contractionary if $\mathbf{M}^\Pi = \mathbf{M}^Z > \mathbf{0}$ and $\omega < 1$.

[17]See Appendix D.1.

Corollary 2 suggests that, unlike markup shocks, cost-push shocks produce contractionary effects in any model with $\mathbf{M}^{\Pi} = \mathbf{M}^{Z} > 0$, including the representative agent case ($\mathbf{M}^{Z} = \mathbf{M}^{\Pi}$). This is because, whenever $\omega < 1$, some resources leave the domestic economy as domestic firms must pay more for foreign inputs, making the contractionary effects unavoidable.

Figure 7 illustrates this in the quantitative model. The left panel shows that for the RANK model - which features permanent income type behaviour - there is a small but persistent effect on output coming from the direct effect. The right panel shows that the HANK model, which features the additional distributional channel from endogenous markups, shows pronounced amplification. The decline in output over the first year is 3 times larger in the HANK model compared to the RANK model.

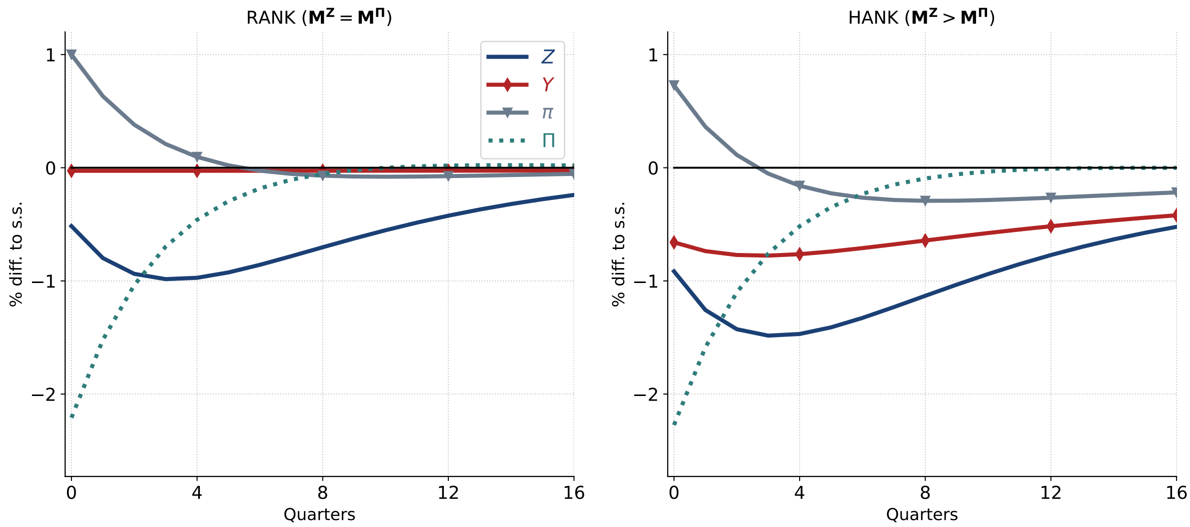


Figure 7: Effect of cost-push shock in RANK and HANK

Note: Impulse responses to an AR(1) shock to the import prices with persistence 0.8 when imports are fully owned by foreigners, $\omega = 0$. The shock is normalized such that inflation increase 1% on impact. The Figure shows real labor income Z (red), real output Y (dark blue), CPI inflation π (grey) and real profits Π (orange).

For completeness, proposition 5 shows the equilibrium response of output to the cost-push shock. The solution reveals that the direct effect is proportional to the MPC out of profits (and not $\mathbf{M}^{Z}$ as prop. 4 might lead one to think), and therefore relatively weaker than the contribution coming from the indirect, factor income distribution effect.

Proposition 5 (Equilibrium output response to cost-push shocks). *Given a sequence of cost-push shocks $\left\{dP^{*}_{X,t}\right\}_{s=0}^{\infty}$ the equilibrium response of output is:*

$$\mathrm{dY} = -\mathscr{M}\left[\mathbf{M}^{Z} - \mathbf{M}^{\Pi}\right](1-\alpha_L)\,\mathbf{\Theta}^{\mu}\mathrm{d}\mathbf{P}^{*}_{\mathbf{X}} - \mathscr{M}\mathbf{M}^{\Pi}(1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}\mathbf{P}^{*}_{\mathbf{X}} \tag{30}$$

where the multiplier is defined by:

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

Proof: appendix D.2.

Real GDP. It is worth noting that a shock to import prices P_X^* decouples the responses of output and GDP, $\mathrm{d}\mathscr{Y}_t = \mathrm{d}Y_t - (1-\omega)(1-\alpha_L)\left[\mathrm{d}Y_t + Y\,\mathrm{d}P^*_{X,t}\right]$, implying that real GDP may decline persistently in both models due to the *mechanical effect* of higher material prices, $\mathrm{d}P_X^*$. I therefore focus on the response of output as a measure of *internal propagation.*[18]

Empirical evidence. Unlike markup shocks, empirical estimates of the effects of foreign cost-push shocks are available in the existing literature, the most prominent type being oil shocks. Most of the literature find that oil shocks are contractionary and produces stagflation (Hamilton 2003; Kilian 2008; Känzig 2021). Of course the empirical effects of oil supply shocks also induce an endogenous response of monetary policy, and therefore the observed contractionary effects can be consistent with both the RANK and HANK models. In a recent contribution Broer et al. (2025) investigate the effects of euro area oil shocks under a counterfactual, neutral monetary policy using the method from Sims and Zha (2006). They find that the negative effects oil shocks remain, consistent with the HANK model.

4.1 Markup shock equivalence.

The cost-push shock and markup shock differ because the former involves a transfer to foreign households through higher import prices. Assuming that stock of materials is entirely owned by domestic households, $\omega = 1$ nullifies this effects, and the two shocks are equivalent:

Proposition 6 (markup shock equivalence). *When the endowment X is entirely owned by domestic households, $\omega = 1$, markup shocks $\mathrm{d}\boldsymbol{\mu}$ and cost-push shocks $\mathrm{d}\mathbf{P}_X^*$ are equivalent up to a constant scaling factor given by $1 - \alpha_L$. Proof: The result follows immediately from setting $\omega = 1$ in (29) and (30).*

Figure 8 illustrates this in the quantitative model.

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

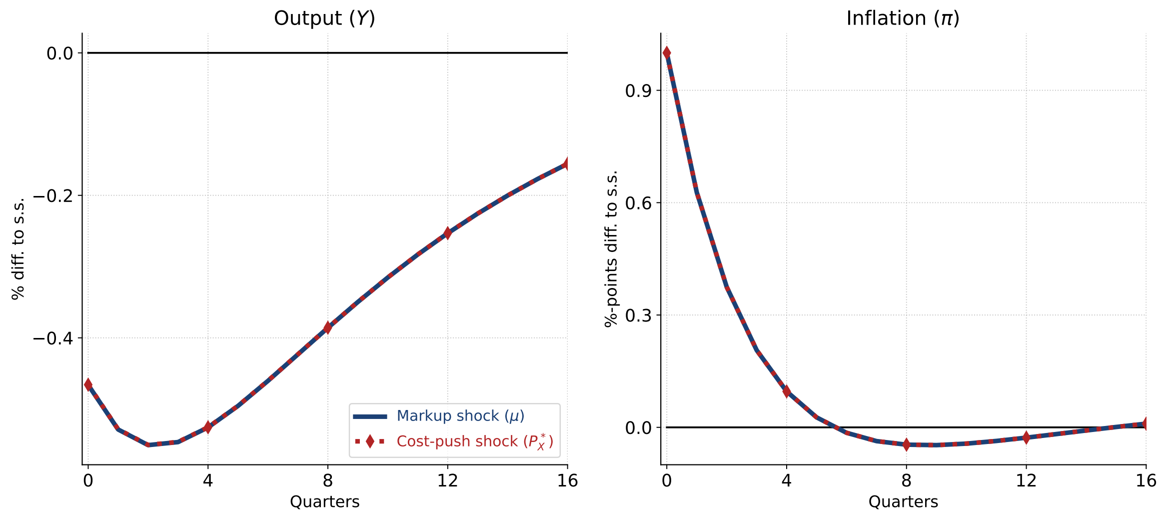


Figure 8: Equivalence between markup shocks and cost-push shocks

Note: The figure shows the response of output and inflation to a markup shock and to a cost-push shock for $\omega = 1$. The shocks are scaled to increase inflation in the first period by 1%.

