I Z A Institute of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 17950

Monetary Policy in Currency Unions with Unequal Countries

Lukas Boehnert
Sergio de Ferra
Kurt Mitman
Federica Romei

JUNE 2025

DISCUSSION PAPER SERIES

IZA DP No. 17950

Monetary Policy in Currency Unions with Unequal Countries

Lukas Boehnert
University of Oxford

Sergio de Ferra
University of Oxford and CEPR

Kurt Mitman
IIES, CEMFI, CEPR and IZA

Federica Romei
University of Oxford and CEPR

JUNE 2025

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Monetary Policy in Currency Unions with Unequal Countries*

We investigate how the composition of expenditure shapes the transmission of monetary policy in a currency union. European Monetary Union data reveal three facts: (1) higher inequality countries have larger service expenditure shares; (2) monetary policy has a weaker output impact in these high-service-share, high-inequality countries; and (3) monetary policy induces systematic trade flows between high- and low-service-share countries. We develop a New Keynesian model with non-homothetic preferences and heterogeneous sectoral income that rationalizes these facts. Pro-cyclical inequality, driven by wealthier households' greater income exposure to services, buffers poorer households' consumption to contractionary shocks, dampening overall policy transmission. Our findings suggest that accounting for cross-country differences in consumption and income distributions is essential for understanding common monetary policy.

Keywords: inequality, monetary policy, currency union

Corresponding author:
Kurt Mitman
Institute for International Economic Studies
Stockholm University
SE-106 91, Stockholm
Sweden
E-mail: kurt.mitman@iies.su.se

* An earlier version of this paper was presented under the title "Inequality, Expenditure Composition and the Transmission of Monetary Policy". We thank for precious feedback and suggestions Christian Bayer, Florin Bilbiie, Davide Debortoli, Andrea Ferrero, Katja Mann, Dmitry Mukhin, Gianluca Violante, and seminar participants at Banco de España, Bonn, CREI, CEMFI, European Central Bank, ESSIM, Konstanz Seminar, Midwest Macro, Oxford, SED, Sheffield, UT Austin. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 759482) and the Swedish Research Council Project Grant 2023-01635. Mitman gratefully acknowledges the support of the Ragnar Söderbergs stiftelse, the Riksbankens Jubileumsfond, the Ministerio de Ciencia, Innovación y Universidades Grant IneqEx. Romei gratefully acknowledges financial support from the UK Research and Innovation joint European Research Council grant (CUR01080-HetAgHetCou).

1 Introduction

The European Monetary Union (EMU) spans countries with different levels of per-capita income and inequality, presenting a significant challenge for common monetary policy. As the EMU has expanded, these cross-country heterogeneities have become more pronounced, raising a key question: How do differences in the level and distribution of income across member states affect the efficacy of a single monetary policy? This paper investigates this question, focusing on an expenditure composition channel. We argue that heterogeneity in income and its distribution systematically shapes how economies respond to monetary policy, primarily through its influence on the relative consumption of goods and services.

Our point of departure is to document empirical regularities related to the composition of consumption expenditures within and across countries in the EMU. We begin by confirming the findings of a large literature on structural transformation (e.g., Chenery, 1960; Clark, 1940; Kuznets, 1957): within EMU countries higher-income households allocate a greater proportion of their spending to services. Building on this foundation, we document three novel empirical regularities about the EMU.

First, at the aggregate level, countries with higher income inequality allocate a larger share of their total expenditure to services. This pattern is closely linked to our initial observation: high-income households, who account for a larger share of total income in more unequal countries, allocate a larger portion of their expenditure to luxuries (services), resulting in a higher aggregate expenditure share on services.

Second, these differences in expenditure composition have direct consequences for monetary policy transmission. Using local projections (Jorda, 2005), we show that countries with a higher average share of expenditure on services exhibit a *weaker* output response to identified monetary policy shocks. This finding is striking. The service sector typically exhibits greater price rigidity than the goods sector (see, e.g. Alvarez et al., 2006; Cravino et al., 2020; Gautier et al., 2024), which, all else equal, should amplify the real effects of monetary policy in economies with large service sectors. Yet, we find the contrary: a higher service expenditure share is associated with a *weaker* monetary policy transmission to output.

Third, monetary policy shocks induce heterogeneous responses in external balances. Using the same methodology as above, we document that countries with high service expenditure shares tend to run trade deficits following a contractionary shock, while those with low service shares run surpluses.

We rationalize these empirical findings through the lens of a multi-country New Keynesian model. Our framework incorporates: cross-country variation in income and inequality, non-homothetic preferences, where services are luxuries, incomplete financial markets, and unequal incidence of sectoral income, allowing wealthier households' income to be disproportionately exposed to the service sector. Our choice of non-homothetic preferences is a natural way (motivated by models in the structural change literature e.g., Boppart, 2014; Herrendorf et al., 2014; Kongsamut et al., 2001) to generate higher service expenditure shares in higher-income and more unequal countries, consistent with our first empirical regularity. To keep the model parsimonious, we consider only two types of households in the model economy: Ricardian and Hand-to-Mouth (HtM). The Ricardian household has access to financial markets, while the HtM household does not. Both earn income from goods and service sectors, but their relative income shares from these sectors can differ across countries, as observed empirically. These differences in income distributions lead to differences in the cyclicality of relative household incomes, and specifically in the response of income inequality to aggregate shocks.

The model's ability to generate dampened monetary policy transmission observed in high service-share countries (our second empirical regularity) hinges on a mechanism of *pro-cyclical inequality*. This arises when wealthier households derive a larger share of their income from the service sector. Such an income structure not only generates higher inequality and larger service shares in those countries but also makes the earnings of Ricardian households more pro-cyclical than those of HtM households. These differences in income structure are key to generating both the cross-country variation in aggregate service shares (via inequality) and the heterogeneous cyclical responses in relative household incomes that drive pro-cyclical inequality and weaken the transmission of monetary policy.

We first analyze a homogeneous monetary union (akin to a closed economy). Here, comparative statics with the model demonstrate that higher inequality (driven by Ricardian exposure to services) indeed leads to both a higher aggregate service expenditure share and a weaker transmission of monetary policy to output. This provides a direct, joint rationalization for our first two empirical regularities.

Extending the model to a heterogeneous monetary union where countries differ in their income distributions (and thus in their baseline service shares), the model further predicts the emergence of systematic trade imbalances following a common monetary policy shock, consistent with our third empirical regularity. Unequal, high service-share countries experience a milder consumption contraction due to the pro-cyclical inequality mechanism and run trade deficits, while more equal, lower service-share countries run surpluses. This occurs even as goods output falls similarly across the union, highlighting how domestic distributional dynamics and expenditure composition spill over into external positions.

Literature Review. This paper contributes to the macroeconomic literature on the transmission of monetary policy with heterogeneous agents, and on non-homothetic preferences, consumption, and household heterogeneity.

We contribute to the literature on monetary policy with heterogeneous agents empirically and theoretically. Empirically, we document cross-country differences in monetary policy transmission and their systematic links to the composition of consumption. Theoretically, we introduce non-homothetic preferences and heterogeneity across countries in the distribution and composition of income, in a heterogeneous-agent, open-economy, New-Keyensian model. We show that the combination of non-homothetic preferences, market incompleteness, and income composition heterogeneity can generate pro-cyclical inequality, weakening monetary policy transmission relative to a representative-agent model. We thus contribute to the large and growing macroeconomics literature on heterogeneous agents and monetary policy, including seminal works by Kaplan et al. (2018), Auclert (2019), Gornemann et al. (2021) and Krueger et al. (2010). Our two-agent model allows for an analytical characterization of the transmission of monetary policy, thus expanding on the insights from the work by Debortoli and Galí (2024), Bilbiie (2024) and Acharya and Dogra (2020). Our open-economy results build on our previous work on the implications of international differences in inequality for countries' external balance, de Ferra et al. (2021), and on the international transmission of monetary policy in heterogeneous-agent economies in de Ferra et al. (2020).[1]

Our contribution to the literature on non-homothetic preferences is again twofold. First, we document empirically differences in the composition of consumption across households and countries in the euro area, and we relate these systematic differences to cross-country differences in average income and in its distribution. Second, we introduce non-homothetic preferences in a model of a monetary union with heterogeneous agents, and we show how these preferences interact with income inequality and market incompleteness to shape the transmission of monetary policy. Our theoretical contribution builds on the seminal work by Deaton and Muellbauer (1980) and incorporates the description of preferences introduced by Boppart (2014) to characterize long-run trends in the composition of consumption between luxuries and necessities.

Several recent papers have analysed the implications of non-homothetic preferences in heterogeneous-agent models. Straub (2019) consider non-homothetic preferences in the context of saving rates, Cravino et al. (2020) study heterogeneity in the nominal rigidity of consumption baskets, Jaravel (2018) documents heterogeneity in inflation fluctuations experienced by different households in the income distribution and Jaimovich et al. (2019) show that consumption shifts towards lower-quality goods exacerbate recessions. Our paper contributes to this literature by showing that when households differ in terms of the composition of their income from different sources, non-homothetic preferences give

[1] A growing literature studies the implications of household heterogeneity for the transmission of shocks in open economies. See, inter alia Bayer et al. (2024), Guo et al. (2023), Ferrante and Gornemann (2022), Auclert et al. (2021), Hong (2020), Oskolkov (2023), Guntin et al. (2023).

rise to heterogeneous income fluctuations across households, and thus may weaken the transmission of monetary policy.

We also relate to the recent paper by Olivi et al. (2024), who study optimal monetary policy in a model with non-homothetic preferences and household heterogeneity. Relative to that paper, we show that heterogeneity across households in the severity of income fluctuations is a key driver of the aggregate implications of non-homothetic preferences for the transmission of monetary policy. Another recent contribution in the field is the work by Ferriere et al. (2024), who analyze the optimal conduct of fiscal policy in an economy with long-run changes in inequality and non-homothetic preferences.

2 Empirical Analysis

We document three empirical facts regarding expenditure composition, the income distribution, and monetary policy transmission in the EMU. These facts motivate and guide our theoretical analysis.

First, we document that countries with higher income inequality tend to allocate a larger share of total consumption to services. Second, we show that economies with lower service expenditure shares exhibit stronger output responses to monetary policy shocks. Third, we show that monetary policy shocks induce heterogeneous responses in external balances across countries in the EMU.

2.1 Data

We combine data on household consumption expenditure, income levels, macroeconomic aggregates, and monetary policy shocks for 19 European Monetary Union (EMU) member states.

Household consumption expenditure across income levels is primarily from the quinquennial Household Budget Survey (HBS, Eurostat), covering 1999-2020, which provides expenditure shares on three-digit COICOP categories per income quintile.[2] We convert these quintiles to disposable income levels using Eurostat income distribution data.[3]

Consumption expenditure is classified as goods (G) and services (S) based on COICOP (see Appendix A.4 for Table 4), excluding housing. Aggregate service consumption shares are calculated annually. Income inequality is measured by the Gini coefficient (World

[2] Note that for Bulgaria, the Czech Republic, Estonia, Croatia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia the sample starts in 2005 due to their later accession to the European Union. For Italy, data exists only until 2010.

[3] Income statistics are given as top cut-off points for each decile. We match the income level for each quintile with the top cut-off point of the first corresponding decile (e.g., the second quintile, spanning 3rd and 4th deciles, is matched with the 4th decile cut-off; the fifth quintile with the 9th decile cut-off).

Inequality Database, WID). Quarterly macroeconomic data (real GDP, value added by NACE Rev.2, price levels, trade balances, etc.) are from Eurostat. Value added is also classified as goods/services (Appendix A.5). Household-level wealth and income-by-industry data are from the Household Finance and Consumption Survey (HFCS), used to estimate Hand-to-Mouth (HtM) shares and sectoral income differences. Monetary policy shocks are high-frequency surprises from Jarociński and Karadi (2020). Our sample for local projections includes countries post-ERM II entry, following Dorrucci et al. (2022).[4]

Finally, we gather household-level data on wealth and income by industry from the Household Finance and Consumption Survey (HFCS). We use this data to compute the share of Hand-to-Mouth (HtM) households by country and to estimate differences in sectoral income shares between constrained and unconstrained households.

2.2 Empirical Regularities

A well-documented pattern, consistent with theories of structural transformation and non-homothetic preferences (Boppart, 2014; Herrendorf et al., 2014; Kongsamut et al., 2001), is that households with higher incomes allocate a systematically larger share of their consumption expenditure to services. We confirm this for our sample of euro-area countries. At the micro level, Figure 1 shows that the average service expenditure share rises from under 20% for the lowest income quintiles to nearly 50% for the highest. This underscores the relevance of non-homotheticity, with services functioning as luxury goods, as a foundational element for our subsequent analysis.

Disaggregating consumption into finer (2-digit COICOP) categories further underscores this non-homotheticity. Estimating the relationship between income and expenditure shares ($\omega_{t,i,j} = \alpha_i + \beta_i I_{t,j} + \phi_{i,j} + \psi_{i,t} + \epsilon_{t,i,j}$, controlling for country and time fixed effects), Figure 2 shows that the income coefficient (β_i) is significantly positive for most service categories (e.g., restaurants) and significantly negative for key tradable necessities like food.

Empirical Regularity 1: Services consumption increases with income inequality

At the aggregate level, countries with higher income inequality tend to have a larger expenditure share on services. We document this by estimating the following weighted (by GDP) linear regression:

$$\bar{\omega}_{N,k} = \alpha + \beta \overline{Gini}_k + \gamma_i \bar{X}_k' + \epsilon_k, \tag{1}$$

[4] As a result, we exclude Cyprus, Estonia, Latvia, Lithuania, Malta, and Slovenia before 2004, and Slovakia before 2005.

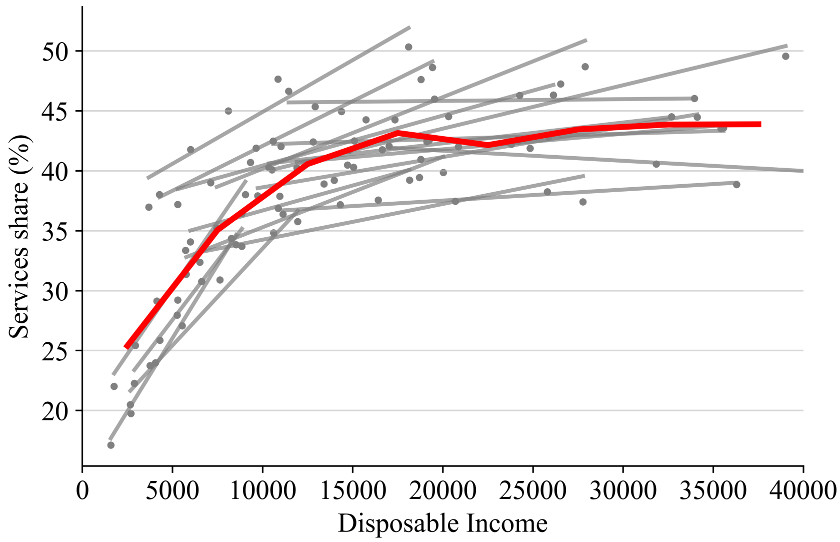


Figure 1: **Services expenditure shares by household income level.**

where $\bar{\omega}_{N,k}$ is the average service consumption share, $\overline{Gini}_k$ is the Gini coefficient of income, and $\bar{X}$ is a vector of controls including the trade balance, demographics, government size, and GDP per capita. Figure 3 and Table 1 show a positive and significant relationship: greater inequality correlates with higher service shares. This is consistent with our findings that services are luxury goods if higher-income households, who spend more on services, account for a larger share of total expenditure in more unequal countries.

