# Recessionary Wage Flexibility in a Monetary Union

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**Abstract**

We examine how wage flexibility affects the transmission of economic shocks within a monetary union using a two-agent New Keynesian small open economy model. We show that, in the presence of financially constrained households, greater wage flexibility can amplify shocks rather than mitigate them. This amplification arises through an income channel that dominates the standard expenditure-switching mechanism when price flexibility is limited. The critical threshold of price flexibility required to offset this effect depends on the economy's trade openness and the share of constrained households, but not on wage flexibility itself. These findings challenge the conventional view that wage flexibility inherently enhances macroeconomic stability within a monetary union.

*Keywords:* monetary union, nominal rigidities, structural reforms, two-agent models, incomplete markets

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# 1 Introduction

Does greater wage flexibility help countries within a monetary union stabilize economic fluctuations? For members of a currency union, traditional tools such as exchange rate devaluations are unavailable, leaving policymakers with limited options to regain competitiveness and mitigate downturns. A prevailing policy view holds that these countries should pursue internal devaluations by reducing wages and prices to restore competitiveness externally and stimulate demand.

This view shaped policy responses during the Eurozone crisis and continues to influence contemporary policy debates. Spain's reforms implemented after 2012 focused on enhancing wage flexibility and decentralizing collective bargaining, with further adjustments in 2022 that balanced flexibility with worker protection.

Yet recent experience raises questions about this conventional wisdom. The EU's 2022 Minimum Wage Directive shifts away from the post-crisis wage-flexibility orthodoxy, motivated by concerns about in-work poverty. The inflation crisis starkly validated those concerns, with nearly a quarter of minimum-wage earners struggling to make ends meet. Recent experiences – from Spain's persistent labor market challenges despite flexibility reforms to widespread real wage losses across Europe during the inflation crisis – highlight the need to reconsider how wage adjustment mechanisms perform when many households face financial constraints.

While the logic of internal devaluation is well established in policy discourse, its general-equilibrium implications when households face financial constraints remain less understood. Does enhancing wage flexibility necessarily improve macroeconomic stability, or could it have unintended consequences when aggregate demand is constrained? This paper revisits the case for wage flexibility in a monetary union, highlighting mechanisms that may counteract its stabilizing intent and offering insights relevant to current European policy debates.

In a standard representative-agent New Keynesian model, greater wage flexibility generally leads to lower employment volatility. Reductions in nominal wages lead to lower prices, prompting the central bank to lower interest rates. As the central bank lowers the nominal interest rate, the real interest rate also drops, encouraging households to increase their consumption and, in turn, stimulating labor demand by firms (see, e.g., Galí (2013)). However, in a currency area, union-wide monetary policy does not respond to developments in the small open economy, effectively shutting down the interest rate channel. Despite this, greater wage flexibility enables firms to reduce prices and improve international competitiveness. This international expenditure-switching channel reduces employment volatility, but does so at the cost of reduced domestic welfare (Galí and Monacelli, 2016).

This standard view overlooks the direct effect of falling wages, namely the lower labor income households receive. This paper analyzes the hitherto unexplored income channel through which more flexible wages directly affect domestic demand. We focus on the role of financially constrained households by studying a Two-Agent New-Keynesian (TANK) model of a small open economy in a monetary union. The framework includes two household types: Ricardian and Hand-to-Mouth. The former have full access to international financial markets, where they can trade in state-contingent bonds and hedge their income risk. The latter have no access to financial markets and consume all their income each period.

Following a negative foreign demand shock, wage flexibility affects the economy through two opposing channels. The competitiveness channel operates as falling wages reduce prices, improving international competitiveness through expenditure switching. The income channel works in the opposite direction: wage reductions directly lower household income, reducing domestic demand. This income effect only operates when households are financially constrained and cannot hedge income risk.

We analytically demonstrate that wage flexibility destabilizes the economy when price flexibility is lower than the product of the hand-to-mouth household share and home bias in consumption. Intuitively, when prices are sticky, the competitiveness channel is muted while the income channel remains strong.

Our findings contrast with the standard prediction in labor economics that wage rigidity leads to higher unemployment during recessions, as firms reduce employment when wage adjustments are constrained. This partial-equilibrium intuition overlooks the general-equilibrium implications of wage rigidity. In general equilibrium, firms employ the amount of labor necessary to meet the demand for their goods, implying that labor demand is driven primarily by aggregate demand rather than by wage levels alone. While wages influence a firm's marginal costs – and therefore prices – this transmission is muted in the short run due to price rigidities. Wage rigidity affects aggregate demand through two channels. First, a competitiveness channel limited by price stickiness. Second, an income channel reflecting that workers are also consumers. The relative strength of these two channels determines whether output and employment are more sensitive to shocks under flexible or rigid wage regimes.

This result requires the interaction of four frictions: a currency peg, price rigidity, financial constraints, and home bias. Wage rigidity mitigates economic volatility only when all four are present. In the absence of any single friction, wage flexibility returns to its conventional stabilizing role.

We discuss the recessionary effects of wage flexibility in the context of a foreign demand shock. However, the results hold for several alternative shocks, such as domestic demand shocks and foreign (or global) interest rate shocks. The condition for the stabilizing effect of low wage flexibility is the same across all those shocks, indicating that the result relies on the trade-off between the two fundamental forces: competitiveness and income channels.

We confirm these analytical predictions quantitatively using a calibrated model, with a realistic calibration of elasticities and shock persistence. In this model, reducing wage rigidity implies substantially larger output and consumption responses to foreign demand shocks, as well as more countercyclical inequality. The latter means that poorer, financially constrained households experience larger consumption declines during recessions and greater overall consumption volatility.

The quantitative exercise enables us to confirm that the features of the economy most relevant to the emergence of recessionary wage flexibility are low price flexibility, a high degree of financial constraints, and a relatively low degree of trade openness. Calibrating the model to different euro-area economies, we find that price rigidity does not differ significantly across union members. The key dimensions differentiating European countries are trade openness and the degree of financial constraints. As such, Greece, Latvia, Italy, and Portugal are the countries most likely to experience greater economic volatility under flexible wages. The results highlight that structural reforms should be analyzed at the country level, and that there is no one-size-fits-all institutional setting that would work in the EMU.

We also show that the recessionary wage flexibility might arise in a Heterogeneous-Agent New Keynesian model à la Auclert et al. (2021) extended with price rigidities, which are key to obtaining our results. The need for the additional friction highlights the difference between their real income channel and the income channel that we discuss. In Auclert et al. (2021), households' real wages are a fixed fraction of aggregate real income, so any change in wages passes directly through to aggregate income. The channel we analyze is therefore absent in their framework. In our setting, wage rigidity alone does not generate amplifying effects: if wages are rigid but prices adjust fully, the terms of trade improve sufficiently to stabilize the economy through expenditure switching. The recessionary effect arises only when price rigidities prevent this adjustment. Through this lens, our mechanism is not purely distributional: it is not simply that constrained households become relatively poorer when wages are flexible. Rather, the key friction is that when prices are sticky, wage flexibility reduces the income of constrained households without generating the offsetting terms-of-trade improvement needed to stimulate demand for domestic goods. While the competitiveness channel arising from price rigidity is known, our contribution is to show how it interacts with financial constraints to amplify, rather than dampen, the effects of wage flexibility.

**Related literature.** Our paper contributes to two main strands of literature: (i) the macroeconomic effects of labor market reforms within monetary unions, and (ii) the interaction of household heterogeneity and open economy dynamics in New Keynesian models under currency pegs.

First, we build on studies examining the impact of wage flexibility on macroeconomic stability and welfare in a currency union. A key insight from this literature is that the effectiveness of wage adjustment mechanisms depends critically on the broader macroeconomic environment. Galí and Monacelli (2016) show that absent household liquidity constraints, greater wage flexibility modestly stabilizes output but reduces welfare due to labor supply distortions. Schmitt-Grohé and Uribe (2016) emphasize the role of downward nominal wage rigidity in amplifying shocks in small open economies, though their framework abstracts from price rigidity. Our model nests these cases, confirming that wage flexibility reduces volatility when prices are fully flexible, but its stabilizing effect is dampened once price stickiness and financial constraints are introduced.

Eggertsson et al. (2014) highlight how structural reforms aimed at increasing flexibility can be destabilizing in the short run when central bank policy is constrained, particularly in the periphery of a monetary union. Our findings align with this result but extend the analysis by explicitly modeling liquidity-constrained households, illustrating how income effects further weaken the transmission of wage adjustments.

Recent work by Diz et al. (2023) studies wage flexibility in a two-agent New Keynesian model with wage and price rigidities, though in a closed economy setting. They emphasize the interplay between nominal rigidities in determining output volatility following demand shocks. Our contribution complements this by incorporating an open economy channel, showing how external competitiveness interacts with domestic financial constraints in a small open economy within a currency union.

Second, our paper relates to the growing literature on open-economy Heterogeneous Agent New Keynesian models. Bellifemine et al. (2023) analyze the transmission of union-wide monetary policy in a small open economy setting, while Bayer et al. (2024) and Chen et al. (2025) focus on aggregate euro area dynamics in two-country HANK models. While these studies examine the macroeconomic implications of household heterogeneity at the union level, we focus on the implications of wage flexibility for a single, financially constrained small open economy within a monetary union.

Additionally, studies on exchange rate regimes provide indirect evidence relevant to our analysis. De Ferra et al. (2020) argue that sudden stops justify a fear of floating in the presence of household heterogeneity, as flexible exchange rates exacerbate welfare losses. Oskolkov (2023) finds that under fixed exchange rates, wage declines disproportionately harm poorer households, increasing consumption inequality – a finding consistent with our results. In contrast, Guo et al. (2023) show that fixed exchange rates can mitigate the distributional effects of external shocks. However, these studies abstract from wage rigidity, focusing solely on price stickiness. By explicitly modeling both wage and price rigidities, our paper provides a more comprehensive understanding of how external shocks propagate in small open economies under a currency peg.

The paper is organized as follows. Section 2 introduces the baseline model. Section 3 presents the main analytical results and identifies the key transmission channels. Section 4 conducts a quantitative analysis using model extensions to assess the magnitude of the effects and their robustness. Section 5 concludes.

# 2 Model

Let us consider a small open economy populated by two types of households: savers and hand-to-mouth (or financially constrained households). The former have access to complete international financial markets, while the latter do not hold assets and receive only labor income. The economy features two nominal frictions; a price and a wage rigidity. The economy is part of a monetary union, which implies a fixed exchange rate and no monetary policy at the national level. This prevents the economy from using the nominal exchange rate as a stabilizing tool in response to shocks.

The model is a combination of a standard small open economy model (Galí and Monacelli (2005), Galí and Monacelli (2008)) and a standard TANK model (Bilbiie (2008)). Extending the small open economy model with financial imperfections, in the form of financially constrained households, allows us to relax the perfect risk sharing assumption. This is especially important in the context of wage rigidity as wage fluctuations can have a direct impact on the consumption of the constrained households.

## 2.1 Households

The domestic economy is populated by households, indexed by $i \in [0,1]$. A fraction $\lambda$ of households are financially constrained (or hand-to-mouth, labeled by $c$), and the remaining $(1-\lambda)$ households are financially unconstrained, i.e., they save and trade in state-contingent bonds (they are labeled by $u$). These two household types are indexed by $K \in \{c, u\}$.

Domestic households maximize their utility over consumption $C_{i,t}$, but households' labor supply $N_{i,t}$ is determined through labor unions. The unions ration labor supply such that all households provide the same amount of labor $N_{i,t} = N_t$ at nominal wage $W_t$.

All households share the same preferences, characterized by the lifetime utility

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \chi_{t+k} \left( u(C_{i,t+k}) - v(N_{i,t+k}) \right), \tag{1}$$

where $\beta$ is the discount factor and $\chi_t$ a preference shifter following a log-AR(1) process. The period utility function $u(C, N)$ takes the form:

$$u(C_{i,t}, N_{i,t}) \equiv \frac{{C_{i,t}}^{1-\sigma} - 1}{1-\sigma} - \frac{{N_{i,t}}^{1+\varphi}}{1+\varphi}. \tag{2}$$

$\sigma$ is the inverse of the intertemporal elasticity of substitution and $\varphi$ is the inverse of the Frisch elasticity.

The consumption basket $C_{i,t}$ consists of domestic ("$H$") and international goods ("$F$") with respective consumption levels $C_{i,Ht}$ and $C_{i,Ft}$ :

$$C_{i,t} = \left[ \nu^{\frac{1}{\eta}} C_{i,Ft}^{\frac{\eta-1}{\eta}} + (1-\nu)^{\frac{1}{\eta}} C_{i,Ht}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \tag{3}$$

where $\nu$ is the openness of the economy and $\eta > 0$ is the elasticity of substitution between domestic and international goods.

Consumers in the domestic economy optimally allocate their expenditure between domestic and imported goods:

$$C_{Ht} = (1-\nu) \left( \frac{P_{Ht}}{P_t} \right)^{-\eta} C_t, \quad \text{and} \tag{4}$$

$$C_{Ft} = \nu \left( \frac{P_{Ft}}{P_t} \right)^{-\eta} C_t, \tag{5}$$

where $P_{Ft}$ is the price of the Foreign good in domestic currency, $P_{Ht}$ is the price of Home goods, and the consumer price index (CPI) is defined as

$$P_t \equiv \left[\nu P_{Ft}^{1-\eta} + (1-\nu) P_{Ht}^{1-\eta}\right]^{1/(1-\eta)}. \tag{6}$$

**Constrained households.** Hand-to-mouth households have no access to financial markets and only receive income from supplying labor. Hence, their budget constraint takes the simple form

$$P_t C_{c,t} = W_t N_t. \tag{7}$$

**Unconstrained households.** Unconstrained households supply labor, obtain firm dividends $D_{u,t} = \frac{1}{1-\lambda} D_t$, and participate in financial markets where they trade state-contingent bonds that return a nominal payoff $B_{u,t+1}$ in $t+1$ for the portfolio that was held at the end of period $t$. Thus, their budget constraint takes the form

$$P_t C_{u,t} + \mathbb{E}_t\{\mathcal{M}_{t|t+1} B_{u,t+1}\} = B_{u,t} + D_{u,t} + W_t N_t, \tag{8}$$

where $\mathcal{M}_{t|t+1}$ is the stochastic discount factor for a portfolio purchased in period $t$.

The optimization problem of the unconstrained households yields a standard Euler equation:

$$1 = \beta(1+i_t)\mathbb{E}_t \left\{ \frac{\chi_{t+1}}{\chi_t} \left( \frac{C_{u,t+1}}{C_{u,t}} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right\}, \tag{9}$$

where $i_t$ is the interest rate on a one-period riskless nominal bond.

The assumption of complete financial markets enables us to combine the Euler equations for the unconstrained domestic household with a similar condition for foreign households, thereby obtaining an international risk-sharing condition. It takes the familiar form

$$C_{u,t}^{\sigma} = \vartheta Q_t \frac{\chi_t}{\chi_t^*} (C_t^*)^{\sigma}, \tag{10}$$

where $C_t^*$ is the consumption of foreign households, $\chi_t^*$ is a foreign preference shock, $Q_t \equiv \frac{P_t^*}{P_t}$ is the real exchange rate defined as the ratio of price levels abroad and at home. Further, $\vartheta$ is the initial condition. Since we assume that net foreign assets and net exports are zero in steady-state and the ex-ante aggregate consumption across countries is identical

$(C_{-1} = C^*_{-1})$, this implies that $\vartheta \equiv \left(\frac{C_u}{C^*}\right)^\sigma$ depends on the steady-state ratio of consumption levels of the unconstrained domestic households and the foreign households.[1]

To track inequality in the economy, we define consumption inequality as the ratio of consumption levels between unconstrained and constrained households:

$$\gamma_t \equiv \frac{C_{u,t}}{C_{c,t}}. \tag{11}$$

## 2.2 Labor Unions and Labor Packers

We follow the standard approach in the heterogeneous agent literature and delegate the labor supply decisions of the household and the wage bargaining to labor unions. The latter operate under monopolistic competition as they specialize in different types of labor. The unions sell the labor services to labor packers, who bundle the differentiated services into an aggregate labor service. (See, e.g., Auclert and Rognlie (2018).)

In particular, each household $i$ supplies $N_{i,lt}$ hours of work to each labor union $l \in [0, 1]$. The union aggregates the labor supply of all households

$$N_{lt} = \int N_{i,lt} di = (1 - \lambda) N_{u,lt} + \lambda N_{c,lt}. \tag{12}$$

The union sells the labor services at the wage $W_{lt}$ to perfectly competitive labor packers who aggregate the services and sell them to final goods firms at wage $W_t$. The elasticity of substitution of packers for different labor services is $\epsilon_W$. Aggregation by labor packers follows

$$N_t = \left( \int N_{lt}^{\frac{\epsilon_W - 1}{\epsilon_W}} dl \right)^{\frac{\epsilon_W}{\epsilon_W - 1}}, \tag{13}$$

which implies aggregate demand for labor services of type $l$ of

$$N_{lt} = \left( \frac{W_{lt}}{W_t} \right)^{-\epsilon_W} N_t. \tag{14}$$

When setting the wage $W_{lt}$, the union maximizes the total welfare of all its members. Since household type is private information, the union sets one wage across households and requires all members to supply the same amount of hours $N_{i,lt} = N_{lt}$.

[1] Galí and Monacelli (2005) discuss international risk sharing in the case of a small open economy, while Galí and Monacelli (2008) focus on the case of a small open economy participating in a monetary union.

For tractability, in the benchmark model, we consider a simplified nominal rigidity as in Diz et al. (2023). The nominal rigidity works similarly to the Calvo friction, but avoids the excessive duration of prices. In every period, a fraction $(1-\theta^W)$ of labor unions can set their wages after the realization of shocks, while the remainder of unions $\theta^W$ makes the decision before shocks are realized.

A union that sets its wages after the realization of a shock maximizes the following objective function:

$$\mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \chi_{t+k} \left\{ (1-\lambda) \frac{{C_{u,t+k}}^{1-\sigma} - 1}{1-\sigma} + \lambda \frac{{C_{c,t+k}}^{1-\sigma} - 1}{1-\sigma} - \int \frac{{N_{lt+k}}^{1+\varphi}}{1+\varphi} dl \right\}, \tag{15}$$

subject to a sequence of budget constraints of the two household types, i.e., equations (7) and (8), and the sequence of labor market clearing conditions for labor of type $l$, which follows from equations (12) and (14).