4.2 Substitution in production

The analytical results assume zero substitution between production inputs. Figure 9 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 (proposition 6) and both generate a large decline in output. As the elasticity becomes larger firms respond to the increase in import prices by substituting away from materials towards 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 since this directly changes the relative price of materials vs. labor. Thus a necessary condition for the amplification of the cost-push shock is the presence of 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 substitutability is required for consumption and output to *increase* in response to the cost-push shock.

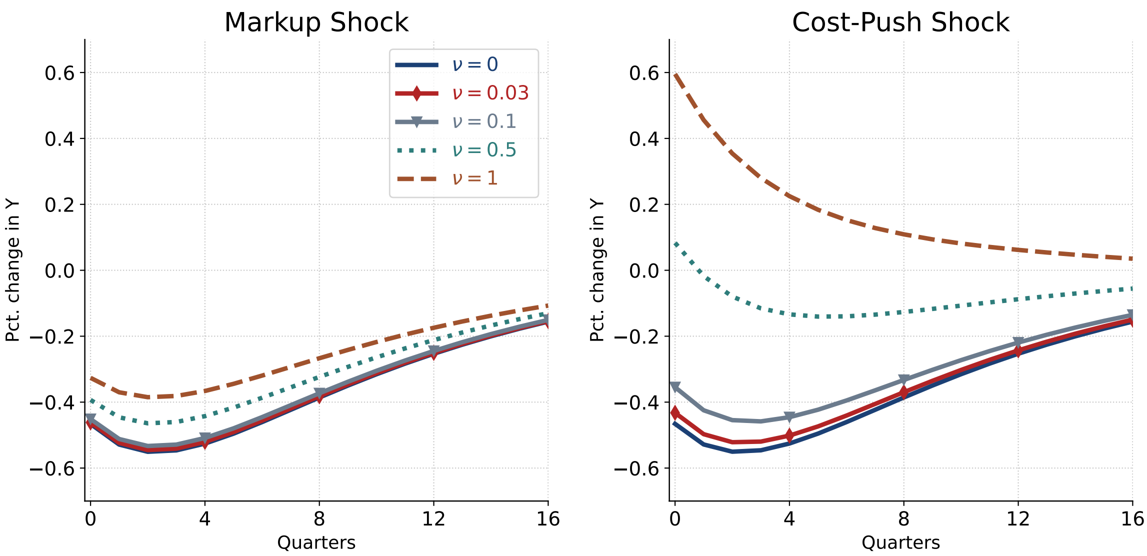


Figure 9: Importance of labor-materials substitution

Note: Impulse responses to a markup shock and a cost-push shock in HANK for different elasticities of substitution between labor and materials ν, and with $\omega = 1$

5 Tariffs

Lastly, I study the effects of an increase in domestic tariffs τ on goods imported by households and firms. Motivated by the tariffs imposed by the United States on several trading partners in 2025, a growing body of literature examines the short-run macroeconomic effects of such policies, see for example, Auclert et al. (2025), Monacelli (2025), Bianchi and Coulibaly (2025), Guerrieri et al. (2025), Schmitt-Grohé and Martín Uribe (2025) and Barnichon and Singh (2025). As formally shown below, domestic tariff shocks are closely related to the cost-push shocks analyzed previously. For households and firms, tariffs act as an import price shock by increasing the effective price of imported goods, which raises firms' marginal costs when imports are used as intermediate inputs and reduces real income.

To illustrate these effects in the present model, Proposition 7 shows the equilibrium response of output under the assumption that the revenue from the tariff is rebated to households under some general rule with (intertemporal) MPCs $\mathbf{M}^{\tau}$.[19][20] The proposition shows that the effect on output is determined by 3 distinct channels. Firstly, higher tariffs increase costs for firms as they pay more for imported materials, which induces a real wage channel which is proportional to the MPC gap, and the price pass-through matrix, as with the domestic markup shock and the cost-push shock studied earlier. Secondly, there is a *demand stabilization* effect as the revenue from the increase in tariffs is rebated to households which increases domestic demand by the MPC matrix $\mathbf{M}^{\tau}$. Lastly, a higher tariff also tweak the terms-of-trade

[19] For instance, if transfers are rebated similarly to labor income (proportionally to idiosyncratic income) we have $\mathbf{M}^{\tau} = \mathbf{M}^{Z}$, and if rebated similarly to profits we have $\mathbf{M}^{\tau} = \mathbf{M}^{\Pi}$.

[20] In this section I assume $\omega = 0$, such that material inputs in production are fully imported from abroad.

by reducing the relative price of domestic vs. foreign goods, thereby inducing an expenditure switching effect which increases demand as agents substitute toward domestically produced goods. This effect is proportional to the trade elasticity η.

Proposition 7 (Equilibrium output response to tariffs). *Given a sequence of tariff shocks* $\{d\tau_t\}_{s=0}^{\infty}$ *the equilibrium response of output is:*

$$\begin{aligned}\mathrm{dY} = \; & -\overbrace{\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\Theta^\mu\left((\boldsymbol{\kappa}^P)^{-1}\frac{\alpha}{1-\alpha} + (1-\alpha_L)\right)\mathrm{d}\boldsymbol{\tau}}^{\textit{Real wage effect}} \\ & + \overbrace{\mathscr{M}\frac{1-\alpha_L(1-\alpha)}{\alpha_L}\left[\mathbf{M}^\tau - \frac{1}{1-\alpha}\mathbf{M}^\Pi\right]\mathrm{d}\boldsymbol{\tau}}^{\textit{Tax/transfer effect}} \\ & + \overbrace{\mathscr{M}\frac{\alpha}{1-\alpha}\eta\left(1+\frac{\alpha^*}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau}}^{\textit{Terms-of-trade effects}} \end{aligned} \tag{31}$$

Proof: appendix E.

The main difference between the tariff shock and the two prior shocks lie in the expenditure switching effect. If there is no expenditure switching, $\eta = 0$, then the shock has no effect on domestic output if agents behave identically $\mathbf{M}^\Pi = \mathbf{M}^Z$ and transfers are distributed to agents such that $\mathbf{M}^\tau = \frac{1}{1-\alpha}\mathbf{M}^\Pi$. The intuition for the two conditions is as follows. $\mathbf{M}^\Pi = \mathbf{M}^Z$ eliminates the real wage channel: the decline in demand from lower real wages is exactly offset by the increased income of profit recipients. $\mathbf{M}^\tau = \frac{1}{1-\alpha}\mathbf{M}^\Pi$ then ensures that the tariff rebate neutralises the remaining tax/transfer effect on demand. Note that this allocation requires a larger demand effect since $\frac{1}{1-\alpha} > 1$. The reason is that the tariff directly alters the relative price P_H/P, thereby affecting the real income of domestic households through imported final goods, and not only through the price setting of domestic firms. The transfer must therefore compensate for this additional distortion to fully neutralise the impact on aggregate demand.

In the absence of this knife-edge case the tariff shock can have either an expansionary or contractionary effect on the domestic economy depending on how strong the expenditure switching effect is vs. the drag on household's demand. This is similar to the finding of Auclert et al. (2025) though they focus on a representative agent and so the transmission to domestic households' demand occurs primarily through intertemporal substitution instead of income effects, and the rebate policy of the government therefore does not matter. Proposition 7 also clearly illustrates how my results relate to Guerrieri et al. (2025), who show that in a simple New-Keynesian model, a tariff shock resembles a cost-push shock and the optimal monetary policy response is therefore the same. Their model explicitly shuts of terms-of-trade effects and features Ricardian equivalence, hence removing the two additional terms in (31), leaving the real wage effect, which is also the only effect present in the markup shock from section 3.

Thus Proposition 7 generalises their result to a HANK environment.

