Monetary Policy in Currency Unions with Unequal Countries

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Abstract

We investigate how heterogeneity in both the level and distribution of income across member countries shapes the transmission of monetary policy in a currency union. We study a multi-country New-Keynesian framework with three key features: (1) cross-country variation in both income levels and inequality, (2) non-homothetic preferences over tradable and non-tradable consumption, and (3) unequal incidence of sectoral income across households. In higher-income and more unequal countries, tradable goods account for a relatively smaller fraction of aggregate consumption. Nevertheless, we find that monetary policy shocks exert weaker real effects in these countries—despite the fact that prices are more rigid in the non-tradable sector. The greater exposure of wealthier households to the non-tradable sector generates pro-cyclical inequality and dampens the effect of monetary policy. Empirically, we confirm this pattern by analyzing how identified monetary policy shocks affect output, prices, and trade flows within the European Monetary Union. Our findings suggest that accounting for cross-country differences in consumption and income distributions is essential for understanding (and designing) common monetary policy.

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1 Introduction

The European Monetary Union (EMU) spans countries with different levels of economic development and income inequality—differences that have become more pronounced as the EMU has expanded to include economies of varying sizes and stages of development over the past two decades. This expansion raises a key question: How do cross-country differences in both the level and distribution of income affect the efficacy of monetary policy within a monetary union?

This paper addresses that question empirically and theoretically. Our point of departure is documenting three stylized facts related to the level and distribution of income in the EMU. First, we show that countries with higher income inequality have a larger share of expenditure on non-tradables. We also find that in countries with higher income inequality, households with access to financial markets tend to earn a larger share of their income from the non-tradable sector. Third, we find substantial heterogeneity in expenditure composition within countries in the euro area, across households that differ in terms of income. Higher-income households allocate a greater proportion of their spending to non-tradables. The second and third empirical findings are closely related: higher-income households account for a larger share of total income in more unequal countries. These allocate a larger share of their expenditure to luxuries, resulting in a higher aggregate expenditure share on non-tradables.

comprises countries that are heterogeneous in terms of their level and distribution of income yet operate under a common monetary policy. How do the effects of monetary policy differ across these union members? Prior research in microeconomics has highlighted that household expenditure patterns differ significantly by income level.[1] This paper examines how differences in income distribution and expenditure composition across countries shape the transmission of monetary policy. Specifically, we ask: How does monetary policy impact output in countries in the euro area, given the differences in expenditure composition across them, as well as income heterogeneity both across and within countries?

We explore this question empirically and theoretically. Our empirical analysis reveals three key findings: First, monetary policy transmission is weaker in countries with a higher average share of expenditure on non-tradables. We estimate via local projections the effects of monetary policy on output, interacting the monetary policy shock with each country's non-tradable expenditure share, and obtaining a negative and significant estimate for this interaction coefficient. This result is surprising because non-tradable sectors tend to suffer from more severe nominal rigidities, and because in an economy with a higher share of non-

[1] Deaton and Muellbauer (1980) is a seminal contribution on differences in consumption behavior across households.

tradable production, output should be more sensitive to local demand conditions.[2] Instead, we find that the higher the share of consumption allocated to non-tradables, the weaker the monetary policy transmission. Second, we observe significant differences in average expenditure shares across countries in the euro area that vary in income distribution. Specifically, countries with higher income inequality display a greater average share of expenditure on non-tradables. We also find that in countries with higher income inequality, households with access to financial markets tend to earn a larger share of their income from the non-tradable sector. Third, we find substantial heterogeneity in expenditure composition within countries in the euro area, across households that differ in terms of income. Higher-income households allocate a greater proportion of their spending to non-tradables. The second and third empirical findings are closely related: higher-income households account for a larger share of total income in more unequal countries. These allocate a larger share of their expenditure to luxuries, resulting in a higher aggregate expenditure share on non-tradables.

We rationalize these findings through the lens of an open-economy model. The model economy features heterogeneous households with non-homothetic preferences, nominal rigidities, market incompleteness, international differences in the income distribution, and multiple goods, with non-tradables entering preferences as a luxuries. The joint presence of these features, and in particular of household heterogeneity, market incompleteness, and non-homotheticity, is crucial for explaining the weaker monetary policy transmission observed in countries with higher income inequality.

Non-homotheticity, market incompleteness, and income heterogeneity across households can give rise to pro-cyclical inequality, which dampens the impact of monetary policy shocks on output. Two types of households inhabit the model economy: Ricardian and Hand-to-Mouth. The Ricardian household has access to financial markets, while the Hand-to-Mouth household does not. Both households earn income from tradable and non-tradable sectors, but crucially, the shares of output distributed to them differ across sectors and countries. These international differences in income distributions lead to differences in the cyclicality of relative household incomes, and specifically in the response of income inequality to monetary policy shocks.

Pro-cyclical inequality weakens the transmission of monetary policy shocks to output. When inequality is pro-cyclical, a contractionary monetary policy shock results in a milder income contraction for poorer Hand-to-Mouth households. This milder income contraction reduces the magnitude of the indirect effect of monetary policy. Pro-cyclical inequality arises when the Ricardian household earns a larger share of its income from the non-tradable sector. Since non-tradables are luxuries, their relative value rises during ex-

[2]Gautier et al. (2024) documents heterogeneity in the frequency of price changes across sectors.

pansions and falls during recessions. When the Ricardian household mostly derives income from the non-tradable sector, her relative income inherits the pro-cyclical nature of luxuries. This mechanism can rationalize why we observe weaker monetary policy transmission in countries with higher non-tradable expenditure shares: in more unequal countries, the aggregate non-tradable share is higher. In addition, if in more unequal countries, the higher inequality arises due to a larger share of income from the non-tradable sector, inequality will be procyclical, and the transmission of monetary policy will be weaker.

Contractionary monetary policy shocks in our model economy give rise to heterogeneous output contractions across the individual countries that make up the monetary union, and to trade imbalances between them. We examine two scenarios regarding the composition of the monetary union: a homogeneous monetary union where all countries are identical, and a heterogeneous union where countries differ in income distribution. In the homogeneous union, no trade occurs across identical countries, which are equivalent to closed economies. We use this setting to show that higher inequality weakens the transmission of monetary policy when Ricardian households derive greater income from the non-tradable sector. When countries in the union are heterogeneous, upon a contractionary shock, current account imbalances emerge. These trade imbalances occur because while tradable output falls similarly across countries in the union, consumption in unequal countries contracts by less, leading to a trade deficit in unequal countries, and to a trade surplus in equal countries. In this heterogeneous monetary union setting, Ricardian and Hand-to-Mouth households have the same income and earn equally from both sectors in equal countries, while in unequal countries, Ricardian households earn a greater share of income from the non-tradable sector. Across countries in the union, more inequality is also associated with a higher average share of expenditure allocated to non-tradables.

Our empirical evidence supports the model predictions: we find that a trade deficit follows a contractionary monetary policy shock for countries with a high non-tradable share. Furthermore, the model predicts that tradable output declines similarly across country groups, and that differences in the decline of total output are driven by heterogeneous fluctuations in non-tradable output. Again, we find empirically that the heterogeneous sectoral response of output across countries in the union is consistent with this model prediction.

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).[3]

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

[3] 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).

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 findings on the composition of expenditure across euro-area countries and their implications for monetary policy transmission.

First, we show that economies with lower non-tradable expenditure shares exhibit stronger output responses to monetary policy shocks. This finding is counterintuitive, as higher non-tradable shares should imply greater exposure of output to local demand fluctuations, which are typically more sensitive to monetary policy shocks. Additionally, the presence of stronger nominal rigidities in the non-tradable sector suggests that output in these economies should be more responsive to such shocks. However, our findings indicate the opposite: countries with higher expenditure shares on non-tradables experience weaker output responses to monetary policy shocks.

Second, at the aggregate level, we document that countries with higher income inequality tend to allocate a larger share of total consumption to non-tradables. We also find that in more unequal countries, households with access to financial markets earn a larger share of their income from the non-tradable sector.

Third, at the household level, we show that higher-income households allocate a systematically higher share of their consumption to non-tradables, underscoring significant non-homotheticity in preferences. Our focus is on how the elasticity of expenditure to income varies with the tradability of items in the consumption basket.[4] These micro-level findings suggest that income inequality has a dampening effect on the responsiveness of economies to monetary policy shocks, as households with higher incomes disproportionately drive non-tradable consumption.

In the remainder of this section, we detail the data used for the empirical analysis and we then proceed to examine our three main empirical findings in depth.