The union's first order optimality condition is a standard consumption-leisure trade-off with two caveats: (i) the marginal utility of consumption being a weighted average of the marginal utilities of the two household types; (ii) the union is able to impose a wage mark-up, $\mathcal{M}_W \equiv \frac{\epsilon^W}{\epsilon^W - 1}$. The condition can be written as:

$$W_{lt}^o = \mathcal{M}_W P_t \left[ (1-\lambda) C_{u,t}^{-\sigma} N_{lt}^{-\varphi} + \lambda C_{c,t}^{-\sigma} N_{lt}^{-\varphi} \right]^{-1}, \tag{16}$$

where the superscript "$o$" indicates that the union is able to set the optimal full-information wage.

The equivalent condition for union's setting wages prior to the realization of shocks, takes the form

$$W_{lt}^m = \mathcal{M}_W \mathbb{E}_{t-1} \left\{ P_t \left[ (1-\lambda) C_{u,t}^{-\sigma} N_{lt}^{-\varphi} + \lambda C_{c,t}^{-\sigma} N_{lt}^{-\varphi} \right]^{-1} \right\} = \mathbb{E}_{t-1} W_{lt}^o, \tag{17}$$

where "$m$" indicates unions that set their wage at the beginning of the period. The best a union in this situation can do is to set its wages equal to the expected value of the optimal wage.

## 2.3 Firms

### 2.3.1 Final Good Producers

Final good producers aggregate output of intermediate good producers $Y_{jt}$, where $j \in [0,1]$, into final goods under perfect competition. The domestic output is aggregated through standard CES technology:

$$Y_t = \left( \int Y_{jt}^{\frac{\epsilon_H - 1}{\epsilon_H}} dj \right)^{\frac{\epsilon_H}{\epsilon_H - 1}}, \tag{18}$$

where $\epsilon_H$ is the elasticity of substitution between Home good varieties. Demand for intermediate goods by final good-producing firms follows

$$Y_{jt} = \left( \frac{P_{jHt}}{P_{Ht}} \right)^{-\epsilon_H} Y_t. \tag{19}$$

In turn, aggregate demand $Y_t$ depends on consumption of the Home good by domestic and international consumers:

$$Y_t = C_{Ht} + C_{Ht}^*. \tag{20}$$

Producer prices are defined as $P_{Ht} = \left( \int P_{jHt}^{1-\epsilon_H} dj \right)^{\frac{1}{1-\epsilon_H}}$.

### 2.3.2 Intermediate Good Producers

Intermediate goods firms $j \in [0,1]$ produce good $j$ monopolistically using labor as their only input:

$$Y_{jt} = z N_{jt}^{1-\alpha} \tag{21}$$

where $N_{jt}$ is the labor input that firm $j$ employs, $\alpha \geq 0$ defines the degree to which the production function exhibits decreasing returns to scale, and $z$ is a productivity parameter.

Similarly to the labor unions, intermediate good producers face an information friction, which mimics price stickiness á la Calvo. In every period, a fraction of $(1 - \theta_H)$ firms can optimize their prices after the realization of shocks, while the remainder of firms $\theta_H$ sets prices before the realization of shocks. Optimizing firms "$o$" choose the profit-maximizing price with steady-state markup over their marginal costs: $P_{Ht}^o = \mathcal{M}_H \frac{N_{jt}^\alpha}{z(1-\alpha)} W_t$. The steady-state markup $\mathcal{M}_H = \frac{\epsilon^H}{\epsilon^H - 1}$ is determined by the elasticity of substitution between different Home goods varieties in the aggregation of the final good. Non-optimizing firms "$m$" set their prices for period $t$ at the end of the previous period: $P^m_{Ht} = \mathbb{E}_{t-1}\{\mathcal{M}_H \frac{N^{\alpha}_{jt}}{z(1-\alpha)} W_t\}$.

Aggregate nominal dividends of firms are given by the difference of revenues from selling Home goods and the effective labor costs:

$$D_t = P_{Ht} Y_t - W_t N_t, \tag{22}$$

where the aggregate price level of the domestic goods is $P_{Ht} = (1 - \theta_H) P^o_{Ht} + \theta_H P^m_{Ht}$.

## 2.4 Foreign Economy and Equilibrium

The Foreign agents are symmetric to domestic unconstrained households. For simplicity, we assume that union-wide monetary policy ensures price stability of the foreign goods, with $P^*_{Ft} = 1$ and since the Home economy is small it also follows that the international consumer price index is stable $P^*_t = 1$. Further, the law of one price holds, therefore $P_{Ft} = P^*_{Ft}$ and $P_{Ht} = P^*_{Ht}$, where the nominal exchange rate is equal to one and omitted, since the two regions share the same currency.

The Euler equation of the household in Foreign is given analogously to Home as

$$1 = \beta(1 + i^*_t)\mathrm{E}_t \left\{ \frac{\chi^*_{t+1}}{\chi^*_t} \left( \frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \right\}, \tag{23}$$

where $\chi^*_t$ denotes the Foreign preference shock. Equation (23) highlights the fact that a preference shock can affect the Foreign interst rate, $i^*_t$, or Foreign consumption, $C^*_t$. We follow Galí and Monacelli (2016) and assume that the preference shock is a combination of two orthogonal shocks

$$\chi^*_t \equiv \chi^*_{1t} \cdot \chi^*_{2t}. \tag{24}$$

The union-wide central bank does not respond to $\chi^*_{1t}$, but fully stabilizes prices in response to $\chi^*_{2t}$. Such a decomposition of the shock implies the following dynamics

$$\hat{c}^*_t = \frac{1}{\sigma} \hat{\chi}^*_{1t}, \tag{25}$$

$$\hat{i}^*_t = (1 - \rho^*_2)\, \hat{\chi}^*_{2t}, \tag{26}$$

where $\hat{x}_t$ denotes the log-deviation of $X_t$ from its steady-state value.

The effect of the Foreign consumption shock on domestic output can be seen in the Foreign household's consumption of the Home good, which takes the familiar form

$$C_{Ht}^{*} = \nu \left( \frac{P_{Ht}^{*}}{P_{Ft}^{*}} \right)^{-\eta^{*}} C_t^{*}, \tag{27}$$

The price ratio in the equation can be also expressed through the terms of trade:

$$S_t \equiv \frac{P_{Ft}}{P_{Ht}}, \tag{28}$$

which expresses the amount of Home goods that need to be given up to obtain one Foreign good. Thus, an increase in $S_t$ is a depreciation of the terms of trade which implies that Home goods become relatively cheaper compared to Foreign goods.

Lastly, the definition of net exports is standard:

$$\mathrm{NX}_t \equiv \frac{P_{Ht}}{P_t} Y_t - C_t.$$

In equilibrium goods, labor, and assets markets clear. The domestic goods markets equilibrium requires

$$Y_t = C_{Ht} + C_{Ht}^{*}. \tag{29}$$

Given the Home economy is small, the foreign market clearing condition simplifies to $Y_t^{*} = C_t^{*}$.

When solving for the steady state of the model, we concentrate on the symmetric equilibrium with zero-inflation. We scale labor productivity to such that steady-state production in both regions $Y = Y^{*} = 1$, as well as domestic steady-state prices, which implies $P_H = P_F = P = P^{*} = S = 1$. We provide the details of the steady-state equilibrium in Online Appendix A.1.

# 3 Analytical results

In this section, we concentrate on a simplified version of the model to derive our main analytical results. In particular, we assume a Cole-Obstfeld parametrization of the economy, where the elasticity of substitution between Home and Foreign goods and the risk-aversion parameters are equal to one ($\eta = \eta^* = \sigma = 1$). Returns to labor are constant, yielding a linear production function. Finally, all shocks are non-persistent, independent, and identically distributed. The simplifications imply that labor unions and firms, who make their pricing decisions before shock realizations, set their wages and prices at the steady-state value, i.e., $W_{lt}^m = \mathbb{E}_{t-1} W_{lt}^o = W$ and $P_{jHt}^m = \mathbb{E}_{t-1} P_{jHt}^o = P_H$.

The equilibrium dynamics of the log-linearized model can be expressed as a system of five equations in five endogenous variables: output, consumption inequality, consumption, terms-of-trade, and real wages.

$$\hat{y}_t = (1-\nu)\hat{c}_t + (1-\nu)\left(\nu + \frac{\nu}{1-\nu}\right)\hat{s}_t + \nu\hat{\chi}_{1t}^*, \tag{30}$$

$$\hat{\gamma}_t = -\left[\hat{\omega}_t + \hat{y}_t - (1-\nu)\hat{s}_t\right] + \left(\hat{\chi}_t - \hat{\chi}_{2t}^*\right), \tag{31}$$

$$\hat{c}_t = (1-\nu)\,\hat{s}_t - \lambda C_c \hat{\gamma}_t + \left(\hat{\chi}_t - \hat{\chi}_{2t}^*\right), \tag{32}$$

$$\hat{s}_t = -\frac{1-\theta_H}{\nu + (1-\nu)\theta_H}\hat{\omega}_t, \tag{33}$$

$$\begin{aligned}\hat{\omega}_t = {} & \frac{\kappa_W}{1+\kappa_W}\left(\varpi_Y + \bar{\varphi}\right)\hat{y}_t - \frac{1}{1+\kappa_W}\left(\kappa_W \varpi_S - (1-\nu)\right)\hat{s}_t \\ & - \frac{\kappa_W}{1+\kappa_W}\frac{\nu}{(1-\bar{u})(1-\nu)}\chi_{1t}^* - \frac{\kappa_W}{1+\kappa_W}\frac{\bar{u}}{(1-\bar{u})}\left(\hat{\chi}_t - \hat{\chi}_{2t}^*\right). \end{aligned} \tag{34}$$

where we define several auxiliary parameters to facilitate the presentation of the equations: $\kappa_W \equiv \frac{1-\theta_W}{\theta_W}\frac{1}{1+\bar{\varphi}\epsilon_W}$, $\varpi_Y \equiv \frac{\frac{1}{1-\nu}+\bar{u}}{1-\bar{u}}$, $\bar{\varphi} \equiv \frac{\varphi}{1-\bar{u}}$, $\varpi_S \equiv \frac{(1-\nu)\bar{u}+\frac{\nu(2-\nu)}{1-\nu}}{1-\bar{u}}$, and $\bar{u} \equiv \frac{\lambda\left[1-C_c\left(\lambda+(1-\lambda)\gamma^{-1}\right)\right]}{\lambda+(1-\lambda)\gamma^{-1}}$.The derivations can be found in Appendix A.2.

Equations (30)-(34) have natural economic interpretations, which go back to a standard small open economy NK model, but with the twist of agent heterogeneity and wage rigidities. Equation (30) is the log-linearized market-clearing condition for Home goods; it captures demand from domestic and foreign households, as well as the demand-shifting effect of terms-of-trade movements. The second equation of the system comes directly from the definition of the consumption inequality measure, with the two consumption levels substituted. Consumption of constrained households is replaced by equilibrium labor earnings, while consumption of the unconstrained households is replaced by the international risk-sharing condition. Equation (32) is the simplified aggregate Euler equation. Equations (33) and (34) are simplified versions of the NK price and wage Phillips curves, respectively.[2]

[2]The uncharacteristic lack of dynamics in those equations comes from the simplifying assumptions in this section. In particular, the iid assumption on shocks and the information-based nature of nominal frictions. Online Appendix A.2 presents a version of the equations without the no-persistence assumption.

The simplifying assumptions introduced in this section enable us to obtain a solution for the model, where the endogenous variables are represented as functions of contemporaneous shocks only. Lemma 1 formalizes this result for output and provides the coefficients in front of the shocks, which are key for establishing our main results.

**Lemma 1.** *The dynamics of output in the simplified model can be expressed as*

$$\hat{y}_t = a_\chi \hat{\chi}_t + a_1^* \hat{\chi}_{1t}^* + a_2^* \hat{\chi}_{2t}^*, \tag{35}$$

*where the coefficients* $a_\chi$*,* $a_1^*$*, and* $a_2^*$ *are combinations of the structural parameters of the model.*

*Proof.* In Appendix A.3.

The nominal rigidities that we introduced through informational frictions do not lead to persistence in prices or wages. Agents who do not observe the shocks, when resetting the nominal variables, choose to set them at their steady-state values. This result also requires no persistence of external shocks. Those two features lead to a static representation of the model, which allows us to interpret the immediate response to shocks as the total response.

The above result implies that when we want to assess the volatility of the economy, it is sufficient to investigate the absolute value of the coefficients in equation (35). In the context of structural changes leading to more or less shock amplification, we can simply examine the effects of the reform on the $a$-coefficients. In this context, Proposition 1 establishes the conditions under which higher wage flexibility amplifies the impact of a shock in the model.

**Proposition 1.** *Whenever the parameters of the economy satisfy*

$$1 - \theta_H < (1 - \nu)\lambda C_c, \tag{36}$$

*then an increase in wage flexibility amplifies the response of the economy to the shocks* $\{\chi_t, \chi_{1t}^*, \chi_{2t}^*\}$.

*Proof.* In Appendix A.3.

Proposition 1 shows that it is possible for an economy to be more volatile under flexible wages than under rigid ones. For this to happen, inequality (36) needs to hold. This inequality requires prices to be rigid, relative to the degree of home bias and financial constraints. The main intuition behind the inequality stems from the interaction of two channels, as illustrated by the example of a wage decline following a negative shock. On the one hand, more flexible prices mean that a larger portion of the wage decline is passed on to prices, leading to stronger expenditure switching. This mechanism, driven by the expenditure switching (or competitiveness) channel, stabilizes the economy by increasing demand for domestic goods. On the other hand, a wage decline directly reduces the labor income of households. While unconstrained households can insure against this loss, financially constrained households (a fraction $\lambda$ of the population) must lower their consumption. A share $1-\nu$ of this reduced consumption falls on domestic goods, diminishing domestic demand and destabilizing the economy. This is the income channel.

Depending on which of the two channels dominates, a fall in wages after a negative shock can either stabilize or destabilize the economy. If the latter is true, then more flexible wages lead to a more volatile economy.

# 4 Quantitative analysis of the extended model

The previous section establishes the conditions under which flexible wages can lead to more shock amplification in a country in a monetary union. In this section, we evaluate the quantitative significance and robustness of the results. To do so, we relax the simplifying assumptions of the analytical model. In particular, we allow for non-unitary elasticities, more general utility and production functions, Calvo prices and wages, and persistent shocks.

## 4.1 Calibration

Table 1 presents the benchmark values for the model parameters, calibrated on a quarterly frequency based on evidence from Greece, Italy, Portugal, and Spain (henceforth GIPS). The inverse of the Frisch elasticity is set at $\varphi = 2$, following Chetty (2012). Due to the limited evidence on trade elasticities for imports and exports, we assume unitary elasticities in the baseline calibration. Additionally, Appendix B.2 demonstrates that the results hold for low ($\eta = \eta^* = 0.5$) and high ($\eta = \eta^* = 2$) trade elasticities.

The elasticity of substitution between good varieties is calibrated to $\epsilon_H = 4.3$, which implies a 30 percent price markup and is a compromise of recent evidence (see, e.g., Cavalleri et al. (2019); De Loecker and Eeckhout (2018); Kouvavas et al. (2021)). Similarly, based on evidence in Christoffel et al. (2008), we set the elasticity of substitution across labor varieties to $\epsilon_W = 4.3$, resulting in a 30 percent wage markup. Data from the International Labor Organization indicate that the labor income share from 2004 to 2024 averages 58 percent for the GIPS countries. Thus, the labor share is $1 - \alpha = 0.77$. Our calibration for

Table 1: Model parameters

| Parameter | Value | Description |
|---|---|---|
| $\lambda$ | 0.31 | HtM share |
| $\alpha$ | 0.24 | Complement of the labor share |
| $\beta$ | 0.99 | Quarterly discount factor |
| $\sigma$ | 1.0 | CRRA utility coefficient |
| $\varphi$ | 2.0 | Curvature of labor disutility |
| $\epsilon_H$ | 4.3 | Elasticity of substitution (goods) |
| $\epsilon_W$ | 4.3 | Elasticity of substitution (labor) |
| $\theta_H$ | 0.79 | Price rigidity |
| $\theta_W$ | 0.8 | Wage rigidity |
| $\nu$ | 0.33 | Openness |
| $\eta$ | [0.5,1,2] | Trade elasticity of imports |
| $\eta^*$ | [0.5,1,2] | Trade elasticity of exports |
| $\rho_i$ | 0.9 | Persistence of shocks |

the Calvo parameters for price and wage rigidity is $\theta_W = 0.8$ and $\theta_H = 0.79$, implying an average duration of 5 quarters. The calibration for the price rigidity follows evidence for the GIPS countries in Gautier et al. (2024). The calibration for wage rigidity is consistent with estimates by Druant et al. (2012) and in line with the baseline calibration of Galí and Monacelli (2016). The share of hand-to-mouth households $\lambda = 0.31$ is the average share of hand-to-mouth households in the GIPS countries based on evidence provided in Almgren et al. (2022). The openness measure ($\nu = 0.33$) reflects import and export share data from 2004 to 2024 provided by the OECD. Finally, the calibration for the discount factor $\beta = 0.99$, the inverse of the elasticity of intertemporal substitution $\sigma = 1$, and the shock persistence $\rho_i = 0.9$ follows standard practice.