Tariff revenues and expenditure switching. Figure 10 shows how the effects of the tariff shock on output and consumption depend jointly on the fiscal treatment of tariff revenues and the strength of expenditure switching. As implied by Proposition 7, tariffs generate two opposing forces on household demand: higher prices reduce real wages, while tariff revenues provide an offset through transfers. Fiscal adjustment is governed by

$$dB_t = \rho_B \left(dB_{t-1} - dR_t^{\tau} \right),$$

where ρ_B determines the share of revenues used to reduce public debt.

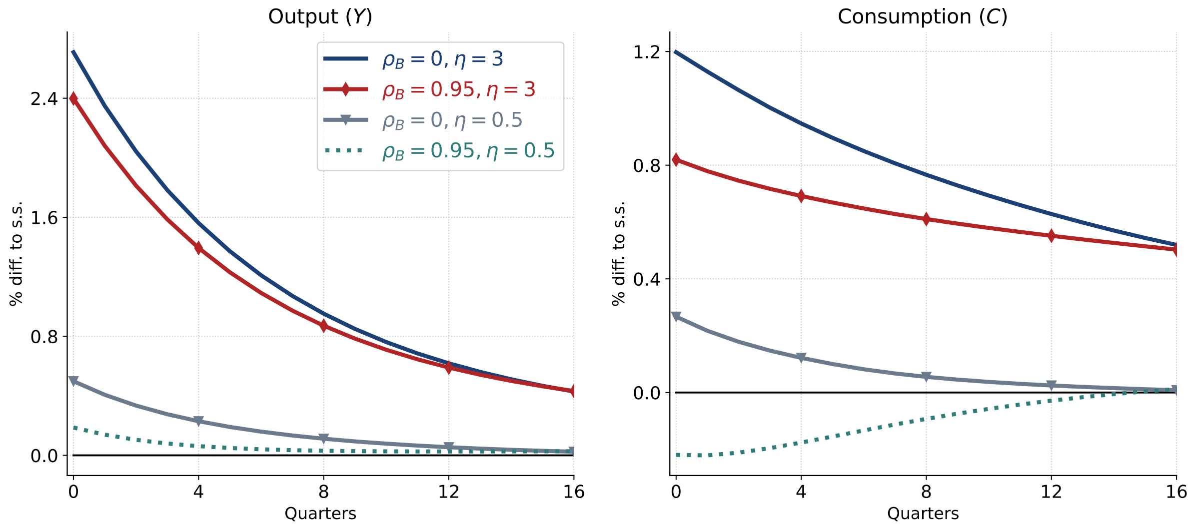


Figure 10: Tariff shock with varying financing and trade elasticity

Output increases across all specifications, reflecting reallocation toward domestic goods. The response of consumption, however, depends on the interaction between ρ_B and the trade elasticity η. When $\rho_B = 0$, revenues are fully rebated and consumption rises across calibrations, as transfers offset the decline in real wages. When $\rho_B = 0.95$, revenues are largely used for debt reduction, and consumption falls when η is low, as the negative income effect dominates. For higher η, stronger expenditure switching raises domestic activity sufficiently to sustain an increase in consumption even in the absence of transfers. Empirically, short-run trade elasticities are estimated to be relatively low (e.g., Boehm et al. 2023), suggesting that the contractionary consumption response under limited revenue recycling is the more relevant benchmark at business-cycle frequencies.

6 Conclusion

This paper has analytically characterized the transmission of inflationary shocks in a heterogeneous-agent New Keynesian model, emphasizing changes in factor income as a channel through which cost-push 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. Across all three shocks studied — domestic markup shocks, foreign cost-push shocks, and tariffs — the HANK model implies large demand effects in general equilibrium. Two structural features moderate the magnitude of the channel: more flexible prices amplify the real wage decline, while more flexible wages attenuate it, as nominal wages adjust to restore purchasing power of workers.

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 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 $L = 1$, 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 $\frac{1}{\alpha_L} - (1 - \alpha)$.

A.1 Derivation of eq. (21)

Starting from goods market clearing condition (19) 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 (18):

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

Using the law of one price $\mathrm{d}P^*_{H,t} + \mathrm{d}\mathcal{E}_t = \mathrm{d}P_{H,t}, \mathrm{d}P_{F,t} = d\mathcal{E}_t + \mathrm{d}P^*_{F,t}$ 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:

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

where the second line uses the definition of the real exchange rate $Q_t = \frac{\mathcal{E}_t P^*_{F,t}}{P_t}$. Since the real UIP condition (17) implies $\mathrm{d}Q_t = 0$ under a constant real rate policy we have:

$$\mathrm{d}Y_t = \mathrm{d}C_{H,t} + \frac{\alpha}{(1-\alpha)}\eta\alpha^*\mathrm{d}\tau_t$$

Linearizing the demand for imported goods (6) gives:

$$\mathrm{d}C_{H,t} = (1-\alpha)\,\mathrm{d}C_t - \eta\,(1-\alpha)\left(\mathrm{d}P_{H,t} - \mathrm{d}P_t\right)$$

Next, using the law of one price and the definition of the real exchange rate $\mathrm{d}P_{H,t} - \mathrm{d}P_t$ can be written as:

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

With a constant real exchange rate we thus have:

$$\mathrm{d}Y_t = (1-\alpha)\,\mathrm{d}C_t + \alpha\eta\left(1 + \frac{\alpha^*}{1-\alpha}\right)\mathrm{d}\tau_t$$

Further assuming constant tariffs gives equation (21).

A.2 Proof of Proposition 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: $\mathbf{C} = \mathbf{C}\left(\{\mathbf{Z}, \mathbf{\Pi}, \mathbf{T}\}\right)$. Linearizing and subbing this into (21) gives:

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

To derive Proposition 1 we need to derive an expression for labor income $\mathrm{d}\mathbf{Z}$. To do this we start from the definition of profits (14). Using $\nu \to 0$ we have that:

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

Linearizing gives:

$$
\begin{aligned}
\mathrm{d}\Pi_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t + Y\mathrm{d}\left(\frac{P_{H,t}}{P_t}\right) - Y(1-\omega)(1-\alpha_L)\,\mathrm{d}P^*_{X,t} - Y(1-\alpha_L)\,d\tau_t - \mathrm{d}Z_t \\
\Leftrightarrow \mathrm{d}\Pi_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t - Y\frac{\alpha}{(1-\alpha)}\mathrm{d}\tau_t - Y(1-\omega)(1-\alpha_L)\,\mathrm{d}P^*_{X,t} - Y(1-\alpha_L)\,\mathrm{d}\tau_t - \mathrm{d}Z_t \\
\Leftrightarrow \mathrm{d}Z_t &= \left[1-(1-\omega)(1-\alpha_L)\right]\mathrm{d}Y_t - \frac{1}{\alpha_L}\frac{\alpha}{(1-\alpha)}\mathrm{d}\tau_t - (1-\omega)\frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}P^*_{X,t} - \frac{(1-\alpha_L)}{\alpha_L}\mathrm{d}\tau_t - \mathrm{d}\Pi_t
\end{aligned}
\tag{A.2}
$$

Assume that we are only interested in a markup shock so $\omega = 1, d\tau_t = 0$. Writing (A.2) in sequence-space and substituting into (A.1) gives:

$$
\begin{aligned}
\mathbf{dY} &= (1-\alpha)\left[\mathbf{M}^Z\left[\mathbf{dY}-\mathbf{d\Pi}\right] + \mathbf{M}^\Pi\mathbf{d\Pi} + \mathbf{MdT}\right] \\
\Leftrightarrow \frac{1}{1-\alpha}\mathbf{dY} &= \mathbf{M}^Z\mathbf{dY} - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathbf{d\Pi} + (1-\alpha)\,\mathbf{MdT}
\end{aligned}
$$

Using the assumption $\mathbf{dB} = 0$ implies $\mathbf{dT} = 0$, which is eq. (22) in the main text.