[4]It is well-known in the literature that the composition of demand varies significantly across households. See e.g. the seminal contribution by Deaton and Muellbauer (1980).

2.1 Data

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

For household consumption expenditure across income levels, our main data source is the quinquennial Household Budget Survey (HBS) hosted by Eurostat. The sample covers the following five quinquennial census years: 1999, 2005, 2010, 2015 and 2020.[5] The HBS documents the expenditure shares on three-digit COICOP consumption categories for every quintile in the household income distribution. We convert income quintiles into the corresponding levels of disposable income using data on income distributions from Eurostat.[6]

We classify consumption expenditure as tradable (T) and non-tradable (N) based on the COICOP classification. We calculate non-tradable and tradable consumption shares as

$$\omega_{s,t} = \frac{\sum_{j \in \mathbb{S}_s} e_{j,t}}{e_t}, \quad s \in (N, T),$$

with consumption expenditure $e_{j,t}$ on COICOP consumption category j, total non-tradable and tradable consumption expenditure e_t at time t, and $\mathbb{S}_N$ and $\mathbb{S}_T$ as the sets of tradable and non-tradable consumption categories.[7] We exclude housing expenditure, including rents and imputed rents, from the calculation of consumption shares in our baseline empirical exercises, as differing housing market structures across countries make data comparability challenging. Nevertheless, our results remain robust when considering housing expenditure, as discussed below and in Appendix A.7.

We calculate the non-tradable consumption share for each country, using mean household expenditure shares from the HBS, at annual frequency. We measure after-tax income inequality by the Gini coefficient using data from the World Inequality Database (WID).

Furthermore, we collect quarterly, country-level data on macroeconomic variables. These include seasonally adjusted real GDP and real value added by industry (NACE Rev.2), tradable and non-tradable price levels, industrial production, employment, and fixed capital formation from Eurostat. We further classify value added as tradable, non-tradable,

[5] 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.

[6] Income statistics are given as the top cut-off points for each decile. Hence, the top cut-off point for the highest decile is undefined. We thus match the income level for each quintile with the top cut-off point of the first of the two income deciles it corresponds to. For example, for the second quintile that spans the 3th and 4th deciles, we match its income level with the cut-off point at the 4th decile. For the fifth quintile, we thus use the cut-off point at the 9th decile.

[7] Table 5 in Appendix A.4 describes the detailed classification in full.

and housing, based on the NACE classification, which corresponds to the consumption COICOP classification.[8]

In addition, we use 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.

We include in the dataset monetary policy shocks measured by Jarociński and Karadi (2020), focusing on shocks identified via monetary policy surprises. In the local projection exercise, we include countries that joined the monetary union after 2000 starting from when they entered the European Exchange Rate Mechanism II (ERM II) and exclude these countries before their ERM II membership (see Dorrucci et al. (2022)). As a result, we exclude Cyprus, Estonia, Latvia, Lithuania, Malta, and Slovenia before 2004, and Slovakia before 2005.

2.2 Empirical Results

Fact 1: Weaker response of output to monetary policy shocks in countries with high non-tradable consumption expenditure shares

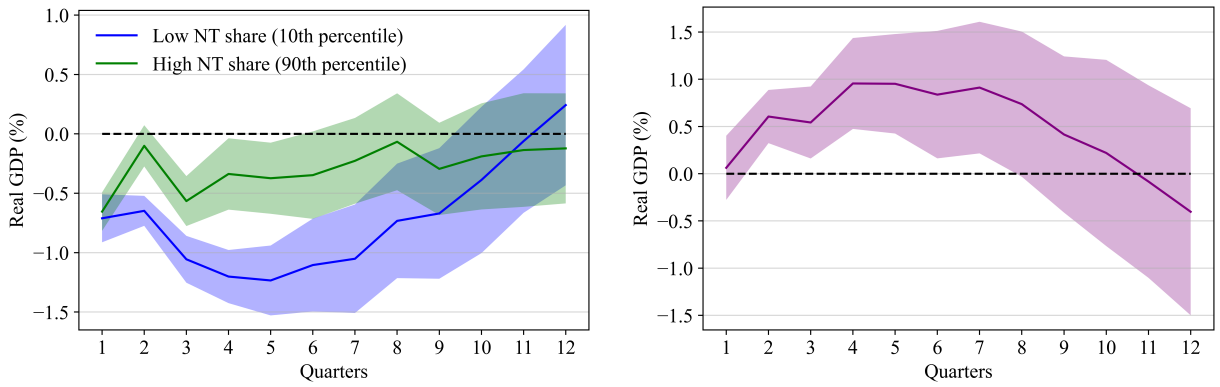
We analyse the relationship between monetary policy and countries' consumption expenditure shares. We find that a contractionary monetary policy shocks causes output to decline significantly less in countries with high non-tradable shares.

We construct impulse responses of real GDP to monetary policy shocks, controlling for countries' non-tradable consumption expenditure shares. We follow the methodology by Jorda (2005) and Montiel Olea and Plagborg-Møller (2021) and we estimate the following equation:

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

The left-hand side represents the deviation of the log-dependent variable, which is real GDP in our main exercise, from its initial value over the horizon of $H = 12$ quarters. The right-hand side includes the monetary shock series i_t and its interaction with the average non-tradable consumption share $\bar{\omega}_k$ in each country k. For each country, the impulse response is thus the linear combination of the coefficients on the monetary policy shock β^h and on the interaction with the non-tradable share γ^h, from the above equation: $\beta^h + \gamma^h \bar{\omega}_k$. The results thus reflect the cumulative percentage deviation of the dependent variable in response to a shock in year t, allowing for differences in countries' expenditure shares.

[8] Appendix A.5 reports the corresponding classification table.



(a) High and low non-tradable share

(b) Difference

Figure 1: **Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for countries with high and low non-tradable consumption expenditure shares.** In graph a), the low non-tradable (N) share line is based on the 10th percentile of non-tradable shares in the sample of countries and the high non-tradable share line on the 90th percentile, respectively. Graph b) shows the interaction term coefficient γ^h. The shaded areas represent 90th percent confidence intervals. Standard errors are clustered around countries.

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 1a presents the impulse responses of real GDP to a one-standard-deviation contractionary monetary policy shock for countries with high and low non-tradable consumption expenditure shares. The impulse response for a low non-tradable share reflects a country at the 10^{th} percentile of the distribution, with a 38% share. For a high non-tradable share, we consider a country at the 90^{th} percentile, with a 55% share. We show in Appendix A.6 that our impulse response functions for individual countries closely align with estimates found in existing literature.

The graphs reveal our key result: the decline in output following a contractionary monetary policy shock is significantly larger in countries with low non-tradable shares. After five quarters, the cumulative output decline is 1.2% in low non-tradable economies, compared to 0.5% in high non-tradable economies. The difference across countries remains statistically significant up to the 7^{th} quarter after the shock, as indicated by the interaction term coefficient γ^h in Figure 1b. We provide an extensive discussion of empirical robustness tests and extensions in Section 4.3.

Fact 2: Non-tradable consumption increases in income inequality

Across countries, higher income inequality is associated with a higher expenditure share on non-tradables. We document this fact by examining the relationship between the average

expenditure share on non-tradables and income inequality for each country. Specifically, we estimate the following linear regression model:

$$\bar{\omega}_{N,k} = \alpha + \beta \overline{Gini}_k + \gamma_i \bar{X}'_k + \epsilon_k \tag{2}$$

where $\bar{\omega}_{N,k}$ denotes the average non-tradable consumption expenditure share in country k between 2000 to 2020, $\overline{Gini}$ is the average Gini index on disposable income in the same period. $\bar{X}$ is a vector of controls that include the trade balance, the old-age dependency ratio, the size of the government, and GDP per capita, all averaged over the same time period. We estimate this relationship weighting each country according to its GDP. Figure 2 graphically displays this estimated relationship. The corresponding regression results using different measures of income inequality are reported in Table 1.

The estimation results show that greater income inequality is associated with higher non-tradable consumption expenditure shares. This result is consistent with non-homothetic preferences: higher-income households account for a larger share of total expenditure in more unequal countries. If these households allocate more of their spending to non-tradables, the overall expenditure share on non-tradables rises. We document below that higher-income households allocate a larger share of their expenditure to non-tradables.