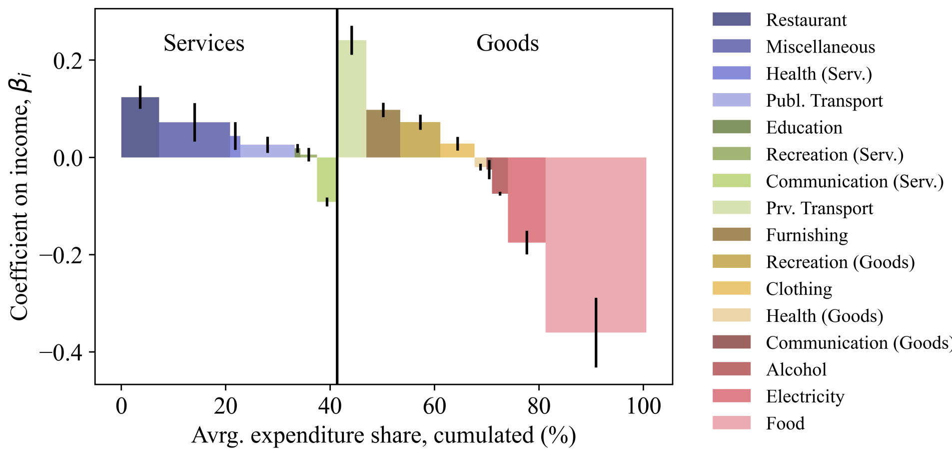


Figure 2: **Income elasticity of consumption shares by COICOP category.**

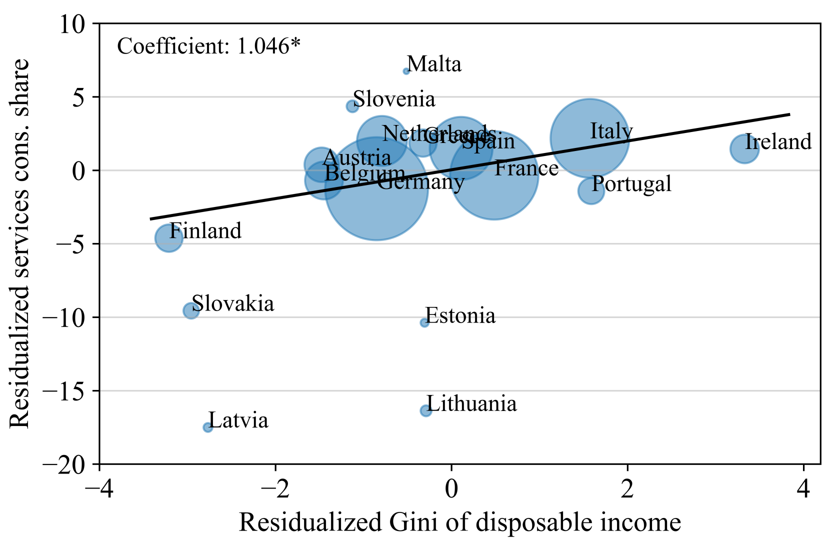


Figure 3: **Inequality and Services Expenditure Shares.**

	Services expenditure share		
Gini	1.046*		
	(-0.397)		
p90p10		6.128**	
		(-1.596)	
p75p25			13.36**
			(-3.91)
Trade balance	-1.034	-0.658	-0.769
	(-0.664)	(-0.529)	(-0.534)
Old-age dependency	-0.764**	-0.769***	-0.679**
	(-0.209)	(-0.173)	(-0.166)
Gov. exp.	-0.246	0.0512	-0.0482
	(-0.364)	(-0.288)	(-0.286)
GDP p.c.	0.648	0.625*	0.597*
	(-0.327)	(-0.231)	(-0.244)
N	17	17	17
adj. R-sq	0.571	0.689	0.644

Table 1: **Coefficient Estimates from Regression (1).**

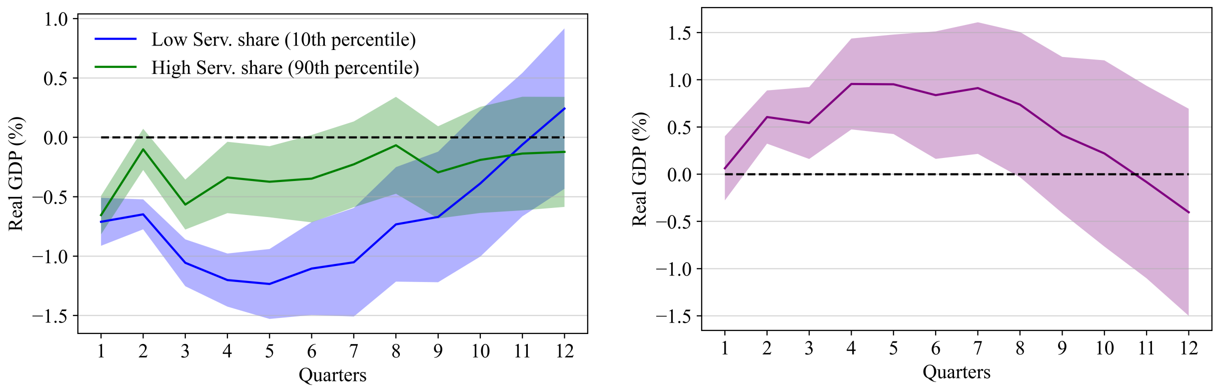
Empirical Regularity 2: Weaker monetary policy response in countries with high services consumption shares

Countries with a higher average share of expenditure on services exhibit a significantly weaker output response to monetary policy shocks. We establish this fact using local projections (Jorda, 2005; Montiel Olea & Plagborg-Møller, 2021) to estimate the impact of identified monetary policy shocks (i_t) on real GDP ($y_{t,k}$), interacted with the average service consumption share ($\bar{\omega}_k$):

$$y_{t+h,k} - y_{t-1,k} = \alpha + \beta^h i_t + \gamma^h (i_t \times \bar{\omega}_k) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,k} + \phi_k + u_{t+h,k}. \tag{2}$$

for each country k in the EMU. For inference, we follow the approach proposed by Montiel Olea and Plagborg-Møller (2021). In particular, we include $p = 3$ lags of the dependent variable as regressors to deal with potential auto-correlation and we cluster standard errors around countries. Finally, we also control for country fixed effects ϕ_k and an intercept α. Figure 4 shows that the output decline following a contractionary shock is substantially larger and more persistent in countries with low service shares (e.g., 1.2% cumulative decline after five quarters at the 10th percentile of service share) compared to those with high service shares (0.5% decline at the 90th percentile). The interaction term γ^h is negative and significant, confirming this differential response.

We provide an extensive discussion of robustness and extensions in Appendix A.6. We also show in Appendix A.7 that our impulse response functions for individual countries closely align with estimates found in the existing literature.



(a) High and low service share

(b) Difference (Interaction Term γ^h)

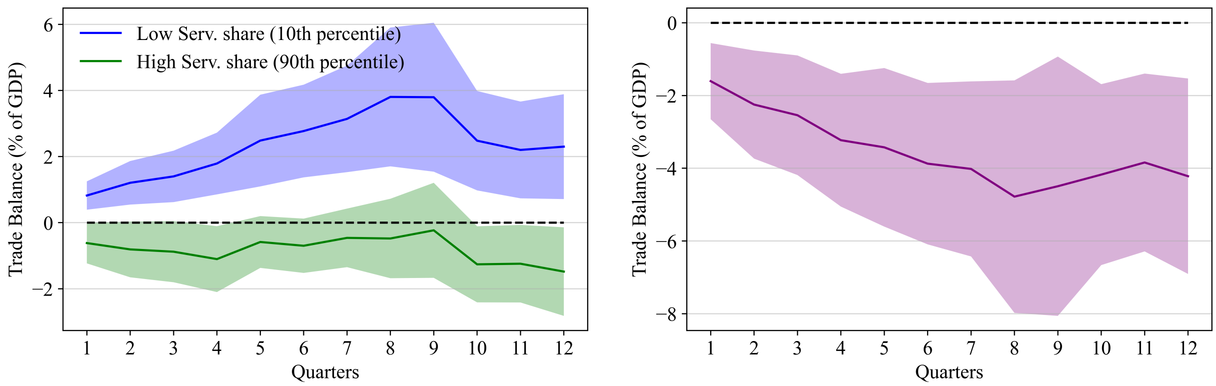
Figure 4: **Impulse response of real GDP to a contractionary monetary policy shock.**

Empirical Regularity 3: Monetary policy shocks induce heterogeneous trade balance responses

The expenditure composition across countries also correlates with how their trade balances respond to monetary policy shocks. We find that countries with relatively low service consumption shares experience a larger *improvement* (or smaller deterioration) in their trade balance following a contractionary monetary policy shock. To show this, we again use local projections, estimating the cumulative response of the trade balance (as a % of GDP) to monetary policy shocks, interacted with the service consumption share $\bar{\omega}_k$:

$$\sum_{j=0}^{h}(tb_{t+j,k} - tb_{t-1,k}) = \alpha^h + \beta^h \sum_{j=0}^{h} i_{t+j} + \gamma^h \left(\sum_{j=0}^{h} i_{t+j} \times \bar{\omega}_k \right) + \cdots + u_{t+h,k}. \qquad (3)$$

Figure 5 illustrates this. Following a one standard deviation contractionary shock, countries at the 10th percentile of service share see their trade balance improve by about 0.5 percentage points of GDP after two quarters. In contrast, countries at the 90th percentile of service share experience a slight deterioration. The difference, captured by the interaction term γ^h, is positive and statistically significant.



(a) High and low service share

(b) Difference (Interaction Term)

Figure 5: **Cumulative impulse response of trade balance (% of GDP) to a contractionary monetary policy shock.** Countries with low service consumption shares experience a larger increase in the trade balance. The shaded areas represent 90% confidence intervals. Standard errors are clustered around countries.

3 Model

We introduce a model that can rationalize the empirical findings in Section 2. The model economy comprises a continuum of small open economies in a monetary union. Each small open economy is indexed by $k \in [0, 1]$.[5] In each small open economy, households consume two types of commodities: goods (G) and services (S). Goods can be exchanged frictionlessly among countries in the monetary union, while the services are produced and consumed exclusively within the domestic economy. Household preferences over the two commodities are non-homothetic: Goods are a necessity, and services are a luxury, consistent with the micro-level evidence presented in Section 2. Heterogeneous households inhabit each small open economy, differing in income, wealth, and their ability to share risks in financial markets. Countries differ in their distribution of income. Firms produce goods subject to nominal rigidities, implying that monetary policy has real effects.

3.1 Households

Two types of households inhabit each small open economy. Ricardian (R) households have access to financial markets and can borrow or save. Hand-to-Mouth (H) households cannot hold assets or debt. Each small open economy is inhabited by one representative household of each type. These two household types, each with a mass of one, are indexed by $j \in \{R, H\}$.

All households have identical preferences, independently of their type. Their preferences

[5]In what follows, we suppress the country index k to lighten notation where describing properties of individual countries.

over a stream of expenditures $\{e_{j,t}\}_{t=0}^{\infty}$ are represented by:

$$V_{j,0} = \sum_{t=0}^{\infty} \beta^t v(e_{j,t}, P_t^G, P_t^S),$$

where $v(e_{j,t}, P_t^G, P_t^S)$ is an indirect utility function defined over total expenditure within the period $e_{j,t}$ and nominal prices of goods and services P_t^G, P_t^S. Prices are denominated in units of currency, which serves as the numéraire of the economy. Expenditure satisfies $e_{j,t} = P_t^G c_{j,t}^G + P_t^S c_{j,t}^S$.

We adopt the functional form for the indirect utility function from Boppart (2014):

$$v(e_{j,t}, P_t^G, P_t^S) = \frac{1}{\varepsilon}\left[\left(\frac{e_{j,t}}{P_t^S}\right)^{\varepsilon} - 1\right] - \frac{\nu}{\gamma}\left[\left(\frac{P_t^G}{P_t^S}\right)^{\gamma} - 1\right]. \tag{4}$$

The parameters $\varepsilon, \gamma \in [0,1]$ and $\nu > 0$. These preferences allow for non-homotheticity, and thus for expenditure shares over the two commodities that vary in the level of total expenditure. The parameter ε characterizes the degree of non-homotheticity. For $\varepsilon > 0$, the expenditure share on goods is decreasing in the level of total expenditure. The parameter ν controls the share of expenditure that is allocated to goods. γ governs the elasticity of substitution between the two commodities, which is not constant for $\gamma \neq \varepsilon$. These preferences embed homothetic, Cobb-Douglas preferences with $\varepsilon = \gamma = 0$.

Households supply labor to firms inelastically. Each household's labor endowment is denoted by l_j. Due to a nominal wage rigidity, some of this endowment may remain unemployed. $l_{j,t}$ denotes the amount of labor supplied by each household type that is employed by firms in a given period t.

Each household's budget constraint, expressed in units of currency, is:

$$P_t^G c_{j,t}^G + P_t^S c_{j,t}^S = W_{j,t} l_{j,t} + \Psi_{j,t} + P_t^G R_{t-1} b_{j,t} + R_{t-1}^m b_{j,t}^m - P_t^G b_{j,t+1} - b_{j,t+1}^m, \tag{5}$$

where the left-hand side represents expenditure $e_{j,t}$ and the right-hand side represents resources available to households. Labor income equals the product of the household-specific wage $W_{j,t}$ and the household's labor employment $l_{j,t}$. Nominal firms' profits accruing to household j are $\Psi_{j,t}$. Total income of each household thus equals $i_{j,t} = W_{j,t} l_{j,t} + \Psi_{j,t}$. Ricardian household resources additionally include holdings of real and nominal risk-free bonds $b_{R,t}$ and $b_{R,t}^m$, which yield gross returns R_{t-1} and R_{t-1}^m, respectively, net of purchases of real and nominal bonds $b_{j,t+1}$ and $b_{j,t+1}^m$. Hand-to-Mouth households do not hold bonds, $b_{H,t} = b_{H,t}^m = 0$.

Households allocate their expenditures across goods and services in each period as follows:[6]

$$c_{j,t}^G = \frac{e_{j,t}}{P_t^G}\left[\nu\left(\frac{P_t^S}{e_{j,t}}\right)^{\varepsilon}\left(\frac{P_t^G}{P_t^S}\right)^{\gamma}\right], \tag{6}$$

$$c_{j,t}^S = \frac{e_{j,t}}{P_t^S}\left[1-\nu\left(\frac{P_t^S}{e_{j,t}}\right)^{\varepsilon}\left(\frac{P_t^G}{P_t^S}\right)^{\gamma}\right], \tag{7}$$

and the corresponding expenditure shares $\omega_{j,t}^G$ and $\omega_{j,t}^S$ are given by:

$$\omega_{j,t}^G \equiv \frac{P_t^G c_t^G}{e_{j,t}} = \nu\left(\frac{P_t^S}{e_{i,j,t}}\right)^{\varepsilon}\left(\frac{P_t^G}{P_t^S}\right)^{\gamma}, \tag{8}$$

$$\omega_{j,t}^S \equiv \frac{P_t^S c_t^S}{e_{j,t}} = 1-\nu\left(\frac{P_t^S}{e_{j,t}}\right)^{\varepsilon}\left(\frac{P_t^G}{P_t^S}\right)^{\gamma}. \tag{9}$$

The share of expenditure allocated to goods decreases with total expenditure, since preferences in (4) imply that goods are a necessity. Conversely, the share allocated to services increases with total expenditure. This dependence of expenditure shares on total expenditure is a key feature of the model, marking a significant departure from most contributions to the heterogeneous-agents New Keynesian literature. With $\varepsilon = \gamma = 0$, the two expenditure shares are constant and given by ν and $1-\nu$ for goods and services, respectively, embedding the standard Cobb-Douglas case.

Ricardian households decide how to best allocate their expenditure over time. They maximize lifetime welfare subject to the stream of period budget constraints (5) and to standard transversality conditions. An inter-temporal Euler equation for expenditure describes how Ricardian households optimally allocate resources across periods:

$$\frac{v_e(e_{j,t}, P_t^G, P_t^S)}{v_e(e_{j,t+1}, P_{t+1}^G, P_{t+1}^S)} = \left(\frac{e_{j,t+1}}{e_{j,t}}\right)^{1-\varepsilon}\left(\frac{P_{t+1}^S}{P_t^S}\right)^{\varepsilon} = \beta R_t^m, \tag{10}$$

From this Euler equation and from the intra-temporal allocation of expenditure, the Ricardian household's intertemporal Euler equation for goods follows:

$$\frac{c_{R,t+1}^G}{c_{R,t}^G} = \beta R_t^m \left(\frac{P_t^G}{P_{t+1}^G}\right)^{1-\gamma}\left(\frac{P_t^S}{P_{t+1}^S}\right)^{\gamma}. \tag{11}$$

Arbitrage ensures equality of returns on nominal and real bonds, leading to the following Fisher equation:

$$R_t^m = R_t \frac{P_{t+1}^G}{P_t^G}. \tag{12}$$

[6]The household's intra-temporal problem associated with the indirect utility function (4) determines this allocation.

Hand-to-Mouth households spend their entire labor and profit income in each period:

$$e_{H,t} = W_{H,t} l_{H,t} + \Psi_{H,t}.$$

3.2 Firms, Production, and Nominal Rigidities

3.2.1 Technology

A continuum of infinitesimal firms that produce either goods or services inhabits each small open economy.

Firms in each sector combine labor supplied by both Ricardian and Hand-to-Mouth households to produce output. The labor bundle, l_t^a, is the only factor used to produce each commodity $a \in \{G, S\}$, according to the production function:

$$y_t^a = (l_t^a)^{\alpha_a} \tag{13}$$

where α_a denotes the elasticity of output to labor in each sector s. The labor input bundle l_t^a is a Cobb-Douglas aggregator of labor supplied by Ricardian and Hand-to-Mouth households:

$$l_t^a \equiv \left(l_{H,t}^a\right)^{1-\xi_a} \left(l_{R,t}^a\right)^{\xi_a}, \tag{14}$$

where $l_{j,t}^a$ is the amount of labor supplied by household j that is employed in sector s. The parameter ξ_a controls the elasticity of the labor input bundle with respect to Ricardian households' labor in sector a. It also determines the share of total labor income in sector a accruing to Ricardian households.

Each household can supply labor to any firm, so labor of each type is mobile across sectors.

3.2.2 Firms' Problem and Distribution of Profits

Firms' maximize profits, defined as the revenue from sales minus the wage bill. The profit maximization problem for a representative firm in sector a is:

$$\max_{l_t^a} P_t^a \left(l_t^a\right)^{\alpha_a} - W_t^a l_t^a,$$

where P_t^a is the price of output, W_t^a is the wage associated with the labor bundle l_t^a.

The wage W_t^a is a Cobb-Douglas aggregator of the wages paid to Ricardian and Hand-to-Mouth households:

$$W_t^a = \left(\frac{W_{H,t}}{1-\xi_a}\right)^{1-\xi_a} \left(\frac{W_{R,t}}{\xi_a}\right)^{\xi_a},$$

where $W_{H,t}$ and $W_{R,t}$ denote the wages of Hand-to-Mouth and Ricardian households, respectively.

Profit maximization leads to the following labor demand schedules for each household type:

$$\alpha_a(1-\xi_a)P_t^a\frac{y_t^a}{l_{H,t}^a} = W_{H,t}, \tag{15}$$

and

$$\alpha_a\xi_a P_t^a\frac{y_t^a}{l_{R,t}^a} = W_{R,t}. \tag{16}$$

The total profits in sector a are given by:

$$\Psi_t^a = (1-\alpha_a)\,P_t^a y_t^a,$$

where profits reflect the share of output not allocated to labor costs.

Both Ricardian and Hand-to-Mouth households own equity in firms. Ownership is proportional to their contributions to labor income in each sector. Ricardian households own a fraction ξ_a of the equity in sector a, while Hand-to-Mouth households own $1-\xi_a$. Thus, profits are distributed as follows:

$$\Psi_{R,t} = \xi_G\Psi_t^G + \xi_S\Psi_t^S, \Psi_{H,t} = (1-\xi_G)\Psi_t^G + (1-\xi_S)\Psi_t^S.$$

This distribution implies that both household types share in the profits generated by firms in proportion to their labor contributions.

3.2.3 Nominal Rigidities

The wages of both worker types are constrained by a time-varying nominal rigidity:

$$W_{j,t} \geq \bar{\varpi}_t W_{j,t-1},$$

where $\bar{\varpi}_t$ controls the severity of downward wage rigidity.

When the wage rigidity binds, the labor demand schedules (15) and (16) determine employment for each worker type.