A.3 Derivation of eq. (23)

Start by writing out eq. (22) at time t:

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

Define $MPC_{t,s}$ as the time t MPC out of a lump-sum transfer at time s and $MPC_{i,t,s}$ the corresponding MPC for some households i in the population. Then, using the budget constraint (2) we have:

$$
\frac{1}{1-\alpha}\mathrm{d}Y_t = \sum_{s=0}^{\infty} M^Z_{t,s}\mathrm{d}Y_s - \sum_{s=0}^{\infty}\left[\int MPC_{i,t,s}e_i\mathrm{d}\mathscr{D} - \int MPC_{i,t,s}g\left(e_i\right)\mathrm{d}\mathscr{D}\right]\mathrm{d}\Pi_s
$$

Let us first rewrite the term $\int MPC_{i,t,s}e_i d\mathscr{D}$ using that:

$$
\begin{aligned}
\mathrm{Cov}\left(MPC_{i,t,s}, e_i\right) &= \int \left(MPC_{i,t,s} - MPC_{t,s}\right)\left(e_i - \bar{e}\right)\mathrm{d}\mathscr{D} \\
&= \int MPC_{i,t,s}e_i\mathrm{d}\mathscr{D} - \int e_i MPC_{t,s}\mathrm{d}\mathscr{D} - \int \bar{e}MPC_{i,t,s}d\mathscr{D} + \int \bar{e}MPC_{t,s}\mathrm{d}\mathscr{D} \\
&= \int MPC_{i,t,s}e_i\mathrm{d}\mathscr{D} - \bar{e}MPC_{t,s}
\end{aligned}
$$

Implying that:

$$
\int MPC_{i,t,s}e_i\mathrm{d}\mathscr{D} = \bar{e}MPC_{t,s} + \mathrm{Cov}\left(MPC_{i,t,s}, e_i\right)
$$

The derivation is the same for $\int MPC_{i,t,s} g\left(e_i\right) \mathrm{d}\mathscr{D}$ term, which gives:

$$\int MPC_{i,t,s} g\left(e_i\right) \mathrm{d}\mathscr{D} = \overline{g\left(e_i\right)} MPC_{t,s} + \mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, g\left(e_i\right)\right)$$

Inserting we have:

$$\begin{aligned}
\sum_{s=0}^{\infty}\left[M_{t,s}^{Z} - M_{t,s}^{\Pi}\right] \mathrm{d}\Pi_s &= \sum_{s=0}^{\infty}\left[\bar{e} MPC_{t,s} + \mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, e_i\right)\right] \mathrm{d}\Pi_s \\
&\quad - \sum_{s=0}^{\infty}\left[\overline{g\left(e_i\right)} MPC_{t,s} + \mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, g\left(e_i\right)\right)\right] \mathrm{d}\Pi_s \\
&= \sum_{s=0}^{\infty} MPC_{t,s}\left(\bar{e} - \overline{g\left(e_i\right)}\right) \mathrm{d}\Pi_s \\
&\quad + \sum_{s=0}^{\infty}\left[\mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, e_i\right) - \mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, g\left(e_i\right)\right)\right] \mathrm{d}\Pi_s
\end{aligned}$$

Since the Markov chain of e_i has mean 1 we have $\bar{e} = 1$. Similarly, since $g\left(e_i\right)$ distributes all aggregate profits we have $\overline{g\left(e_i\right)} = 1$. We are then left with:

$$\sum_{s=0}^{\infty}\left[M_{t,s}^{Z} - M_{t,s}^{\Pi}\right] \mathrm{d}\Pi_s = \sum_{s=0}^{\infty}\left[\mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, e_i\right) - \mathbb{C}\mathrm{ov}\left(MPC_{i,t,s}, g\left(e_i\right)\right)\right] \mathrm{d}\Pi_s$$

Writing this in sequence space and subbing into eq. (22) yields eq. (23) in the main text:

$$\frac{1}{1-\alpha} \mathrm{d}\mathrm{Y} = \alpha_L \mathbf{M}^{Z} \mathrm{d}\mathrm{Y} - \left[\mathbb{C}\mathrm{ov}\left(\mathbf{M}^{i}, e_i\right) - \mathbb{C}\mathrm{ov}\left(\mathbf{M}^{i}, g\left(e_i\right)\right)\right] \mathrm{d}\mathbf{\Pi}$$

A.4 Phillips curve pass-through matrices

This section derives the expression for the pass-through matrices $\boldsymbol{\kappa}^P, \boldsymbol{\kappa}^W$ appearing in eq. (13) and (16). The baseline analysis assumes a price Phillips-curve of the form:

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

or, in linearized form around the zero inflation steady state:

$$\mathrm{d}\pi_{H,t} = \kappa^P \mathrm{d}mc_t + \beta \mathrm{d}\pi_{H,t+1} + \kappa^P \mathrm{d}\mu_t \tag{A.3}$$

Imposing $\mathrm{d}\pi_{\infty} = 0$ we have that $\mathrm{d}\pi_t = \kappa^P \sum_{s=0}^{\infty} \beta^s dmc_s$. This equation can be written in sequence space as:

$$\mathrm{d}\boldsymbol{\pi} = \kappa^P \mathbf{\Psi}\left(\mathrm{d}\mathrm{mc} + \mathrm{d}\boldsymbol{\mu}\right) \tag{A.4}$$

where:

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

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

$$\mathrm{d}\mathbf{P} = \boldsymbol{\kappa}^P \mathrm{d}\mathbf{mc}$$

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

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

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

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

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

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

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

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

To write in terms of wages in levels I use the defined $\mathbf{U}$ matrix above, noting that we have to pre-multiply with steady state wages (which was done implicitly for the NKPC as $P_H = 1$ in steady state):

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

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

A.5 Proof of Proposition 2

The proof for Proposition 2 involves solving for $\mathrm{d}\mathbf{\Pi}$ as a function of the price shock and output. Starting from the equation:

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

found in A.2 and using the assumption Leontief production:

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

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 $\frac{1}{\mu}$):

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

To proceed we go to the sequence-space notation and subtract the NKPC from the NKWPC using that $\mathrm{d}\mathbf{P}_H + \frac{\alpha}{(1-\alpha)}\mathrm{d}\boldsymbol{\tau} = \mathrm{d}\mathbf{P}$

$$\begin{aligned}
\mathrm{dw} &= \mathrm{d}\mathbf{W} - W\,\mathrm{d}\mathbf{P} \\
&= \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{dL} - \mathrm{dw}\right) - W\boldsymbol{\kappa}^P \mathrm{d}\mathbf{mc} - W\boldsymbol{\kappa}^P \mathrm{d}\boldsymbol{\mu} - \frac{W\alpha}{(1-\alpha)}\mathrm{d}\boldsymbol{\tau} \\
\Leftrightarrow \left(\mathbf{I} + \boldsymbol{\kappa}^W\right)\mathrm{dw} &= \frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W \mathrm{dY} - W\boldsymbol{\kappa}^P \mathrm{d}\mathbf{mc} - W\boldsymbol{\kappa}^P \mathrm{d}\boldsymbol{\mu} - \frac{W\alpha}{(1-\alpha)}\mathrm{d}\boldsymbol{\tau} \\
\Leftrightarrow \left(\mathbf{I} + \boldsymbol{\kappa}^W\right)\mathrm{dw} &= \frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W \mathrm{dY} - W\boldsymbol{\kappa}^P \left[\alpha_L \mathrm{dw} + (1-\alpha_L)\,\mathrm{d}\mathbf{P}^*_{\mathbf{X}} + (1-\alpha_L)\,\mathrm{d}\boldsymbol{\tau}\right] - W\boldsymbol{\kappa}^P \mathrm{d}\boldsymbol{\mu} - \frac{W\alpha}{(1-\alpha)}\mathrm{d}\boldsymbol{\tau} \\
\Leftrightarrow \left(\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W\boldsymbol{\kappa}^P\right)\mathrm{dw} &= \frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W \mathrm{dY} - W\boldsymbol{\kappa}^P (1-\alpha_L)\,\mathrm{d}\mathbf{P}^*_{\mathbf{X}} - W\boldsymbol{\kappa}^P \mathrm{d}\boldsymbol{\mu} \\
&\quad - \left[\frac{W\alpha}{(1-\alpha)} + W\boldsymbol{\kappa}^P (1-\alpha_L)\right]\mathrm{d}\boldsymbol{\tau}
\end{aligned}$$