## 4.2 Wage flexibility and business cycles

We have already seen that wage flexibility can lead to an amplification of shocks and to a destabilization of the economy. Figure 1 presents the response of the size of the dynamic responses of the economy to a foreign demand shock under two different levels of wage rigidity. Under our benchmark calibration, the model displays recessionary wage flexibility, i.e., the response to a foreign demand shock is amplified when wages are less rigid. The difference is not quantitatively large - it accounts for approx. 10% of the initial response in the shock. The small difference in domestic output hides a much larger difference in consumption, which

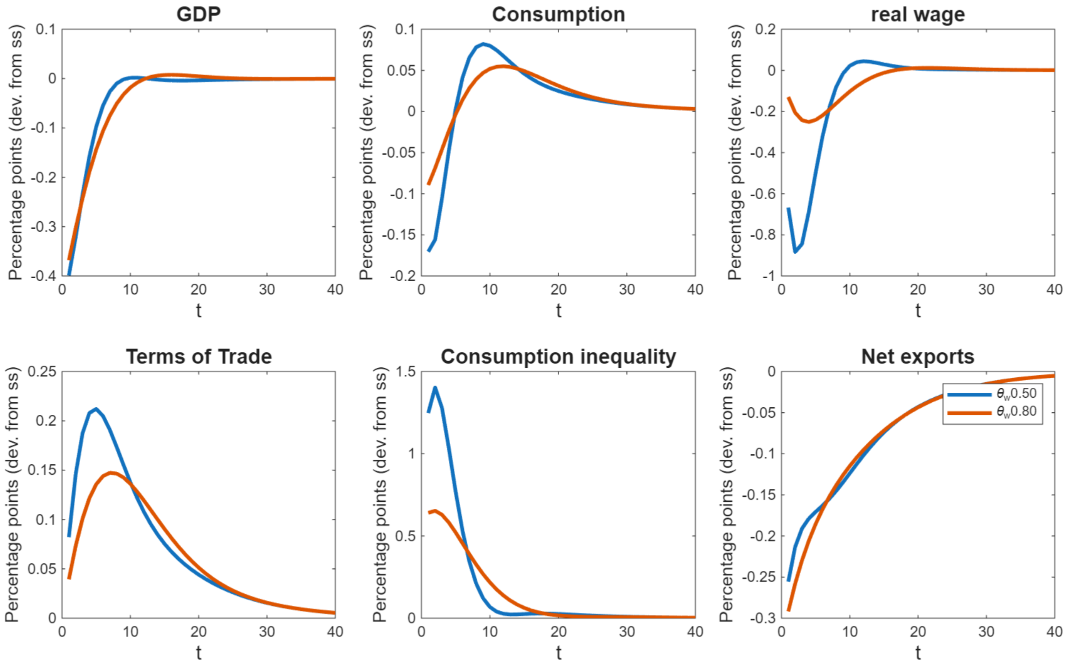


Figure 1: Dynamic response of the economy to a foreign demand shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

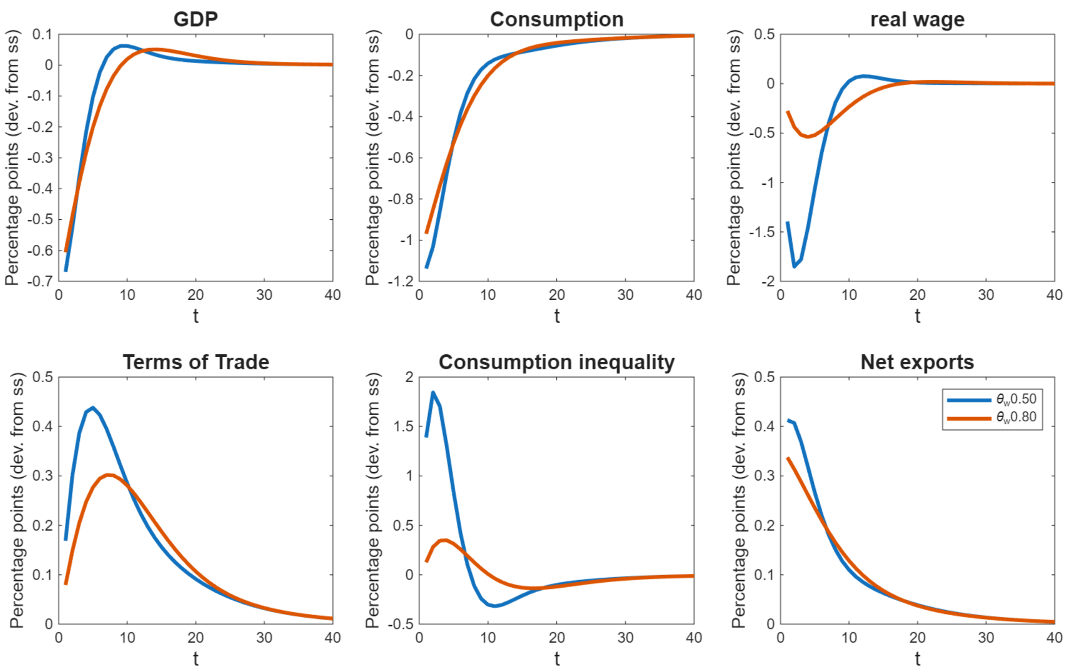


Figure 2: Dynamic response of the economy to an interest rate shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

decreases almost twice as much in the economy with more flexible wages. The large fall in consumption is driven by a substantial decrease in real wages, which affects especially the financially constrained households. The latter effect can be seen in the substantial jump in consumption inequality. The higher response of the terms of trade cannot offset the fall in domestic consumption coming from lower real wages.

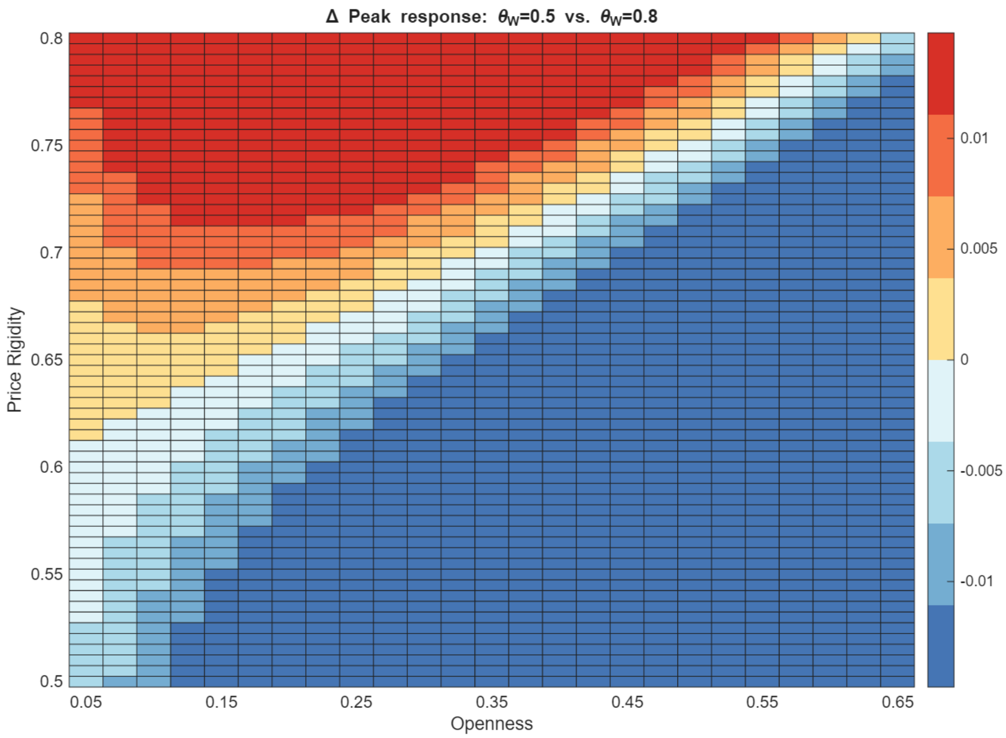


Figure 3: Difference in peak responses to a foreign demand shock between an economy with relatively flexible wages ($\theta_W = 0.5$) and an economy with rigid wages ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible wages.

The results are similar for the two other shocks, which affect the economy symmetrically. Figure 2 shows the response of the economy to a contractionary interest rate shock. The entailing drop in consumption of Ricardian households reduces aggregate demand. Again, flexible wages make the financially constrained households more vulnerable to the economic downturn, amplifying the drop in aggregate consumption and hence economic volatility.

Figure 3 illustrates the sensitivity of the results to two key parameters of the model identified already in Proposition 1: price rigidity and the openness of the economy. The heat map in the figure indicates the difference between the response of the flexible and rigid economies, i.e., $\theta_W = 0.5$ and $\theta_W = 0.8$, respectively. Positive values indicate that the economy is more volatile under flexible prices, which is the case for a non-negligible

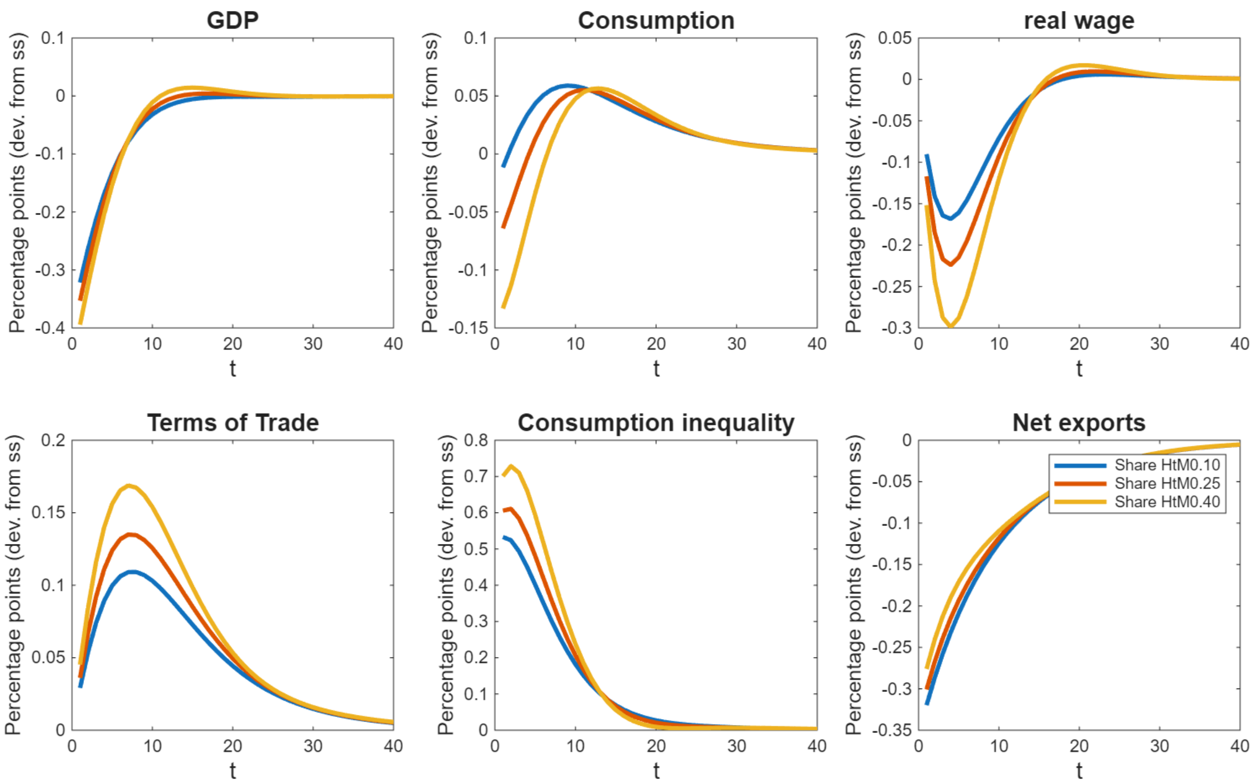


Figure 4: Dynamic response of the economy to a foreign demand shock under varying shares of hand-to-mouth households, with a low ($\lambda = 0.1$, blue), medium ($\lambda = 0.25$, red), and high share ($\lambda = 0.40$, yellow) of constrained households.

share of the parameter values. Consistently with the intuition developed so far, higher price rigidity reduces the effectiveness of flexible prices in stimulating the economy, or put differently the competitiveness channel relies heavily on price reductions. Furthermore, this channel can only operate if the economy is sufficiently open, else any gains in international competitiveness have little impact on the economy as a whole.[3]

Figure 4 illustrates the sensitivity of the model's outcomes to varying proportions of financially constrained households. In response to a decrease in international demand, domestic output declines, which subsequently affects labor demand, wages, real marginal costs, and producer prices. Ricardian households, insulated from the international shock by their ability to maintain consumption through financial markets, contrast sharply with hand-to-mouth households, who must significantly cut their consumption as their income falls.

As the proportion of financially constrained households increases, the transmission of

[3]The non-monotonicity of the heat map along the openness dimension for high values of price rigidity stems from the fact that we look at the effects of a foreign demand shock that depends on the openness of the economy to have a sizable effect.

reduced income to domestic demand and output becomes more pronounced in the small open economy. Consequently, a larger share of these households leads to a greater decline in GDP and a more substantial drop in producer prices. The degree of openness influences how much domestic output is stabilized, as the terms of trade depreciation encourages consumption switching towards domestically produced goods.

## 4.3 Recessionary wage flexibility in the euro area

The previous subsection shows that recessionary wage flexibility can occur under a range of plausible parametrizations. In this section, we go a step further and calibrate the model to fifteen Eurozone countries to study the magnitude of the phenomenon in those economies.[4] In particular, we vary the fraction of Hand-to-Mouth households in the economy ($\lambda$), the openness ($\nu$), the price rigidity ($\theta_H$), and the returns-to-scale of the production function ($\alpha$). The details of the calibration can be found in Appendix C.

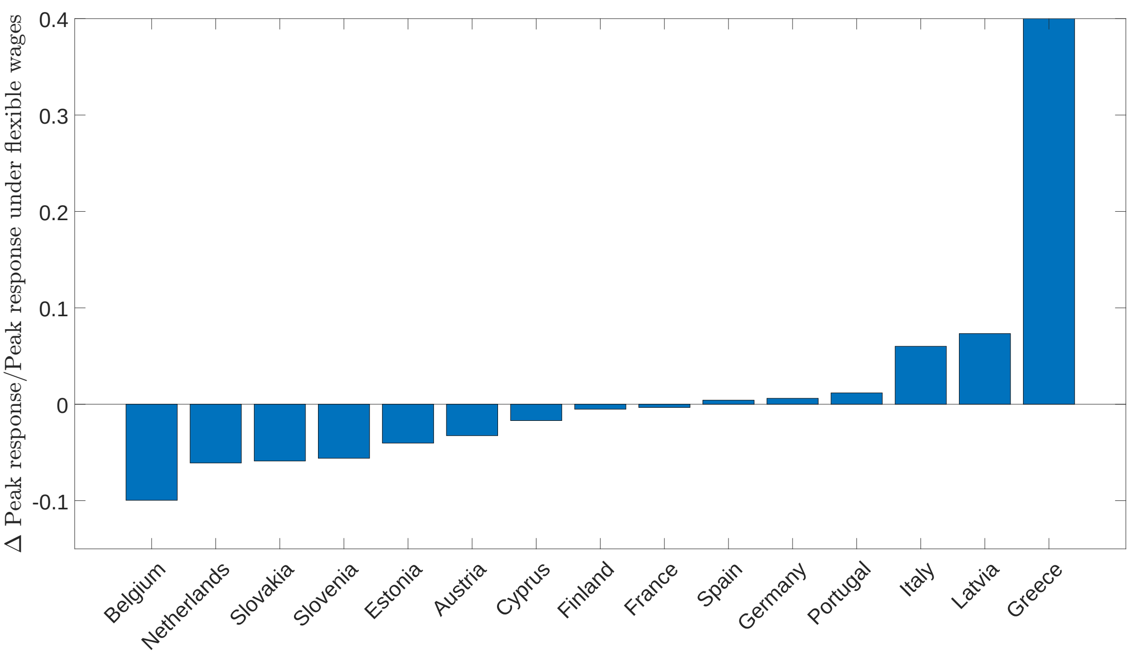


Figure 5: Difference in peak responses to a foreign demand shock between an economy with relatively flexible wages ($\theta_W = 0.5$) and an economy with rigid wages ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible wages.

Figure 5 presents the relative difference of the peak response of output to a foreign

[4] We consider all EMU member states. We dropped countries based on the availability of Hand-to-Mouth share estimates in Almgren et al. (2022) and countries with an openness parameter exceeding one. The full list of countries can be found in Appendix C.

demand shock under flexible ($\theta_W = 0.5$) and rigid ($\theta_W = 0.8$) wages. For example, a value of 0.073 for Latvia implies that the economy has a 7.3% larger response to a foreign demand shock under flexible wages than under rigid wages. Hence, making wages more flexible would make the Latvian economy more volatile. On the contrary, the value of -0.10 for Belgium implies that the Belgian economy would be less volatile with more flexible wages.

Six out of the fifteen economies in our sample are more volatile under flexible than under rigid wages. The main features of the economy that seem to matter in our calibrations are the fraction of constrained households and the economy's trade openness. Among the economies exhibiting recessionary wage flexibility, all but Latvia have a low trade openness, while Latvia has the highest share of constrained households in the sample. It is also telling that the country most responsive to wage flexibility reforms, namely Greece, is characterized by low openness and substantial financial constraints.

Overall, Figure 5 highlights that our mechanism is more than a theoretical curiosity and it is likely to be present in some European economies. It seems especially important for the peripheral countries hit hard by the Eurozone Crisis, which faced pressure to implement structural reforms as a policy response to the crisis.

### 4.4 Robustness to a HANK setup

The results of the quantitative TANK model confirm the main findings of the analytical section. To ensure our findings are not an artifact of the two-agent specification with complete financial markets, we generalize the household heterogeneity in the spirit of Auclert and Rognlie (2018) and Auclert et al. (2021). The model in this section is a Heterogeneous Agent New Keynesian (HANK) model with agents facing idiosyncratic income risk, borrowing constraints, and incomplete international financial markets. The detailed model specification is provided in Appendix D.

Figure 6 demonstrates that our core results remain robust in this richer heterogeneous environment. Output responds more to a foreign demand shock under flexible wages. The difference is even starker for consumption, consistent with the argument that domestic demand is the driving force behind the amplifying effect of flexible wages.