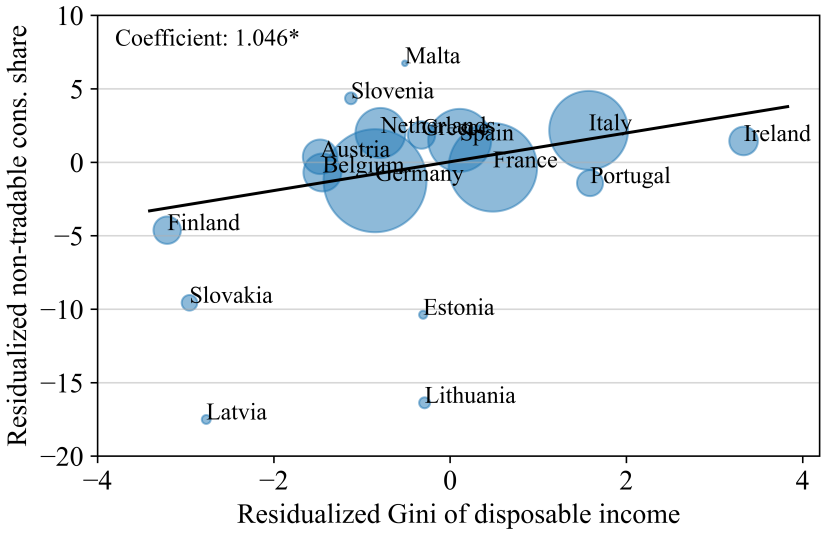


Figure 2: **Inequality and Non-Tradable Expenditure Shares.** Weighted linear regression fit of non-tradable expenditure share on the Gini coefficient of disposable income, averaged over 2000 to 2020. Both variables are residualized, i.e. presented as residuals from a regression on the set of controls in (2). Weights are based on countries' average GDP in the period 2000-2020. The estimation excludes Cyprus and Luxembourg, due to their frequent classification as tax havens. Appendix A.2 shows the results for the unweighted and for the not residualized regressions.

	NT 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** (2)**.** 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.

Fact 3: Non-tradable consumption increases with household income

Households with higher incomes allocate a systematically larger share of their consumption expenditure to non-tradables. We document this result by comparing households across different income levels within each country, as well as across different countries. Figure 3 presents the non-tradable expenditure share for each income quintile in euro-area countries, averaged over the period 2000–2020. The non-tradable expenditure share varies significantly, rising from less than 20% for households in the lowest income groups to nearly 50% for those in the highest income groups. This heterogeneity in expenditure shares suggests that preferences of households in the euro area exhibit substantial non-homotheticity, with non-tradables functioning as a luxury good.

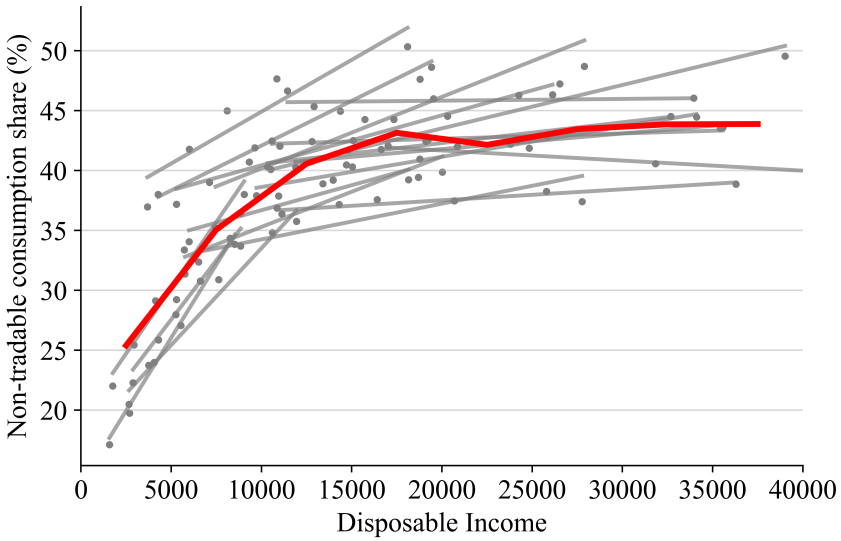


Figure 3: **Non-tradable expenditure shares by household income level.** The expenditure shares are calculated as the ratio of non-tradable expenditure to the sum of tradable and non-tradable expenditure: $\omega_N = e_N/(e_N + e_T)$. We consider averages over the period 2000-2020. Each point denotes the non-tradable expenditure share of one of the five income quintiles in each country. Each grey straight line represents the best linear fit of a country-by-country, non-tradable share - income relationship. The red line represents a non-parametric estimate of this relationship for the entire sample. Appendix A.1 presents further details on this relationship, displaying disaggregated information at the country level.

We analyze in further detail the relationship between income and consumption expenditure shares, disaggregating the latter across finer categories. We find this relationship to be highly heterogeneous across consumption categories, with non-tradable categories showing a positive relationship with income. Among tradables, the relationship varies, with some categories displaying a strong negative association with income, and others a positive one. Specifically, the expenditure share rises with income for all non-tradable categories except the non-tradable component of communication, with restaurant expenditure displaying the highest positive coefficient. For tradables, the results are mixed: while private transport shows a positive and significant coefficient, food accounts for a large share of total expenditure and shows a large negative coefficient.

We obtain this finding by estimating the empirical relationship between income and expenditure shares of the finer categories within the 2-digit COICOP classification. The COICOP classification contains 12 2-digit categories, but some of these are neither purely tradable nor non-tradable. Therefore, we decompose these hybrid categories into their tradable and non-tradable components, allocating the corresponding 3-digit subcategories accordingly. This separation yields 17 distinct 2-digit consumption categories for our analysis.

We estimate the following linear regression model to study this relationship:

$$\omega_{t,i,j} = \alpha_i + \beta_i I_{t,j} + \phi_{i,j} + \psi_{i,t} + \epsilon_{t,i,j}$$

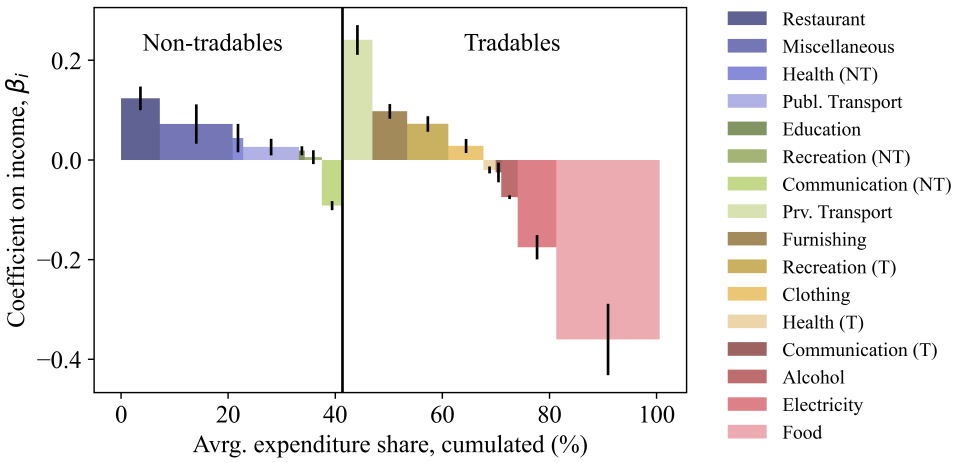


Figure 4: **Beta coefficients from the regression of consumption shares on fine two-digit COICOP categories on income.** Whiskers show one standard error bands based on clustered standard errors around country and year.

where $\omega_{t,i,j}$ represents the expenditure share for each 2-digit COICOP category i, household j, and year t. $I_{t,j}$ denotes the income level of household j at time t. The model includes country ($\phi_{i,j}$) and time ($\psi_{i,t}$) fixed effects to account for structural differences across countries and years. Each household in this regression corresponds to one of the five income groups within each country for which we have detailed consumption data.

Figure 4 presents the estimated coefficients on income β_i for each category, with several of these coefficients being significantly different from zero. These result further underscore the presence of non-homotheticity in preferences across the various expenditure categories.