To ease notation use the definitions explain the main text:

$$\begin{aligned}
\boldsymbol{\Theta}^\mu &\equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W\boldsymbol{\kappa}^P\right]^{-1} W\boldsymbol{\kappa}^P. \\
\boldsymbol{\Theta}^L &\equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W\boldsymbol{\kappa}^P\right]^{-1} \frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W,
\end{aligned}$$

to get:

$$\mathrm{dw} = \boldsymbol{\Theta}^L \mathrm{dY} - \boldsymbol{\Theta}^\mu (1-\alpha_L)\,\mathrm{d}\mathbf{P}^*_{\mathbf{X}} - \boldsymbol{\Theta}^\mu \mathrm{d}\boldsymbol{\mu} - \boldsymbol{\Theta}^\mu \left[\left(\boldsymbol{\kappa}^P\right)^{-1} \frac{\alpha}{(1-\alpha)} + (1-\alpha_L)\right]\mathrm{d}\boldsymbol{\tau}$$

Sub into profits:

$$\begin{aligned}
\mathrm{d}\boldsymbol{\Pi} &= \left[\frac{\mu - 1}{\mu} + \omega(1-\alpha_L) - \boldsymbol{\Theta}^L\right]\mathrm{dY} \\
&\quad - \left\{\left(\frac{\mathbf{I}}{\alpha_L} - \boldsymbol{\Theta}^\mu \left(\boldsymbol{\kappa}^P\right)^{-1}\right)\frac{\alpha}{(1-\alpha)} + \left(\frac{\mathbf{I}}{\alpha_L} - \boldsymbol{\Theta}^\mu\right)(1-\alpha_L)\right\}\mathrm{d}\boldsymbol{\tau} \\
&\quad - (1-\alpha_L)\left\{\frac{1-\omega}{\alpha_L} - \boldsymbol{\Theta}^\mu\right\}\mathrm{d}\mathbf{P}^*_{\mathbf{X}} + \boldsymbol{\Theta}^\mu \mathrm{d}\boldsymbol{\mu}
\end{aligned} \tag{A.5}$$

Focusing on the markup shock ($\mathrm{d}\boldsymbol{\tau} = 0, \mathrm{d}\mathbf{P}^*_{\mathbf{X}} = 0$), and substituting into eq. (22):

$$\frac{1}{1-\alpha}\mathrm{dY} = \mathbf{M}^Z \mathrm{dY} - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\left\{\left[\frac{\mu-1}{\mu} + \omega(1-\alpha_L) - \boldsymbol{\Theta}^L\right]\mathrm{dY} + \boldsymbol{\Theta}^\mu \mathrm{d}\boldsymbol{\mu}\right\}$$

Defining:

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

We get Proposition 2:

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

A.6 Proof of Proposition 3

I first derive the derivative of dY w.r.t κ^P. 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 $\mathbf{\Theta}^\mu = \mathbf{R}^{-1}\mathbf{K}$ and $\mathbf{\Theta}^L = \mathbf{R}^{-1}\frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W$, and define:

$$\mathbf{B} = \frac{\mathbf{I}}{1-\alpha} - \mathbf{M}^Z\left(1-(1-\omega)(1-\alpha_L)\right) - \left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\left[\mathbf{\Theta}^L - \frac{\mu-1}{\mu}\mathbf{I} - \omega(1-\alpha_L)\mathbf{I}\right]$$

so that $\mathscr{M} = \mathbf{B}^{-1}$. The derivative of dY w.r.t. κ^P is:

$$\frac{\partial \mathrm{dY}}{\partial \kappa^P} = -\left[\frac{\partial \mathscr{M}}{\partial \kappa^P}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathbf{\Theta}^\mu + \mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^P}\right]\mathrm{d}\boldsymbol{\mu}$$

To evaluate the sign it suffices to derive the signs of $\frac{\partial \mathscr{M}}{\partial \kappa^P}$ and $\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^P}$. Since $\boldsymbol{\kappa}^P = \kappa^P\mathbf{U\Psi}$, we have $\mathbf{K} = \kappa^P W\mathbf{U\Psi}$ and $\frac{\partial \mathbf{R}}{\partial \kappa^P} = \alpha_L W\mathbf{U\Psi}$. Using the matrix inverse derivative identity $\frac{\partial \mathrm{A}^{-1}}{\partial x} = -\mathbf{A}^{-1}\frac{\partial \mathrm{A}}{\partial x}\mathbf{A}^{-1}$:

$$\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^P} = -\mathbf{R}^{-1}\frac{\partial \mathbf{R}}{\partial \kappa^P}\mathbf{R}^{-1}\mathbf{K} + \mathbf{R}^{-1}\frac{\partial \mathbf{K}}{\partial \kappa^P} = \mathbf{R}^{-1}\left[\mathbf{I} - \alpha_L W\mathbf{U\Psi}\mathbf{R}^{-1}\right]W\mathbf{U\Psi} \geq 0$$

where the inequality follows since $\mathbf{R}^{-1}\mathbf{K} = \mathbf{\Theta}^\mu \leq \mathbf{I}$ implies $\alpha_L W\mathbf{U\Psi R}^{-1} \leq \mathbf{I}$. Since $\boldsymbol{\kappa}^W$ does not depend on κ^P:

$$\frac{\partial \mathbf{\Theta}^L}{\partial \kappa^P} = -\mathbf{R}^{-1}\frac{\partial \mathbf{R}}{\partial \kappa^P}\mathbf{R}^{-1}\frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W = -\alpha_L W\mathbf{R}^{-1}\mathbf{U\Psi R}^{-1}\frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W \leq 0$$

The derivative of $\mathbf{B}$ with respect to κ^P is therefore:

$$\frac{\partial \mathbf{B}}{\partial \kappa^P} = -\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^L}{\partial \kappa^P} = \alpha_L W\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathbf{R}^{-1}\mathbf{U\Psi R}^{-1}\frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W \geq 0$$

and therefore:

$$\frac{\partial \mathscr{M}}{\partial \kappa^P} = -\mathbf{B}^{-1}\frac{\partial \mathbf{B}}{\partial \kappa^P}\mathbf{B}^{-1} = -\alpha_L W\mathbf{B}^{-1}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathbf{R}^{-1}\mathbf{U\Psi R}^{-1}\frac{W\alpha_L}{\phi}\boldsymbol{\kappa}^W\mathbf{B}^{-1} \leq 0$$

Since both $\frac{\partial \mathscr{M}}{\partial \kappa^P} \leq 0$ and $\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^P} \geq 0$, both terms in $\frac{\partial \mathrm{dY}}{\partial \kappa^P}$ are non-positive, proving that:

$$\frac{\partial \mathrm{dY}}{\partial \kappa^P} \leq 0$$

whenever $\mathbf{M}^Z \geq \mathbf{M}^\Pi$.

For the derivative w.r.t. κ^W, $\frac{\partial \mathrm{dY}}{\partial \kappa^W}$, we have:

$$\frac{\partial \mathrm{dY}}{\partial \kappa^W} = -\left[\frac{\partial \mathscr{M}}{\partial \kappa^W}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\mathbf{\Theta}^\mu + \mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^W}\right]\mathrm{d}\boldsymbol{\mu}$$

Since $\boldsymbol{\kappa}^W = \kappa^W \mathbf{U}\mathbf{\Psi}$, we have $\frac{\partial \mathbf{R}}{\partial \kappa^W} = \mathbf{U}\mathbf{\Psi}$, and $\mathbf{K} = W\boldsymbol{\kappa}^P$ does not depend on κ^W, so:

$$\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^W} = -\mathbf{R}^{-1}\frac{\partial \mathbf{R}}{\partial \kappa^W}\mathbf{R}^{-1}\mathbf{K} = -\mathbf{R}^{-1}\mathbf{U}\mathbf{\Psi}\mathbf{R}^{-1}W\boldsymbol{\kappa}^P \leq 0$$