## 5 Conclusion

In conclusion, our findings demonstrate that increased wage flexibility within a monetary union, while potentially beneficial for international competitiveness, can exacerbate eco-

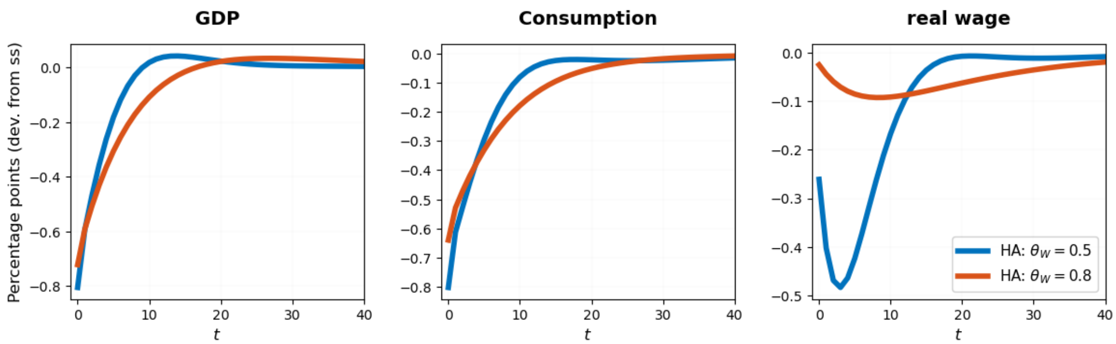


Figure 6: Dynamic response of the HANK economy to a foreign demand shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

nomic instability under certain conditions. Utilizing a Two-Agent New-Keynesian model, the analysis highlights the dual impact of wage adjustments: the competitiveness channel, which enhances demand for cheaper domestic goods, and the income channel, which reduces domestic consumption due to lower household income. The findings reveal that the income channel's destabilizing effects can dominate in the presence of significant financial constraints, low price flexibility, and a high home bias in consumption.

This paper's insights contribute to the broader discussion on labor market reforms in monetary unions, suggesting that policymakers should carefully consider the conditions under which wage flexibility is implemented. While flexibility can aid in adjusting to external shocks, its potential to increase economic volatility and inequality underscores the need for a nuanced approach that accounts for the specific economic context and the presence of other structural frictions.

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Online Appendix

# A Analytical Results

## A.1 Steady-state

In steady-state, preference shocks are normalized to unity. As in the dynamic model, price stability in the foreign economy implies that $P^* = P_F^* = 1$ in steady-state. From the domestic and foreign Euler equations, it follows that $i = i^* = \frac{1-\beta}{\beta}$. With stable prices in steady-state, gross inflation remains constant at $\Pi_P = \Pi_H = \Pi_W = 1$.

We normalize the price ratio of foreign to domestic prices to one, implying that the terms of trade are unity ($S = \frac{P_F}{P_H} = 1$). We set the scaling parameter in the production function, $z$, such that output is unity ($Y = 1$). Due to symmetry, aggregate international output and consumption also equal one in steady state ($Y = C = 1$). From the aggregate price equation (6):

$$P \equiv \left[\nu P_F^{1-\eta} + (1-\nu) P_H^{1-\eta}\right]^{1/(1-\eta)}.$$

Given $P_F = 1$, it follows that $P = P_F = P_H = 1$, further $Q = 1$ and $P_H^* = 1$.

From the production function (21), it follows that $N = z^{-\frac{1}{1-\alpha}}$. Profit maximization by monopolistically competitive firms implies:

$$\frac{P_H}{P} = 1 = \frac{\epsilon_H}{\epsilon_H - 1} \frac{N^\alpha}{z(1-\alpha)} \omega.$$

Combining the previous two terms, we obtain an expression for the real wage $\omega$

$$\omega = z^{\frac{1}{1-\alpha}} \frac{\epsilon_H - 1}{\epsilon_H} (1-\alpha).$$

Given that output is unity, the consumption of constrained agents is:

$$C_c = \omega N = \frac{1-\alpha}{\mathcal{M}_H} Y = \frac{\epsilon^H - 1}{\epsilon^H} (1-\alpha). \tag{37}$$

Consumption of domestic (4), (27) and Foreign goods (5) implies

$$C_H = (1-\nu) C,$$

$$C_H^* = \nu C^*,$$
$$C_F = \nu C.$$

Substituting this into the market clearing condition (20) implies $Y = C_H + C_H^* = (1-\nu)C + \nu C^*$. Given that $Y = C^* = 1$, aggregate consumption is $C = 1$. Consumption of constrained households is now implied by $C = (1-\lambda)C_u + \lambda C_c$. Solving for $C_u$ and substituting the previous results yields

$$C_u = \frac{1}{1-\lambda} - \frac{\lambda}{1-\lambda}\frac{\epsilon^H - 1}{\epsilon^H}(1-\alpha).$$

The consumption gap between households $\gamma = \frac{C_u}{C_c}$ in steady state is

$$\gamma = \frac{(1-\alpha) + \frac{1}{1-\lambda}\left(\frac{\epsilon_H}{\epsilon_H - 1} - (1-\alpha)\right)}{1-\alpha}. \tag{38}$$

Now, we can back out $z$ using equation (16) that determines the optimal wage setting of the unions $\omega N^{-\varphi} = \frac{\epsilon_W}{\epsilon_W - 1}\left[(1-\lambda)C_u^{-\sigma} + \lambda C_c^{-\sigma}\right]^{-1}$ and substituting the steady state values of $\omega$ and $N$ only, as the consumption of households is independent of $z$.

$$z = \left\{\frac{\epsilon_W}{\epsilon_W - 1}\frac{\epsilon_H}{\epsilon_H - 1}\frac{1}{1-\alpha}\left[(1-\lambda)C_u^{-\sigma} + \lambda C_c^{-\sigma}\right]^{-1}\right\}^{\frac{1-\alpha}{1+\varphi}}.$$

Lastly, under complete markets, the risk-sharing condition (10) $C_u^\sigma = \vartheta Q \frac{\chi}{\chi^*}(C^*)^\sigma$ implies that the initial condition $\vartheta$ depends on the relationship between consumption of constrained households and international demand:

$$\vartheta = (C_u)^\sigma.$$

Since $C_u > 1$, $\vartheta$ is generally greater than unity. Additionally, it can be shown that the consumption ratios $\frac{C_u}{C} > 1$ and $\frac{C_c}{C} < 1$, indicating that the steady-state consumption gap between constrained and unconstrained agents $\gamma > 1$.

## A.2 Model derivations

### A.2.1 Market clearing condition

Aggregate output in the economy is given by the demand for domestic goods by agents in the Home and the Foreign economy $Y_t = C_{Ht} + C^*_{Ht}$. Substituting the demand schedules of agents, equations (4) and (27) yields

$$Y_t = (1-\nu)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_t + \nu \left(\frac{P^*_{Ht}}{P^*_{Ft}}\right)^{-\eta^*} C^*_t.$$

Log-linearizing the previous expression and substituting the exogenous process of shocks for $C^*_t$ gives

$$\hat{y}_t = (1-\nu)\hat{c}_t + (1-\nu)(\eta\nu + \frac{\nu}{1-\nu}\eta^*)\hat{s}_t + \frac{\nu}{\sigma}\hat{\chi}^*_{1t}. \tag{39}$$

where we use that $\hat{p}_{Ht} - \hat{p}_t = -\nu\hat{s}_t$, and further $\hat{s}_t = \hat{p}^*_{Ft} - \hat{p}^*_{Ht} = -\hat{p}^*_{Ht}$. Setting $\eta = \eta^* = \sigma = 1$ yields equation (30) in the main text.

### A.2.2 Consumption inequality

Firstly, recall that the consumption of unconstrained households is given by the risk-sharing condition, equation (10).

Thus, substituting consumption of constrained and unconstrained households in the expression for consumption inequality yields

$$\gamma_t = Q_t^{1/\sigma}\left(\frac{\chi_t}{\chi^*_t}\right)^{1/\sigma} C^*_t \frac{P_t}{W_t N_t},$$

Further, using that aggregate output in the economy is $Y_t = zN_t^{1-\alpha}(\Delta_{Ht}\Delta_{Wt})^{-(1-\alpha)}$, and rearranging the previous equation, we obtain

$$\gamma_t = \left(\frac{\chi_t}{\chi^*_t}\right)^{1/\sigma} C^*_t Q_t^{1/\sigma} \frac{P_t}{W_t} Y_t^{-\frac{1}{1-\alpha}} z^{\frac{1}{1-\alpha}} \left(\Delta_{Wt}\Delta_{Ht}\right)^{-1}.$$

In deviations from steady state, using that $\hat{q}_t = (1-\nu)\hat{s}_t$, the consumption gap is

$$\hat{\gamma}_t = -\left[\hat{\omega}_t + \frac{1}{1-\alpha}\hat{y}_t - (1-\nu)\frac{1}{\sigma}\hat{s}_t\right] + \frac{1}{\sigma}\left(\hat{\chi}_t - \hat{\chi}^*_t\right) + \hat{c}^*_t.$$

Substituting the definition for the shocks and substituting out international demand, and setting $\alpha = 0$, and $\sigma = 1$, yields the expression in the main text:

$$\hat{\gamma}_t = -\left[\hat{\omega}_t + \hat{y}_t - (1-\nu)\hat{s}_t\right] + \left(\hat{\chi}_t - \hat{\chi}^*_{2t}\right)$$

### A.2.3 Aggregate Euler equation

The income of constrained households is $C_{c,t} = \frac{W_t}{P_t} N_t$. Unconstrained households face a consumption-savings trade-off governed by their Euler equation, equation (9). Log-linearizing the equation yields

$$\hat{c}_{u,t} = \mathrm{E}_t\left\{\hat{c}_{u,t+1}\right\} - \sigma^{-1}\left(i_t - \mathrm{E}_t\left\{\hat{\pi}_{p,t+1}\right\} - \hat{\chi}_t + \mathrm{E}_t\left\{\hat{\chi}_{t+1}\right\}\right). \tag{40}$$

Further, we can rewrite aggregate consumption $C_t = (1-\lambda)C_{u,t} + \lambda C_{c,t}$ when defining the consumption gap between unconstrained and constrained households as $\gamma_t \equiv \frac{C_{u,t}}{C_{c,t}}$ to arrive at $\frac{C_t}{C_{u,t}} = (1-\lambda) + \lambda\gamma_t^{-1}$. Log-linearizing this expression yields

$$\hat{c}_t - \hat{c}_{u,t} = -\frac{\lambda}{\gamma(1-\lambda)+\lambda}\hat{\gamma}_t. \tag{41}$$

Combining equations (40) and (41) and defining $\Delta\hat{\chi}_{t+1} = \mathrm{E}_t\left\{\hat{\chi}_{t+1}\right\} - \hat{\chi}_t$ yields

$$\hat{c}_t = \mathrm{E}_t\left\{\hat{c}_{t+1}\right\} - \sigma^{-1}\left(i_t - \mathrm{E}_t\left\{\hat{\pi}_{p,t+1}\right\} + \Delta\hat{\chi}_{t+1}\right) + \frac{\lambda}{\gamma(1-\lambda)+\lambda}\mathrm{E}_t\left\{\Delta\hat{\gamma}_{t+1}\right\}. \tag{42}$$

Solving this equation forward, consumption today depends on the sequence of future real interest rate, as well as the current preference shock and the consumption gap:

$$\hat{c}_t = -\frac{1}{\sigma}\mathrm{E}_t\sum_{k=0}\left(i_{t+k} - \hat{\pi}_{p,t+k+1}\right) + \frac{1}{\sigma}\hat{\chi}_t - \frac{\lambda}{\gamma(1-\lambda)+\lambda}\hat{\gamma}_t. \tag{43}$$

### A.2.4 Price Phillips Curve

As noted previously, to keep the model analytically tractable, we assume that a fraction $(1-\theta_H)$ of optimizing firms ("o") can reset their prices after the realization of shocks. The remainder of Home firms ("m") $\theta_H$ set the prices at the end of the previous period. The individual output of each firm depends on individual prices, as well as aggregate prices and output, see equation (19). Taking the natural logarithm implies that $y_{jt} = y_t - \epsilon_H(p_{jHt} - p_{Ht})$.

Therefore, optimizers produce

$$y_{o,jt} = y_t - \epsilon_H(p_{o,jHt} - p_{Ht}). \tag{44}$$

The optimal price that firms choose is determined by the markup over marginal costs: $p_{o,jHt} = \mu_H + w_t + \alpha n_{jt} - \log(z(1-a))$. Substituting that $n_{jt} = \frac{1}{1-\alpha}y_{jt} - \frac{1}{1-\alpha}\log z$, the optimal price is

$$p_{o,jHt} = \mu_H + w_t + \frac{\alpha}{1-\alpha}y_{jt} - \bar{z}, \tag{45}$$

where $\bar{z} \equiv \frac{\alpha}{1-\alpha}\log z - \log z - \log(1-\alpha)$ Combining the production of optimizers equation (44) with equation (45) yields

$$\frac{1-\alpha+\alpha\epsilon_H}{1-\alpha}p_{o,jHt} = (\mu_H + w_t - p_t + \frac{\alpha}{1-\alpha}y_t - \bar{z}) + \frac{\alpha\epsilon_H}{1-\alpha}p_{Ht} + p_t$$
$$p_{o,jHt} = \frac{1-\alpha}{1-\alpha+\alpha\epsilon_H}(\mu_H + w_t - p_t + \frac{\alpha}{1-\alpha}y_t - \bar{z}) + \frac{1-\alpha}{1-\alpha+\alpha\epsilon_H}\left(\frac{\alpha\epsilon_H}{1-\alpha}p_{Ht} + p_t\right),$$

where the index $j$ drops, implying that all optimizing firms choose the same price. Noting that $p_t = p_{Ht} - q_t + s_t = p_{Ht} + \nu s_t$ and rearranging the previous equation, we obtain

$$p_{o,Ht} = \frac{1-\alpha}{1-\alpha+\alpha\epsilon_H}(\mu_H + \omega_t + \frac{\alpha}{1-\alpha}y_t - \bar{z} + \nu s_t) + p_{Ht} \tag{46}$$
$$\Rightarrow \hat{p}_{o,Ht} = \frac{1-\alpha}{1-\alpha+\alpha\epsilon_H}(\hat{\omega}_t + \frac{\alpha}{1-\alpha}\hat{y}_t + \nu\hat{s}_t) + \hat{p}_{Ht}. \tag{47}$$

Non-optimizers choose their prices at the end of period $t-1$:

$$p_{m,jHt} = \mathrm{E}_{t-1}\left\{\mu_H + w_t - p_t + p_t + \alpha n_{m,jt} - \log(z(1-\alpha))\right\} \tag{48}$$
$$\Rightarrow \hat{p}_{m,jHt} = \mathrm{E}_{t-1}\left\{\hat{\omega}_t + \hat{p}_t + \alpha\hat{n}_{m,jt}\right\} = \mathrm{E}_{t-1}\{\hat{\omega}_t + \hat{p}_t + \frac{\alpha}{1-\alpha}\hat{y}_t\} \tag{49}$$

The aggregate price index $P_{Ht} = \left(\int P_{jHt}^{1-\epsilon_H}dj\right)^{\frac{1}{1-\epsilon_H}}$ in this specification is equivalent to $P_{Ht} = \left((1-\theta_H)P_{o,Ht}^{1-\epsilon_H} + \theta_H P_{m,Ht}^{1-\epsilon_H}\right)^{\frac{1}{1-\epsilon_H}}$. If $P_{o,H} = P_{m,H}$ in steady state, then it follows that $\hat{p}_{Ht} = (1-\theta_H)\hat{p}_{o,Ht} + \theta_H\hat{p}_{m,Ht}$. Substituting the expressions for the prices of optimizing and non-optimizing firms gives

$$\hat{\pi}_{Ht} = \mathrm{E}_{t-1}\left[\hat{\pi}_{Ht}\right] + \kappa_H\left[\hat{\omega}_t + \nu\hat{s}_t + \frac{\alpha}{1-\alpha}\hat{y}_t\right] + \mathrm{E}_{t-1}\left[\hat{\omega}_t + \nu\hat{s}_t + \frac{\alpha}{1-\alpha}\hat{y}_t\right], \tag{50}$$

where $\kappa_H \equiv \frac{1-\theta_H}{\theta_H}\frac{1-\alpha}{1-\alpha+\alpha\epsilon_H}$. Thus, Home price inflation depends on real wages, output, and the terms of trade, just as in a standard open economy New Keynesian Phillips Curve.

Applying the assumption of iid shocks and replacing $\hat{p}_{Ht}$ with the terms-of-trade yields the Price Phillips Curve

$$\begin{aligned} -\hat{s}_t &= \kappa_H \left[\hat{\omega}_t + \frac{\alpha}{1-\alpha}\hat{y}_t + \nu\hat{s}_t\right], \\ \hat{s}_t &= -\frac{\kappa_H}{1+\kappa_H\nu}\left[\hat{\omega}_t + \frac{\alpha}{1-\alpha}\hat{y}_t\right]. \end{aligned} \tag{51}$$

Lastly, to obtain the equation of the main text, let $\alpha = 0$.

### A.2.5 Wage Phillips Curve

**Average marginal utility of consumption**

Note that period utility of agents is $U_{K,t} = \chi_t\left(u(C_{K,t}) - v(N_{K,t})\right)$, thus the average marginal utility of consumption in the economy is $U_t \equiv \lambda\chi_t C_{c,t}^{-\sigma} + (1-\lambda)\chi_t C_{u,t}^{-\sigma}$. Log-linearizing the expression yields

$$\hat{u}_t = -\sigma\left(u_c\hat{c}_{c,t} + u_u\hat{c}_{u,t}\right) + \hat{\chi}_t, \tag{52}$$

where, using that $\gamma = \frac{C_u}{C_c}$ implies $u_c \equiv \frac{\lambda C_c^{-\sigma}}{\lambda C_c^{-\sigma}+(1-\lambda)C_u^{-\sigma}} = \frac{\lambda}{\lambda+(1-\lambda)\gamma^{-\sigma}}$ and $u_u \equiv \frac{(1-\lambda)C_u^{-\sigma}}{\lambda C_c^{-\sigma}+(1-\lambda)C_u^{-\sigma}} = \frac{(1-\lambda)\gamma^{-\sigma}}{\lambda+(1-\lambda)\gamma^{-\sigma}}$.