3.2.4 Total Real and Nominal Output

Total nominal output in each country equals the sum of the sectoral outputs, valued at their current-period nominal prices:

$$y_t^{nom} = P_t^G y_t^G + P_t^S y_t^S.$$

Total real output is similarly defined, with both goods and service outputs valued at base-year prices:

$$y_t = P_0^G y_t^G + P_0^S y_t^S.$$

3.3 Monetary Policy

A central bank controls the nominal interest rate R_t^m in the monetary union. It sets R_t^m to achieve a constant rate of inflation for the geometric average of the prices of the two commodities in the union:

$$\bar{\Pi} = \left(\frac{P_t^G}{P_{t-1}^G}\right)^{1-\gamma} \left(\frac{\tilde{P}_t^S}{\tilde{P}_{t-1}^S}\right)^{\gamma} = 1, \tag{17}$$

where the geometric weight γ coincides with the preference parameter. $\tilde{P}_t^S$ denotes the geometric average price of services across countries in the union:

$$\tilde{P}_t^S \equiv \exp\left(\int_0^1 \log P_{t,k}^S dk\right).$$

The central bank controls the supply of nominal bonds to maintain monetary policy objectives.

3.4 Market Clearing and Equilibrium

Labor market clearing ensures that the total labor employed by firms in both sectors does not exceed households' total labor endowment:

$$l_{j,t}^S + l_{j,t}^G = l_{j,t} \leq l_j \text{ for } j \in \{H, R\}, \tag{18}$$

where the inequality allows for involuntary unemployment arising from nominal wage rigidity. In each period, either all labor is fully employed, or the downward wage rigidity binds:

$$(l_{j,t}^S + l_{j,t}^G - l_{j,t})(W_{j,t} - \varpi_t W_{j,t-1}) = 0 \text{ for } j \in \{H, R\}. \tag{19}$$

The market-clearing condition for services in each country k requires that consumption equals output:

$$c_{R,k,t}^S + c_{H,k,t}^S = y_{k,t}^S. \tag{20}$$

For each small open economy k in the monetary union, aggregate consumption of goods equals output, net of changes in net foreign assets:

$$c_{k,t}^{G} \equiv c_{R,k,t}^{G} + c_{H,k,t}^{G} = y_{k,t}^{G} + R_{t-1}b_{k,t} - b_{k,t+1}, \tag{21}$$

This expression can be rearranged to express the law of motion for the net foreign assets of country k, defining its current account:

$$ca_{k,t} \equiv b_{k,t+1} - b_{k,t} = y_{k,t}^{G} - c_{k,t}^{G} + b_{k,t}(R_{t-1} - 1) \tag{22}$$

The current account is given by the sum of the trade balance, $y_{k,t}^{G} - c_{k,t}^{G}$, and net interest payments on the stock of net foreign assets owned by the country at the start of the period, $b_{k,t}(R_{t-1} - 1)$.

If considering a small open economy in partial equilibrium, the path of $b_{k,t}$ can take any value, and thus $y_{k,t}^{G}$ and $c_{k,t}^{G}$ can diverge. If, instead, considering the interaction of all small open economies in the monetary union, market clearing for tradable goods at the union-level must hold:

$$\int_k y_{k,t}^{G} dk = \int_k (c_{R,k,t}^{G} + c_{H,k,t}^{G}) dk. \tag{23}$$

The no-arbitrage condition (12) implies that households are indifferent between holding real and nominal bonds. The net amount of nominal bonds supplied by the monetary authority is zero:

$$\int_k b_{R,k,t}^{m} dk = 0 \quad \text{for all } t. \tag{24}$$

We are now ready to define a competitive equilibrium for a small open economy in isolation.

Equilibrium 1 (Small Open Economy)**.** *Given a path for* $\{R_t, P_t^G, R_t^m\}_t$*, nominal rigidities* $\{\bar{\varpi}_t\}_t$*, and an initial condition* b_0*, a competitive equilibrium for country* k *consists of a path of quantities* $\{c_{H,k,t}^{G}, c_{R,k,t}^{G}, c_{H,k,t}^{S}, c_{R,k,t}^{S}, e_{H,k,t}, e_{R,k,t}, l_{k,t}^{G}, l_{H,k,t}^{G}, l_{R,k,t}^{G}, l_{k,t}^{S}, l_{H,k,t}^{S}, l_{R,k,t}^{S}, y_{k,t}^{G}, y_{k,t}^{S}, b_{k,t+1}\}_t$*, and prices* $\{P_{k,t}^{S}, W_{H,k,t}, W_{R,k,t}\}_t$ *satisfying households' optimality conditions* (5), (6), (7), (10)*, the firm's profit maximization* (13), (14), (15), (16)*, nominal rigidities* (19)*, and the market-clearing condition* (20)*.*

An equilibrium for the monetary union is defined below.

Equilibrium 2 (Monetary Union)**.** *Given an initial condition for* $b_{R,k,0}^{n}$ *for each country* k *and a path for nominal rigidities* $\{\bar{\varpi}_t\}_t$*, a competitive equilibrium consists of a path of quantities* $\{c_{H,t}^{G}, c_{R,t}^{G}, c_{H,t}^{S}, c_{R,t}^{S}, e_{H,t}, e_{R,t}, l_t^{G}, l_{H,t}^{G}, l_{R,t}^{G}, l_t^{S}, l_{H,t}^{S}, l_{R,t}^{S}, y_t^{G}, y_t^{S}, b_{t+1}\}_t$*, and prices* $\{P_t^S, P_t^G, W_{H,t}, W_{R,t}, R_t, R_t^m\}_t$*, satisfying for each country* k *the set of conditions in Equi-*

librium 1, the tradable goods market-clearing condition (23)*, the monetary policy target* (17)*, and the Fisher equation* (12)*.*

Finally, we define a stationary allocation as an equilibrium of the model economy where all variables take constant values.[7]

4 Results: Revealing the Mechanism

This section leverages our model framework to explore how differences in expenditure composition across countries impact the strength of monetary policy transmission. Our main theoretical prediction, mirroring our empirical findings, is that in countries where the service expenditure share is higher, output responds less strongly to monetary policy shocks. We build up to this result through a sequence of findings, first examining the determinants of expenditure shares and then how monetary policy transmission changes with varying degrees of inequality. Our headline findings rely on the following maintained assumptions:

Assumption 4.1. *Household preferences are non-homothetic, that is $\varepsilon > 0$, and that income effects dominate substitution effects $\gamma < \varepsilon$.*

Assumption 4.2. *The income in the service sector accrues disproportionately to Ricardian households, that is, $\xi_{S,k} > 0.5$ in all countries. The income in the goods sector accrues equally across households, $\xi_{G,k} = 0.5$, in all countries.*

We also explain how our qualitative results change when either of these two assumptions is relaxed. For quantitative illustrations of results from the model, we set the labor endowment of both households l_j to 0.93. This value normalizes expenditure to unity in a benchmark allocation where income shares are identical across households and sectors ($\xi_{G,k} = \xi_{S,k} = 0.5$) in all countries. We set the parameter governing the expenditure share ν to 0.6, implying an expenditure share on services in this benchmark allocation of 40%, which approximates the median of households' expenditure shares documented in Section 2. We set the parameter governing the degree of non-homotheticity ε to 0.18, following Boppart (2014). For analytical convenience, we set the remaining preference parameter $\gamma = 0$ in the baseline case but also consider a version of the model with $\gamma = \varepsilon$, which ensures a constant elasticity of substitution across goods below unity. We set the labor share of income in the service sector α_N to unity. In the goods sector, we set the labor share α_T to 0.43. These two parameters jointly determine an aggregate labor share of income of 0.66, consistent with standard stylized facts in macroeconomics.

[7] Appendix B.1 characterizes this stationary allocation in detail.

4.1 Non-Homotheticity, Inequality, and Expenditure Shares

First, we examine the drivers of expenditure shares and show that households and countries with higher expenditure levels allocate a larger share of their expenditure to services. Our model's ability to generate heterogeneity in expenditure shares lies with non-homothetic preferences a la Boppart (2014). These preferences, where services are luxury goods and goods are necessities, have direct and intuitive consequences for consumption patterns, which we establish formally in Lemmas 1-3.[8]

First, as individual household income and expenditure rise, non-homothetic preferences lead them to allocate a successively larger share of their spending to services (Lemma 1). This micro-level behavior directly underpins our empirical finding that services expenditures increase with household income. Figure 6 illustrates this: under non-homotheticity, the expenditure share on services slopes upward with expenditure, in contrast to the flat line under homothetic preferences.

Lemma 1. *Under Assumption 4.1, each household allocates to services a share of its expenditure that is increasing in the level of expenditure itself:*

$$\frac{\partial \omega^S_{j,k}\left(e_{j,k}\right)}{\partial e_{j,k}} > 0.$$

Sketch of Proof: Consider the expenditure share on services $\omega^S_{j,k}$, as defined in (9). Given $\nu > 0$ and non-homotheticity ($\varepsilon > 0$), it is straightforward to show that the service expenditure share of household j in country k increases with its expenditure $e_{j,k}$. The partial derivative of the expenditure share with respect to the expenditure level is given by:

$$\frac{\partial \omega^S_{j,k}\left(e_{j,k}\right)}{\partial e_{j,k}} = \varepsilon \frac{1-\omega^S_{j,k}}{e_{j,k}},$$

which is strictly positive for $\varepsilon > 0$. $\square$

Aggregating this micro household behavior, two further implications emerge. First, countries with higher average expenditure levels will, on average, also have a larger share of services consumption:

Lemma 2. *Under Assumption 4.1, the average expenditure share allocated to services in a country, $\bar{\omega}^S_k$, increases with the country's aggregate expenditure level, $\bar{e}_k$:*

$$\frac{\partial \bar{\omega}^S_k\left(\bar{e}_k\right)}{\partial \bar{e}_k} > 0,$$

given prices and the distribution of households' relative expenditures, $\left\{x_{j,k}\right\}_{j\in\{H,R\}}$.

[8] Appendix B.5.1 provides more details on the proofs for these Lemmas.

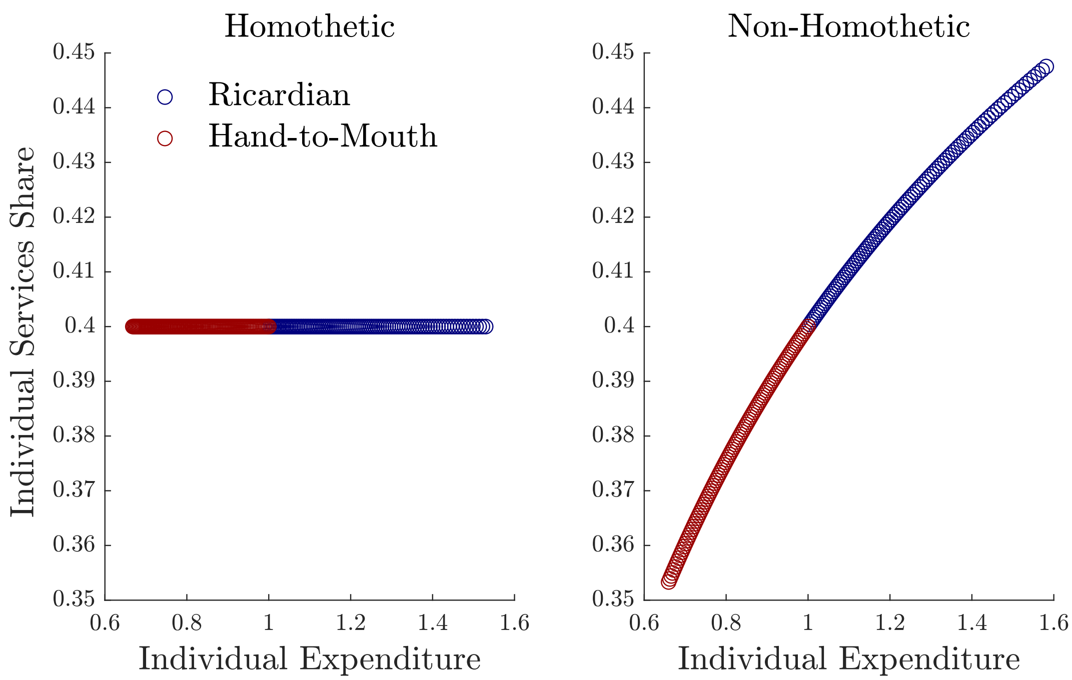


Figure 6: **Household-level service expenditure share $\omega^S_{j,k}$ as a function of household expenditure.** Stationary allocation under homothetic ($\varepsilon = 0$) or non-homothetic ($\varepsilon > 0$) preferences. Each dot represents one household, either Ricardian or Hand-to-Mouth, in one of the countries of the monetary union. Countries in the monetary union differ in terms of their income distribution, with $\xi_{S,k} \in [0.5, 1]$ and $\xi_{T,k} = 0.5$.

Sketch of Proof: This result follows directly from the behavior of household-level expenditure share established in Lemma 1. The average expenditure share satisfies

$$\bar{\omega}^S_k\left(\bar{e}_k\right) = x_{H,k}\omega^S_{H,k}\left(x_{H,k}\bar{e}_k\right) + x_{R,k}\omega^S_{R,k}\left(x_{R,k}\bar{e}_k\right) \tag{25}$$

As Lemma 1 establishes that household-level service expenditure shares increase with expenditure, the average service expenditure share also increases in aggregate expenditure, given the distribution of such expenditure across households. □

Second, and central for our analysis, countries with greater income inequality will also feature a higher average service expenditure share (Lemma 3). This occurs because higher inequality, driven by a larger share of service sector income accruing to wealthier Ricardian households (Assumption 4.2), concentrates a larger portion of total expenditure among these Ricardian households. Given their higher income and non-homothetic preferences, these households spend disproportionately more on services, increasing the aggregate service share.[9] This mechanism provides a theoretical basis for our *Empirical Regularity 1* (service consumption increases with income inequality). Figure 7 demonstrates this positive relationship between the Gini index and the average service expenditure share.

[9] Considering the opposite case with $\xi_{S,k} \in [0, 0.5]$ would give rise to higher inequality, the lower is $\xi_{S,k}$, but with the unusual assumption that the Hand-to-Mouth household is the one with the highest income.

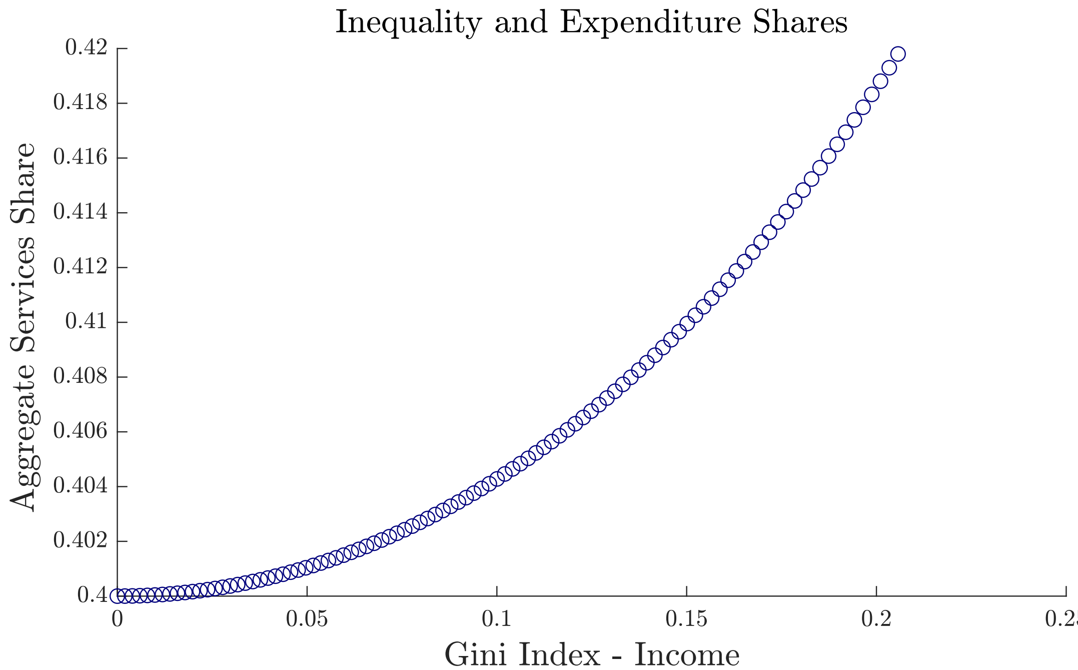


Figure 7: **Average service expenditure share $\bar{\omega}_k^S$ as a function of income inequality.** Income inequality is represented by the Gini index on household income. Stationary allocation with non-homothetic preferences ($\varepsilon > 0$). Each dot represents one country in the monetary union. Countries differ in income distribution, with $\xi_{S,k} \in [0.5, 1]$ and $\xi_{T,k} = 0.5$.

Lemma 3. *Under Assumptions 4.1 and 4.2, the average expenditure share allocated to services in one country, $\bar{\omega}_k^S$, increases with the dispersion of household expenditure in that country, $\sigma_{x,k}$:*

$$\frac{\partial \bar{\omega}_k^S (\bar{e}_k)}{\partial \sigma_{x,k}} > 0,$$

Sketch of Proof: To see this result, consider the expression for the average expenditure share in (25). For each household, total service expenditure is increasing and convex in own expenditure $e_{j,k}$:

$$P^S c_{j,k}^S = e_{j,k} - \nu \left(e_{j,k}\right)^{1-\varepsilon} P^{S\varepsilon} \left(\frac{P_t^G}{P_t^S}\right)^{\gamma}.$$

The average service expenditure share is therefore a convex function of the households' shares of total expenditure $x_{j,k}$, resembling the household-level expenditure share. By Jensen's inequality, an increase in the dispersion of $(x_{H,k}, x_{R,k})$ away from equality $(0.5, 0.5)$ leads to a higher average service expenditure share $\bar{\omega}_k^S$. $\square$

4.2 Monetary Policy Transmission: The Role of Income Inequality and Expenditure Shares

Having established how non-homothetic preferences and the income distribution shape expenditure patterns, we now turn to our central question: how do these features affect the transmission of monetary policy? We analyze a temporary, unexpected contractionary monetary policy shock (an increase in R_t^m at $t = 1$), assuming nominal wage rigidities bind only in the short run ($t = 1$).

4.2.1 Benchmark: A Monetary Union of Homogeneous Countries

To isolate the core mechanisms through which the income distribution and non-homothetic preferences influence monetary policy's impact, we first analyze a monetary union of identical countries—a benchmark equivalent to a closed economy. Here, the interaction between non-homothetic preferences and income inequality is key for understanding the dampened transmission of monetary policy.