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 $k \in [0, 1]$.[9] In each small open economy, households consume two types of goods: a tradable good (T) and a non-tradable good (N). The tradable good can be exchanged frictionlessly among countries in the monetary union, while the non-tradable good is produced and consumed exclusively within the domestic economy.. Household preferences over the two goods are non-homothetic: The tradable good is a necessity, and the non-tradable good is a luxury, consistently with the micro-level evidence presented in Section 2.2. Heterogeneous households inhabit each small open economy, differing in income, wealth, and their ability to share risks in financial markets. Countries

[9]In what follows, we suppress the country index k to lighten notation where describing properties of individual 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 over a stream of expenditures $\{e_{j,t}\}_{t=0}^{\infty}$ are represented by:

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

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

The Boppart (2014) indirect utility function characterizes household preferences over tradable and non-tradable goods:

$$v(e_{j,t}, P_t^T, P_t^N) = \frac{1}{\varepsilon}\left[\left(\frac{e_{j,t}}{P_t^N}\right)^{\varepsilon} - 1\right] - \frac{\nu}{\gamma}\left[\left(\frac{P_t^T}{P_t^N}\right)^{\gamma} - 1\right]. \tag{3}$$

with the parameters $\varepsilon, \gamma \in [0, 1]$ and $\nu > 0$. These preferences allow for non-homotheticity, and thus for expenditure shares over the two goods that vary in the level of total expenditure. The parameter ε characterizes the degree of non-homotheticity. For $\varepsilon > 0$, the expenditure share on tradable good is decreasing in the level of total expenditure. The parameter ν controls the share of expenditure that is allocated to the tradable good. γ governs the elasticity of substitution between the two goods, 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:

$$P_t^T c_{j,t}^T + P_t^N c_{j,t}^N = W_{j,t} l_{j,t} + \Psi_{j,t} + P_t^T R_{t-1} b_{j,t} + R_{t-1}^m b_{j,t}^m - P_t^T b_{j,t+1} - b_{j,t+1}^m, \tag{4}$$

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 tradable and non-tradable goods in each period as follows:[10]

$$c_{j,t}^T = \frac{e_{j,t}}{P_t^T} \left[\nu \left(\frac{P_t^N}{e_{j,t}} \right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N} \right)^{\gamma} \right], \tag{5}$$

$$c_{j,t}^N = \frac{e_{j,t}}{P_t^N} \left[1 - \nu \left(\frac{P_t^N}{e_{j,t}} \right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N} \right)^{\gamma} \right], \tag{6}$$

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

$$\omega_{j,t}^T \equiv \frac{P_t^T c_t^T}{e_{j,t}} = \nu \left(\frac{P_t^N}{e_{i,j,t}} \right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N} \right)^{\gamma}, \tag{7}$$

$$\omega_{j,t}^N \equiv \frac{P_t^N c_t^N}{e_{j,t}} = 1 - \nu \left(\frac{P_t^N}{e_{j,t}} \right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N} \right)^{\gamma}. \tag{8}$$

The share of expenditure allocated to tradable goods decreases with total expenditure, since preferences in (3) imply that this good is a necessity. Conversely, the share allocated to non-tradable goods 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 expenditure shares on the two goods are constant and given by ν and $1-\nu$ for the tradable and non-tradable good, 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 (4) and to standard transversality conditions. An inter-temporal Euler equation for expenditure de-

[10] The household's intra-temporal problem associated with the indirect utility function (3) determines this allocation.

scribes how Ricardian households optimally allocate resources across periods:

$$\frac{v_e(e_{j,t}, P_t^T, P_t^N)}{v_e(e_{j,t+1}, P_{t+1}^T, P_{t+1}^N)} = \left(\frac{e_{j,t+1}}{e_{j,t}}\right)^{1-\varepsilon} \left(\frac{P_{t+1}^N}{P_t^N}\right)^{\varepsilon} = \beta R_t^m, \tag{9}$$

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

$$\frac{c_{R,t+1}^T}{c_{R,t}^T} = \beta R_t^m \left(\frac{P_t^T}{P_{t+1}^T}\right)^{1-\gamma} \left(\frac{P_t^N}{P_{t+1}^N}\right)^{\gamma}. \tag{10}$$

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

$$R_t^m = R_t \frac{P_{t+1}^T}{P_t^T}. \tag{11}$$

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 tradable or non-tradable goods 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^s, is the only factor used to produce each good $s \in \{T, N\}$, according to the production function:

$$y_t^s = (l_t^s)^{\alpha_s} \tag{12}$$

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

$$l_t^s \equiv \left(l_{H,t}^s\right)^{1-\xi_s} \left(l_{R,t}^s\right)^{\xi_s}, \tag{13}$$

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

$$\max_{l_t^s} P_t^s \left(l_t^s\right)^{\alpha_s} - W_t^s l_t^s,$$

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

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

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

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:

$$\alpha_s(1-\xi_s)P_t^s \frac{y_t^s}{l_{H,t}^s} = W_{H,t}, \tag{14}$$

and

$$\alpha_s \xi_s P_t^s \frac{y_t^s}{l_{R,t}^s} = W_{R,t}. \tag{15}$$

The total profits in sector s are given by:

$$\Psi_t^s = (1-\alpha_s)\, P_t^s y_t^s,$$

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_s of the equity in sector s, while Hand-to-Mouth households own $1-\xi_s$. Thus, profits are distributed as follows:

$$\Psi_{R,t} = \xi_T \Psi_t^T + \xi_N \Psi_t^N, \Psi_{H,t} = (1-\xi_T)\Psi_t^T + (1-\xi_N)\Psi_t^N.$$

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 (14) and (15) 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:

$$y_t^{nom} = P_t^T y_t^T + P_t^N y_t^N.$$

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

$$y_t = P_0^T y_t^T + P_0^N y_t^N.$$

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 goods in the union:

$$\bar{\Pi} = \left(\frac{P_t^T}{P_{t-1}^T}\right)^{1-\gamma} \left(\frac{\tilde{P}_t^N}{\tilde{P}_{t-1}^N}\right)^{\gamma} = 1, \tag{16}$$

where the geometric weight γ coincides with the preference parameter. $\tilde{P}_t^N$ denotes the geometric average price of non-tradable good across countries in the union:

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

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:

$$l_{j,t}^N + l_{j,t}^T = l_{j,t} \leq l_j \text{ for } j \in \{H, R\}, \tag{17}$$

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:

$$(l_{j,t}^N + l_{j,t}^T - l_{j,t})(W_{j,t} - \bar{\varpi}_t W_{j,t-1}) = 0 \text{ for } j \in \{H, R\}. \tag{18}$$

The market-clearing condition for the non-tradable good in each country k requires that consumption equals output:

$$c_{R,k,t}^N + c_{H,k,t}^N = y_{k,t}^N. \tag{19}$$

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

$$c_{k,t}^T \equiv c_{R,k,t}^T + c_{H,k,t}^T = y_{k,t}^T + R_{t-1} b_{k,t} - b_{k,t+1}, \tag{20}$$

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

$$ca_{k,t} \equiv b_{k,t+1} - b_{k,t} = y_{k,t}^T - c_{k,t}^T + b_{k,t}(R_{t-1} - 1) \tag{21}$$

The current account is given by the sum of the trade balance, $y_{k,t}^T - c_{k,t}^T$, 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 $y_{k,t}^T$ and $c_{k,t}^T$ 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:

$$\int_k y_{k,t}^T dk = \int_k (c_{R,k,t}^T + c_{H,k,t}^T) dk. \tag{22}$$

The no-arbitrage condition (11) implies that households are indifferent between holding real and nominal bonds. The net amount of nominal bonds supplied by the monetary

authority is zero:

$$\int_k b^m_{R,k,t} dk = 0 \quad \text{for all } t. \tag{23}$$

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* $\{R_t, P^T_t, R^m_t\}_t$*, nominal rigidities* $\{\bar{\varpi}_t\}_t$*, and an initial condition* b_0*, a competitive equilibrium for country* k *consists of a path of quantities* $\{c^T_{H,k,t}, c^T_{R,k,t}, c^N_{H,k,t}, c^N_{R,k,t}, e_{H,k,t}, e_{R,k,t}, l^T_{k,t}, l^T_{H,k,t}, l^T_{R,k,t}, l^N_{k,t}, l^N_{H,k,t}, l^N_{R,k,t}, y^T_{k,t}, y^N_{k,t}, b_{k,t+1}\}_t$*, and prices* $\{P^N_{k,t}, W_{H,k,t}, W_{R,k,t}\}_t$ *satisfying households' optimality conditions* (4)*,* (5)*,* (6)*,* (9)*, the firm's profit maximization* (12)*,* (13)*,* (14)*,* (15)*, nominal rigidities* (18)*, and the market-clearing condition* (19)*.*

An equilibrium for the monetary union is defined below.