**Consumption of constrained and unconstrained agents**

Aggregate output in the economy is given by the demand for domestic goods by agents in the Home and in the Foreign economy $Y_t = C_{Ht} + C_{Ht}^*$. Substituting the demand schedules of agents, equations (4) and (27), as well as the composition of overall demand by domestic agents in terms of the output gap $C_t = C_{ut}\left(\frac{\lambda}{\gamma_t} + (1-\lambda)\right)$ yields

$$Y_t = (1-\nu)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_{ut}\left(\frac{\lambda}{\gamma_t} + (1-\lambda)\right) + \nu\left(\frac{P_{Ht}^*}{P_{Ft}^*}\right)^{-\eta^*} C_t^*.$$

Log-linearizing the previous expression gives

$$\hat{y}_t = (1-\nu)\left[\eta\nu\hat{s}_t + \hat{c}_{ut}\right] + \nu\left[\eta^*\hat{s}_t + \hat{c}_t^*\right] - C_u(1-\nu)\frac{\lambda}{\gamma}\hat{\gamma}_t,$$

where we again used that $\hat{p}_{Ht} - \hat{p}_t = -\nu\hat{s}_t$, and further $\hat{s}_t = \hat{p}_{Ft}^* - \hat{p}_{Ht}^* = -\hat{p}_{Ht}^*$. Now, we can solve for consumption of constrained and unconstrained agents (note that $\hat{c}_{ct} = \hat{c}_{ut} - \hat{\gamma}_t$):

$$\hat{c}_{ut} = \frac{1}{(1-\nu)}\hat{y}_t - (\eta\nu + \frac{\nu}{(1-\nu)}\eta^*)\hat{s}_t - \frac{\nu}{(1-\nu)}\hat{c}_t^* + C_u\frac{\lambda}{\gamma}\hat{\gamma}_t \tag{53}$$

$$\hat{c}_{ct} = \frac{1}{(1-\nu)}\hat{y}_t - (\eta\nu + \frac{\nu}{(1-\nu)}\eta^*)\hat{s}_t - \frac{\nu}{(1-\nu)}\hat{c}_t^* + \left[C_u\frac{\lambda}{\gamma} - 1\right]\hat{\gamma}_t. \tag{54}$$

**Average marginal utility of consumption in terms of output, real wage and the terms of trade**

To obtain the average marginal utility of consumption in terms of output, the real wage and the terms of trade, we combine the average marginal utility of consumption, equation (52), with the consumption of agents, equations (53) and (54), to obtain

$$\hat{u}_t = -\sigma\frac{1}{(1-\nu)}\hat{y}_t + \sigma(\eta\nu + \frac{\nu}{(1-\nu)}\eta^*)\hat{s}_t + \sigma\frac{\nu}{(1-\nu)}\hat{c}_t^* + \sigma\bar{u}\hat{\gamma}_t + \hat{\chi}_t,$$

where $\bar{u} \equiv -\frac{\lambda(C_c(\lambda+(1-\lambda)\gamma^{-\sigma})-1)}{(\lambda+(1-\lambda)\gamma^{-\sigma})}$. Note that $\bar{u}$ is positive as the numerator is negative. This follows since in steady-state $C_c < 1$ and $\gamma > 1$.

Now, we can plug the expressions for the consumption gap in the previous expression to obtain the average marginal utility of consumption depending on output, the real wage, the terms of trade, as well as changes in exogenous parameters.

$$\hat{u}_t = -\varpi_1\hat{y}_t - \varpi_2\hat{\omega}_t + \varpi_3\hat{s}_t + \varpi_4\hat{c}_t^* + \varpi_5\hat{\chi}_t - \varpi_6\hat{\chi}_t^*, \tag{55}$$

where $\varpi_1 \equiv \sigma(\frac{1}{(1-\nu)} + \bar{u}\frac{1}{1-\alpha})$, $\varpi_2 \equiv \sigma\bar{u}$, $\varpi_3 \equiv \bar{u} + \nu(\sigma(\eta + \frac{\eta^*}{1-\nu}) - \bar{u})$, $\varpi_4 \equiv \sigma\left(\frac{\nu}{(1-\nu)} + \bar{u}\right)$, $\varpi_5 \equiv 1 + \bar{u}$, $\varpi_6 \equiv \bar{u}$.

**Labor supply schedule**

The log-linearized version of the optimality condition for labor unions reads $\hat{\omega}_t + \hat{u}_t - \hat{\chi}_t = \varphi\hat{n}_t$, plugging in equation (55) and solving for the real wage yields

$$\hat{\omega}_t = \varpi_Y\hat{y}_t + \bar{\varphi}\hat{n}_t - \varpi_S\hat{s}_t - \hat{\varkappa}_t,$$

where $\varpi_Y \equiv \frac{\varpi_1}{1-\varpi_2}$, $\bar{\varphi} \equiv \frac{\varphi}{1-\varpi_2}$, $\varpi_S \equiv \frac{\varpi_3}{1-\varpi_2}$, and aggregate shocks are summarized in $\hat{\varkappa}_t \equiv \frac{1}{1-\varpi_2}\left[\sigma\left(\frac{\nu}{(1-\nu)} + \bar{u}\right)\hat{c}_t^* + \bar{u}(\hat{\chi}_t - \hat{\chi}_t^*)\right]$.[5]

[5] The definitions of the auxiliary parameters in the appendix differ somewhat from the definitions in the main text (as presented in the description of equation (34). The differences stem from the simplifying assumptions in the analytical section; hence, the parameters in the main text are special case values of the

Thus, a union that can optimize wages chooses

$$\hat{\omega}_{olt} = \varpi_Y \hat{y}_t + \bar{\varphi}\hat{n}_{olt} - \varpi_S \hat{s}_t - \hat{\varkappa}_t. \tag{56}$$

Substituting the log-linearized labor demand function for labor variety $l$, $\hat{n}_{olt} = \hat{n}_t - \epsilon_W(\hat{\omega}_{olt} - \hat{\omega}_t)$ into the previous equation (56) determines the wage changes of optimizers as a function of aggregate changes in labor:

$$\begin{aligned}\hat{\omega}_{ot} &= \frac{1}{1+\bar{\varphi}\epsilon_W}\left[\varpi_Y \hat{y}_t + \bar{\varphi}\hat{n}_t - \varpi_S \hat{s}_t + \bar{\varphi}\epsilon_W \hat{\omega}_t - \hat{\varkappa}_t\right]. \\ &= \frac{1}{1+\bar{\varphi}\epsilon_W}\left[\left(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha}\right)\hat{y}_t - \varpi_S \hat{s}_t + \bar{\varphi}\epsilon_W \hat{\omega}_t - \hat{\varkappa}_t\right].\end{aligned}$$

The non-optimizing labor unions set a real wage

$$\hat{\omega}_{mt} = \hat{w}_{mt} - \hat{p}_t = \mathrm{E}_{t-1}\left[\hat{\omega}_{ot} + \hat{p}_t\right] - \hat{p}_t = \mathrm{E}_{t-1}\left[\hat{\omega}_t + \hat{p}_t\right] - \hat{p}_t. \tag{57}$$

Bringing the two above results together gives us the real wage set in the economy

$$\begin{aligned}\hat{\omega}_t &= (1-\theta_W)\hat{\omega}_{ot} + \theta_W \hat{\omega}_{mt} \\ &= (1-\theta_W)\frac{1}{1+\bar{\varphi}\epsilon_W}\left[\varpi_Y \hat{y}_t + \bar{\varphi}\hat{n}_t - \varpi_S \hat{s}_t - \hat{\varkappa}_t + \bar{\varphi}\epsilon_W \hat{\omega}_t\right] + \theta_W \mathrm{E}_{t-1}\left[\hat{\omega}_t + \hat{p}_t\right] - \theta_W \hat{p}_t.\end{aligned}$$

Next, multiply the equation with $1/\theta_W$ and subtract $\frac{1-\theta_W}{\theta_W}\frac{\bar{\varphi}\epsilon_W}{1+\epsilon_W\bar{\varphi}}\hat{\omega}_t$ on both sides:

$$\left(\frac{1}{\theta_W} - \frac{1-\theta_W}{\theta_W}\frac{\bar{\varphi}\epsilon_W}{1+\epsilon_W\bar{\varphi}}\right)\hat{\omega}_t = \frac{1-\theta_W}{\theta_W}\frac{1}{1+\bar{\varphi}\epsilon_W}\left[\left(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha}\right)\hat{y}_t - \varpi_S \hat{s}_t - \hat{\varkappa}_t\right] + \mathrm{E}_{t-1}\left[\hat{\omega}_t + \hat{p}_t\right] - \hat{p}_t.$$

Further, define $\kappa_W \equiv \frac{1-\theta_W}{\theta_W}\frac{1}{1+\bar{\varphi}\epsilon_W}$ and note that we can rewrite

$$\begin{aligned}\frac{1}{\theta_W} - \frac{1-\theta_W}{\theta_W}\frac{\bar{\varphi}\epsilon_W}{1+\epsilon_W\bar{\varphi}} &= \frac{(1+\bar{\varphi}\epsilon_W) - (1-\theta_W)\bar{\varphi}\epsilon_W}{\theta_W(1+\epsilon_W\bar{\varphi})} \\ &= \frac{1+\theta_W\bar{\varphi}\epsilon_W + \theta_W - \theta_W}{\theta_W(1+\epsilon_W\bar{\varphi})} = \frac{1-\theta_W}{\theta_W(1+\epsilon_W\bar{\varphi})} + \frac{\theta_W(1+\bar{\varphi}\epsilon_W)}{\theta_W(1+\epsilon_W\bar{\varphi})} = 1+\kappa_W.\end{aligned}$$

Lastly, substituting the last expression on the left-hand side and rearranging the equation

definitions in the appendices.

yields

$$\hat{\omega}_t = \mathrm{E}_{t-1}\left[\hat{\omega}_t + \hat{p}_t\right] - \hat{p}_t + \kappa_W \left[\left(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha}\right)\hat{y}_t - \varpi_S \hat{s}_t - \hat{\omega}_t - \hat{\varkappa}_t\right]. \tag{58}$$

Thus, the wage Philips curve (in nominal wages) is given by:

$$\hat{w}_t = \mathrm{E}_{t-1}\left[\hat{w}_t\right] + \kappa_W \left[(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha})\hat{y}_t - \varpi_S \hat{s}_t - \hat{\omega}_t - \hat{\varkappa}_t\right].$$

Further, note that $\hat{\omega}_t + \hat{p}_t = \hat{\omega}_t - (1-\nu)\hat{s}_t$. Applying the assumption of i.i.d. non-persistent shocks to equation (58) and using that $\hat{\varkappa}_t = \frac{1}{1-\bar{u}}\frac{\nu}{1-\nu}\hat{\chi}^*_{1t} + \frac{\bar{u}}{1-\bar{u}}(\hat{\chi}_t - \hat{\chi}^*_{2t})$, and setting $\alpha = 0$ we obtain equation (34) in the main text

$$\begin{aligned} \hat{\omega}_t - (1-\nu)\hat{s}_t = \kappa_W &\left[(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha})\hat{y}_t - \varpi_S \hat{s}_t - \hat{\omega}_t - \frac{1}{1-\bar{u}}\frac{\nu}{1-\nu}\hat{\chi}^*_{1t} - \frac{\bar{u}}{1-\bar{u}}(\hat{\chi}_t - \hat{\chi}^*_{2t})\right] \\ \Longleftrightarrow \hat{\omega}_t = &\frac{\kappa_W}{1+\kappa_W}\left[(\varpi_Y + \frac{\bar{\varphi}}{1-\alpha})\hat{y}_t\right] - \frac{1}{1+\kappa_W}\left[\kappa_W \varpi_S - (1-\nu)\right]\hat{s}_t \\ &- \frac{\kappa_W}{1+\kappa_W}\left[\frac{1}{1-\bar{u}}\frac{\nu}{1-\nu}\hat{\chi}^*_{1t} + \frac{\bar{u}}{1-\bar{u}}(\hat{\chi}_t - \hat{\chi}^*_{2t})\right]. \end{aligned} \tag{59}$$

## A.3 Proofs

**Lemma 1.** *The dynamics of output in the simplified model can be expressed as*

$$\hat{y}_t = a_\chi \hat{\chi}_t + a^*_1 \hat{\chi}^*_{1t} + a^*_2 \hat{\chi}^*_{2t}, \tag{35}$$

*where the coefficients $a_\chi$, $a^*_1$, and $a^*_2$ are combinations of the structural parameters of the model.*

*Proof.* Equations (30) to (34) determine the system's equilibrium. Plugging equation (31) into equation (32), and subsequently combining the new equation with (30) and solving for $\hat{y}_t$, we obtain an expression of $\hat{y}_t$ as a function of $\hat{s}_t$, $\hat{\omega}_t$, and the three shocks. This yields

$$\hat{y}_t = \frac{\mathcal{A}}{\mathcal{C}}\hat{s}_t + \frac{(1-\nu)\lambda C_c}{\mathcal{C}}\hat{\omega}_t + \frac{(1-\nu)(1-\lambda C_c)}{\mathcal{C}}(\hat{\chi}_t - \hat{\chi}^*_{2t}) + \frac{\nu}{\mathcal{C}}\hat{\chi}^*_{1t}, \tag{60}$$

where we define $\mathcal{A} \equiv (1-\nu)\left[(1-\nu)(1-\lambda C_c) + \nu(1+\frac{1}{1-\nu})\right]$ and $\mathcal{C} \equiv 1 - (1-\nu)\lambda C_c$.

To simplify the derivation, we can write the system generically and only focus on one shock at a time. That is, we can restate (60) as

$$\hat{y}_t = \frac{\mathcal{A}}{\mathcal{C}}\hat{s}_t + \frac{(1-\nu)\lambda C_c}{\mathcal{C}}\hat{\omega}_t + \frac{\mathcal{B}_i}{\mathcal{C}}\hat{\chi}_{it}, \tag{61}$$

where $\mathcal{B}_i \in \{\mathcal{B}_\chi, \mathcal{B}_{\chi_1^*}, \mathcal{B}_{\chi_2^*}\}$ relate respectively to $\hat{\chi}_{it} \in \{\hat{\chi}_t, \hat{\chi}_{1t}^*, \hat{\chi}_{2t}^*\}$, where the parameters are defined as $\mathcal{B}_\chi \equiv (1-\nu)(1-\lambda C_c)$, $\mathcal{B}_{\chi_1^*} \equiv \nu$, and $\mathcal{B}_{\chi_2^*} \equiv -(1-\nu)(1-\lambda C_c)$.

Next, recall equation (33) from the main text (in its form from equation (51)):

$$\hat{s}_t = -\frac{\kappa_H}{1+\kappa_H\nu}\hat{\omega}_t, \tag{62}$$

and restate equation (34) as

$$\hat{\omega}_t = \frac{\kappa_W}{1+\kappa_W}\left(\varpi_Y + \bar{\varphi}\right)\hat{y}_t - \frac{1}{1+\kappa_W}\left(\kappa_W\varpi_S - (1-\nu)\right)\hat{s}_t - \frac{\kappa_W}{1+\kappa_W}\mathcal{D}_i\chi_i, \tag{63}$$

where $\mathcal{D}_i \in \{\mathcal{D}_\chi, \mathcal{D}_{\chi_1^*}, \mathcal{D}_{\chi_2^*}\}$ relate respectively to $\hat{\chi}_{it} \in \{\hat{\chi}_t, \hat{\chi}_{1t}^*, \hat{\chi}_{2t}^*\}$.

Further $\mathcal{D}_\chi \equiv \frac{\bar{u}}{1-\bar{u}}$, $\mathcal{D}_{\chi_1^*} \equiv \frac{1}{1-\bar{u}}\frac{\nu}{1-\nu}$, and $\mathcal{D}_{\chi_2^*} \equiv -\frac{\bar{u}}{1-\bar{u}}$.

Thus, our generic equilibrium system consists of equations (61), (62), and (63).

To solve the system, first combine equations (62) and (63) to obtain

$$\hat{\omega}_t = (1+\kappa_H\nu)f(\kappa_W)\left(\varpi_Y + \bar{\varphi}\right)\hat{y}_t - (1+\kappa_H\nu)f(\kappa_W)\mathcal{D}_i\hat{\chi}_{it}, \tag{64}$$

where $f(\kappa_W) \equiv \frac{\kappa_W}{(1+\kappa_W)(1+\kappa_H\nu)-(\kappa_W\varpi_S-(1-\nu))\kappa_H}$.

Next, plugging equation (62) into equation (61) yields

$$\hat{y}_t = \left(\frac{(1-\nu)\lambda C_c}{\mathcal{C}} - \frac{\mathcal{A}}{\mathcal{C}}\frac{\kappa_H}{1+\kappa_H\nu}\right)\hat{\omega}_t + \frac{\mathcal{B}}{\mathcal{C}}\hat{\chi}_{it}.$$

Inserting equation (64) into the previous equation and rewriting yields

$$\begin{aligned}&\left[\mathcal{C} - \left((1-\nu)\lambda C_c - \mathcal{A}\frac{\kappa_H}{1+\kappa_H\nu}\right)f(\kappa_W)(1+\kappa_H\nu)(\varpi_Y+\bar{\varphi})\right]\hat{y}_t \\ &= \left[-\left((1-\nu)\lambda C_c - \mathcal{A}\frac{\kappa_H}{1+\kappa_H\nu}\right)f(\kappa_W)(1+\kappa_H\nu)\mathcal{D}_i + \mathcal{B}_i\right]\hat{\chi}_{it}.\end{aligned}$$

Thus, yielding

$$\hat{y}_t = a_i\hat{\chi}_{it}, \tag{65}$$

with $a_i \equiv \frac{\mathcal{B}_i+(\mathcal{A}\kappa_H-(1-\nu)\lambda C_c(1+\kappa_H\nu))f(\kappa_W)\mathcal{D}_i}{\mathcal{C}+(\mathcal{A}\kappa_H-(1-\nu)\lambda C_c(1+\kappa_H\nu))f(\kappa_W)(\varpi_Y+\bar{\varphi})}$ and $a_i \in \{a_\chi, a_1^*, a_2^*\}$. □

**Proposition 1.** *Whenever the parameters of the economy satisfy*

$$1-\theta_H < (1-\nu)\lambda C_c, \tag{36}$$

*then an increase in wage flexibility amplifies the response of the economy to the shocks* $\{\chi_t, \chi_{1t}^*, \chi_{2t}^*\}$.