For $\mathbf{\Theta}^L = \mathbf{R}^{-1}\frac{W\alpha_L\kappa^W}{\phi}\mathbf{U}\mathbf{\Psi}$, both $\mathbf{R}$ and $\boldsymbol{\kappa}^W$ depend on κ^W, giving:

$$\frac{\partial \mathbf{\Theta}^L}{\partial \kappa^W} = -\mathbf{R}^{-1}\mathbf{U}\mathbf{\Psi}\mathbf{R}^{-1}\frac{W\alpha_L\kappa^W}{\phi}\mathbf{U}\mathbf{\Psi} + \mathbf{R}^{-1}\frac{W\alpha_L}{\phi}\mathbf{U}\mathbf{\Psi} = \mathbf{R}^{-1}\frac{W\alpha_L}{\phi}\left[\mathbf{I} - \kappa^W\mathbf{U}\mathbf{\Psi}\mathbf{R}^{-1}\right]\mathbf{U}\mathbf{\Psi} \geq 0$$

where the inequality follows by an analogous argument to before. Therefore:

$$\frac{\partial \mathbf{B}}{\partial \kappa^W} = -\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^L}{\partial \kappa^W} \leq 0$$

and:

$$\frac{\partial \mathscr{M}}{\partial \kappa^W} = -\mathbf{B}^{-1}\frac{\partial \mathbf{B}}{\partial \kappa^W}\mathbf{B}^{-1} = \mathbf{B}^{-1}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^L}{\partial \kappa^W}\mathbf{B}^{-1} \geq 0$$

The two terms in $\frac{\partial \mathrm{dY}}{\partial \kappa^W}$ therefore have opposite signs. Since $\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^W} \leq 0$ and $\mathscr{M} \geq 0$, the second term $\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right]\frac{\partial \mathbf{\Theta}^\mu}{\partial \kappa^W} \leq 0$ dominates, proving that:

$$\frac{\partial \mathrm{dY}}{\partial \kappa^W} \geq 0$$

whenever $\mathbf{M}^Z \geq \mathbf{M}^\Pi$.

B Policy response to markup shock

B.1 Monetary policy

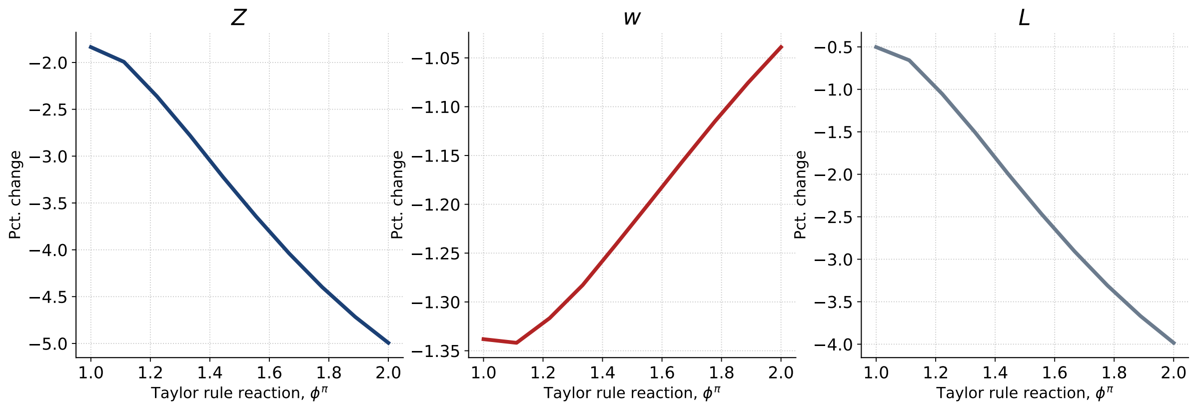


Figure A.1: Response of real labor income, real wages and labor to markup shock with varying inflation coefficient in Taylor rule

Note: First-year response of real labor income Z, real wages w and employment L to an AR(1) markup shock with persistence 0.85, normalized such that inflation increases 1% on impact. The Taylor rule is $di_t = \phi^\pi d\pi_{t+1}$ where $\phi^\pi = 1$ recovers the constant real rate baseline.

B.2 Fiscal policy

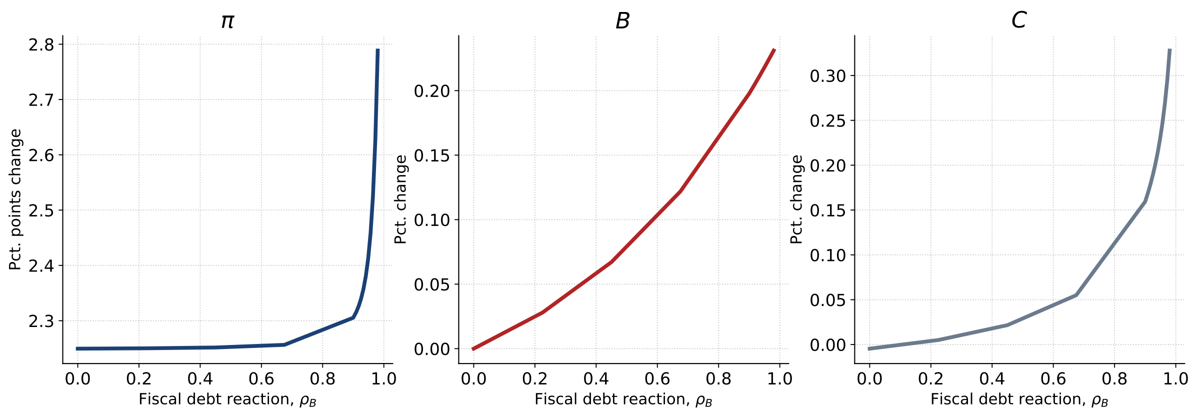


Figure A.2: Response of inflation, government bonds and consumption to markup shock with debt reaction

Note: Impulse responses to an AR(1) markup shock with persistence 0.85, normalized such that inflation increases 1% on impact. The transfer stabilizes the real labor income loss, financed by taxes on rich households with varying degrees of deficit financing ρ_B.

C Model extensions with markup shock

C.1 Investment

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

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

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 $\Phi(I_t, K_t) = \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t$ where investment follows from the law of motion $K_t = (1-\delta)K_{t-1} + I_t$. Profits are:

$$\Pi_t = \frac{P_{H,t}}{P_t} Y_t - P_{X,t} X_t - Z_t - I_t - \Phi(I_t, K_t)$$

The first-order conditions are:

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

where q_t^I is the Lagrange multiplier associated with the investment law of motion (Tobin's Q), and $MPK_{t+1} = mc_t \alpha_K K_{t+1}^{\alpha_K - 1} R_{t+1}^{1-\alpha_K}$ is the marginal product of capital.

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 the an earnings constraint binds, which implies that a fraction s of operating surplus is used for investment:

$$I_t - \delta K_{t-1} = s \times dOS_t$$

where:

$$OS_t = \frac{P_{H,t}}{P_t} Y_t - P_{X,t} X_t - Z_t$$

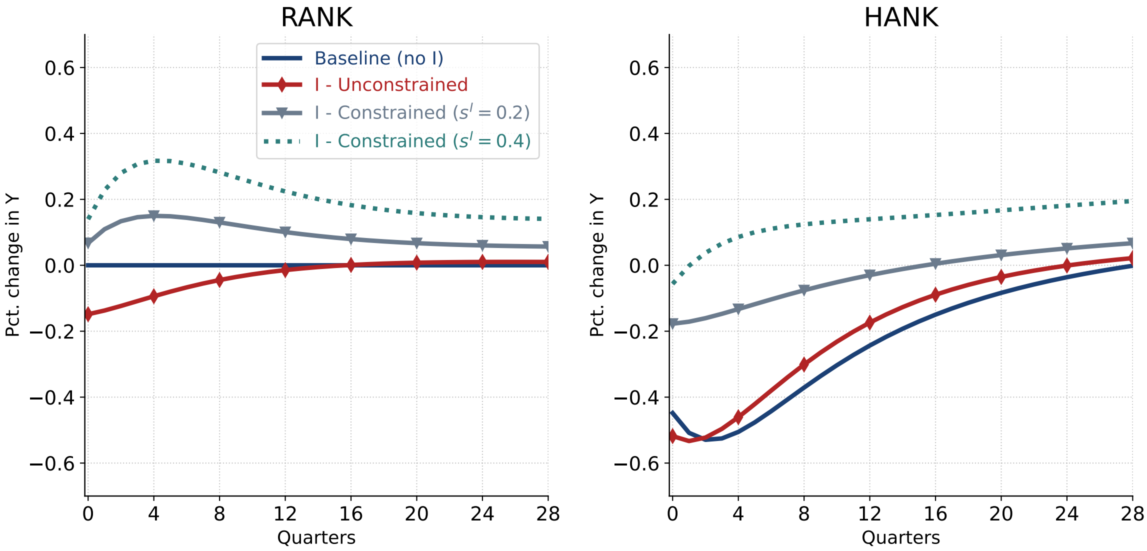


Figure A.3: Response to markup in the RANK and HANK model

Baseline refers to the model without capital and investment. *I - Unconstrained* refer to the models with investment subject only to an adjustment cost. *I - Constrained* refer to models with investment, where investment is constraint by an earnings constraint.