Our main theoretical prediction for this homogeneous union (formalized in Proposition 1) is the comparative static that the higher the income inequality with the member countries of the monetary union, the weaker is the transmission of monetary policy to total output and, as established in Section 4.1 (Lemma 3), the higher is average expenditure share on services. This occurs when higher inequality stems from Ricardian households deriving a larger fraction ξ_S of their income from the service (luxury) sector (Assumption 4.2). This theoretical result directly rationalizes our primary *Empirical Regularity 2*: countries with high service expenditure shares experience a dampened output response to monetary policy. Figure 8 graphically depicts how the output response to a contractionary shock becomes more muted as the service expenditure share (driven by inequality ξ_S) rises.

Proposition 1. *Under Assumptions 4.1 and 4.2, countries feature: i) a weak transmission of monetary policy to output,*

$$\left.\frac{y_1}{y_2}\right|_{Unequal} > \left.\frac{y_1}{y_2}\right|_{Equal}$$

ii) a high share of average expenditure allocated to the service good,

$$\bar{\omega}^S_{Unequal} > \bar{\omega}^S_{Equal}.$$

Proof: See Appendix B.2.

The intuition behind this muted transmission hinges on how income inequality itself responds to the policy shock, becoming *pro-cyclical*. Because services are luxuries, their

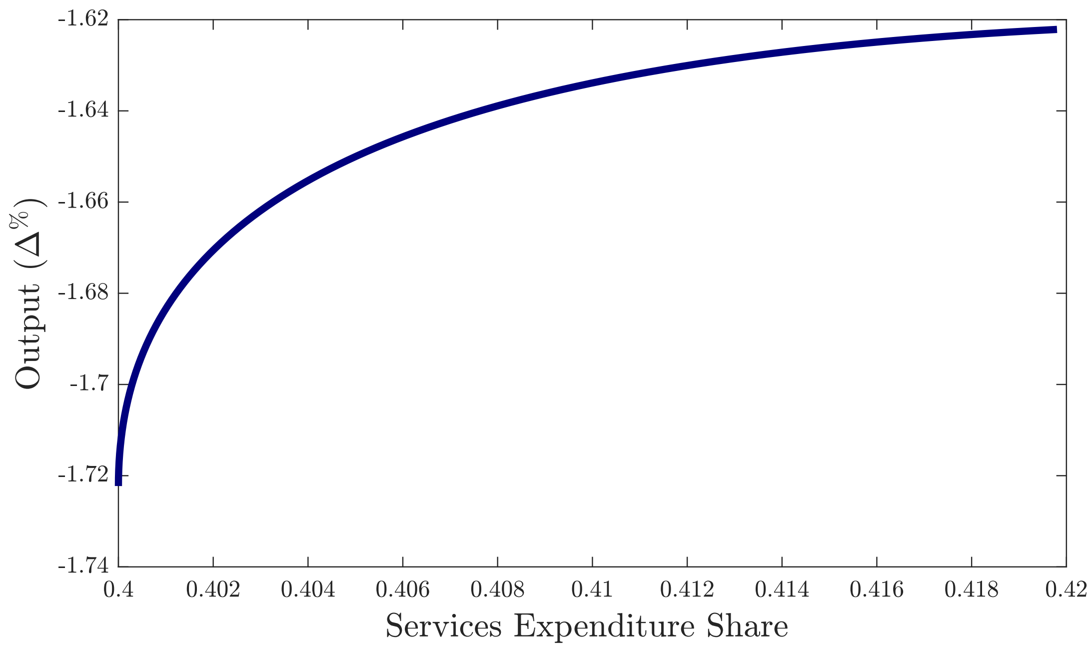


Figure 8: **Contractionary monetary policy in union of identical countries. Effect on total output, as function of the stationary-allocation service share of expenditure.** The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

relative value is pro-cyclical (falls in recessions, rises in expansions).[10] When Ricardian households' income is disproportionately tied to the service sector ($\xi_S > \xi_G$), their income also becomes more pro-cyclical than that of Hand-to-Mouth households.

Following a contractionary monetary policy shock:

1. The relative value of services falls. Ricardian households, disproportionally exposed, see a sharp income decline.

2. Conversely, Hand-to-Mouth households, less exposed to the service sector contraction, experience a *milder* income drop. This is formally established in Lemma 4, which shows that the Ricardian household's expenditure relative to the Hand-to-Mouth's (e_R/e_H) falls during the policy-induced recession (Figure 9, right panel).

3. This differential income response means that overall income inequality (between Ricardian and Hand-to-Mouth) actually *decreases* during the recession (hence that inequality is pro-cyclical).

4. Since Hand-to-Mouth consumption is highly sensitive to current income, their smaller income drop translates to a smaller consumption drop. This effect is crucial because, as shown in Lemma 5, the pro-cyclicality of e_R/e_H also makes the Ricardian share

[10] Appendix B.2 establishes that the relative value of service output is increasing in aggregate expenditure and therefore pro-cyclical under non-homothetic preferences.

of total tradable consumption (c_R^G/c^G) pro-cyclical. Thus, during the contraction, Hand-to-Mouth households account for a larger share of tradable consumption.

This pro-cyclical behavior of inequality, driven by non-homothetic preferences and the specific income structure, effectively insulates Hand-to-Mouth consumption partially from the shock. Since these households have a high marginal propensity to consume, the overall drop in aggregate demand—particularly for tradable goods—is less acute.

Proposition 2 formalizes this by showing that the aggregate contraction in goods consumption (and thus output in this closed setting) is *weaker* than the direct fall in Ricardian households' tradable consumption demand. Ricardian demand falls proportionally to the shock itself (i.e., $\frac{c^G_{R,1}}{c^G_{R,2}} = \frac{\bar{\Pi}}{\beta R^m_1}$),[11] but the overall impact is dampened by the relatively stable consumption of Hand-to-Mouth agents. The left panel of Figure 9 illustrates this: the aggregate goods consumption contraction is milder than what Ricardian demand alone would imply.

Proposition 2. *Under Assumptions 4.1 and 4.2, a contractionary monetary policy shock reduces goods output and aggregate goods consumption less than it reduces the demand for goods by Ricardian households, which are directly exposed to the shock:*

$$\frac{c^G_{R,1}}{c^G_{R,2}} < \frac{y^G_1 = c^G_1}{y^G_2 = c^G_2}.$$

Proof: See Appendix B.2.

Lemma 4. *The Ricardian household's relative expenditure is pro-cyclical, i.e.:*

$$\frac{e_{R,1}}{e_{H,1}} < \frac{e_{R,2}}{e_{H,2}},$$

if i) $\xi_S > \xi_G$, and ii) $\varepsilon > 0$.

Proof: See Appendix B.2.

Lemma 5. *The Ricardian's share of total goods consumption $c^G_{R,t}/c^G_t$ is pro-cyclical, if and only if the expenditure of this household, relative to that of the Hand-to-Mouth, $e_{R,t}/e_{H,t}$, is pro-cyclical:*

$$\frac{e_{R,2}}{e_{H,2}} > \frac{e_{R,1}}{e_{H,1}} \iff \frac{c^G_{R,2}}{c^G_2} > \frac{c^G_{R,1}}{c^G_1}.$$

Proof: See Appendix B.2.

[11] This follows from the Ricardian household's Euler equation for goods (11), total expenditure (10), intra-temporal allocation (8), and the inflation target (17). In a homogeneous union, $\tilde{P}^S_t = P^S_{k,t}$.

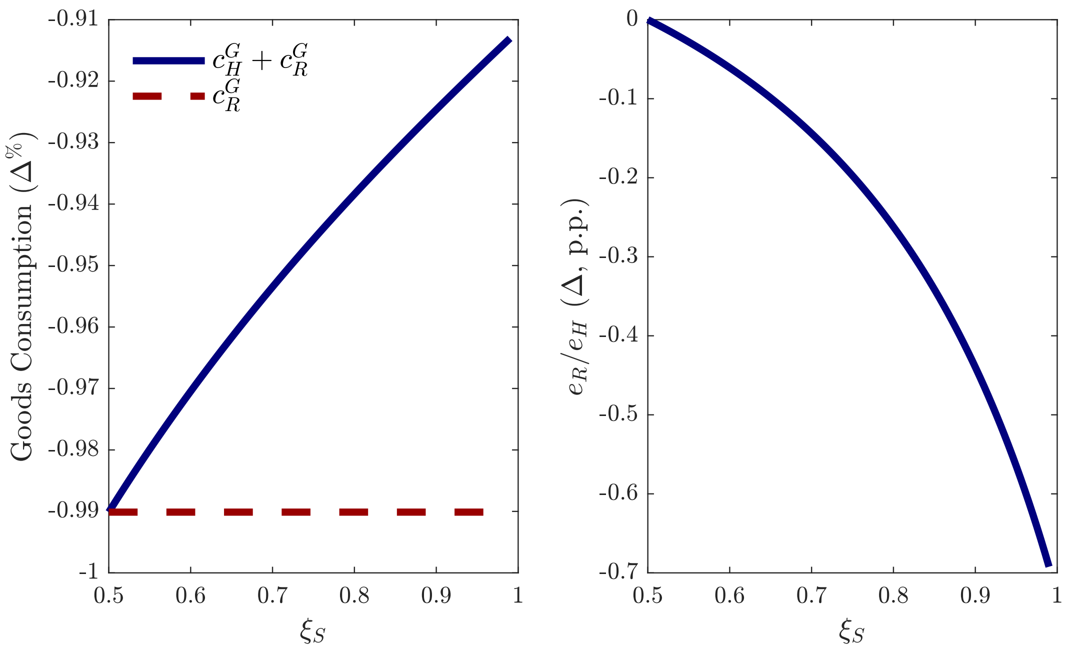


Figure 9: **Contractionary monetary policy in union of identical countries. Effects of monetary policy shock on consumption of goods, aggregate and of Ricardian household (left panel) and on relative expenditure of Ricardian household (right panel).** Effects are displayed as function of the share of service sector output accruing to Ricardian household (ξ_S). The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

Since service and total output move in lockstep with output of goods in this setting,[12] the weaker response of goods' output directly translates to a weaker response of total output (as shown in Proposition 1). Figure 10 further illustrates that the impact on goods' prices and service output is also weaker in more unequal countries. Both non-homothetic preferences and the specific income distribution ($\xi_S > \xi_G$) are crucial; without either, this pro-cyclical inequality channel would not operate, and goods' output would fall in line with Ricardian demand, as in a representative-agent setting.

We now transition to a setting with heterogeneous countries, where these core mechanisms interact with cross-country trade, allowing us to explore how heterogeneity in monetary policy transmission arises across countries within the union — our main empirical focus.

4.2.2 Extended Framework: Monetary Union of Heterogeneous Countries

We now extend our analysis to a monetary union where countries differ in their income distribution, specifically in the share of service income accruing to Ricardian households ($\xi_{S,Un} > \xi_{S,Eq}$, while ξ_G is uniform). This heterogeneity delivers two key results, formalized in Propositions 3 and 4.

[12] Appendix B.3 proves this result. This co-movement arises because output of goods responds positively to its price, and service output (a luxury) increases with both goods' output and the relative price of goods.

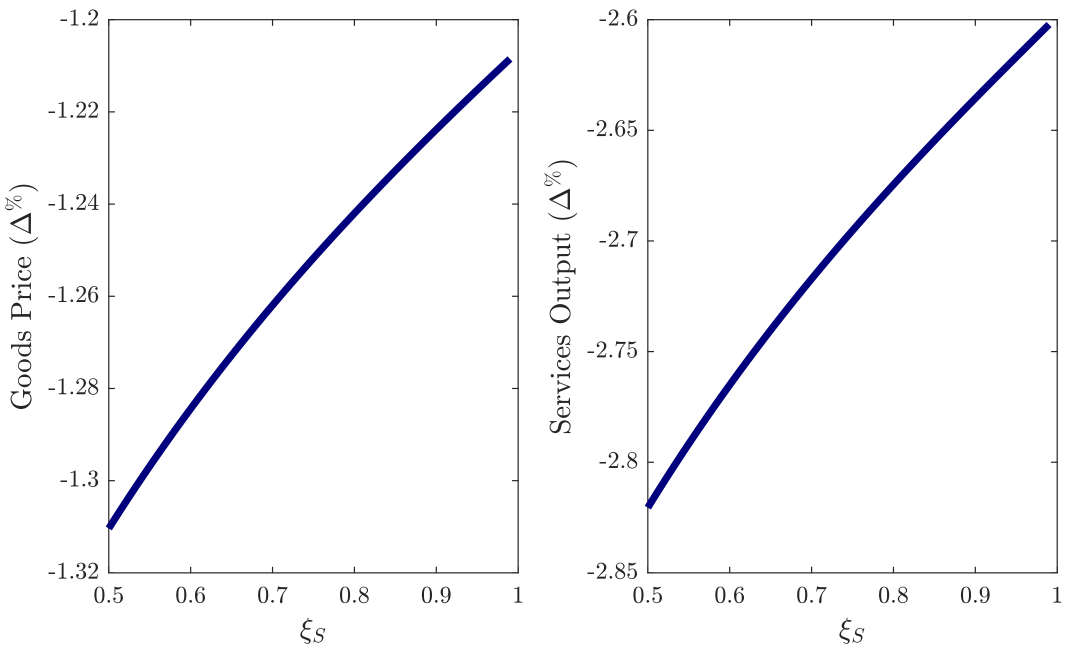


Figure 10: **Contractionary monetary policy in union of identical countries. Effects on the price of tradable good (left panel) and on service output (right panel).** Effects are displayed as function of the share of service sector output accruing to Ricardian household (ξ_S). The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

First, consistent with the homogeneous case and our empirical findings, monetary policy exerts a weaker effect on total output in the "unequal" countries (those with higher ξ_S and thus higher service expenditure shares) compared to the "equal" countries (Proposition 3). Figure 11 (left panel) illustrates how the output decline in unequal countries is less pronounced.

Proposition 3. *In a monetary union of heterogeneous countries, monetary policy has a weaker effect on total output in "unequal" than in "equal" countries. Upon a contractionary shock:*

$$\frac{y_{1,Un}}{y_{0,Un}} > \frac{y_{1,Eq}}{y_{0,Eq}}.$$

Second, and novel to the heterogeneous country setting, monetary policy shocks generate systematic trade imbalances: unequal countries run trade deficits, while equal countries run trade surpluses following a contractionary shock (Proposition 4). This rationalizes our empirical observations (Empirical Regularity 3) that trade flows respond heterogeneously to monetary policy. Figure 11 (right panel) shows the emergence of these imbalances.

Proposition 4. *In a monetary union of heterogeneous countries, a contractionary monetary policy shock gives rise to a trade deficit in the "unequal" countries and to a trade* *surplus in the "equal" ones:*

$$\frac{c^G_{1,Un}}{y^G_{1,Un}} > \frac{c^G_{2,Un}}{y^G_{2,Un}} \quad and \quad \frac{c^G_{1,Eq}}{y^G_{1,Eq}} < \frac{c^G_{2,Eq}}{y^G_{2,Eq}}.$$

The mechanics behind these cross-country differences (detailed below Lemma 6 revolve around the common price of tradables ($P^G_{1,MU}$) in the union. This union-wide price settles between what would be the autarky prices for equal and unequal countries (Lemma 6). While goods' output declines similarly across all countries due to the common shock and price, total goods' *consumption* declines *less* in unequal countries. This is because the pro-cyclical inequality mechanism (milder income fall for Hand-to-Mouth agents) still operates, supporting their consumption more. To finance this relatively higher consumption, unequal countries must import more goods (or export less), leading to a trade deficit. Conversely, equal countries, lacking this dampening mechanism, see a larger fall in consumption and thus run trade surpluses. This differential impact on goods consumption also means the contraction in service output (and thus total output) is smaller in unequal countries, reinforcing Proposition 3.

Lemma 6. *In a monetary union of heterogeneous countries, the equilibrium price of goods in the initial period is higher than the closed-economy equilibrium price of the equal countries and is lower than that of the unequal countries:*

$$P^G_{1,Eq,CE} < P^G_{1,MU} < P^G_{1,Un,CE}.$$

4.3 Model Robustness and Empirical Grounding

To bolster confidence in our findings, we conduct three sets of exercises. First, we test the sensitivity of our theoretical results to key modeling assumptions. Second, we empirically investigate a key underpinning of our model: the link between aggregate inequality and the sectoral income distribution of Ricardian households. Third, we present extensive robustness checks for our primary empirical facts in Appendix A.7.

4.3.1 Sensitivity of Model Results to Assumptions

Our core theoretical predictions prove robust to a range of alternative modeling choices.

Elasticity of Substitution between goods and services: Varying the elasticity of substitution (Figure 12) reveals that while the *magnitude* of monetary policy's impact changes, the *qualitative* result—that higher service income for Ricardians ($\xi_{S,Un}$) dampens

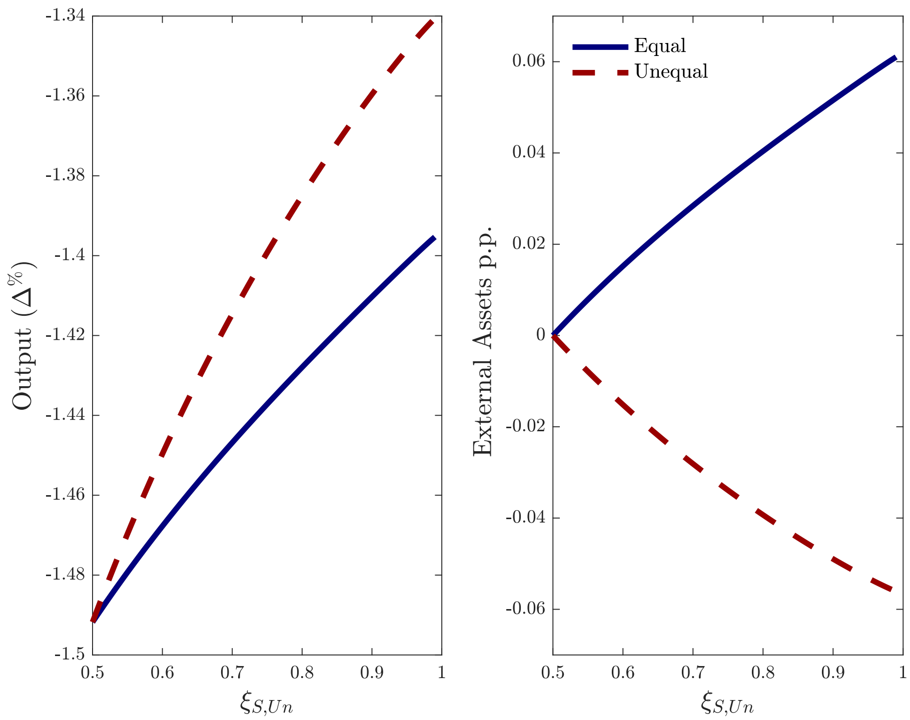


Figure 11: **Contractionary monetary policy in union of heterogenous countries. Effects of monetary policy shock on total output and trade balance.** Effects for Equal and Unequal countries are displayed as function of the share of service sector output accruing to the Ricardian household in the Unequal countries ($\xi_{S,Un}$). The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

policy transmission—holds unless the goods are extremely poor substitutes. Milder fluctuations in the relative demand for services (at lower elasticities) reduce the pro-cyclicality of inequality, thereby diminishing, but not eliminating, the dampening effect.