*Proof.* First note that $\kappa_W = \frac{1-\theta_W}{\theta_W}\frac{1}{1+\bar{\varphi}\epsilon_W}$ is monotonically decreasing in $\theta_W$. Thus, to understand the effect of a change in the duration of the wage setting $\theta_W$, we can focus on how a change in the slope of the Wage Phillips Curve affects the output response, i.e. $\frac{\partial \hat{y}_t}{\partial \kappa_W}$:

$$\frac{\partial \hat{y}_t}{\partial \kappa_W} = -\frac{(\mathcal{A}\kappa_H-(1-\nu)\lambda C_c(1+\kappa_H\nu))\, f'(\kappa_W)\,(\mathcal{B}_i(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_i)}{\left[(\mathcal{A}\kappa_H-(1-\nu)\lambda C_c(1+\kappa_H\nu))\,(\varpi_Y+\bar{\varphi})f(\kappa_W)+\mathcal{C}\right]^2},$$

where $f'(\kappa_W) = \frac{1+\kappa_H}{[(1+\kappa_W)(1+\kappa_H\nu)-(\kappa_W\varpi_S-(1-\nu))\kappa_H]^2} > 0$. The denominator is a squared term, which makes it positive.

The sign of $(\mathcal{B}_i(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_i)$ depends on the shock. We now examine the sign of this expression under each type of shock and show that it is positive for all of them. If the sign is positive for all three shocks, this implies that the sign of $\mathcal{A}\kappa_H-(1-\nu)\lambda C_c(1+\kappa_H\nu)$ determines whether increased wage flexibility stabilizes the output response.

Under a foreign demand shock the expression $(\mathcal{B}_i(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_i)$ can be rewritten as $\mathcal{B}_{\chi_1^*}(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_{\chi_1^*} = \frac{\nu}{1-\bar{u}}(\bar{u}+\varphi)+(1-\nu)\lambda C_c\frac{\nu}{(1-\bar{u})(1-\nu)}$. It is straightforward to show that $\bar{u}\in(0,1)$, given that $\gamma>1$, $0<\lambda<1$ and $0<C_c<1$. Therefore, it is easy to see that $\frac{\nu}{1-\bar{u}}(\bar{u}+\varphi)+(1-\nu)\lambda C_c\frac{\nu}{(1-\bar{u})(1-\nu)} > 0$, as $(1-\bar{u}),(1-\nu)>0$.

For the foreign interest rate shock, it needs to hold that $-(\mathcal{B}_{\chi_2^*}(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_{\chi_2^*}) = -\frac{1}{1-\bar{u}}\left[\bar{u}\nu-(1-\lambda C_c)(1+\varphi(1-\nu))\right] > 0$. Rearranging this equation, it therefore needs to hold that $\nu\,(\bar{u}+\varphi(1-\lambda C_c)) < 1-\lambda C_c+\varphi(1-\lambda C_c)$. This inequality is linear in $\nu$. Consider the two limiting cases for the openness parameter $\nu$: as $\nu$ approaches 0, it is obvious that the previous condition holds, given that $(1-\lambda C_c)>0$. As $\nu$ approaches 1, it needs to hold that $\bar{u}<1-\lambda C_c$. Plugging in the definition of $\bar{u}$ and rearranging the inequality, we obtain the condition that $0<(1-\lambda)\gamma^{-\sigma}$ needs to hold. It is straightforward to see that the inequality holds.

Lastly, for the domestic demand shock it needs to hold that $\mathcal{B}_\chi(\varpi_Y+\bar{\varphi})-\mathcal{C}\mathcal{D}_\chi = (1-\nu)(1-\lambda C_c)(1-\bar{u})^{-1}((1-\nu)^{-1}+\bar{u}+\varphi)-(1-(1-\nu)\lambda C_c)\bar{u} > 0$. Rearranging, we obtain that this term will be positive whenever $1 + \varphi^{-1} - \nu(1 + \frac{\bar{u}}{\varphi}(\frac{1}{1-\lambda C_c})) > 0$. The LHS can be expressed as $LHS = (1-\nu) + \varphi^{-1}(1 - \nu\frac{\bar{u}}{1-\lambda C_c})$. As established above for the foreign interest rate shock, we know that $\bar{u} < 1 - \lambda C_c$, which implies that $LHS > (1-\nu) + \varphi^{-1}(1-\nu) > 0$.

Thus, for all three shock the expression $\mathcal{B}_i(\varpi_Y + \bar{\varphi}) - \mathcal{C}\mathcal{D}_i$ is positive.

Therefore, the sign of $\mathcal{A}\kappa_H - (1-\nu)\lambda C_c(1 + \kappa_H \nu)$ determines whether increased wage flexibility stabilizes the output response. Note that this term is independent of shock-specific parameters. Using the definition of $\mathcal{A}$, we can back out the condition under which a change in wage flexibility amplifies the output response, i.e.

$$(1-\nu)\left[(1-\nu)(1-\lambda C_c) + \nu(1 + \frac{1}{1-\nu})\right]\kappa_H - (1-\nu)\lambda C_c(1 + \kappa_H \nu) < 0.$$

Rearranging yields

$$\kappa_H < \frac{(1-\nu)\lambda Cc}{1 - (1-\nu)\lambda Cc}.$$

Note that $\kappa_H = \frac{1-\theta_H}{\theta_H}$, which we can now substitute into the previous expression

$$1 - \theta_H < (1-\nu)\lambda C_c.$$

□

# B Quantitative Results

## B.1 Foreign demand shock

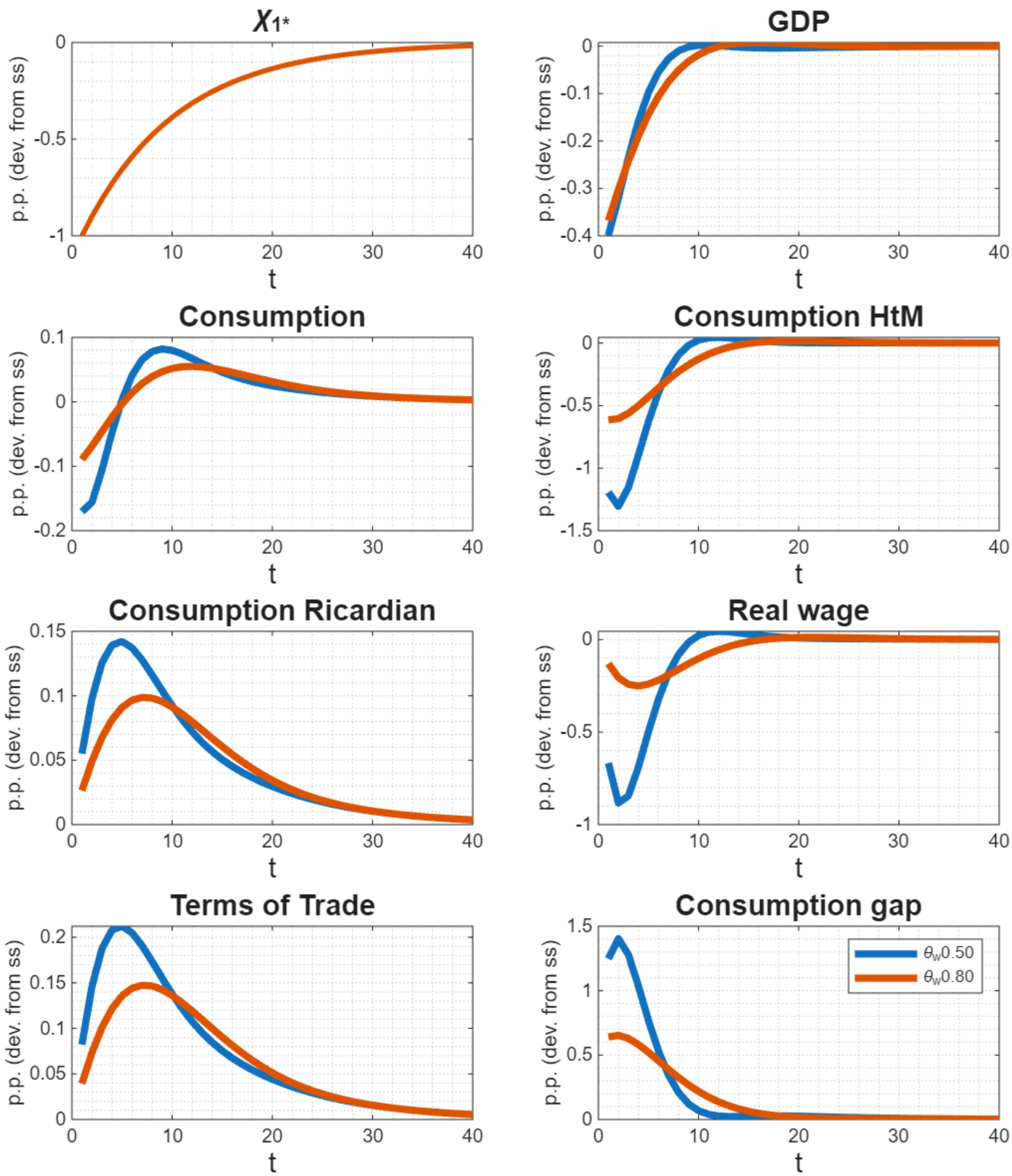


Figure 7: Dynamic response of the economy to a foreign demand shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

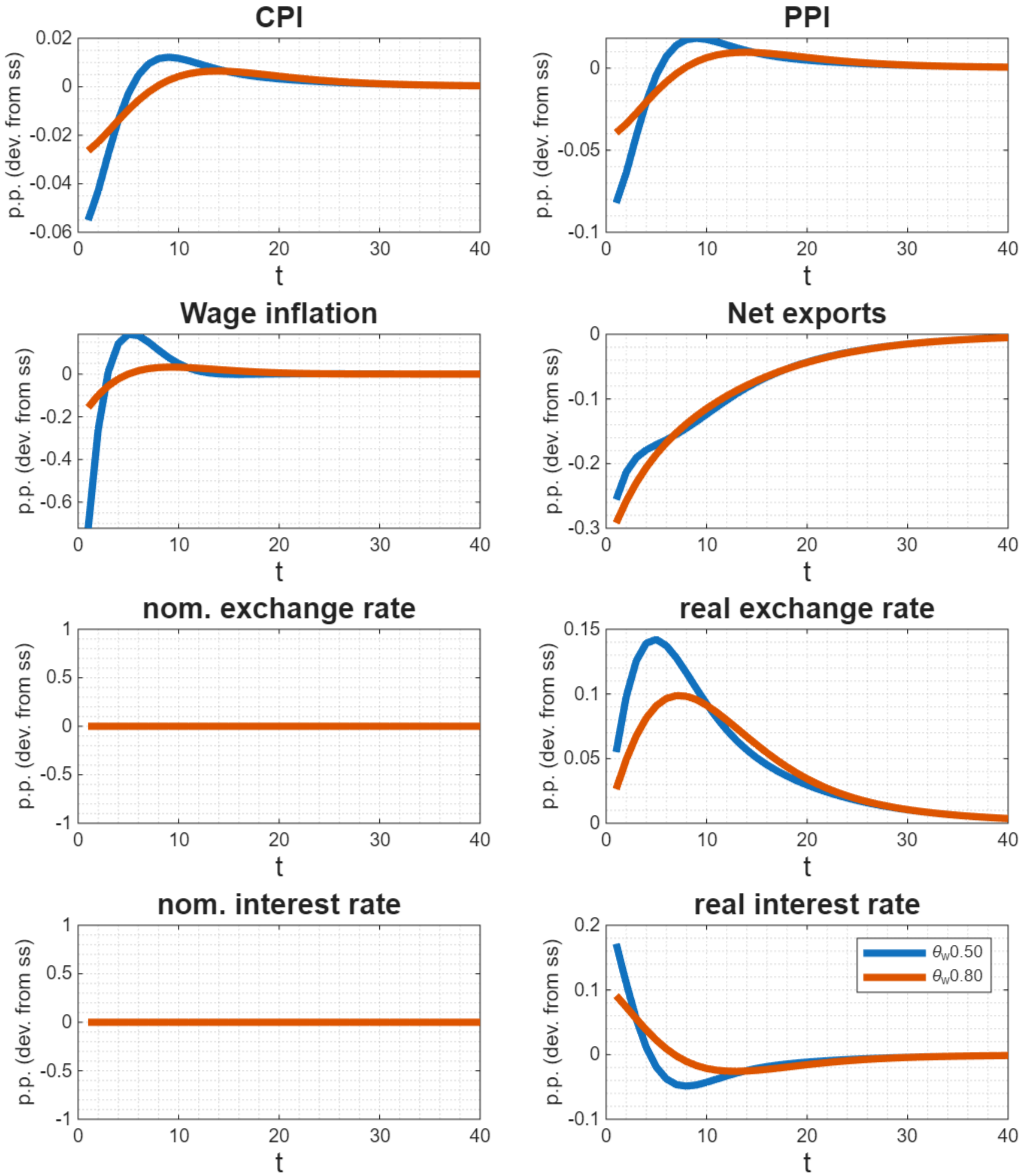


Figure 8: Dynamic response of the economy to a foreign demand shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

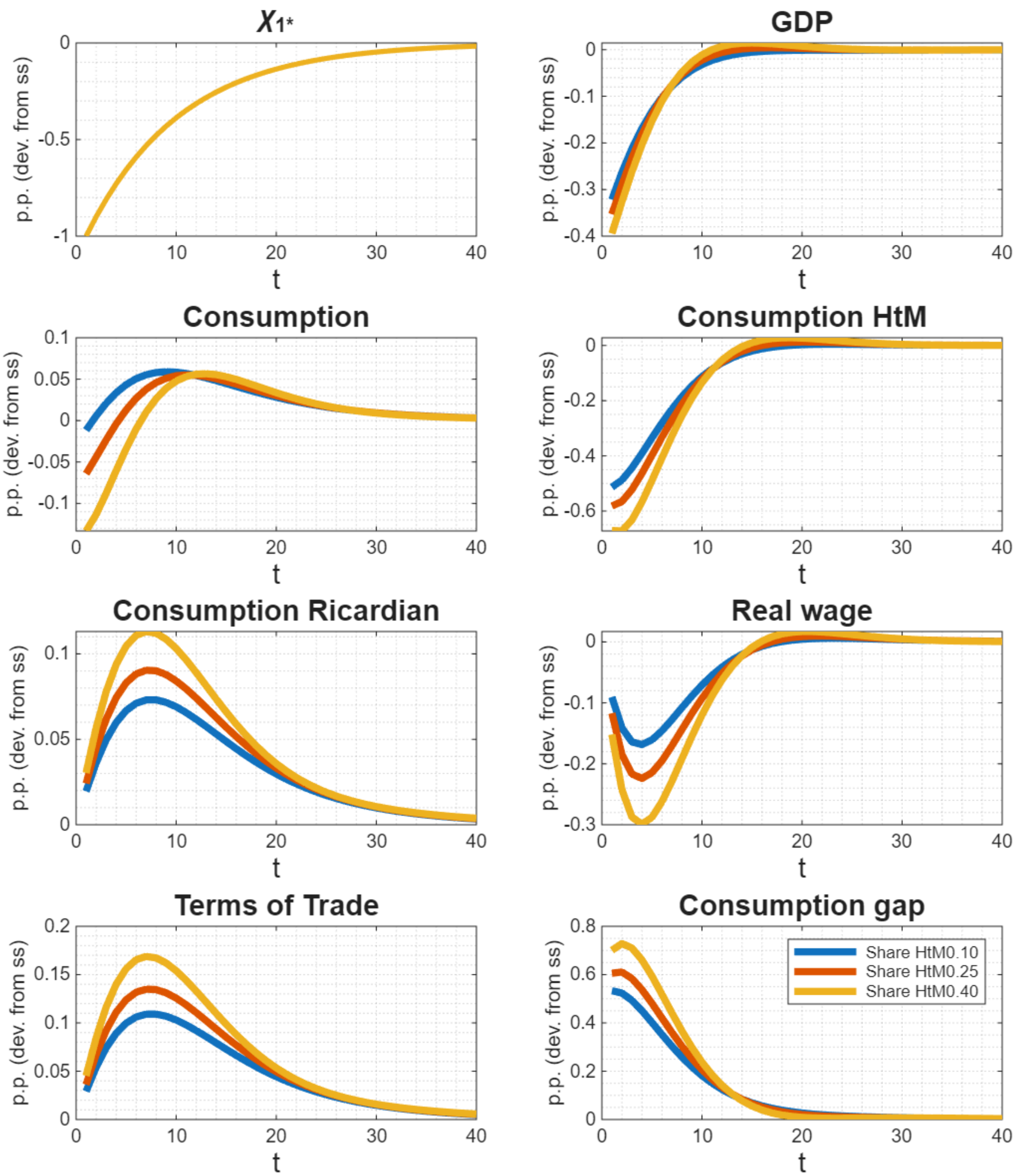


Figure 9: Dynamic response of the economy to a foreign demand shock under varying shares of hand-to-mouth households, with a low ($\lambda = 0.1$, blue), medium ($\lambda = 0.25$, red), and high share ($\lambda = 0.40$, yellow) of constrained households.