Equilibrium 2 (Monetary Union)**.** *Given an initial condition for* $b^n_{R,k,0}$ *for each country* k *and a path for nominal rigidities* $\{\bar{\varpi}_t\}_t$*, a competitive equilibrium consists of a path of quantities* $\{c^T_{H,t}, c^T_{R,t}, c^N_{H,t}, c^N_{R,t}, e_{H,t}, e_{R,t}, l^T_t, l^T_{H,t}, l^T_{R,t}, l^N_t, l^N_{H,t}, l^N_{R,t}, y^T_t, y^N_t, b_{t+1}\}_t$*, and prices* $\{P^N_t, P^T_t, W_{H,t}, W_{R,t}, R_t, R^m_t\}_t$*, satisfying for each country* k *the set of conditions in Equilibrium 1, the tradable goods market-clearing condition* (22)*, the monetary policy target* (16)*, and the Fisher equation* (11)*.*

Finally, we define a stationary allocation as an equilibrium of the model economy where all variables take constant values.[11]

3.5 Calibration

We solve the model analytically and numerically, as the numerical solution allows us to graphically present results. To do so, we assign values to the model's parameters.

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 ($\xi_{T,k} = \xi_{N,k} = 0.5$) in all countries. We set the parameter governing the expenditure share ν to 0.6, implying an expenditure share on non-tradables in this benchmark allocation of 40%, which approximates the median of households' expenditure shares documented in Section 2.2.

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

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

$\gamma = 0$ 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 non-tradable sector α_N to unity. In the tradable 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. Finally, we consider a range of values for the parameters governing the distribution of income, $\xi_{T,k}$ and $\xi_{N,k}$, to study the implications of inequality.

4 Results

In this section, we present the key findings from our model. We show that differences in the composition of expenditure across countries determine the strength of monetary policy transmission. Specifically, in countries where the non-tradable expenditure share is higher, output responds less strongly to monetary policy shocks.

First, we investigate the determinants of expenditure shares, which underpin our main result. We show that households and countries with higher expenditure levels allocate a larger share of their expenditure to non-tradable goods. This result closely follows from the assumption of Boppart (2014) preferences. Moreover, under these preferences, a country's average share of expenditure on non-tradable goods increases with income inequality. This relationship emerges because, as income inequality rises, a greater fraction of total expenditure is concentrated among high-income households. Due to non-homothetic preferences, these households allocate a larger share of their expenditure to non-tradable goods.

Second, we move on to our key result, and we study how inequality, market incompleteness, and non-homothetic preferences shape the response of the economy to monetary policy. Our model shows that countries with a higher share of non-tradable goods in expenditure display a more muted reaction to monetary policy shocks, consistent with the empirical evidence documented in Section 2.2. This muted response occurs if the key driver of income inequality is a high share of income from the non-tradable sector accruing to Ricardian households. When Ricardian households derive a significant fraction of their income from the non-tradable sector, their income and consumption fluctuate more sharply than the aggregate. Conversely, Hand-to-Mouth households experience relatively mild fluctuations in income, weakening the indirect effect of monetary policy.

The sharper fluctuations in Ricardian households' income and consumption occur because non-tradables are a luxury good, whose relative value is pro-cyclical. Hence, in response to a contractionary monetary policy shock, Ricardian households reduce their consumption, yet the contraction in aggregate output is milder relative to their reduction in consumption.

Finally, we discuss the sensitivity of the model's key results to our assumptions. We analyze empirically whether Ricardian households' income from the non-tradable sector explains international differences in income inequality. Additionally, we empirically verify the model's predictions for non-targeted variables, such as the response to monetary policy of sectoral output and trade imbalances.

4.1 Expenditure Shares across Households and Countries

We highlight three key implications of non-homothetic preferences à la Boppart (2014) for the allocation of expenditure between tradable and non-tradable goods. First, across households, the share of expenditure on non-tradable goods increases as household expenditure rises. Second, across countries, the average share of expenditure on non-tradable goods increases with the country's average expenditure. Finally, the average non-tradable expenditure share rises with income inequality across countries.

Consider a monetary union comprising a continuum of small open economies. These economies differ in their income distribution. Within each country, households vary in their expenditure levels. Additionally, countries differ in their total expenditure levels and the dispersion of expenditure across households.

To illustrate results graphically, we consider a monetary union where the distribution of income from the non-tradable sector drives cross-country differences in income inequality. Income in the tradable sector is distributed equally across households in all countries ($\xi_{T,k} = 0.5$). Instead, in each country, the share of income from the non-tradable sector accruing to the Ricardian household is at least a half ($\xi_{N,k} \in [0.5, 1]$). hus, higher values of $\xi_{N,k}$ correspond to greater income inequality in country k.[12] The small open economies are otherwise identical to each other. In particular, Ricardian households in all countries hold zero assets or debt. We normalize the price of tradable P^T in the union to unity.

First, we characterize the relationship between individual household expenditure and the household-level non-tradable expenditure share:

Lemma 1. *If preferences are non-homothetic, $\varepsilon > 0$, each household allocates to non-tradables a share of its expenditure that is increasing in the level of expenditure itself:*

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

Consider the expenditure share on non-tradable goods $\omega^N_{j,k}$, as defined in (8). Given $\nu > 0$ and non-homotheticity ($\varepsilon > 0$), it is straightforward to show that the non-tradable

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

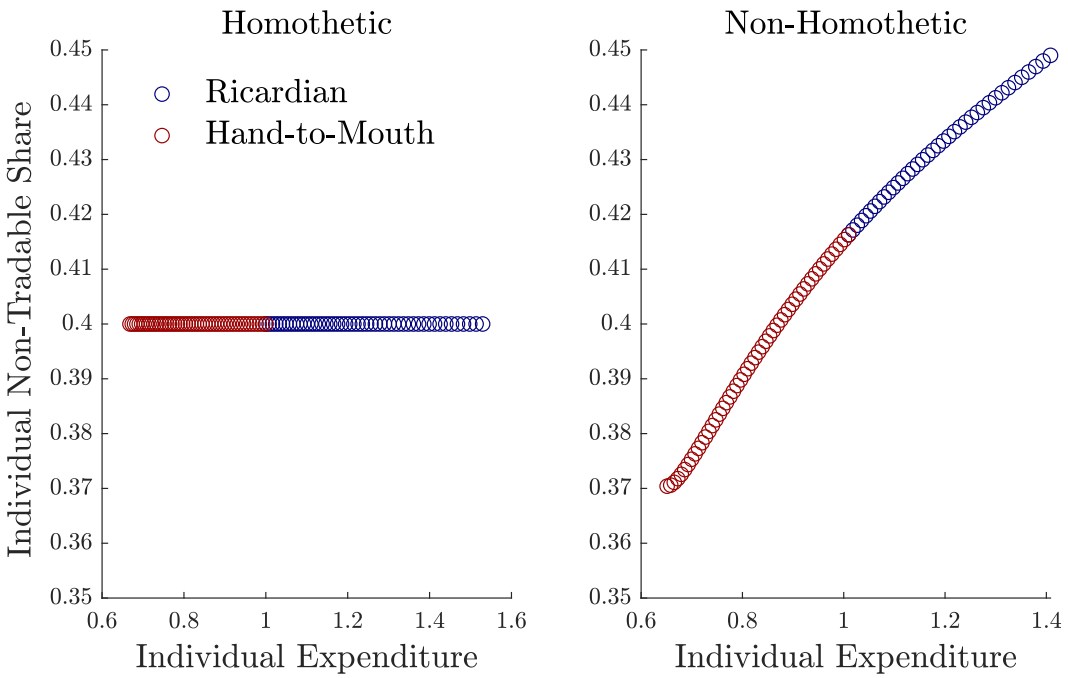


Figure 5: **Household-level non-tradable expenditure share $\omega_{j,k}^N$ as a function of household expenditure.** Stationary allocation under homothetic ($\varepsilon = 0$) or non-homothetic ($\varepsilon > 0$) preferences. Each dot represent one household, either Ricardian or Hand-to-Mouth, in one of the countries of the monetary union. Countries in the monetary union differ in terms of their income distribution, with $\xi_{N,k} \in [0.5, 1]$ and $\xi_{T,k} = 0.5$.

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:

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

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

Figure 5 graphically illustrates this relationship under homothetic ($\varepsilon = 0$) and non-homothetic ($\varepsilon > 0$) preferences. With homothetic preferences, the non-tradable expenditure share remains constant across households and countries. Under non-homothetic preferences, the non-tradable expenditure share increases with household expenditure. Consequently, greater income differences between households result in larger differences in their expenditure allocation.