Degree of Non-Homotheticity: A higher degree of non-homotheticity (a larger ϵ, Figure 13) amplifies the overall impact of monetary policy, as demand for luxury services becomes even more sensitive to income changes. Simultaneously, it *strengthens* our main finding: the difference in output response between unequal and equal countries becomes more pronounced because the pro-cyclicality of inequality is magnified.

Source of Income Inequality: The specific *source* of income inequality is paramount. If inequality stemmed primarily from Ricardian households earning more from the *goods* sector (differing ξ_G rather than ξ_S), monetary policy effects would actually be *stronger* in unequal countries (Figure 14). This underscores the importance of our model's assumption, which is supported by our empirical analysis in Section 4.3.2 that inequality is largely driven by Ricardian exposure to the service sector. Results remain consistent even if goods sector income is also unequal, as long as the *differential* cyclicality is driven by service income (Figure 15).

Richer Household Heterogeneity: While our two-agent framework captures the essential dynamics, extending it to a continuum of agents where sectoral income exposures

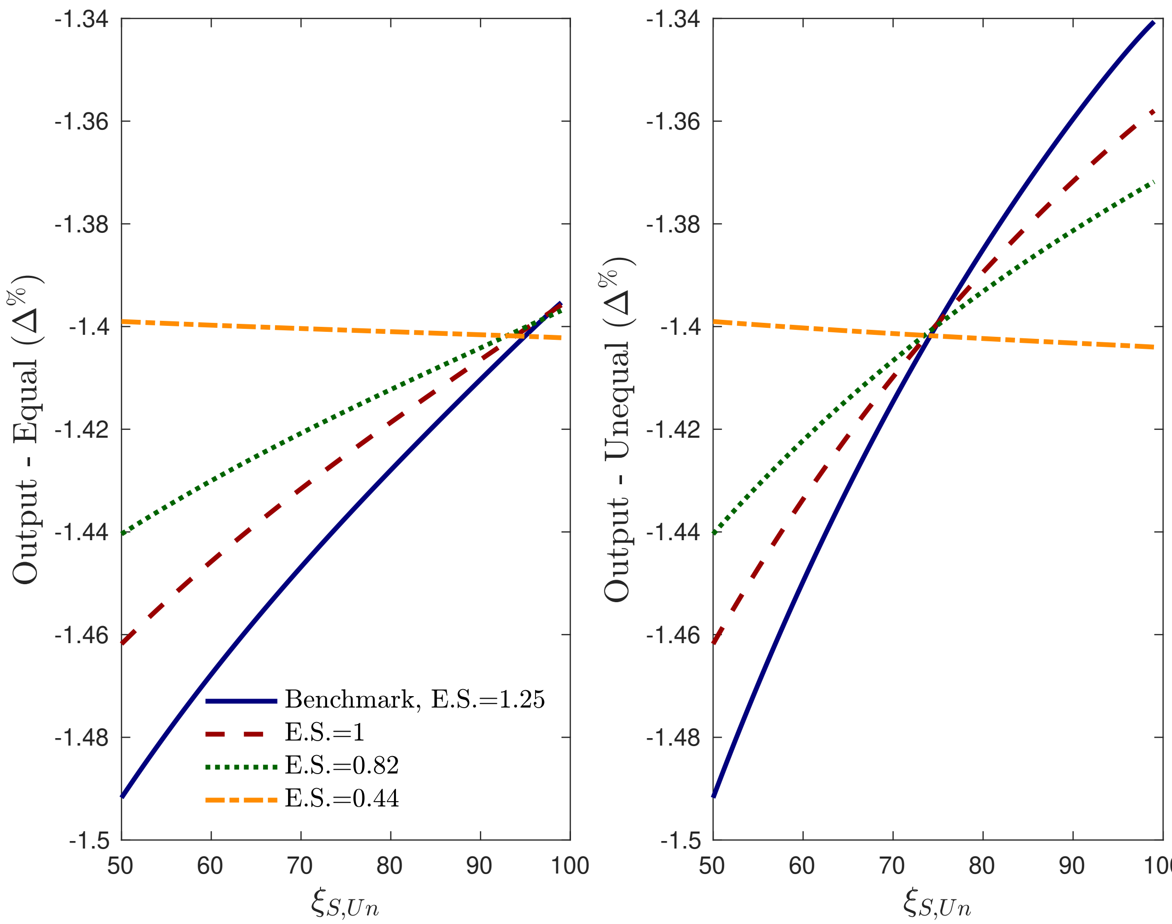


Figure 12: **Contractionary monetary policy in union of heterogenous countries. Alternative values for elasticity of substitution.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of service sector output accruing to the Ricardian household in the Unequal countries ($\xi_{S,Un}$). Each of the different lines correspond to a different value for the elasticity of substitution between tradable and services. The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

emerge endogenously from differences in wealth or risk aversion is a promising avenue. Such a model could endogenize the income distributions (ξ_S, ξ_G) we exogenously vary and introduce other heterogeneous responses, like precautionary savings, further enriching the analysis of monetary policy transmission.

4.3.2 Empirical Validation of Sectoral Income Distribution Assumption

A cornerstone of our model's ability to explain heterogeneous monetary policy effects is the assumption that cross-country differences in income inequality are linked to Ricardian households earning a larger share of their income from the service sector, especially in more unequal countries. We empirically test this in Section 2. Our findings there confirm that higher income inequality (e.g., higher Gini) is indeed associated with a larger difference in the service income share between Ricardian and Hand-to-Mouth households, lending empirical support to this key model mechanism. (Further details on this empirical exercise

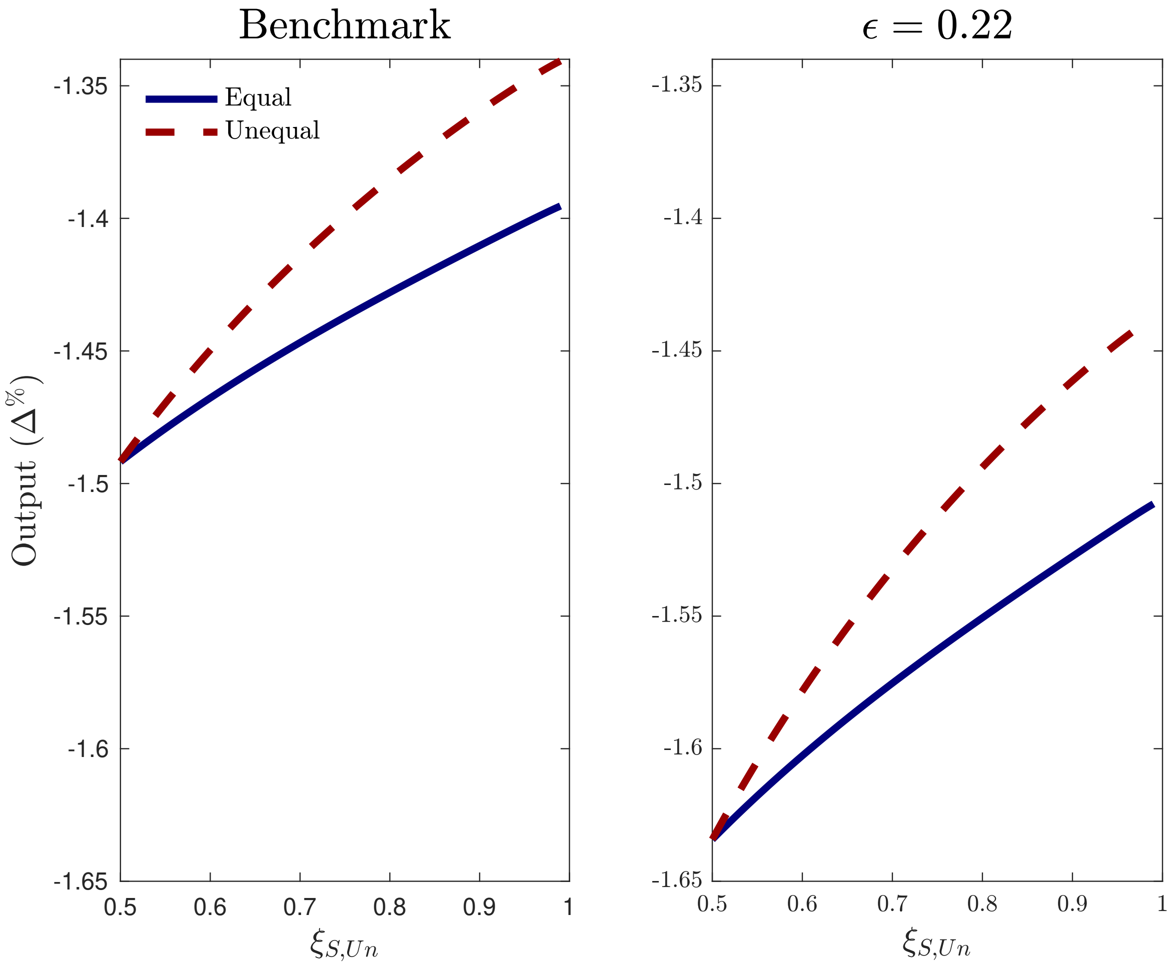


Figure 13: **Contractionary monetary policy in union of heterogenous countries. Higher degree of non-homotheticity.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of service sector output accruing to the Ricardian household in the Unequal countries ($\xi_{S,Un}$). Model with higher degree of non-homotheticity in preferences, $\epsilon = 0.22$, compared to the benchmark case with $\epsilon = 0.18$. The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

are provided in Appendix A.3).

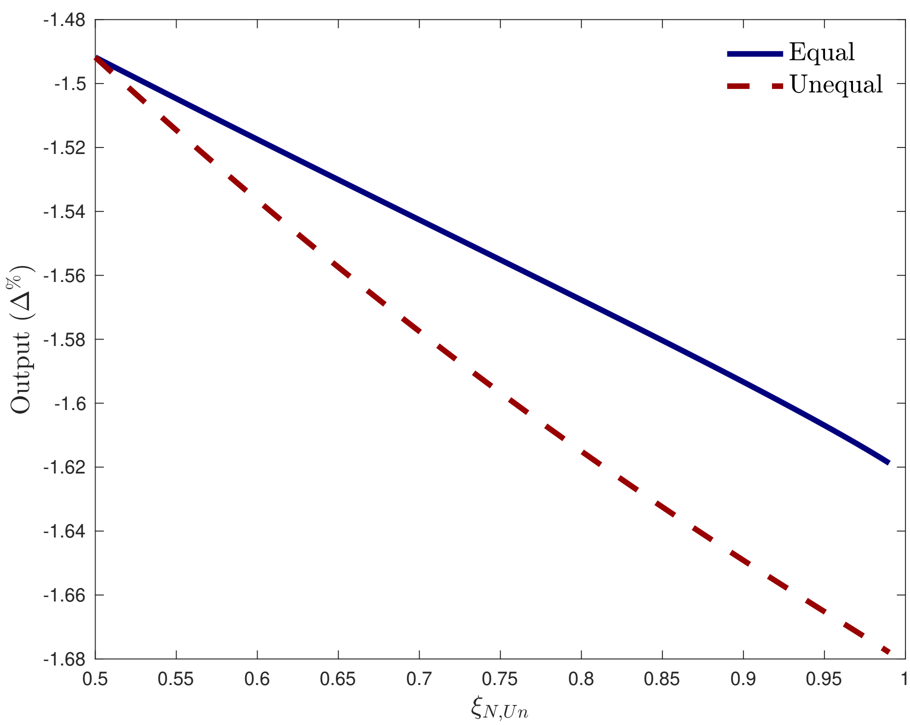


Figure 14: **Contractionary monetary policy in union of heterogenous countries. Inequality stemming from goods sector.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of tradable sector output accruing to the Ricardian household in the Unequal countries ($\xi_{G,Un}$). In this setting with alternative income distribution, income from the service sector is distributed equally in all countries: $\xi_{S,Un} = \xi_{S,Eq} = 0.5$. The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

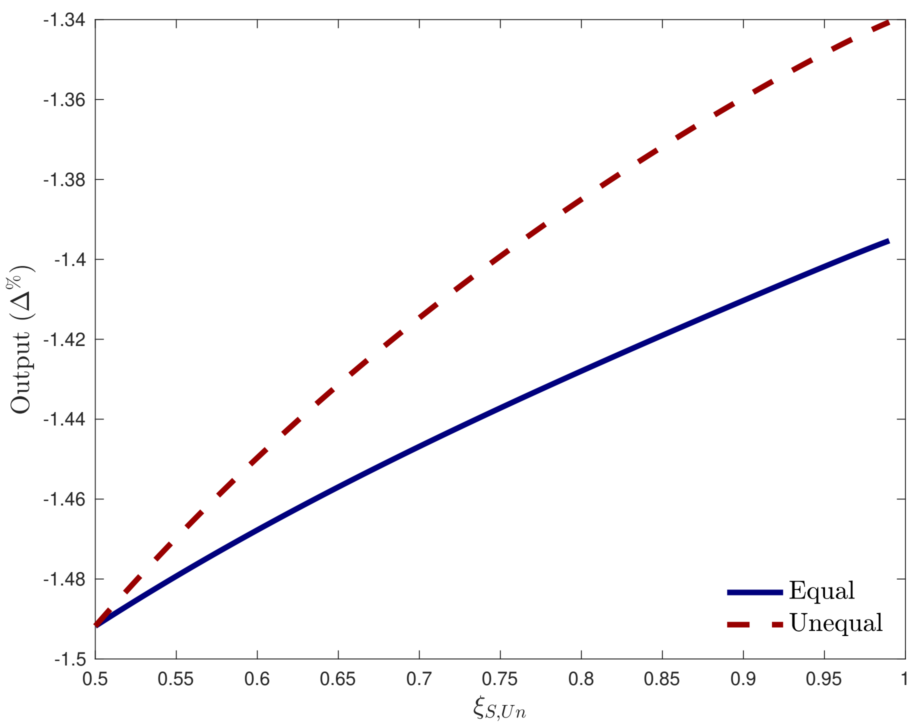


Figure 15: **Contractionary monetary policy in union of heterogenous countries. Inequality in both sectors.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of service sector output accruing to the Ricardian household in the Unequal countries ($\xi_{S,Un}$). Under this distribution, income from the goods sector is distributed unequally in all countries: $\xi_{G,Un} = \xi_{G,Eq} = 0.75$. The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

5 Concluding Remarks

This paper examined how cross-country heterogeneity in income and its distribution influences the transmission of common monetary policy within a currency union, with a focus on the expenditure composition channel. We empirically established four key stylized facts for the euro area: (1) households with higher income dedicate a larger share of their expenditure to services (services); (2) countries with greater income inequality exhibit higher aggregate service expenditure shares; (3) countries with larger service expenditure shares show weaker output responses to monetary policy shocks (when wealthier households' disproportionate income from the service sector); and (4) these countries also tend to experience trade balance deteriorations following contractionary monetary policy, contrasting with improvements in low service share countries.

We rationalized these findings within a heterogeneous-agent New Keynesian model incorporating non-homothetic preferences and unequal sectoral income exposures. The model generates a weaker impact of monetary policy in high service share countries, despite greater price rigidities in that sector. The critical mechanism is *pro-cyclical inequality*: when wealthier (Ricardian) households are more exposed to the volatile luxury service sector, a contractionary shock reduces their income more than that of Hand-to-Mouth households. This relative income shift cushions the consumption of Hand-to-Mouth agents, dampening the overall aggregate demand contraction and thus the policy's impact on output. In a monetary union, this also leads to the observed heterogeneous trade balance responses.

Our results highlight that understanding the interplay between household income distribution, non-homothetic consumption patterns, and sectoral exposures is crucial for assessing the effectiveness of monetary policy in diverse economic unions. Future research could extend this framework to explore optimal monetary policy design in such settings and to endogenize households' sectoral income exposures for a richer treatment of inequality.

6 References

Acharya, S., & Dogra, K. (2020). Understanding hank: Insights from a prank. *Econometrica*, *88*, 1113–1158.

Almgren, M., Gallegos, J.-E., Kramer, J., & Lima, R. (2022). Monetary policy and liquidity constraints: Evidence from the euro area. *American Economic Journal: Macroeconomics*, *14*, 309–340.

Alvarez, L. J., Dhyne, E., Hoeberichts, M., Kwapil, C., Le Bihan, H., Lünnemann, P., Martins, F., Sabbatini, R., Stahl, H., Vermeulen, P., et al. (2006). Sticky prices in the euro area: A summary of new micro-evidence. *Journal of the European Economic association*, *4*(2-3), 575–584.

Auclert, A. (2019). Monetary policy and the redistribution channel. *American Economic Review*, *109*, 2333–2367.

Auclert, A., Rognlie, M., Souchier, M., & Straub, L. (2021). Exchange rates and monetary policy with heterogeneous agents: Sizing up the real income channel. *NBER Working paper.*

Bayer, C., Kriwoluzky, A., Müller, G. J., & Seyrich, F. (2024). A hank2 model of monetary unions. *Journal of Monetary Economics*, *147*, 103–179.