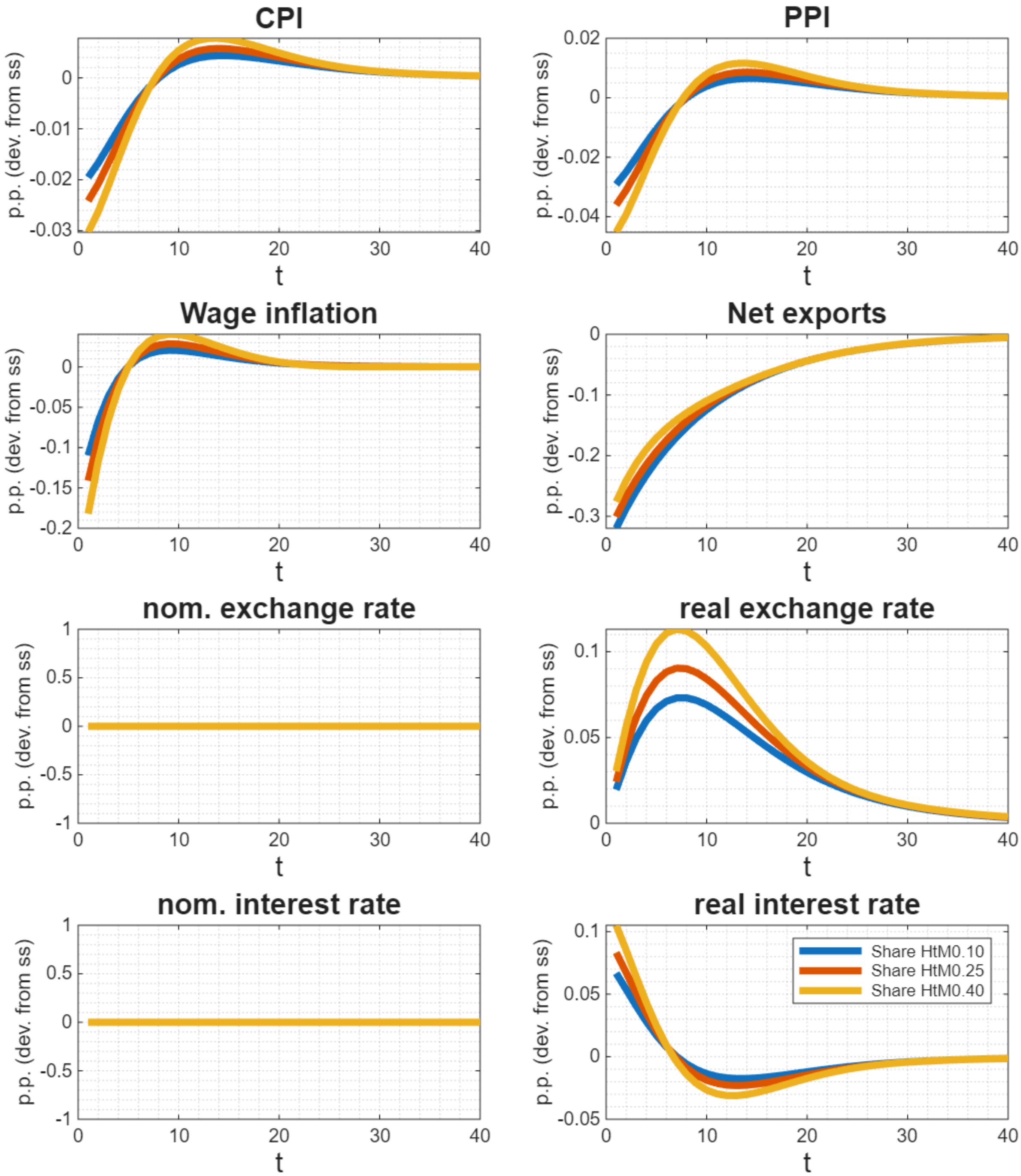


Figure 10: Dynamic response of the economy to a foreign demand shock under varying shares of hand-to-mouth households, with a low ($\lambda = 0.1$, blue), medium ($\lambda = 0.25$, red), and high share ($\lambda = 0.40$, yellow) of constrained households.

## B.2 Foreign demand shock - Sensitivity to trade elasticities

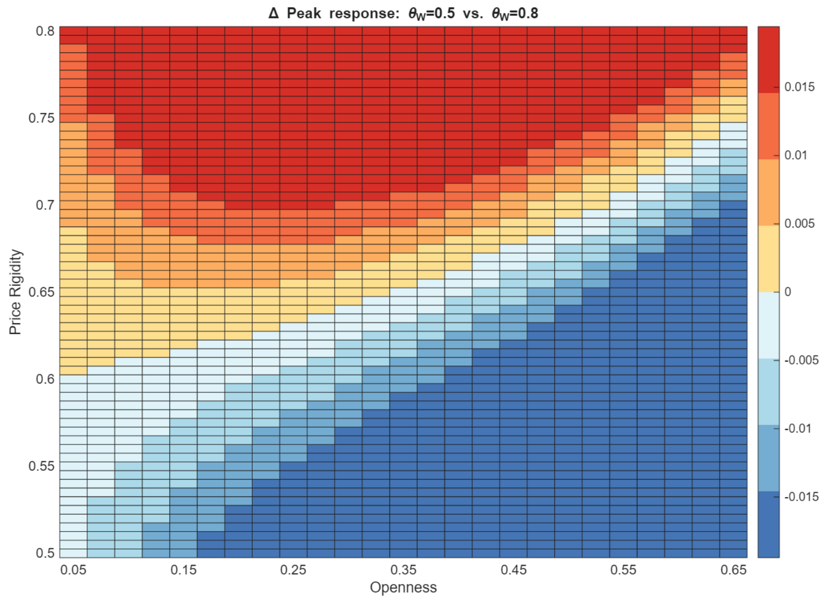


Figure 11: Trade elasticity parameters set to $\eta = \eta^* = 0.5$. Peak difference in the response to a foreign demand shock between an economy with relatively flexible prices ($\theta_W = 0.5$) and an economy with rigid prices ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible prices.

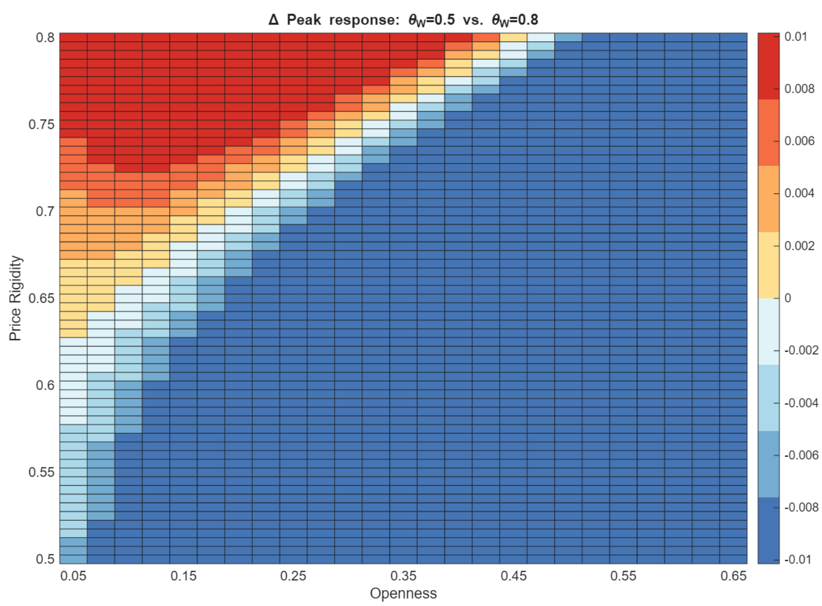


Figure 12: Trade elasticity parameters set to $\eta = \eta^* = 2$. Peak difference in the response to a foreign demand shock between an economy with relatively flexible prices ($\theta_W = 0.5$) and an economy with rigid prices ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible prices.

## B.3 Interest rate shock

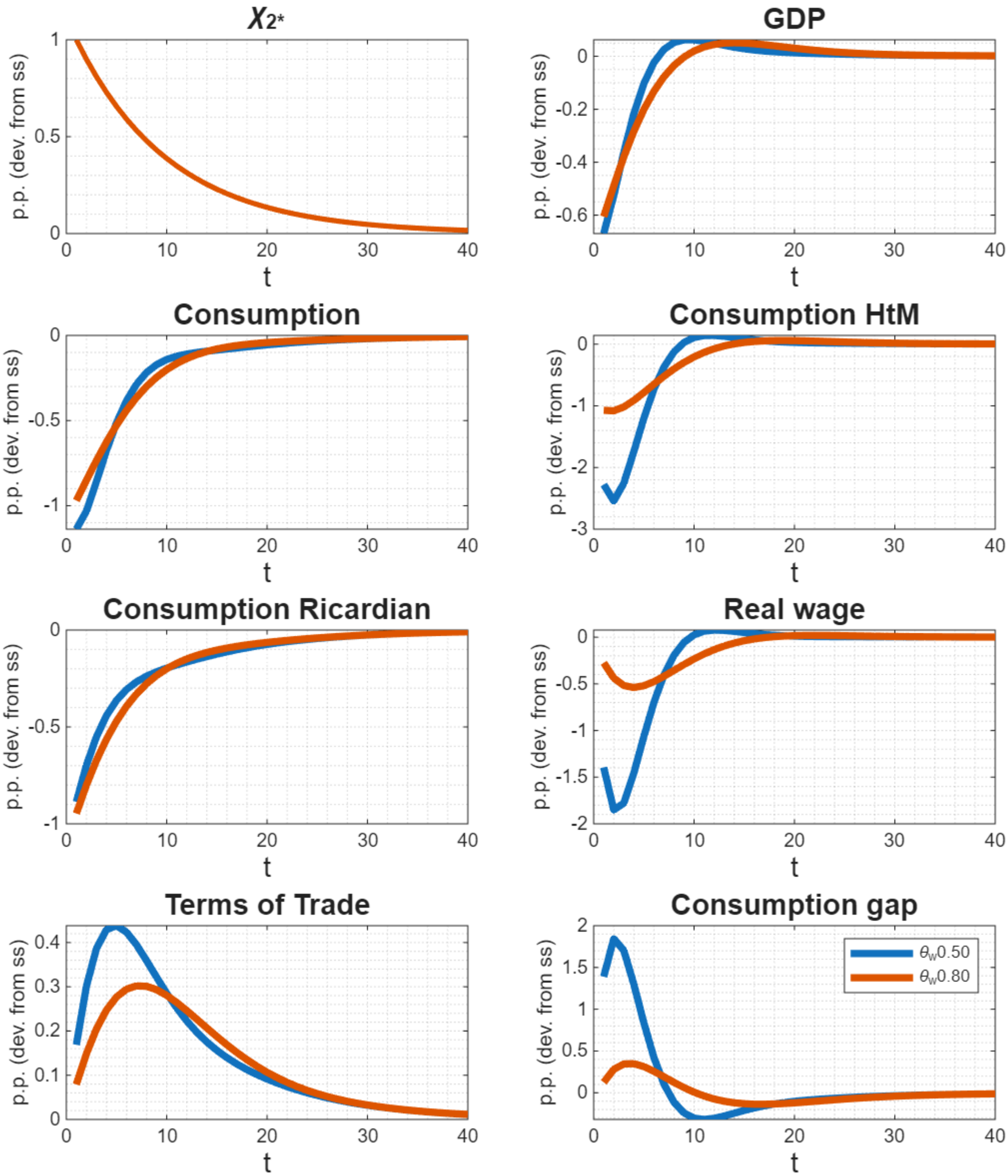


Figure 13: Dynamic response of the economy to an interest rate shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

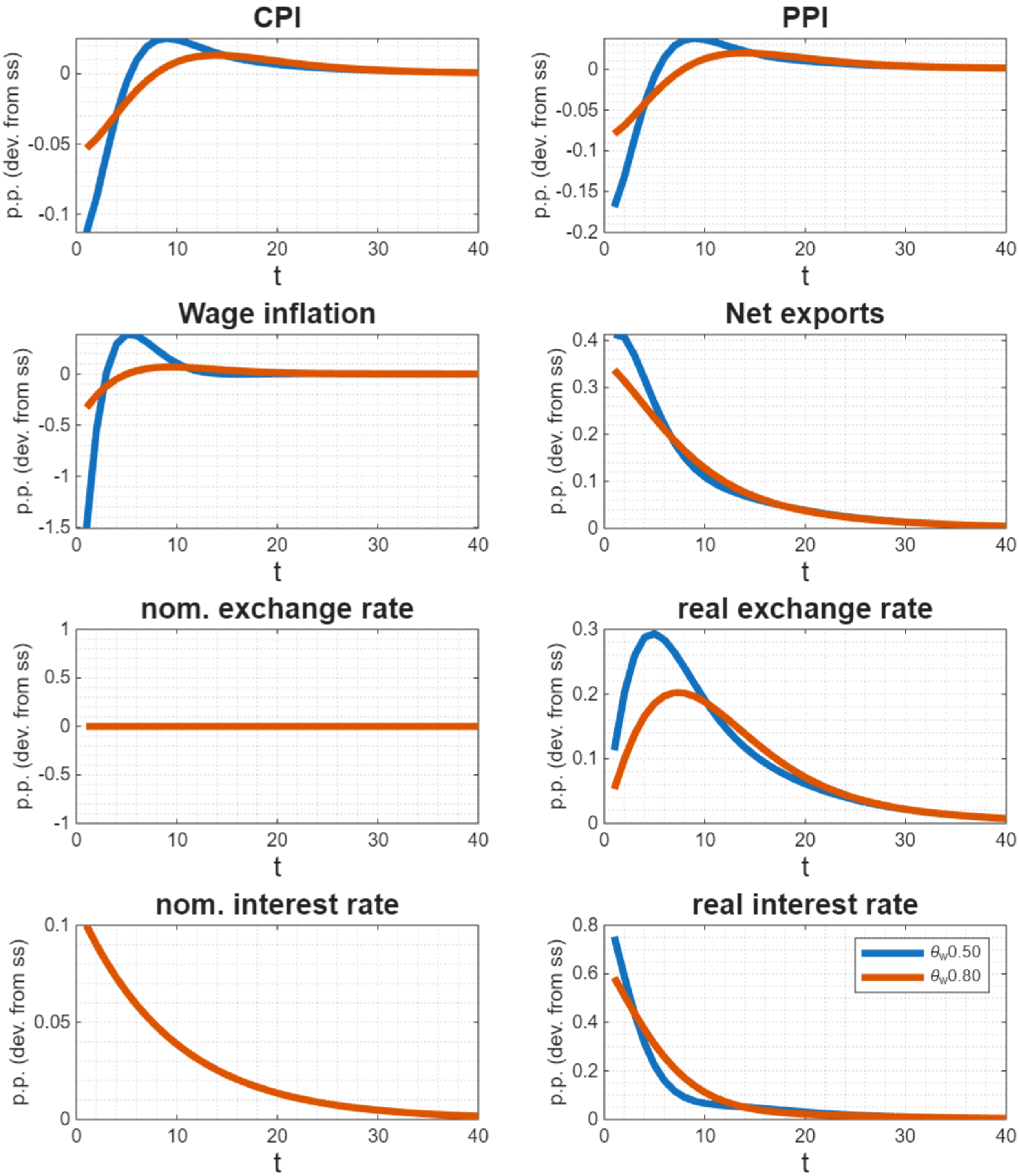


Figure 14: Dynamic response of the economy to an interest rate shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line).

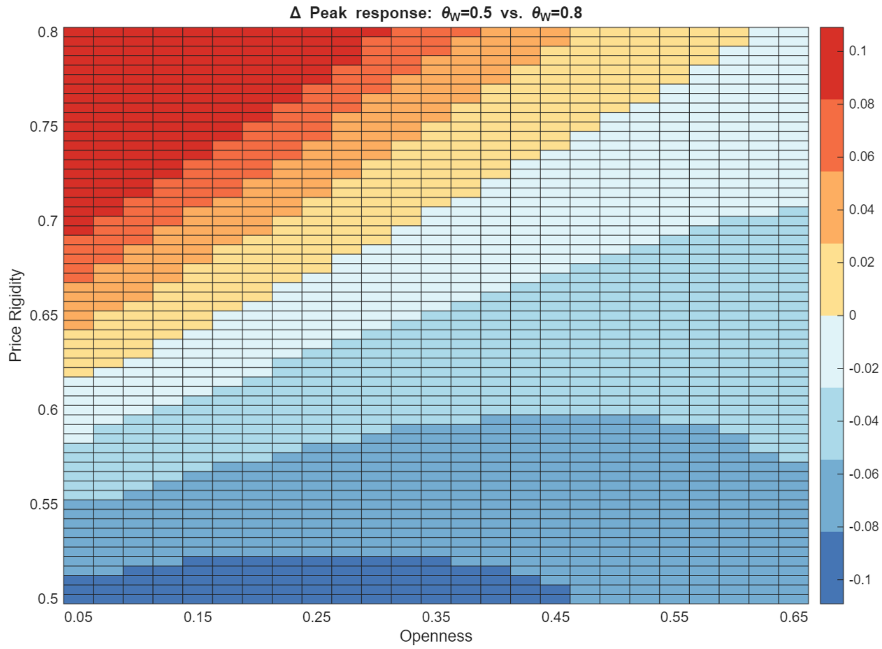


Figure 15: Benchmark calibration. Peak difference in the response to an international interest rate shock between an economy with relatively flexible prices ($\theta_W = 0.5$) and an economy with rigid prices ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible prices.

# C Calibration to Eurozone countries

In section 4.3, we explore the scope for recessionary wage flexibility in the economies of the EMU member states. The calibration in this analysis follows the strategy outlined for Table 1, except for four key parameters, which we calibrate to capture the specific properties of the economies. Those parameters are: (i) the fraction of constrained households in the economy, $\lambda$; (ii) the trade openness of the economy, $\nu$; (iii) the price rigidity, $\theta_H$; (iv) the curvature of the production function, $\alpha$.

Table 2: Country-specific parameters

| **Country** | $\lambda$ | $\nu$ | $\theta_H$ | $\alpha$ |
|---|---|---|---|---|
| Austria | 0.118 | 0.521 | 0.804 | 0.188 |
| Belgium | 0.186 | 0.794 | 0.705 | 0.168 |
| Cyprus | 0.377 | 0.690 | *0.764* | 0.330 |
| Estonia | 0.347 | 0.737 | *0.764* | 0.294 |
| Finland | 0.217 | 0.393 | *0.764* | 0.274 |
| France | 0.192 | 0.310 | 0.779 | 0.203 |
| Germany | 0.240 | 0.381 | 0.776 | 0.204 |
| Greece | 0.516 | 0.337 | 0.797 | 0.280 |
| Italy | 0.230 | 0.279 | 0.828 | 0.244 |
| Latvia | 0.634 | 0.607 | 0.703 | 0.302 |
| Netherlands | 0.181 | 0.734 | *0.764* | 0.198 |
| Portugal | 0.266 | 0.391 | *0.764* | 0.231 |
| Slovakia | 0.327 | 0.782 | 0.746 | 0.362 |
| Slovenia | 0.477 | 0.801 | *0.764* | 0.229 |
| Spain | 0.239 | 0.309 | 0.754 | 0.212 |

Table 2 presents the values of the parameters for our country sample. The fraction of Hand-to-Mouth households is chosen based on the estimates from Almgren et al. (2022). We restrict our analysis to the eighteen eurozone countries included in their study. The degree of financial constraints varies substantially across the included countries, from as low as 10.3% or 11.8% for Malta and Austria, respectively, to as high as 63.4% for Latvia.