Second, we analyze the relationship between aggregate expenditure and the average non-tradable expenditure share at the country level. Define total expenditure in a given country as $\bar{e}_k = e_{H,k} + e_{R,k}$, and the average non-tradable expenditure share as:

$$\bar{\omega}_k^N = \frac{P_k^N \left(c_{H,k}^N + c_{R,k}^N\right)}{e_{H,k} + e_{R,k}}.$$

Let $x_{j,k} = e_{j,k}/\bar{e}_k$ denote each household's share of its country's total expenditure.

We characterize how the average non-tradable expenditure share changes with total expenditure in a country, assuming prices and the distribution of households' relative expenditures remain unchanged:

Lemma 2. *If preferences are non-homothetic ($\varepsilon > 0$), the average expenditure share allocated to non-tradables in a country $\bar{\omega}_k^N$ increases with the country's aggregate expenditure level $\bar{e}_k$:*

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

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

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

$$\bar{\omega}_k^N\left(\bar{e}_k\right) = x_{H,k}\omega_{H,k}^N\left(x_{H,k}\bar{e}_k\right) + x_{R,k}\omega_{R,k}^N\left(x_{R,k}\bar{e}_k\right) \tag{24}$$

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

The final lemma addresses the relationship between a country's average non-tradable expenditure share and its income distribution:

Lemma 3. *If preferences are non-homothetic, ($\varepsilon > 0$), the average expenditure share allocated to non-tradables in one country $\bar{\omega}_k^N$ increases with the dispersion of household expenditure in that country, $\sigma_{x,k}$:*

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

To see this result, consider the expression for the average expenditure share in (24). For each household, total non-tradable expenditure is increasing and convex in own expenditure $e_{j,k}$:

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

The average non-tradable expenditure share is therefore a convex function of the households' shares of total expenditure $x_{j,k}$, resembling the household-level expenditure share:

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

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 non-tradable expenditure share $\bar{\omega}_k^N$.



Figure 6: **Average non-tradable expenditure share $\bar{\omega}_k^N$ 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 $\xi_{N,k} \in [0.5, 1]$ and $\xi_{T,k} = 0.5$.

Figure 6 illustrates this relationship, showing how a country's average non-tradable expenditure share rises with income inequality, measured by the Gini index on household expenditure. As the Gini index increases, so does the average non-tradable expenditure share. Higher income inequality increases the income and non-tradable expenditure shares of Ricardian households, increasing their influence on the country's overall average.

4.2 Monetary Policy, Income Distribution, and Expenditure Shares

We now examine the heterogeneous effects of monetary policy across countries in the monetary union. Specifically, we analyze the impact of a temporary increase in the nominal interest rate set by the central bank and its effects on sectoral and aggregate outcomes in member countries. The magnitude of these effects depends on the distribution of income across households within each country and the composition of consumption expenditure. In particular, we show that countries with higher income inequality exhibit a larger expenditure share on non-tradables and a weaker transmission of monetary policy to output.

We consider a temporary and unexpected increase in the nominal interest rate R_t^m at $t = 1$. Before the shock, the economy is in a stationary allocation. The nominal interest rate returns to its stationary value starting at $t = 2$. We interpret period $t = 1$ as the short run, where monetary policy has real effects on quantities such as output. These real effects depend on nominal rigidities, which we introduce by setting $\bar{\varpi}_1 = 1$ in period

$t = 1$. Periods from $t = 2$ onward represent the long run, where monetary policy has no real effects. To abstract from long-run effects of monetary policy, we set $\bar{\omega}_t = 0$ for $t \geq 2$, ensuring that nominal rigidities cannot bind in the long run.

First, we focus on a monetary union made up of identical countries. In this setting, we analyze how the income distribution and non-homothetic preferences determine the real effects of monetary policy. Second, we allow countries in the monetary union to differ in their income distribution. We study how these heterogeneous countries react differently to the same monetary policy shock, and how a monetary policy shock can give rise to current account imbalances within the monetary union.

4.2.1 Monetary Union of Homogeneous Countries

Consider a homogeneous monetary union made up of a continuum of identical countries. This union is equivalent to a closed economy. Monetary policy has a muted impact on output if the countries that comprise the union feature a high expenditure share on non-tradables and have an unequal distribution of income, in line with our empirical findings in Section 2.

The reasoning proceeds as follows. First, we establish that in countries with an unequal income distribution, the response of tradable output to monetary policy shocks is weaker than in countries with an equal distribution, in Analytical Result 1. Second, we clarify that the response of total output to monetary policy is proportional to that of tradable output, thus underscoring the importance of the dynamics of tradable output. Third, countries with unequal income distributions feature high average expenditure shares on non-tradables, as established in Lemma 3 and consistent with the evidence in Section 2. Finally, Analytical Result 2 shows that monetary policy has a weaker effect on total output in such countries.

We detail in Analytical Result 1 how monetary policy impacts total tradable consumption. Specifically, we demonstrate that the effect of a monetary policy shock on total tradable consumption may be weaker than its direct impact on the tradable consumption demand of Ricardian households, which is directly proportional to the monetary policy shock:

$$\frac{c^T_{R,1}}{c^T_{R,2}} = \frac{\bar{\Pi}}{\beta R^m_1}.$$

We characterize in Analytical Result 1 below the impact of monetary policy on total tradable consumption. We show that this impact may be smaller than that on demand by Ricardian households, which is proportional to the monetary policy shock:[13]

[13]The effect of the monetary policy shock on tradable consumption demand by Ricardian households follows from the Ricardian household's Euler equation for the tradable good (10), which follows in turn

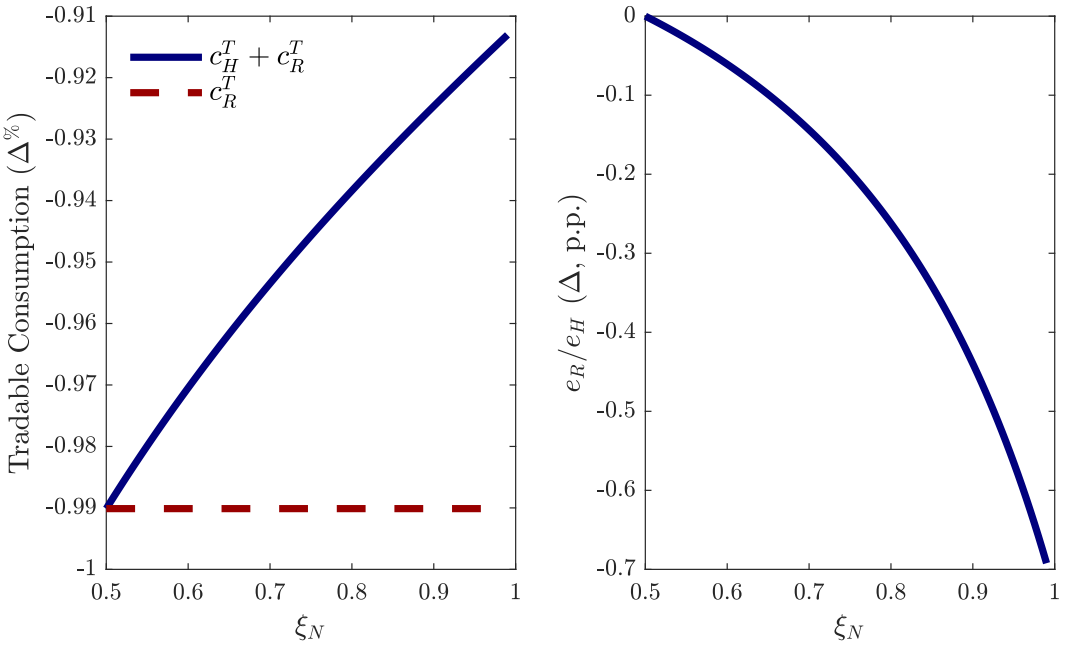


Figure 7: **Contractionary monetary policy in union of identical countries. Effects of monetary policy shock on tradable consumption, aggregate and of Ricardian household (left panel) and on relative expenditure of Ricardian household (right panel).** Effects are displayed as function of the share of non-tradable sector output accruing to Ricardian household (ξ_N). The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1% to 2%.