Bilbiie, F. O. (2024). Monetary policy and heterogeneity: An analytical framework. *Review of Economic Studies*, rdae066.

Boppart, T. (2014). Structural change and the Kaldor facts in a growth model with relative price effects and non-Gorman preferences. *Econometrica*, *82*, 2167–2196.

Chenery, H. B. (1960). Patterns of industrial growth. *The American Economic Review*, *50*(4), 624–654.

Clark, C. (1940). *The conditions of economic progress*. Macmillan.

Cravino, J., Lan, T., & Levchenko, A. A. (2020). Price stickiness along the income distribution and the effects of monetary policy. *Journal of Monetary Economics*, *110*, 19–32.

de Ferra, S., Mitman, K., & Romei, F. (2020). Household heterogeneity and the transmission of foreign shocks. *Journal of International Economics*, *124*, 103–303.

de Ferra, S., Mitman, K., & Romei, F. (2021). Why does capital flow from equal to unequal countries? *CEPR Discussion Paper.*

Deaton, A., & Muellbauer, J. (1980). *Economics and consumer behavior.*

Debortoli, D., & Galí, J. (2024). Heterogeneity and aggregate fluctuations: Insights from tank models. *National Bureau of Economic Research Working Paper.*

Dorrucci, E., Fidora, M., Gartner, C., & Zumer, T. (2022). The european exchange rate mechanism (erm ii) as a preparatory phase on the path towards euro adoption. *ECB Economic Bulletin*, *8.*

Ferrante, F., & Gornemann, N. (2022). Devaluations, deposit dollarization, and household heterogeneity. *International Finance Discussion Paper*.

Ferriere, A., Grübener, P., & Sachs, D. (2024). Optimal redistribution: Rising inequality vs. rising living standards. *CESifo Working paper*.

Gautier, E., Conflitti, C., Faber, R. P., Fabo, B., Fadejeva, L., Jouvanceau, V., Menz, J.-O., Messner, T., Petroulas, P., Roldan-Blanco, P., et al. (2024). New facts on consumer price rigidity in the euro area. *American Economic Journal: Macroeconomics*, *16*, 386–431.

Gornemann, N., Kuester, K., & Nakajima, M. (2021). Doves for the rich, hawks for the poor? distributional consequences of systematic monetary policy. *ECONtribute Discussion Paper*.

Guntin, R., Ottonello, P., & Perez, D. (2023). The micro anatomy of macro consumption adjustments. *American Economic Review*, *113*, 2201–2231.

Guo, X., Ottonello, P., & Perez, D. (2023). Monetary policy and redistribution in open economies. *Journal of Political Economy Macroeconomics*, *1*, 191–241.

Herrendorf, B., Rogerson, R., & Valentinyi, Á. (2014). Growth and structural transformation. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (pp. 855–941). Elsevier.

Hong, S. (2020). *Emerging market business cycles with heterogeneous agents* (tech. rep.).

Jaimovich, N., Rebelo, S., & Wong, A. (2019). Trading down and the business cycle. *Journal of Monetary Economics*, *102*, 96–121.

Jaravel, X. (2018). The unequal gains from product innovations: Evidence from the u.s. retail sector. *Quarterly Journal of Economics*, *134*, 715–783.

Jarociński, M., & Karadi, P. (2020). Deconstructing monetary policy surprises—the role of information shocks. *American Economic Journal: Macroeconomics*, *12*, 1–43.

Jorda, O. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, *95*, 161–182.

Kaplan, G., Moll, B., & Violante, G. L. (2018). Monetary policy according to hank. *American Economic Review*, *108*, 697–743.

Kongsamut, P., Rebelo, S., & Xie, D. (2001). Beyond balanced growth. *The Review of Economic Studies*, *68*(4), 869–882.

Krueger, D., Perri, F., Pistaferri, L., & Violante, G. L. (2010). Cross-sectional facts for macroeconomists. *Review of Economic Dynamics*, *13*, 1–14.

Kuznets, S. (1957). Quantitative aspects of the economic growth of nations: Ii. industrial distribution of national product and labor force. *Economic Development and Cultural Change*, *5*(4, Supplement), 1–111.

Montiel Olea, J. L., & Plagborg-Møller, M. (2021). Local projection inference is simpler and more robust than you think. *Econometrica*, *89*, 1789–1823.

Olivi, A., Sterk, V., & Xhani, D. (2024). Optimal monetary policy during a cost of living crisis. *mimeo UCL.*

Oskolkov, A. (2023). Exchange rate policy and heterogeneity in small open economies. *Journal of International Economics*, *142*, 103750.

Ramey, V. A., & Zubairy, S. (2018). Government spending multipliers in good times and in bad: Evidence from us historical data. *Journal of political economy*, *126*, 850–901.

Straub, L. (2019). Consumption, savings, and the distribution of permanent income. *Unpublished manuscript, Harvard University.*

Online Appendix

A Appendix - Empirical Analysis

A.1 Services consumption shares by income and country

Figure 3 shows the average 2000-2020 service expenditure shares by disposable income across euro area member states. The data is based on the household budget survey (HBS). The figure shows that both across households as well as countries the share of services increases with income revealing non-homothetic preferences. Table 2 further summarizes the graph showing the slope of the linear fit as well as the average disposable income and service expenditure share for each country.

Country	Slope	Disposable Income	Services Expenditure share
Austria	0.09	22062	37.70
Belgium	0.17	20243	42.34
Cyprus	0.60	15904	43.70
Estonia	1.62	6367	27.64
Finland	0.13	22134	42.07
France	0.04	20904	42.69
Germany	0.25	20222	41.20
Greece	0.75	10674	42.58
Ireland	0.36	22281	44.34
Italy	0.30	15601	35.92
Latvia	2.20	4719	29.60
Lithuania	2.44	4363	24.49
Luxembourg	-0.08	34314	40.47
Malta	0.59	11775	36.33
Netherlands	0.01	20982	45.85
Portugal	0.86	9347	44.35
Slovakia	1.97	5570	28.69
Slovenia	0.42	11468	37.30
Spain	0.42	14175	42.18

Table 2: **Summary statistics on countries income and consumption.** The slope corresponds to the linear fit of the service expenditure share on the level of disposable income at every income quintile.

A.2 Inequality and Consumption Baskets

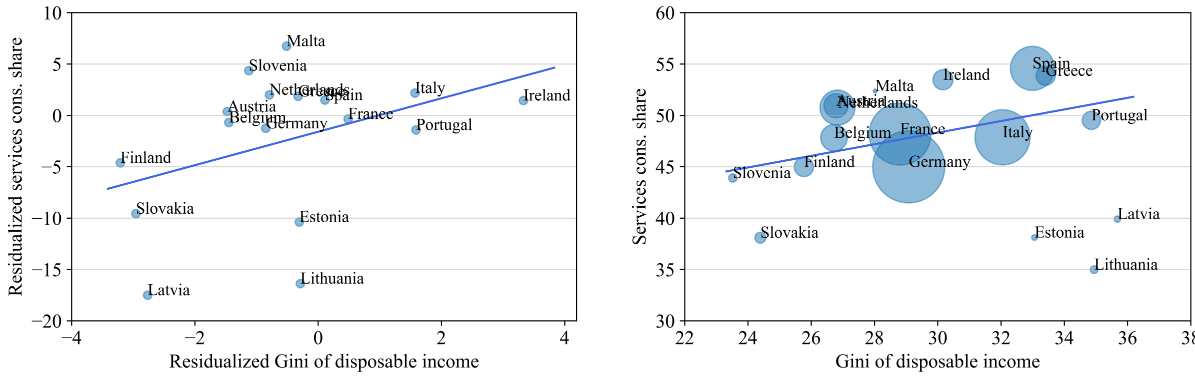
We show that service expenditure share increase with income inequality at the country level. Table 3 shows the regression results of the following specification:

$$\omega_k = \alpha + \beta Gini_c + \gamma X_k' + +\epsilon_c$$

where ω_k is the average 2000-2020 service expenditure share of country k, and X' is a vector of controls averaged between 2000-2020 including the trade balance, the old-age dependency ratio, government expenditure and GDP per capita. Countries are weighted by there GDP respectively. Figure 16 further plots the results for the unweighted regression as well as the regression excluding controls.

	Services expenditure share		
Gini	1.046*		
	(-0.397)		
p90p10		6.128**	
		(-1.596)	
p75p25			13.36**
			(-3.91)
Trade balance	-1.034	-0.658	-0.769
	(-0.664)	(-0.529)	(-0.534)
Old-age dependency	-0.764**	-0.769***	-0.679**
	(-0.209)	(-0.173)	(-0.166)
Gov. exp.	-0.246	0.0512	-0.0482
	(-0.364)	(-0.288)	(-0.286)
GDP p.c.	0.648	0.625*	0.597*
	(-0.327)	(-0.231)	(-0.244)
N	17	17	17
adj. R-sq	0.571	0.689	0.644

Table 3: **Regression table of equation 1.** All variables are averaged over 2000 to 2020. The variables p90p10 and p75p25 correspond to the income ratios of the 90th and 10th as well as the 75th and 25th percentile, respectively.



(a) Unweighted linear fit.

(b) Un-residualzed linear fit.

Figure 16: **Inequality and service expenditure shares across countries.**

A.3 Relationship between sectoral income shares and inequality

While countries' consumption baskets are linked to their income inequality, we further show the sectoral origins of income inequality. We first show how the share of income generated in service sectors increases with the income level. We then further discriminate between Ricardian and Hand-to-Mouth households to pin down the difference in sectoral income shares. We use the first three waves of HFCS data on household incomes and the sector of employment. Finally, we follow Almgren et al. (2022) in defining households as Ricardian or Hand-to-Mouth based on their wealth-income composition.

Figure 17 shows that the service share of income increases by income decile within and across EU members.

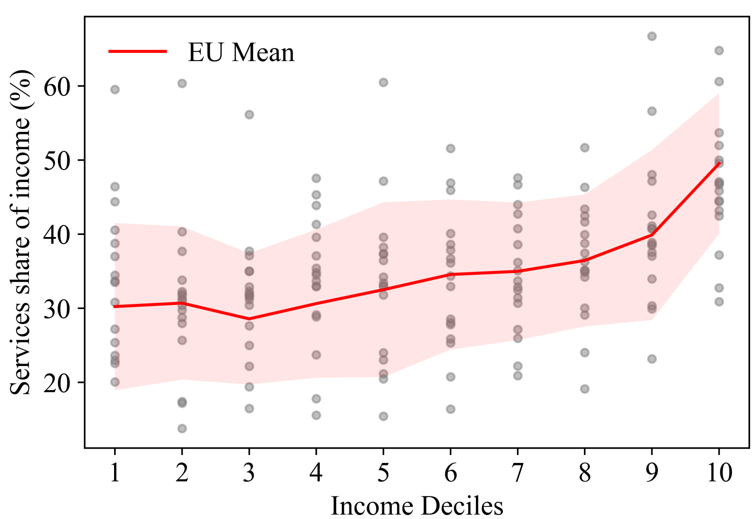


Figure 17: **Service income shares by decile.** This graphs shows the service share of income by income decile across EU members and on average. The red shaded area represents one standard deviation.

A.4 COICOP consumption classification

Table 4 lists all three-digit COICOP consumption categories in the household budget survey and their classification as goods or services.

COICOP		Name	Goods
CP01		*Food and non-alcoholic beverages*	
	CP011	Food	Yes
	CP012	Non-alcoholic beverages	
CP02		*Alcoholic beverages, tobacco and narcotics*	Yes
	CP021	Alcoholic beverages	Yes
	CP022	Tobacco	Yes
CP03		*Clothing and footwear*	
	CP031	Clothing	Yes
	CP032	Footwear	Yes
CP04		*Housing, water, electricity, gas and other fuels*	
	CP041	Actual rents for housing	No
	CP042	Imputed rents for housing	No
	CP043	Maintenance and repair of the dwelling	No
	CP044	Water supply and miscellaneous services relating to the dwelling	No
	CP045	Electricity, gas and other fuels	Yes
CP05		*Furnishings, household equipment and routing household maintenance*	
	CP051	Furniture and furnishings, carpets and other floor coverings	Yes
	CP052	Household textiles	Yes
	CP053	Household appliances	Yes
	CP054	Glassware, tableware and household utensils	Yes
	CP055	Tools and equipment for house and garden	Yes
	CP056	Goods and services for routine household maintenance	Yes
CP06		*Health*	
	CP061	Medical products, appliances and equipment	Yes
	CP062	Out-patient services	No
	CP063	Hospital services	No
CP07		*Transport*	
	CP071	Purchase of vehicles	Yes
	CP072	Operation of personal transport equipment	No
	CP073	Transport services	No
CP08		*Communication*	
	CP081	Postal services	No
	CP082	Telephone and telefax equipment	Yes
	CP083	Telephone and telefax services	No
CP09		*Recreation and culture*	
	CP091	Audio-visual, photographic and information procession equipment	Yes
	CP092	Other major durables for recreation and culture	Yes
	CP093	Other recreational items and equipment, gardens and pets	Yes
	CP094	Recreational and cultural services	No
	CP095	Newspapers, books and stationary	Yes
	CP096	Package holidays	Yes
CP10		*Education*	No
CP11		*Restaurants and hotels*	
	CP111	Catering services	No
	CP112	Accommodation services	No
CP12		*Miscellaneous goods and services*	
	CP121	Personal care	No
	CP122	Prostitution	No
	CP123	Personal effects n.e.c.	No
	CP124	Social protection	No
	CP125	Insurance	No
	CP126	Financial services n.e.c.	No
	CP127	Other services	No

Table 4: Classification of COICOP categories as goods or services.

This classification is based on the information given by Eurostat. Two categories cannot be fully linked to either goods or services. For CP044 and CP072 consist of both categories at a three-digit classification level. However, household consumption data is only available at the given granularity and therefore does not allow for a more precise classification.

A.5 NACE Rv.2 classification

Table 5 lists all two-digit NACE categories and their classification as goods or services.

Services	**Goods**	**Housing**
Financial and insurance activities	Agriculture, forestry and fishing	Real estate activities
Construction	Industry (except construction)	
Scientific and technical activities; administrative and support service activities	Manufacturing	
Information and communication		
Public administration, defence, education, human health and social work activities		

Table 5: Classification of NACE categories as Goods, Services or Housing

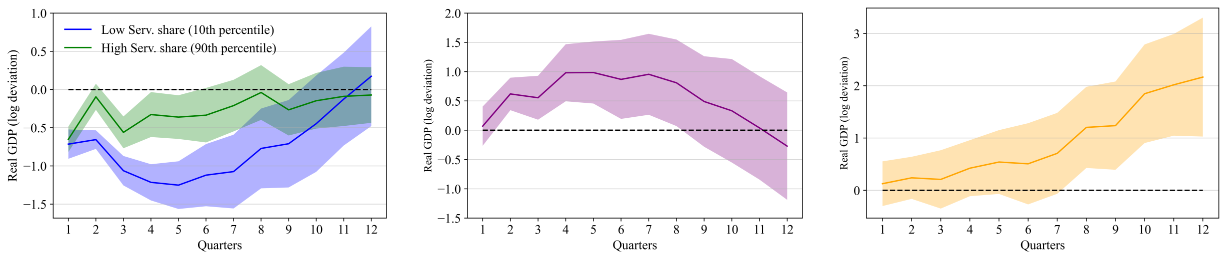
A.6 Empirical Extensions

We run multiple extensions of the baseline local projection to assess effects of additional channels at play. We highlight four main extensions: The role of income inequality, the response of tradable and service price indeces, the response of real exchange rates and the expenditure share on government services.

Income inequality may affect the response of real GDP through various channels - one of which is the non-homothetic preference channel presented above. Therefore, we augment the baseline LP with the average Gini coefficient on disposable income as follows:

$$y_{t+h,k} - y_{t-1,k} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_k) + \lambda^h (i_t * \overline{Gini}_k) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,k} + \phi_k + u_{t+h,k}. \quad (26)$$

Figure 18 presents the IRFs for countries of different service consumption shares controlling for income inequality. The IRFs are constructed as the linear combination of β^h and γ^h with $Gini_c$ fixed at the sample mean. Controlling for income inequality does not alter the effect of the national consumption basket on output responses to monetary policy shocks. The share of service consumption seems to play the key role in driving differences in responses for the majority of the post-shock period. High income inequality is also associated with weaker responses to monetary policy shocks, however, significantly so only after nine quarters.



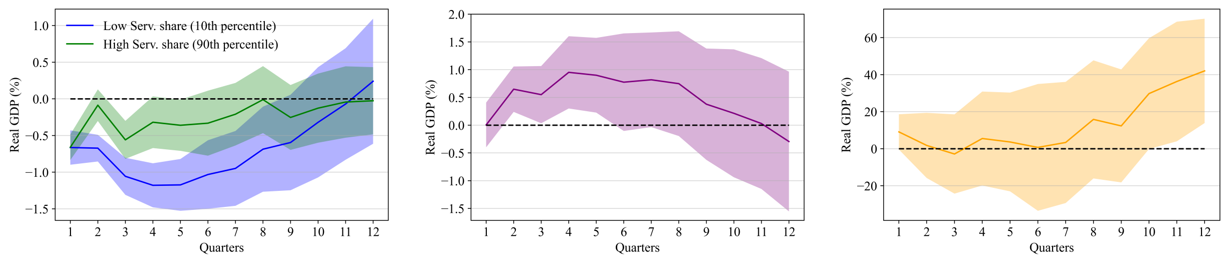
(a) Services share (b) Gamma Difference (c) Lambda Difference

Figure 18: **Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low service consumption shares controlling for income inequality.** In graph a), the low service (S) share line is based on the 10th percentile of service shares in the sample and the high service share line on the 90th percentile keeping Gini fixed at the sample mean. Graph b) shows the interaction term coefficient γ. Graph c) shows the interaction term coefficient λ. The shaded areas represent 90th percent confidence intervals. Standard errors are clustered around countries.

The share of constrained Hand-to-Mouth households (HtM) across countries plays a major role in defining responses to shocks. While we control for these shares indirectly in our baseline estimation with country fixed effects, we extend our analysis to control for them in the local projection directly. We use the shares of HtM agents from Almgren et al. (2022). The resulting impulse response function show no significant difference to the baseline results. We augment the baseline regression by including the HtM shares as follows:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t \times \bar{\omega}_c) + \lambda^h (i_t \times HtM_c) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c}. \tag{27}$$

Figure 19 presents the IRFs for countries of different service consumption share controlling for the share of HtM agents. The IRFs are constructed as the linear combination of β^h and γ^h with HtM_c fixed at the sample mean. Controlling for HtM shares does not alter the effect of the national consumption basket on output responses to monetary policy shocks.