We measure trade openness as the average of imports and exports to GDP, and we evaluate the average value of this ratio over the period 2002-2024. This period captures the years from the establishment of the euro area. For consistency, we do not differentiate between early- and late-joining countries. We use OECD data. Trade openness ranges from barely 28% for Italy to 80% for Slovenia. We dropped Ireland, Luxembourg, and Malta, for which our measure of openness exceeds 100% of GDP.

Similarly, we calculate $1 - \alpha$ from the long-term average of the labor income share as a percent of GDP corrected by the price margin of firms. We use data for the maximum available period 2004-2024 provided by the International Labour Organization.

Finally, our calibration of price rigidity relies on the estimates in Gautier et al. (2024). Their study does not include parameter values for six out of fifteen countries in our remaining sample. Since the parameter values for the countries included in the sample do not differ substantially – ranging from 70.3% to 82.8% – we decided to use the euro area average for the countries not available in the sample. The imputed values are reported in italics in Table 2.

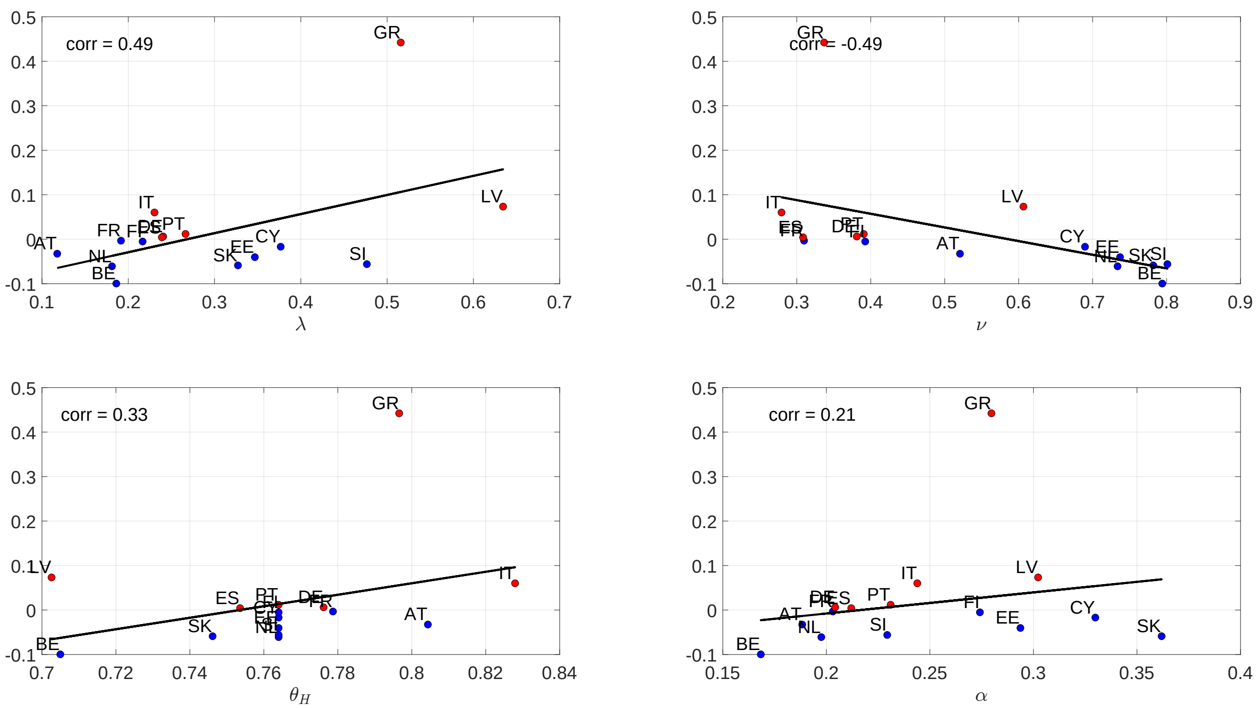


Figure 16: Difference in peak responses to a foreign demand shock between an economy with relatively flexible wages ($\theta_W = 0.5$) and an economy with rigid wages ($\theta_W = 0.8$). Positive values indicate higher volatility under flexible wages. The differences in peaks are plotted against the values of the four parameters calibrated at the country level.

Figure 16 plots the relative difference in peak responses between an economy with flexible and rigid wages against the values of the parameters calibrated at the country level. There is a strong positive relationship between the effect of wage flexibility and the share of financially constrained households (as shown in the upper-left subfigure). Countries with more constrained households are more likely to exhibit recessionary wage flexibility. Similarly, in the upper-right corner, one can observe a strong relationship between trade openness and the effect: less open economies are more likely to exhibit the amplifying effects of flexible wages. The correlation of price rigidity with the studied effect (lower-left subfigure) is smaller. A potential explanation of this might be the reliance on imputed data and the relatively low dispersion of this measure. In general, euro area countries face a similar degree of price rigidity. Finally, our effect correlates only weakly with the labor share (lower-right subfigure).

# D HANK Model

The baseline setup of this small open economy model follows Galí and Monacelli (2016) and Auclert et al. (2021). Relative to Galí and Monacelli (2016), international asset markets are incomplete. Further, dividends are not directly allocated to households but impact the return on assets of households as in Auclert et al. (2021). Relative to the benchmark setup in Auclert et al. (2021), prices are sticky, individual income risk can depend on the business cycle, and the production function possesses decreasing returns to labor. Further, domestic monetary policy ensures a currency peg vis-à-vis the rest of the world.

## D.1 Households

Domestic households are heterogeneous as they face idiosyncratic productivity shocks $e_{it}$. Domestic households maximize their utility over consumption. They derive utility from a consumption basket $c_t$ that consists of domestic ("H") and international goods ("F") with respective consumption $c_{Ht}$ and $c_{Ft}$ :

$$c_t = \left[ \nu^{\frac{1}{\eta}} c_{Ft}^{\frac{\eta-1}{\eta}} + (1-\nu)^{\frac{1}{\eta}} c_{Ft}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \tag{66}$$

The openness of the economy is determined by $\nu$. $\eta > 0$ is the elasticity of substitution between domestic and international goods. Households' labor supply is determined through labor unions that ration labor supply such that all households provide the same amount of labor $N_t$ at real wage $\frac{W_t}{P_t}$, let $Z_t \equiv N_t \frac{W_t}{P_t}$. Moreover, households are subject to idiosyncratic productivity shocks $e_{it}$ and household income $z_{it}$ can depend on the business cycle. This implies that individual household income is determined by

$$z_{it} = Z_t \cdot \frac{e_{it}^{1+\zeta \log(Z_t)}}{\mathbb{E}[e_{it}^{1+\zeta \log(Z_t)}]}, \tag{67}$$

following the set up in Auclert and Rognlie (2018). $\zeta$ determines the cyclicality of income risk, where $\zeta = 0$ implies acyclical risk (standard HANK setup and the calibration in the additional results), $\zeta < 0$ implies countercyclical risk and $\zeta > 0$ implies procyclical risk. Further, households can save into a domestic mutual fund, household $i$ optimally chooses mutual fund position $a_{it+1}$ in period $t$ that is paid back in the next period including its return $r_t^p$. Given the idiosyncratic productivity shocks and the borrowing constraint $\underline{a}$ that households face, households differ in their optimal consumption and savings. The dynamic programming problem that households solve is thus given by

$$V_t(a,e) = \max_{c_F, c_H, a'} u\left(c_F, c_H\right) - v\left(N_t\right) + \beta \mathbb{E}_t\left[V_{t+1}\left(a', e'\right)\right] \tag{68}$$

$$\text{s.t.} \quad \frac{P_{Ft}}{P_t} c_F + \frac{P_{Ht}}{P_t} c_H + a' = \left(1 + r_t^p\right) a + z \tag{69}$$

$$a' \geq \underline{a} \tag{70}$$

Households' utility function is

$$u(c_{it}) \equiv \frac{{c_{it}}^{1-\sigma}}{1-\sigma}, \tag{71}$$

and

$$v(N_t) \equiv \kappa^* \frac{{N_t}^{1+\varphi}}{1+\varphi}. \tag{72}$$

$P_{Ft}$ is the price of the Foreign good in domestic currency, $P_{Ht}$ is the price of Home goods, and the consumer price index is defined as

$$P_t \equiv \left[\nu P_{Ft}^{1-\eta} + (1-\nu) P_{Ht}^{1-\eta}\right]^{1/(1-\eta)}. \tag{73}$$

## D.2 Domestic demand

On aggregate, consumers in the Home economy consume Home and Foreign goods according to

$$C_{Ht} = (1-\nu)\left(\frac{P_{Ht}}{P_t}\right)^{-\eta} C_t, \quad \text{and} \tag{74}$$

$$C_{Ft} = \nu \left(\frac{P_{Ft}}{P_t}\right)^{-\eta} C_t. \tag{75}$$

## D.3 Labor Unions

Similar to the formulation in Auclert and Rognlie (2018) households supply their labor services to a labor union. The labor union maximizes welfare of the average household in the economy and all households are employed for the same amount of hours. A standard formulation of the wage Phillips curve is given by

$$(\Pi_{Wt} - 1) = \kappa^W \left( \frac{v'(N_t)}{\frac{1}{\mu_w} w_t u'(C_t)} - 1 \right) + \beta(\Pi_{Wt+1} - 1), \tag{76}$$

where the slope is given by $\kappa^W = \frac{(1-\theta_w)(1-\theta_w\beta)}{\theta_w(1+\epsilon_w\varphi)}$ as in a standard formulation derived from a Calvo specification, where $(1 - \theta_w)$ is the share of unions able to adjust their wages in a given period and $\epsilon_w$ the elasticity of substitution between different labor services. Nominal gross wage inflation is

$$\Pi_{Wt} \equiv \frac{W_t}{W_{t-1}}. \tag{77}$$

## D.4 Foreign

The Foreign economies are symmetric to Home. For simplicity, we assume that monetary policy abroad ensures price stability of the foreign goods in foreign currency, with $P^*_{Ft} = 1$ and since the Home economy is small it also follows that the international consumer price index is stable $P^*_t = 1$. Further, the law of one price holds, therefore $P_{Ft} = P^*_{Ft}$. The real exchange rate is given by

$$Q_t \equiv \frac{P^*_t}{P_t}. \tag{78}$$

The terms of trade determine how many domestic goods the Home economy needs to give up to obtain one Foreign good: $S_t = \frac{P_{Ft}}{P_{Ht}}$. Foreign households' consumption of the Home good (the export demand) amounts to

$$C^*_{Ht} = \nu \left(P^*_{Ht}\right)^{-\eta^*} C^*_t, \tag{79}$$

where $C^*_t$ is the worldwide demand for goods. As in Galí and Monacelli (2016) and Auclert et al. (2021) worldwide aggregate demand is exogenous. The Home economy is subject to world demand shocks. $\eta^*$ is the elasticity of substitution between the different varieties of international goods. The law of one price also holds for Foreign goods, implying that

$$P_{Ht} = P^*_{Ht}. \tag{80}$$

## D.5 Domestic Firms

Intermediate goods firms $j \in [0,1]$ produce good $j$ monopolistically subject to technology with decreasing returns to labor. Productivity is constant at $z^P$ and used as a scaling parameter.

$$Y_{jt} = z^P N_{jt}^{1-\alpha}. \tag{81}$$

Firms pay the nominal wage according to the effective units of labor supplied by households. Intermediate goods firms are subject to price rigidities. Only a fraction of $(1-\theta_H)$ firms can reset their price every period. Domestic output is aggregated through standard CES technology by final goods-producing firms. The rigidities give rise to a standard formulation of a New Keynesian price Phillips Curve for the Home good:

$$(\Pi_{Ht} - 1) = \kappa^H \left( \mu^H w_t \frac{N_t}{Y_t} \frac{P_t}{P_{Ht}} (1-\alpha)^{-1} - 1 \right) + \frac{1}{1+r_t^*} (\Pi_{Ht+1} - 1). \tag{82}$$

where the slope is given by $\kappa^H = \frac{(1-\theta_H)(1-\theta_H\beta)}{\theta_H} \frac{1-\alpha}{1-\alpha+\alpha\epsilon_p}$ as in Galí and Monacelli (2016). PPI inflation is defined as $\Pi_{Ht} \equiv \frac{P_{Ht}}{P_{Ht-1}}$. $\mu^H = \frac{\epsilon^H}{\epsilon^H - 1}$ is the steady state markup that monopolistic firms charge over their marginal cost, which is determined by the elasticity of substitution between different Home goods varieties in the aggregation of the final good. Lastly, real dividends that firms obtain are given by the real revenues obtained from selling Home goods to domestic and international households reduced by the effective real labor costs:

$$D_t = \frac{P_{Ht}}{P_t} Y_t - w_t N_t. \tag{83}$$

## D.6 Financial sector

The setup of the financial sector closely follows Auclert et al. (2021). In the Home economy, a risk-neutral mutual fund invests in three asset types: domestic nominal bonds that yield interest $i_t$, foreign nominal bonds that yield $i_t^*$ , and domestic firm shares that yield return $\frac{p_{t+1}+D_{t+1}}{p_t}$, where $p_t$ is the end-of-period price of (a unit mass of) outstanding firm shares. The mutual fund issues claims to households that yield a real return of $r_t^p$ to households. The aggregate real value of claims at the end of period $t$ is $A_t$. The objective of the mutual fund is to maximize the expected real rate of return $r_{t+1}^p$. As shown in Auclert et al. (2021) this implies that the expected returns on all assets are equal which implies that the uncovered interest parity condition holds:

$$(1 + i_t) = (1 + i_t^*). \tag{84}$$

The Fisher equation defines the ex-ante real interest rate as

$$(1 + i_t) \equiv (1 + r_t)\Pi_{t+1}. \tag{85}$$

The ex-post real return of the mutual fund is defined by $(1 + i_t^p)\Pi_t^{-1} = (1 + r_t^p)$, This setup implies that the ex-post real return that households receive on their mutual fund claims is equal to the ex-ante real rate for domestic bonds, the ex-ante real return on domestic stocks, and the international ex-ante interest rate adjusted for real exchange rate movements:

$$(1 + r_{t+1}^p) = (1 + r_t) = \frac{p_{t+1} + D_{t+1}}{p_t} = (1 + i_t^*)\frac{Q_{t+1}}{Q_t}. \tag{86}$$

Note that since international prices are held constant, the nominal and real international interest rates are identical. Further, as in Auclert et al. (2021), the real net foreign asset position is defined as

$$\text{nfa}_t = A_t - p_t, \tag{87}$$

i.e. the difference between the overall value of assets held domestically minus the value of assets that are in net supply in the Home economy. Further, the current account is given by net exports plus valuation effects

$$\text{nfa}_t - \text{nfa}_{t-1} = \text{NX}_t + r_{t-1}\text{nfa}_{t-1}, \tag{88}$$

where net exports are the difference between the real value of exports minus the real value of imports $\text{NX}_t = \frac{P_{Ht}}{P_t}C_{Ht}^* - \frac{P_{Ft}}{P_t}C_{Ft}$.

### D.6.1 Monetary Policy

The central bank is assumed to adjust the domestic nominal interest rates to move one-to-one with the international interest rate. Therefore, the nominal exchange rate in the economy is fixed at $\varepsilon_t = \varepsilon_{t-1}$ for all $t$.

## D.7 Market clearing

Market clearing for domestic goods implies that

$$Y_t = C_{Ht} + C^*_{Ht}. \tag{89}$$

Further, asset markets, labor markets, and Foreign exchange markets clear in equilibrium.

## D.8 Additional Calibration

The calibration of the HANK model is identical to that in Table 1 for all values, except for $\lambda$ and $\beta$. For $\beta$ the internal calibration of the model implies a value of $\beta = 0.96$. Further, we choose $\zeta = -0.5$, as in Auclert and Rognlie (2018). However, figure 17 demonstrates that recessionary wage flexibility in the HANK model does not hinge on the assumption that income risk is countercyclical ($\zeta = 0$). The minimum asset level on the grid is $-0.1$, the maximum level is 200., and the number of asset grid points is 200. Following Auclert et al. (2021), we choose a persistence of idiosyncratic productivity shocks to be 0.92, the standard deviation of 0.60, and the number of income grids to 14.

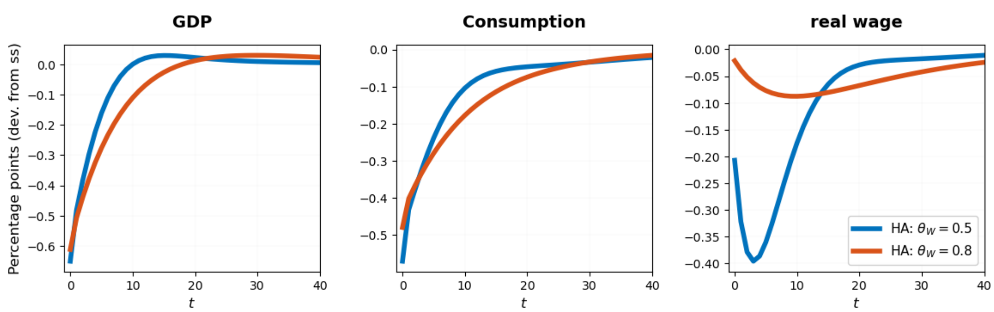


Figure 17: Dynamic response of the HANK economy to a foreign demand shock under two different levels of wage rigidity 0.5 (blue line) and 0.8 (red line) with acyclical income risk ($\zeta = 0$).