Analytical Result 1. *A contractionary monetary policy shock reduces tradable output and total consumption less than it reduces the demand for tradable goods by Ricardian households, which are directly exposed to the shock.:*[14]

$$\frac{c_{R,1}^T}{c_{R,2}^T} < \frac{y_1^T = c_1^T}{y_2^T = c_2^T},$$

if the following conditions hold: i) $\xi_N > \xi_T$, meaning Ricardian households earn a larger share of income from the non-tradable sector than from the tradable one, and ii) $\varepsilon > 0$, meaning preferences are non-homothetic and the non-tradable good is a luxury.

We illustrate this result graphically and analytically. The left panel of Figure 7 directly illustrates Analytical Result 1, displaying the numerical solution of the model. It shows that the contractionary effect of a monetary policy shock on total tradable consumption (or output) is milder compared to its impact on Ricardian households' consumption. This result is presented for a range of homogeneous monetary unions, which differ among them in the share of non-tradable sector output accruing to Ricardian households. As the in-

from the Euler equation for total expenditure (9), the intra-temporal allocation of expenditure to the tradable good (7), and from the next-period inflation target (16). In a union of identical countries, the average price of the non-tradable good equals the price in each country k, $\tilde{P}_t^N = P_{k,t}^N$.

[14] In a closed economy or homogeneous monetary union, for any good, total output equals total consumption.

come distribution becomes more unequal, the effect of monetary policy on output becomes weaker.

We characterize analytically the two key forces in the model that give rise to Analytical Result 1, in Lemmas 4 and 5. A contractionary monetary policy shock redistributes resources from the Ricardian household to the Hand-to-Mouth one, when non-tradables are a luxury and the Ricardian is relatively more exposed to income from the non-tradable sector. (Lemma 4 establishes this). This redistribution implies that the contractionary shock reduces the Ricardian's share of total tradable consumption (Lemma 5). Since the Ricardian's share of total tradable consumption is pro-cyclical, monetary policy has a weaker effect on total tradable output than on demand by Ricardian households. The combination of Lemmas 4 and 5 thus gives rise to Analytical Result 1.

First, fluctuations in the relative income (or expenditure) of the two households occur over the business cycle.[15] The distribution of income from the two sectors between the households shapes these fluctuations. Define the expenditure of the Ricardian relative to the Hand-to-Mouth as $e_{R,t}/e_{H,t}$. The following lemma establishes how the sectoral income distribution and non-homothetic preferences determine the cyclicality of this relative expenditure.

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) $\xi_N > \xi_T$*, i.e. the share of non-tradable output that Ricardian households earn,* ξ_N*, is greater than the share they earn from tradable output,* ξ_T*, and ii)* $\varepsilon > 0$*, i.e. preferences are non-homothetic and the non-tradable good is a luxury.*

When the non-tradable good is a luxury, the relative value of non-tradable output, $P_t^N y_t^N / P_t^T y_t^T$, rises in times of high output and high aggregate expenditure, i.e. it is pro-cyclical.[16] The relative expenditure of the Ricardian household is increasing in the the relative value of non-tradable output when $\xi_N > \xi_T$, as this household's income is relatively more exposed to fluctuations in the value of this good:

$$\frac{e_{R,t}}{e_{H,t}} = \frac{\xi_N \frac{P_t^N y_t^N}{P_t^T y_t^T} + \xi_T}{(1-\xi_N)\frac{P_t^N y_t^N}{P_t^T y_t^T} + 1 - \xi_T}.$$

[15] In a homogeneous monetary union, Ricardian households cannot save or borrow, in equilibrium, and thus their expenditure equals their income, $e_{R,t} = i_{R,t}$.

[16] We establish in Appendix B.2 that the the relative value of output of good N, $\frac{P_t^N y_t^N}{P_t^T y_t^T}$, is increasing in the expenditure of the two households and therefore pro-cyclical when preferences are non-homothetic.

When $\xi_N > \xi_T$, the relative expenditure of the Ricardian household thus inherits the pro-cyclicality of the relative value of non-tradable output. Formally:

$$\frac{P_2^N y_2^N}{P_2^T y_2^T} > \frac{P_1^N y_1^N}{P_1^T y_1^T} \implies \frac{e_{R,2}}{e_{H,2}} > \frac{e_{R,1}}{e_{H,1}} \text{ if } \xi_N > \xi_T.$$

In Figure 7, the right panel displays the decline in the relative expenditure of the Ricardian household in response to the contractionary monetary policy shock, as a function of the distribution of income from the non-tradable sector.

Second, when the relative expenditure of the Ricardian household is pro-cyclical, the Ricardian's share of total tradable consumption is pro-cyclical, as well. Consumption of tradable by the Ricardian household thus fluctuates more sharply than the overall consumption or output of this good. We formally establish this result below.

Lemma 5. *The Ricardian's share of total tradable consumption $c_{R,t}^T/c_t^T$ 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.:*

$$\frac{e_{R,2}}{e_{H,2}} > \frac{e_{R,1}}{e_{H,1}} \iff \frac{c_{R,2}^T}{c_2^T} > \frac{c_{R,1}^T}{c_1^T}.$$

The Ricardian's share of total tradable consumption is increasing in the relative expenditure of the Ricardian household itself, hence the result. We can express this share as:

$$\frac{c_{R,t}^T}{c_t^T} = \frac{c_{R,t}^T}{c_{R,t}^T + c_{H,t}^T} = \frac{1}{1 + c_{H,t}^T/c_{R,t}^T}.$$

In turn, the two households' relative tradable consumption writes as $c_{H,t}^T/c_{R,t}^T = (e_{H,t}/e_{R,t})^{1-\epsilon}$.[17] Hence, if relative expenditure of the Ricardian household is pro-cyclical, the Ricardian's share of total tradable consumption is also pro-cyclical.

The combination of Lemmas 4 and 5 gives rise to Analytical Result 1. Non-homothetic preferences and differing income distributions across the two sectors are both crucial to generate a mild effect of monetary policy on tradable output, weaker than its effect on demand by the Ricardian household. If preferences were homothetic, the relative value of non-tradable output would be constant, and Lemma 4 would fail. Relative expenditure of the two households would then be constant, independently of the income distribution. Similarly, if the income distribution were equal across sectors, $\xi_N = \xi_T$, the relative expenditure of the two households would be constant, independently of fluctuations in the relative value of non-tradable output. The conditions in Lemmas 5 and 5 would then not

[17] This follows from imposing demand for tradable good from the two households, (5).

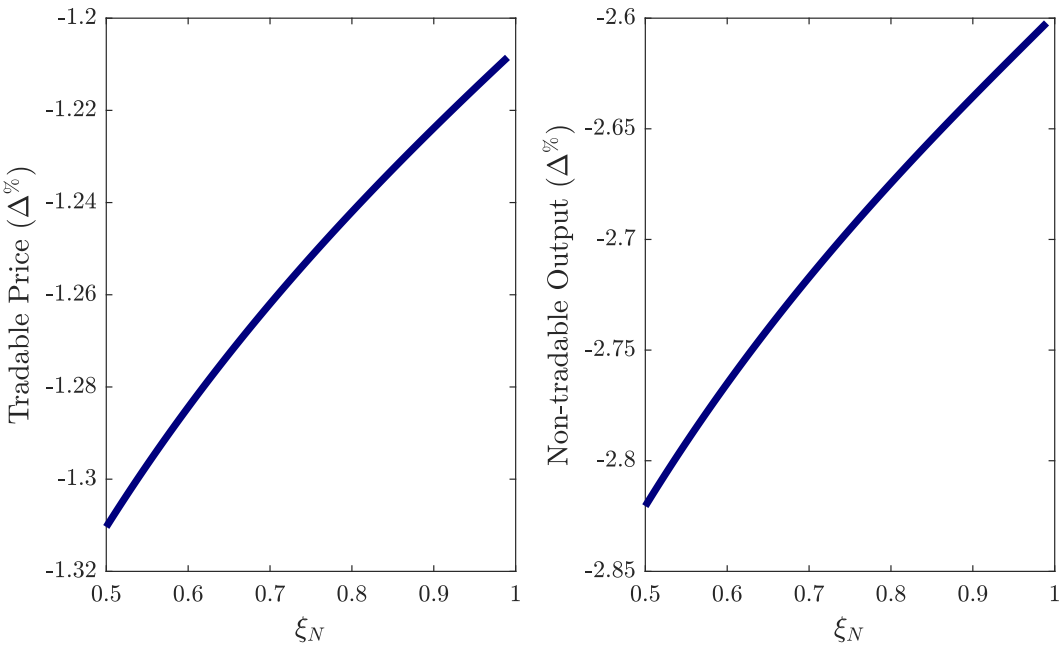


Figure 8: **Contractionary monetary policy in union of identical countries. Effects on the price of tradable good (left panel) and on non-tradable output (right panel).** Effects are displayed as function of the share of non-tradable sector output accruing to Ricardian household (ξ_N). The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1%*to*2%.

be met. In both these settings, output of tradable good would then decline as much as the Ricardian household demand for tradable good, in response to a monetary policy shock, as it is the case in a representative-agent setting.