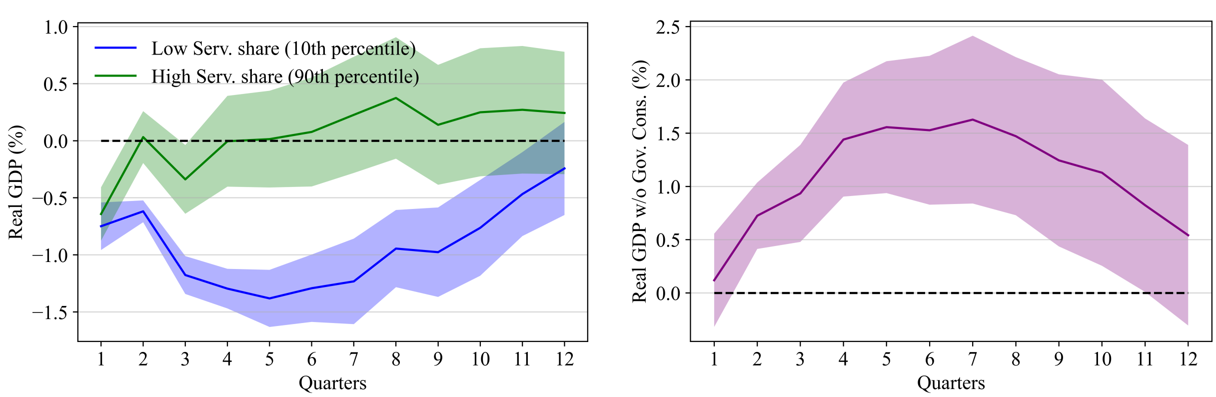
(a) Services share (b) Gamma Difference (c) Lambda Difference

Figure 19: **Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low service consumption shares controlling for the share of HtM agents.** In graph a), the low service (S) share line is based on the 10th percentile of service shares in the sample and the high service share line on the 90th percentile keeping the HtM share at the sample mean. Graph b) shows the interaction term coefficient γ. Graph c) shows the interaction term coefficient λ. The shaded areas represent 90th percent confidence intervals. Standard errors are clustered around countries.

Government services are part of the service expenditure share in our baseline estimation. One potential reason countries with high service shares react less to a monetary policy shock could relate to a higher share of government services that react little to monetary policy. When excluding public services from the service expenditure shares, however, we do not find evidence for this channel as shown in Figure 20. The corresponding specification is as follows:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t \times \tilde{\omega}_c) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c}. \tag{28}$$

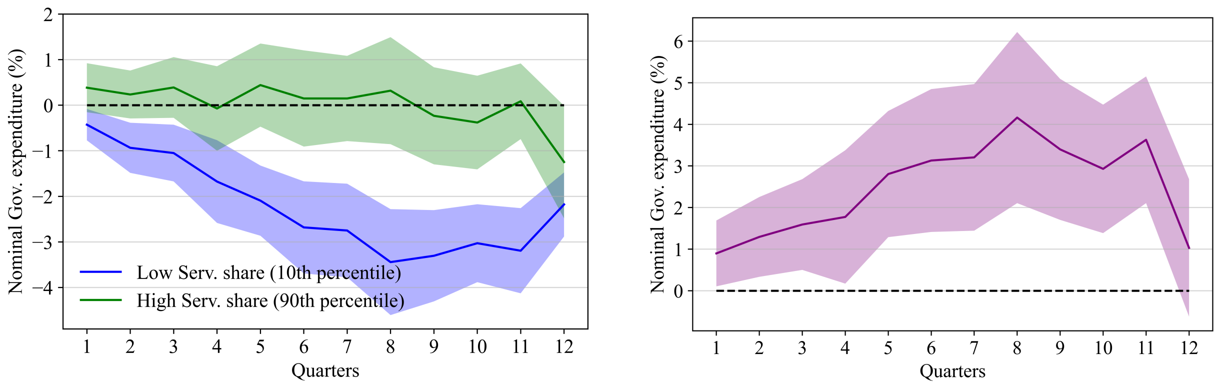
where $\tilde{\omega}_c$ corresponds to a county's share of service expenditure excluding the expenditure shares on government services.



(a) Expenditures shares shares excl. public services (b) Difference

Figure 20: **Impulse response functions**

Government expenditure responses are shown in Figure 21. shows the difference in responses of nominal government expenditure across countries with high and low service expenditure shares.



(a) High and low service share

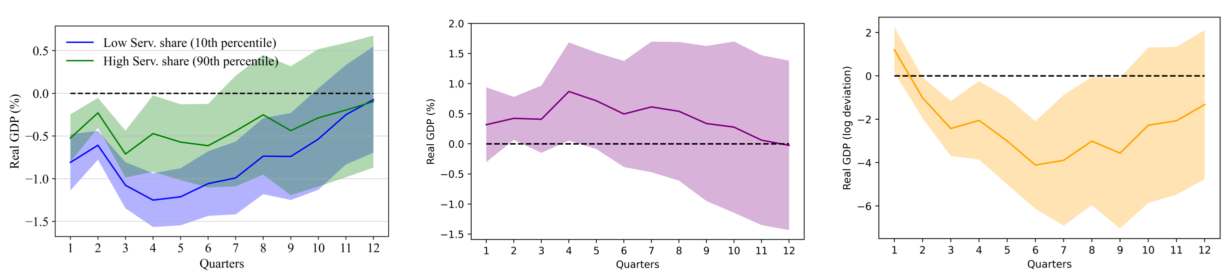
(b) Difference

Figure 21: **Impulse response functions of nominal government expenditure to a contractionary monetary policy shock of one standard deviation for high and low service consumption shares.** In graph a), the low service (NT) share line is based on the 10th percentile of service shares in the sample and the high service share line on the 90th percentile, respectively. Graph b) shows the interaction term coefficient γ. The shaded areas represent 90th percent confidence intervals. Standard errors are clustered around countries.

Non-durable vs durables. We run a regression controlling for durable goods. We divide the goods in durable and non-durable. We estimate the parameters of the following regression:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t \times \bar{\omega}_c) + \lambda (i_t \times \bar{\omega}_{durable}) \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c} \quad (29)$$

where we define $\omega_{durable}$ as the average 2000-2020 share of durable goods. The impulse response functions are plotted in Figure 22. High consumption of durable goods amplify the monetary policy shock. However, the sign and shape of the interaction terms between service expenditure share and monetary policy shock is almost unchanged.



(a) Non-durables vs durables

(b) Gamma difference

(c) Lambda difference

Figure 22: **Non-durables vs durables**

Relationship between service expenditure and housing expenditure shares When computing the service expenditure share ω we exclude housing consumption. In order to show that our results are not driven by difference in housing expenditure shares across countries we run the following regression:

$$\omega_{t,k} = \alpha + \gamma_t + \beta\sigma_{t,k} + \epsilon_{k,t}$$

where γ_t is a year fixed effects and σ corresponds to the housing expenditure shares for country k. Figure 23 shows the linear fit in a binned scatter plot. There is no significant relationship between our measure of service expenditure shares and housing expenditure shares.

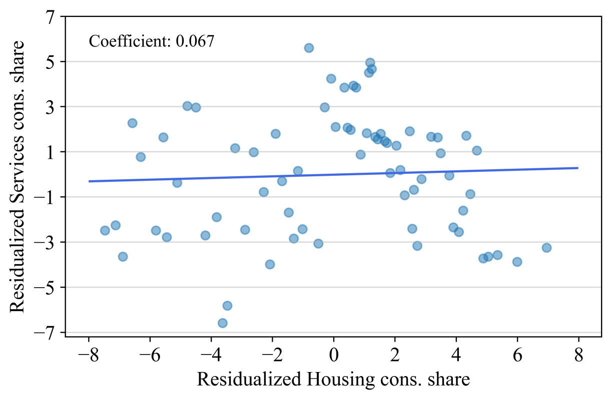


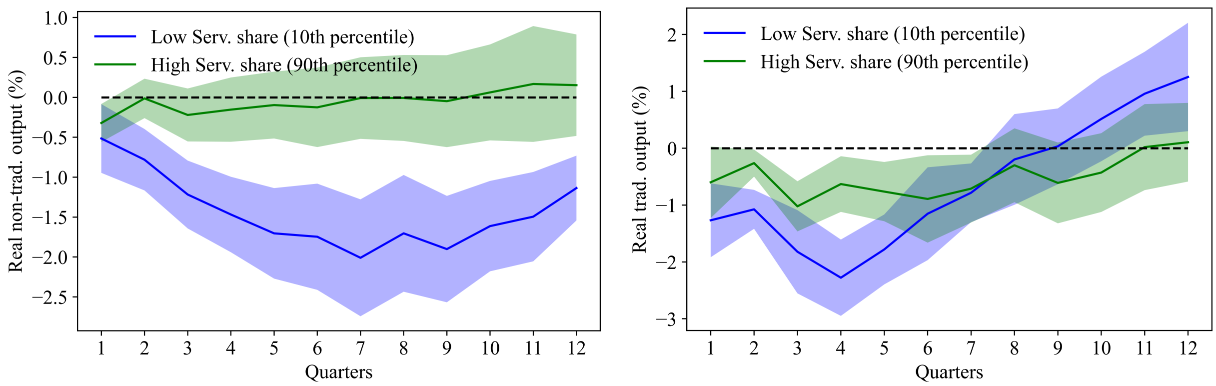
Figure 23: **Services vs housing expenditure shares.**

Output of goods and services. We estimate the following local projection:

$$y^{\iota}_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t \times \bar{\omega}_c) + \sum_{s=1}^{p} \Gamma^h_s y^{\iota}_{t-s,c} + \phi_k + u_{t+h,c} \tag{30}$$

where i_t is the monetary policy shock, ω_c is the 2000-2020 average service expenditure share, ϕ_k is a country fixed effect and $y^{\iota}_{t,c}$ can be the tradable ($\iota = T$) or service output ($\iota = N$).

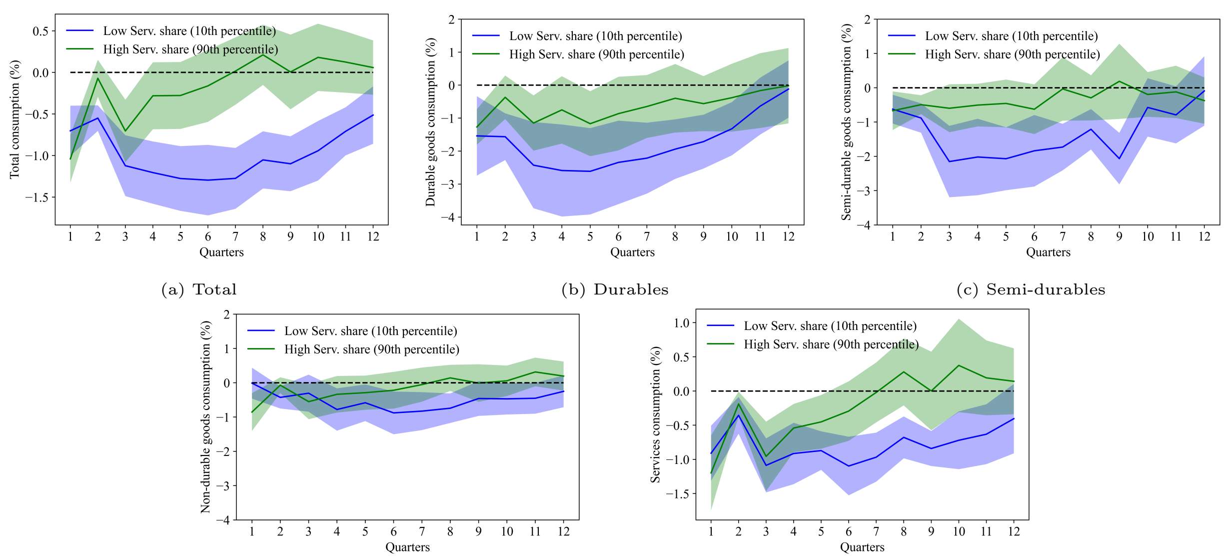
Figure 24 shows the impulse responses function deriving from equation (30). The reaction of service output to a monetary policy shock depends substantially on service expenditure share. Countries with high-non tradable expenditure share service output and do not react much to a monetary policy shock, while service output contracts substantially in countries with low service expenditure share. Instead, tradable output reacts more similarly to a monetary policy shock in countries with different service expenditure share. **Consumption by sector.** Figure 25 shows the difference in consumption responses across sectors for countries with high and low service expenditure shares. The graphs reveal two



(a) Non-tradable output (b) Tradable Output

Figure 24: **Impulse response functions of goods and services output to a contractionary monetary policy shock of one standard deviation.**

key findings. First, total consumption resembles output, with weaker responses in countries with higher service shares. Second, the difference in responses declines with the for less tradable sectors. While consumption in highly tradable, durable goods reacts significantly weaker for countries with larger service consumption shares, the difference is smaller for semi-durable goods and becomes insignificant for services.



(a) Total (b) Durables (c) Semi-durables

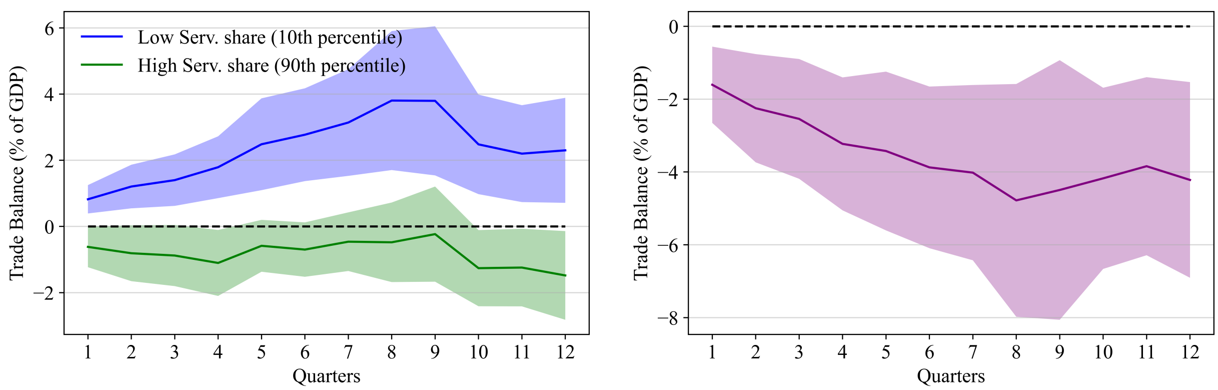
(d) Non-durables (e) Services

Figure 25: **Impulse response functions of real consumption by sector to a contractionary monetary policy shock of one standard deviation.**

The Trade Balance (% of GDP) reacts different for the two groups of countries as shown in Figure 26. We plot the cumulative impulse response of countries' trade balances to a contractionary monetary policy shock. We follow Ramey and Zubairy (2018) in computing the cumulative impulse response as follows:

$$\sum_{h=0}^{H}(y_{t+h,c} - y_{t-1,c}) = \alpha + \beta^h \sum_{h=0}^{H} i_{t+h} + \gamma^h (\sum_{h=0}^{H} i_{t+h} \times \bar{\omega}_c) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c}.$$

The summation on the left-hand side corresponds to the cumulative difference of real GDP at every horizon h from the initial GDP level at time t. The coefficients $beta^h$ and $gamma^h$ are interpreted as the effect of the cumulative change of the monetary policy shocks interacted with the non-tradable expenditure share $\bar{\omega}_c$. Countries with relatively low service consumption shares experience a larger increase in the trade balance than countries with high service consumption shares. A one standard deviation contractionary monetary policy shock results in a 0.5 percentage point increase in the trade balance after two quarters for countries with a service consumption share as low as the 10th percentile of service consumption shares in the sample.



(a) High and low service share

(b) Difference

Figure 26: **Cumulative impulse response functions**

Prices of Goods and Services are important determinants of responses to monetary policy shocks. In particular, we find that service prices react slower and weaker than tradable prices. This finding is in line with Cravino et al., 2020, highlighting the stronger nominal rigidities in service sectors. Figure 27 shows the differences in responses of service and tradable price indices to a contractionary monetary policy shock. The IRFs are constructed from the following local projection exercise

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c} \tag{31}$$

where the left-hand side is the deviation in the price index (2015=100) from its initial value. The graphs reveal that prices of goods respond more strongly to monetary policy shocks.