C.2 Wage indexation

Proposition 3 highlights the importance of real wage dynamics for the transmission of the shock in models with distribution effects. A natural remedy to stabilize real wages in volatile inflation environments is to index nominal wages to CPI inflation (e.g. 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).[21] The implied wage Phillips curve is 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 present in the Phillips curve the effects of a markup shock captured in Proposition 2 modifies to:

Proposition 8. *The general equilibrium response of output* dY *to a markup shock is with wage indexation:*

$$\text{dY} = -\mathscr{M}\left[\mathbf{M}^Z - \mathbf{M}^\Pi\right] \times \mathbf{\Theta}^\mu \times d\boldsymbol{\mu}, \tag{A.6}$$

where the pass-through to markups $\mathbf{\Theta}^\mu$ *is given by:*

$$\mathbf{\Theta}^\mu \equiv \left[\mathbf{I} + \boldsymbol{\kappa}^W + \alpha_L W\left(1-\iota\right)\boldsymbol{\kappa}^P\right]^{-1} W\left(1-\iota\right)\boldsymbol{\kappa}^P. \tag{A.7}$$

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

Proof: appendix C.3.

Inspecting (A.6)-(A.7) one finds that the presence of wage indexation modified 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.4 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.

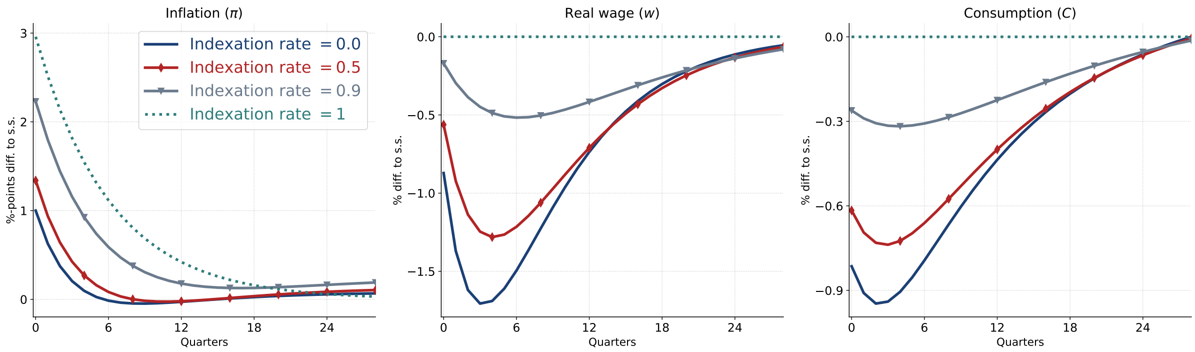


Figure A.4: Transmission of markup shock with varying degree of wage indexation

C.3 Proof of Proposition 8

The derivation of eq. (A.6) is unchanged with wage indexation, as only $\mathbf{\Theta}^\mu$ is affected. To derive $\mathbf{\Theta}^\mu$ under wage indexation, I start by linearizing the wage Phillips curve with indexation:

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

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

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

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

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

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

where $\boldsymbol{\kappa}^W \equiv \kappa^W \mathbf{U\Psi}$ as before.

To solve for $\boldsymbol{\Theta}^\mu$, I start by subbing the NKPC into the NWPC:

$$\begin{aligned}
\mathrm{d}\mathbf{W} - \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) &= \iota W \mathrm{d}\mathbf{P} \\
\Leftrightarrow \mathrm{d}\mathbf{W} - W\mathrm{d}\mathbf{P} + W\mathrm{d}\mathbf{P} - \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) &= W\iota\mathrm{d}\mathbf{P} \\
\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) &= W(\iota - 1)\,\mathrm{d}\mathbf{P} \\
\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) &= W(\iota - 1)\,\boldsymbol{\kappa}^P\left(\mathrm{d}\mathbf{mc} + d\boldsymbol{\mu}\right) \\
\Leftrightarrow \mathrm{d}\mathbf{w} - \boldsymbol{\kappa}^W \left(\frac{W}{\phi}\mathrm{d}\mathbf{L} - \mathrm{d}\mathbf{w}\right) &= W(\iota - 1)\,\boldsymbol{\kappa}^P\left(\alpha_L\mathrm{d}\mathbf{w} + d\boldsymbol{\mu}\right) \\
\Leftrightarrow \mathrm{d}\mathbf{w} &= -\left[\mathbf{I} + \boldsymbol{\kappa}^W + W(1-\iota)\,\boldsymbol{\kappa}^P\alpha_L\right]^{-1} W(1-\iota)\,\boldsymbol{\kappa}^P d\boldsymbol{\mu}
\end{aligned}$$

giving the expression in eq. (A.7).

C.4 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; M. K. Brunnermeier et al. 2023). 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 real return is then given by $r_t^a = \theta^n r_t^n + (1-\theta^n)\,r_t$ where r_t^n is the 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 0 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 return is given by:

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

With a constant-r rule as before the only effect on household behaviour comes from an initial revaluation effect on nominal bonds which occurs at time 0 (only surprise inflation affects the return). The consumption function is now a function of real income, profits and the date 0 real return on assets, $C_t = \mathscr{C}\{Z_t, \Pi_t, r_0\}$. Linearizing in sequence-space and using $\mathrm{d}r_0 = \theta^n \mathrm{d}r_0^n$ we have that:

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

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 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. For a given nominal interest rate, the increase in inflation also affects the value of the bond going forward, which is captured in the initial valuation dq_0. This effect can be found to be:

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

High future real rates or inflation reduce the current price of the bond, with the effects being increasing in the longevity of the bonds δ. Using this expression, the overall effect on aggregate consumption is:

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

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 will tend to be a negative effect since the real value of their bonds get reduced by inflation, thus acting as a negative income shock. Borrowers experience the opposite, and will generally increase in consumption in response to this channel, leaving the overall sign of $\mathbf{M}^{r_0}$ uncertain. At the individual 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 we can write this as:

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

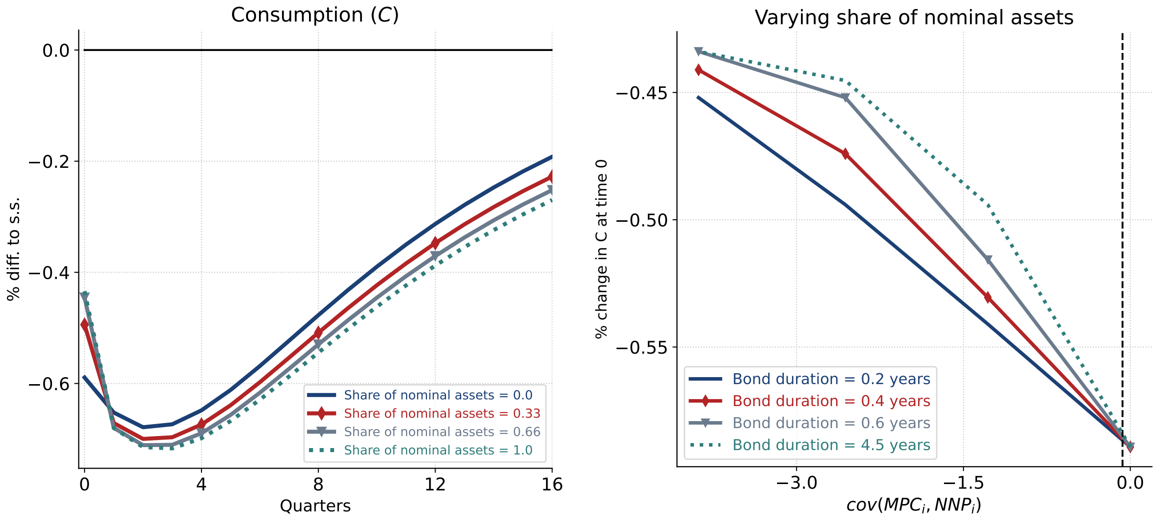
Given that the aggregate net asset position is generally positive, the first term is positive. The second term captures redistribution, between borrowers and savers, and is negative when borrowers have larger MPCs than savers. Auclert (2019) uses the Italian Survey of Household Income and Wealth to measure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