While prices of goods adjust downwards immediately, service prices show a significant adjustment only after 4 and 8 quarters.[13]

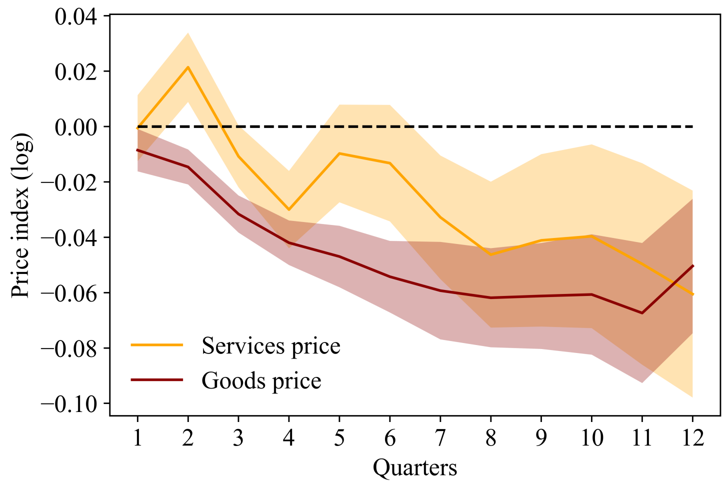


Figure 27: **Impulse response of log goods, and service price indices.**

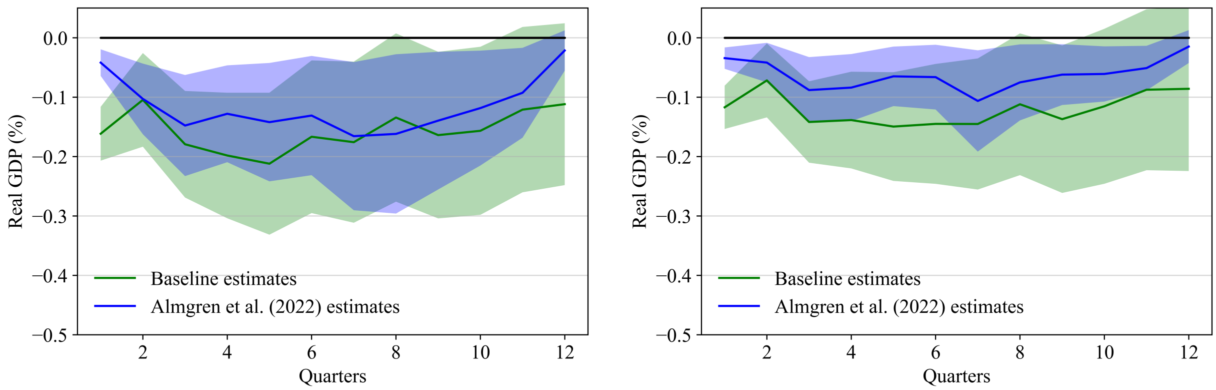
A.7 Comparison of results with existing estimates

In order to check that our baseline results are in line with the estimates obtained in the existing literature we compare our estimates to Almgren et al. (2022). Specifically, we run our baseline local projection for individual countries as follows:

$$y_{t+h,k} - y_{t-1,k} = \alpha + \beta^h i_t + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,k} + u_{t+h,k}. \tag{32}$$

Figure 28 plots our estimates compared to theirs for Germany and the Netherlands. The impulse response functions to a one standard deviation monetary policy shock follow each other closely and are not distinguishable at the 90 percent confidence intervals.

[13]The price indices are computed based on the Nace Rev.2 price indices classified in Appendix A.5.



(a) Germany

(b) Netherlands

Figure 28: **Impulse response functions for individual countries.**

B Appendix - Model

B.1 Stationary Allocation

Consider a stationary allocation of the economy, where all variables are constant through time. Constant prices of individual commodities $P_t^S = P^S$ and $P_t^G = P^G$, jointly with arbitrage across the two types of bonds, imply that the interest rates on bonds denominated in units of tradable and nontradable must be equal: $R_t = R_t^m = R$. We can thus denote B_R as the aggregate wealth of the Ricardian household in the stationary allocation.

The stationary-allocation expenditure by the Ricardian household thus equals

$$e_R = W_R l_R + \Psi_R + (R-1)B_R \tag{33}$$

and for the Hand-to-Mouth:

$$e_H = W_H l_H + \Psi_H \tag{34}$$

From firms' demand for labor and allocation of profits across the two households, incomes of the two agents are given by $W_R l_R + \Psi_R = \xi_S y^S + \xi_G y^G$ and $W_H l_H + \Psi_H = (1-\xi_S)y^S + (1-\xi_G)y^G$. Hence, expenditure of the two households writes as:

$$e_R = \xi_S y^S + \xi_G y^G + (R-1)B_R, \text{ and } e_H = (1-\xi_S)y^S + (1-\xi_G)y^G. \tag{35}$$

The trade balance of the economy in steady state is equal to $TB = (R-1)B_R$. The households' allocation of expenditure across tradables and nontradables is also constant and governed by the conditions in (9) and (8). The aggregate demand for nontradables is given by the sum of the two households' demand, as follows:

$$y^S = c_H^S + c_R^S = e_H \omega_H^S + e_R \omega_R^S \tag{36}$$

which yields:

$$y^S = (y^G - TB)\frac{P^G}{P^S}\frac{\left[\omega_H^S\left(1-\xi_G\right)+\omega_R^S\left(\xi_G\right)\right]}{\left[1-\omega_H^S\left(1-\xi_S\right)-\omega_R^S\left(\xi_S\right)\right]}. \tag{37}$$

The relative allocation of labor of the two households across the two sectors satisfies:

$$\frac{l_H^S}{l_H^G} = \frac{\alpha_N}{\alpha_T}\frac{1-\xi_S}{1-\xi_G} \equiv x_H^S \frac{P^S y^S}{P^G y^G} \text{ and } \frac{l_R^S}{l_R^G} = \frac{\alpha_N}{\alpha_T}\frac{\xi_S}{\xi_G}\frac{P^S y^S}{P^G y^G} \equiv x_R^S. \tag{38}$$

Hence, labor input in the two sectors satisfies

$$l_H^S = \frac{x_H^S}{1+x_H^S} l_H, \text{ and } l_R^S = \frac{x_R^S}{1+x_R^S} l_R, l_H^G = \frac{1}{1+x_H^S} l_H, \text{ and } l_R^G = \frac{1}{1+x_R^S} l_R. \tag{39}$$

B.2 Pro-Cyclical Relative Value of Services Output

We show in this appendix that the relative value of service output is procyclical when preferences are non-homothetic, in a homogeneous monetary union. To ths purpose, it is convenient to express this relative value as function of the two households' income shares in the two sectors, and of their expenditure share on goods. To do so, note that total G-output can be written as, omitting time-subscripts:

$$P^G y^G = P^G c_R^G + P^G c_H^G = \omega_R^G e_R + \omega_H^G e_H.$$

In turn, expenditure of the two households writes as:

$$e_R = \xi_S P^S y^S + \xi_G P^G y^G \text{ and } \left(1-\xi_S\right) P^S y^S + \left(1-\xi_G\right) P^G y^G.$$

Hence, the relative value of output of the two sectors can be expressed as:

$$\frac{P^S y^S}{P^G y^G} = \frac{1-\omega_R^G \xi_G - \omega_H^G\left(1-\xi_G\right)}{\omega_R^G \xi_S + \omega_H^G\left(1-\xi_S\right)}.$$

When a contractionary monetary policy shock reduces aggregate output, both households have lower income and expenditure, and allocate a greater share of their expenditure to goods, i.e. $\omega_{j,1}^G > \omega_{j,2}^G$ for $j \in \{H, R\}$. As the expression for the relative value of output is decreasing in the two expenditure shares for goods, an aggregate contraction leads to a reduction in the relative value of service output, and vice-versa.

B.3 Effects of Monetary Policy on Total Output, Price of Goods, and Services Output

First, we show that there is a positive monotonic relationship between the output and the price of goods in the initial period $t = 1$ of this model economy, in the homogeneous monetary union. Hence, a mild decline in goods output is associated with a mild decline in their price. To see this, note that the relative labor demand in the two sectors can be combined with the technology in the G sector to yield an equation characterizing the supply of G as a function of its nominal price and of the rigid nominal wage:

$$P_1^G = \frac{\bar{W}^G}{\alpha_T} \left(y_1^G\right)^{\frac{1-\alpha_T}{\alpha_T}} \tag{40}$$

Second, consider the impact of monetary policy on output of services. Under Cobb-Douglas preferences, the fall in S-output is proportional to the fall in the value of G-output and given by:

$$y_1^S = \frac{1-\nu}{\nu} \frac{1}{P_1^S} \left(y_1^G\right)^{\frac{1}{\alpha^G}},$$

where $\left(y_1^G\right)^{\frac{1}{\alpha^G}} = P_1^G y_1^G$, and where P_1^S is equal to the stationary-allocation value of the price of services, due to the complete wage rigidity and unitary elasticity of output to labor input in the S-sector.

When preferences are non-homothetic, the impact of monetary policy on S-output is more than proportional to the decline of G output, as all households reallocate their expenditure away from luxuries when output contracts:

$$y_1^N = \zeta(P_1^G y_1^G, y_1^N) \frac{P_1^G y_1^G}{P_1^S}, \tag{41}$$

where $\zeta(P_1^G Y_1^G, Y_1^N) = \frac{P_{N,1} y_{N,1}}{P_{T,1} y_{T,1}}$ is a shifter that reflects the country's preference for services. This shifter is procyclical under the conditions stated in Proposition 2, as Appendix B.2 shows. Thus, services output moves in lockstep with tradable output.

Finally, the effects of monetary policy on total output are simply equal to the sum of the effects on output of the two sectors. If the distribution of income reduces the magnitude of the effects of monetary policy on output of tradable good, it also reduces the effects on output of good S and therefore on total output.

B.4 Conditions for Positive Relationship between Price and Consumption of Goods in Heterogeneous Monetary Union

First, we express Ricardian consumption of goods at $t = 1$ as:

$$c_{R,1}^G = \left(\xi_G y_1^G + \xi_S \frac{P_t^S}{P_t^G} y_1^S - b_{R,2}\right)^{(1-\epsilon)} (P_1^G)^{-\epsilon}. \tag{42}$$

Second, we impose for simplicity that $\frac{P_t^S}{P_t^G} y_1^S = \frac{1-\nu}{\nu} c_t^G$, as would be the case under Cobb-Douglas preferences. With non-homothetic preferences, services output also depends on an extra wedge that follows from the aggregation of non-homothetic demand for services. This wedge is however increasing in total consumption, as services are a luxury. Hence, this simplifying assumption understates the magnitude of the increasing relationship between services output and aggregate goods consumption. Hence, if we can prove that $c_{R,1}^G$ is increasing in P_1^G, the result will be true a fortiori under non-homothetic preferences.

Third, we can use the fact that total goods consumption in country i equals the sum of total output of goods in the same country and the savings/borrowing of the Ricardian household, $c_1^G = y_1^G - b_{R,2}$. Thus, we can write:

$$c_{R,1}^G = \left(\left(\xi_G + \xi_S \frac{1-\nu}{\nu}\right) y_1^G - \left(1 + \xi_S \frac{1-\nu}{\nu}\right) b_{R,2}\right)^{(1-\epsilon)} (P_1^G)^{-\epsilon}. \tag{43}$$

Finally, we can use (40) to write the output of goods as a function of the prices of goods:

$$y_1^G = \left(\frac{\alpha_T P_1^G}{W_1^G}\right)^{\frac{\alpha_T}{1-\alpha_T}}, \tag{44}$$

and plug in (43):

$$c_{R,1}^G = \left(\left(\xi_G + \xi_S \frac{1-\nu}{\nu}\right) \left(\frac{\alpha_T P_1^G}{W_1^G}\right)^{\frac{\alpha_T}{1-\alpha_T}} - \left(1 + \xi_S \frac{1-\nu}{\nu}\right) b_{R,2}\right)^{(1-\epsilon)} (P_1^G)^{-\epsilon}. \tag{45}$$

Ricardian consumption of goods is a function of the price of goods: if the price of goods increases, output of goods increases too. Higher prices of goods also increase consumption and output of services. Thus, the income and consumption of Ricardian household would increase, too. However, as expenditure increases, the Ricardian household reduces the goods' share of its expenditure, in additional to the conventional substitution effect. Therefore, higher goods' prices can also reduce goods' consumption. Differentiating $c_{R,1}^G$

with respect to P_1^G, for a given value of $b_{R,2}$ we obtain:

$$\frac{dc_{R,1}^G}{dP_1^G} = \frac{(1-\epsilon)\frac{\alpha_T}{1-\alpha_T}\left(\xi_G + \xi_S\frac{1-\nu}{\nu}\right)\frac{y_1^G}{P_1^G}}{\left(\xi_G + \xi_S\frac{1-\nu}{\nu}\right)y_1^G - \left(1+\xi_S\frac{1-\nu}{\nu}\right)b_{R,2}} - \frac{\epsilon}{P_1^G} > 0. \tag{46}$$

From this derivative, we obtain a condition on the ratio between Ricardian savings or borrowings and output of goods that is consistent with a positive overall effect of an increase in the price of goods on the Ricardian consumption of goods:

$$-\frac{b_{R,2}}{y_1^G} > \frac{\alpha-\epsilon}{\epsilon(1-\alpha)}\frac{\xi_G + \xi_S\frac{1-\nu}{\nu}}{1+\xi_S\frac{1-\nu}{\nu}}. \tag{47}$$

If $\alpha > \epsilon$ and for ϵ small enough $\frac{\alpha-\epsilon}{\epsilon(1-\alpha)}\frac{\xi_G+\xi_S\frac{1-\nu}{\nu}}{1+\xi_S\frac{1-\nu}{\nu}}$ is a sizable number. We set parameters so that $\frac{\alpha-\epsilon}{\epsilon(1-\alpha)}\frac{\xi_G+\xi_S\frac{1-\nu}{\nu}}{1+\xi_S\frac{1-\nu}{\nu}} > 1$. The above condition is thus satisfied as long as the monetary policy shock generates external balances that are smaller than output.

B.5 Proofs for Propositions and Lemmas

This appendix provides more formal proofs for the propositions and lemmas presented in Section 4 of the main text. We refer to the model equations as defined in Section 3. Assumptions used are Assumption 4.1 ($\varepsilon > 0$) and Assumption 4.2 (e.g., $\xi_{S,R,k} > \xi_{G,R,k}$ where relevant for pro-cyclical inequality).

B.5.1 Proofs for Section 4.1 (Expenditure Shares)

Proof of Lemma 1. The expenditure share on services for household j in country k is given by equation (9):

$$\omega_{j,k}^S(e_{j,k}) = 1 - \nu\left(\frac{P_k^S}{e_{j,k}}\right)^{\varepsilon}\left(\frac{P^G}{P_k^S}\right)^{\gamma}.$$

Differentiating $\omega_{j,k}^S$ with respect to $e_{j,k}$, holding prices P_k^S and P^G constant:

$$\begin{aligned}\frac{\partial \omega_{j,k}^S}{\partial e_{j,k}} &= -\nu(P_k^S)^{\varepsilon-\gamma}(P^G)^{\gamma}\frac{\partial}{\partial e_{j,k}}(e_{j,k}^{-\varepsilon}) \\ &= -\nu(P_k^S)^{\varepsilon-\gamma}(P^G)^{\gamma}(-\varepsilon e_{j,k}^{-\varepsilon-1}) \\ &= \varepsilon\nu(P_k^S)^{\varepsilon-\gamma}(P^G)^{\gamma}e_{j,k}^{-\varepsilon-1}.\end{aligned}$$

Given Assumption 4.1 ($\varepsilon > 0$), and that prices and expenditure are positive, $P_k^S > 0$, $P^G > 0$, $e_{j,k} > 0$, it follows that $\frac{\partial \omega_{j,k}^S}{\partial e_{j,k}} > 0$.

□

Proof of Lemma 2. The average service expenditure share is $\bar{\omega}_k^S(\bar{e}_k) = x_{H,k}\omega_{H,k}^S(x_{H,k}\bar{e}_k) + x_{R,k}\omega_{R,k}^S(x_{R,k}\bar{e}_k)$, where $x_{j,k} = e_{j,k}/\bar{e}_k$ is the share of household j's expenditure in total country expenditure, held constant for this partial derivative. Differentiating $\bar{\omega}_k^S$ with respect to $\bar{e}_k$:

$$\frac{\partial \bar{\omega}_k^S}{\partial \bar{e}_k} = x_{H,k}\frac{\partial \omega_{H,k}^S(e_{H,k})}{\partial e_{H,k}}\frac{\partial e_{H,k}}{\partial \bar{e}_k} + x_{R,k}\frac{\partial \omega_{R,k}^S(e_{R,k})}{\partial e_{R,k}}\frac{\partial e_{R,k}}{\partial \bar{e}_k}.$$

Since $e_{j,k} = x_{j,k}\bar{e}_k$, then $\frac{\partial e_{j,k}}{\partial \bar{e}_k} = x_{j,k}$. Substituting this in:

$$\frac{\partial \bar{\omega}_k^S}{\partial \bar{e}_k} = x_{H,k}^2\frac{\partial \omega_{H,k}^S(e_{H,k})}{\partial e_{H,k}} + x_{R,k}^2\frac{\partial \omega_{R,k}^S(e_{R,k})}{\partial e_{R,k}}.$$

From Lemma 1, $\frac{\partial \omega_{j,k}^S(e_{j,k})}{\partial e_{j,k}} > 0$ under Assumption 4.1 ($\varepsilon > 0$). Since $x_{j,k}^2 \geq 0$ (and typically > 0), the sum of positive terms is positive. Thus, $\frac{\partial \bar{\omega}_k^S}{\partial \bar{e}_k} > 0$. □

Proof of Lemma 3. As stated in the main text, the average service expenditure share is given by:

$$\bar{\omega}_k^S = 1 - \nu\left(\frac{P_k^S}{\bar{e}_k}\right)^{\varepsilon}\left(\frac{P^T}{P_k^S}\right)^{\gamma}\left(x_{H,k}^{1-\varepsilon} + x_{R,k}^{1-\varepsilon}\right).$$

Let $K = \nu\left(\frac{P_k^S}{\bar{e}_k}\right)^{\varepsilon}\left(\frac{P^T}{P_k^S}\right)^{\gamma}$. Since $\nu > 0$ and prices and aggregate expenditure are positive, $K > 0$. Then $\bar{\omega}_k^S = 1 - K\left(x_{H,k}^{1-\varepsilon} + x_{R,k}^{1-\varepsilon}\right)$. Consider the function $f(x) = x^{1-\varepsilon}$. Its second derivative is $f''(x) = (1-\varepsilon)(-\varepsilon)x^{-\varepsilon-1} = -\varepsilon(1-\varepsilon)x^{-\varepsilon-1}$. Under Assumption 4.1 ($\varepsilon > 0$), and assuming $0 < \varepsilon < 1$ (as typical for Boppart, 2014 preferences) then $1 - \varepsilon > 0$. Thus, $f''(x) < 0$, meaning $f(x) = x^{1-\varepsilon}$ is a strictly concave function. By Jensen's inequality, for a concave function f, a mean-preserving spread in its arguments decreases the expected value of the function's evaluations. Therefore, an increase in the dispersion $\sigma_{x,k}$ of $(x_{H,k}, x_{R,k})$ (which is a mean-preserving spread since $x_{H,k}+x_{R,k} = 1$) will decrease the sum $(x_{H,k}^{1-\varepsilon}+x_{R,k}^{1-\varepsilon})$. Since $\bar{\omega}_k^S = 1 - K \times$ (term that decreases with dispersion), and $K > 0$, it follows that $\bar{\omega}_k^S$ increases with the dispersion $\sigma_{x,k}$. □