The left panel in Figure A.5 shows the effects of the markup shock on aggregate consumption for varying degree of nominal bonds, all with $\delta = 0.94$ to match an average duration of 4.5 years as in Doepke and Schneider (2006).[22] A larger share of nominal bonds imply redistribution 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.6 plots the intertemporal MPCs by borrowers and savers which clearly showcases 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.5 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).[23] If I calibrate θ^n to match the empirical covariance from Auclert (2019), the Fisher effect is quantitatively small, and the effect from declining real labor income dominates, and consumption declines following a markup shock, as in the baseline model.

[22]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).

[23]The model over-predicts the size of this covariance because all constraint 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).



(a) Response of aggregate consumption to a markup shock

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

Figure A.5: Model with Fisher debt-inflation effects

Note: The left panel shows response of aggregate consumption for different shares of nominal assets θ^n fixing the bond duration to 4.5 years ($\delta = 0.94$). The right panel shows the response of aggregate consumption at time 0 as a function of the covariance between net-nominal positions and MPCs for different levels of bond durations.

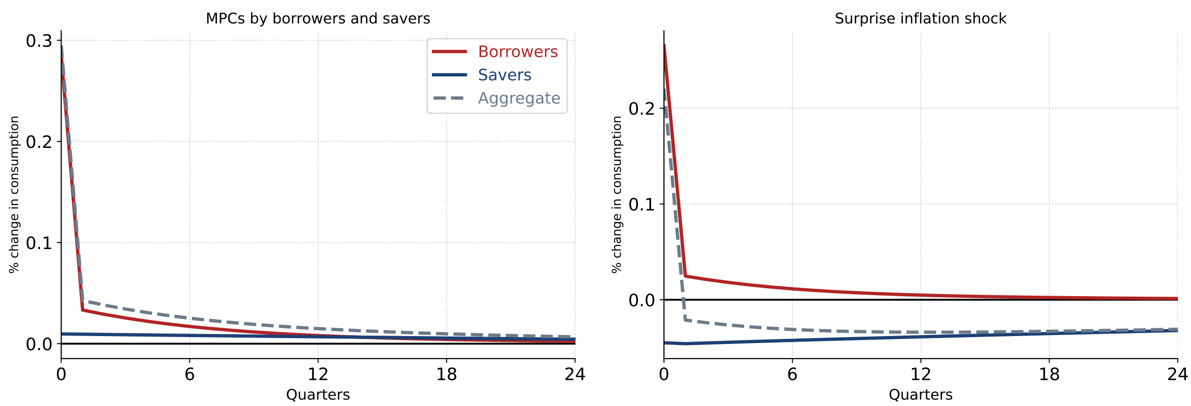


Figure A.6: Partial equilibrium responses by borrowers and savers

D Cost-push shocks

D.1 Neutrality of Cost-push shocks when $\mathrm{d}P^*_{F,t} = \mathrm{d}P^*_{X,t}$

Define $p_{X,t} = \frac{P_{X,t}}{P_t}$ as the price of imported materials in domestic CPI units. If $p_{X,t} = 0$ 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:

$$\mathrm{d}p_{X,t} = \mathrm{d}\mathcal{E}_t + \mathrm{d}P^*_{X,t} - \mathrm{d}P_t$$

$$\mathrm{d}Q_t = \mathrm{d}\mathcal{E}_t + \mathrm{d}P^*_{F,t} - \mathrm{d}P_t$$

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 have 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.[24]

D.2 Proof of Proposition 4

Subbing (A.2) in to (A.1) with $d\mathbf{T} = d\boldsymbol{\tau} = 0$ gives:

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

To derive (30), use (A.5):

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

Solving for output one obtains:

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

where:

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

E Tariff shocks

Combining (A.2) and (A.1) in the case where $dP^*_{X,t} = 0$ and $d\tau_t \neq 0$ gives:

$$\frac{\mathbf{I}}{(1-\alpha)}d\mathbf{Y} = \mathbf{M}^\mathbf{Z}\left[1-(1-\omega)(1-\alpha_L)\right]d\mathbf{Y} - \mathbf{M}^\mathbf{Z}\left[\frac{1}{\alpha_L}\frac{\alpha}{(1-\alpha)} + \frac{(1-\alpha_L)}{\alpha_L}\right]d\boldsymbol{\tau}$$
$$-\left[\mathbf{M}^\mathbf{Z} - \mathbf{M}^\Pi\right]d\boldsymbol{\Pi} + \mathbf{M}^\tau dT + \frac{\alpha}{(1-\alpha)}\eta\left(1+\frac{\alpha^*}{1-\alpha}\right)d\boldsymbol{\tau}$$

[24] 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.

Then, using that $\frac{1}{\alpha_L} - (1-\alpha)\, d\tau_t = \mathrm{d}T_t$ in the case where government debt is not adjusted, and using (A.5):

$$\left[\frac{\mathbf{I}}{(1-\alpha)} - \mathbf{M}^{\mathbf{Z}}\left[1-(1-\omega)(1-\alpha_L)\right] - \left[\mathbf{M}^{\mathbf{Z}} - \mathbf{M}^{\Pi}\right]\left[\mathbf{\Theta}^{L} - \frac{\mu-1}{\mu} - \omega(1-\alpha_L)\right]\right]\mathrm{dY}$$
$$= -\mathbf{M}^{\mathbf{Z}}\left[\frac{1}{\alpha_L}\frac{\alpha}{(1-\alpha)} + \frac{(1-\alpha_L)}{\alpha_L}\right]\mathrm{d}\boldsymbol{\tau}$$
$$+\left[\mathbf{M}^{\mathbf{Z}} - \mathbf{M}^{\Pi}\right]\left\{\left(\frac{\mathbf{I}}{\alpha_L} - \mathbf{\Theta}^{\mu}\left(\boldsymbol{\kappa}^{P}\right)^{-1}\right)\frac{\alpha}{(1-\alpha)} + \left(\frac{\mathbf{I}}{\alpha_L} - \mathbf{\Theta}^{\mu}\right)(1-\alpha_L)\right\}\mathrm{d}\boldsymbol{\tau}$$
$$+\mathbf{M}^{\boldsymbol{\tau}} dT + \frac{\alpha}{(1-\alpha)}\eta\left(1+\frac{\alpha^{*}}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau}$$

Defining the multiplier as:

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

I obtain the final expression:

$$\mathrm{dY} = -\mathscr{M}\mathbf{\Theta}^{\mu}\left[\mathbf{M}^{\mathbf{Z}} - \mathbf{M}^{\Pi}\right]\left\{\left(\boldsymbol{\kappa}^{P}\right)^{-1}\frac{\alpha}{(1-\alpha)} + (1-\alpha_L)\right\}\mathrm{d}\boldsymbol{\tau}$$
$$+\mathscr{M}\left(\frac{1}{\alpha_L} - (1-\alpha)\right)\left[\mathbf{M}^{\boldsymbol{\tau}} - \frac{\mathbf{I}}{1-\alpha}\mathbf{M}^{\Pi}\right]\mathrm{d}\boldsymbol{\tau}$$
$$+\mathscr{M}\frac{\alpha}{(1-\alpha)}\eta\left(1+\frac{\alpha^{*}}{1-\alpha}\right)\mathrm{d}\boldsymbol{\tau}$$