Having characterized the forces that shape the response of tradable good output to a monetary policy shock, we can now move on to studying the effects on total output. Crucially, output of tradable good is increasing in its price. Non-tradable output is also increasing in both tradable output and in the relative price of tradable to non-tradable goods. Hence, non-tradable and total output move in lockstep with tradable output in response to a monetary policy shock.[18] Figure **??** displays the effects of monetary policy on the price of the tradable good and on non-tradable output, across homogeneous monetary unions that differ in their distribution of income.

What is, then, the relationship between the strength of the transmission of monetary policy and the composition of expenditure? Consider two different closed economies, one where $\xi_N = \xi_T = \xi$ and one where a more skewed income distribution in the non-tradable sector gives rise to greater inequality, $\xi_N > \xi_T = \xi$. Analytical Result 1 establishes that the effects of monetary policy on tradable output are milder in the unequal country. Lemma 3 shows that in the unequal country, the expenditure share on non-tradables is higher. The combination of Analytical Result 1 with Lemma 3 allows us to establish the following

[18] Appendix B.3 proves this result.

analytical result:

Analytical Result 2. *A country where a high fraction ξ_N of non-tradable output accruing to the Ricardian household gives rise to high income inequality features: i) a weak transmission of monetary policy to output,*

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

and ii) a high share of average expenditure allocated to the non-tradable good,

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

This result aligns closely with our empirical findings on the heterogeneous impact of monetary policy across countries with different composition of expenditure, as discussed in Section 2.2. Countries with higher non-tradable consumption expenditure shares exhibit weaker output responses to monetary policy shocks than countries with lower shares. Figure 9 graphically presents the result.

The model considered so far assumes identical countries within the monetary union. In the data, countries in the union differ in terms of the share of expenditure allocated to non-tradables. Therefore, we now move on to analyze how a monetary policy shock affects a monetary union composed of countries that differ in both income distribution and expenditure composition.

4.2.2 Monetary Union of Heterogeneous Countries

Consider now a monetary union in which countries differ in their income distribution. Each country in the union belongs to either of two groups, which we denote as "equal" and "unequal", respectively: $k \in \{Eq, Un\}$. The distribution of income from the tradable sector is identical across all countries, regardless of their group: $\xi_{T,Eq} = \xi_{T,Un}$. In equal countries, the income distribution across households is identical across sectors: $\xi_{T,Eq} = \xi_{N,Eq}$.[19] In contrast, in unequal countries, the Ricardian household earns a larger share of income from the non-tradable sector than in equal countries: $\xi_{N,Un} > \xi_{N,Eq}$. Two key results emerge from this analysis: monetary policy has a weaker effect on output in unequal countries, and monetary policy shocks generate trade imbalances. We formally establish these findings in the following two analytical results.

[19]When presenting results graphically, we set $\xi_{T,Eq} = \xi_{T,Un} = \xi_{N,Eq} = 0.5$. As in the previous section, we vary $\xi_{N,Un}$ between 0.5 and 1.

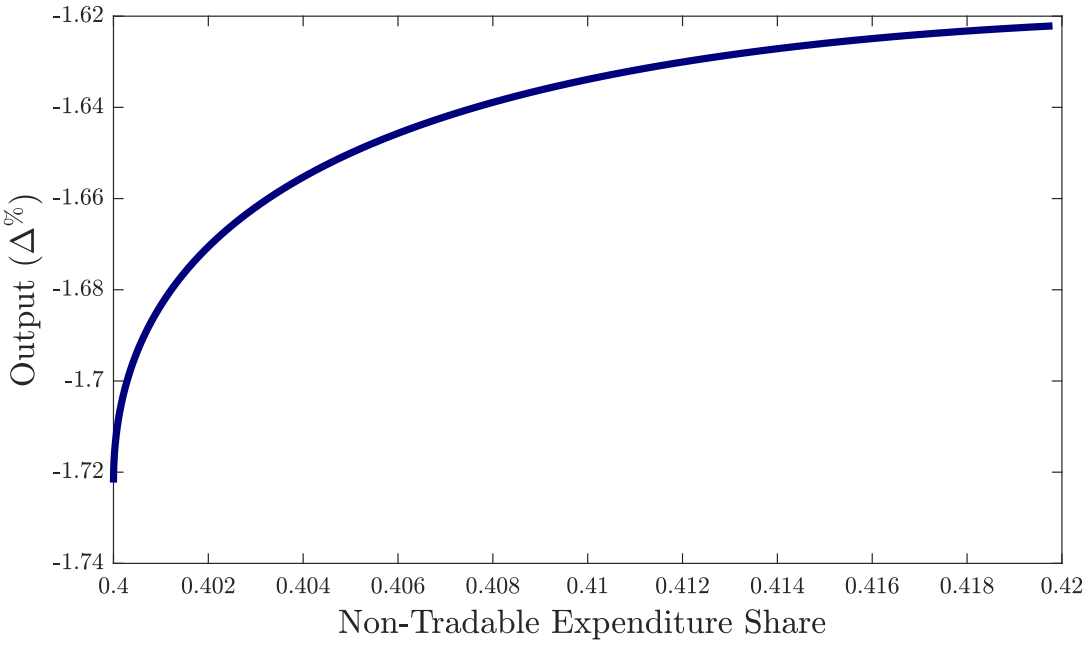


Figure 9: **Contractionary monetary policy in union of identical countries. Effect on total output, as function of the stationary-allocation non-tradable share of expenditure.** The monetary policy shock amounts to a one-period increase in the nominal interest rate from 1%*to*2%.

Analytical Result 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:*

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

Analytical Result 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:*

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

These results on the heterogeneous impact of monetary policy on output and the trade balance align with our empirical findings. In Section 2, we show that countries with a low share of expenditure on non-tradable goods increase their trade balance following a contractionary monetary policy shock. This behavior is consistent with the model, where equal countries allocating a low share of expenditure to non-tradable goods exhibit similar responses. Additionally, the model attributes cross-country differences in total output responses to variations in non-tradable output, while tradable output behaves similarly

across countries. This prediction matches our empirical evidence, which highlights significant heterogeneity in non-tradable output responses to monetary policy shocks, but not in tradable output responses.

We now detail the economic forces underlying these results. To derive analytical results for this monetary union with heterogeneous countries, we assume $\gamma = 0$. We demonstrate numerically that these results hold across a wide range of γ values.

Two key endogenous variables characterize the equilibrium of the monetary union with heterogeneous countries: the price of the tradable good and the distribution of external positions across countries.[20] The values of these variables at $t = 1$, when the monetary policy shock occurs, play a crucial role. From $t = 2$ onward, in the absence of further monetary policy shocks, the central bank's inflation target determines the price of the tradable good. Similarly, the trade balance in later periods primarily reflects its value in the initial period. In the stationary allocation from $t = 2$ onward, all countries have a zero current account, so the trade balance equals the interest payments received or paid on external assets.

The initial-period price of the tradable good in the monetary union falls between the two prices that would emerge in the closed-economy equilibria of the two countries, as the following lemma establishes.

Lemma 6. *In a monetary union of heterogeneous countries, the equilibrium price of the tradable good 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:*

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

We now outline our strategy to characterize the response of the price of the tradable good and countries' external positions to the initial-period monetary policy shock. First, we characterize the tradable consumption of Ricardian households in each country, for both the initial and subsequent periods, in two simplified static equilibria. In these equilibria, tradable consumption is a function of the tradable good prices and of assets chosen in the initial period.

The initial-period static equilibrium simplifies the small open economy Equilibrium 1, treating external assets, $b_{k,2}$, as given and focusing solely on variables at $t = 1$. In subsequent periods ($t \geq 2$), nominal rigidities are absent, meaning nominal variables are irrelevant for quantities. External assets remain constant at $b_{k,2}$, given the constant real interest rate $R = 1/\beta$. In these equilibria, tradable consumption by Ricardian households at $t = 1$ and $t = 2$ depends on the price of the tradable good and external assets: $c^T_{R,t,k}\left(b_{k,2}, P^T_t\right)$.

[20] External positions can be represented by either countries' external assets or their trade balances.

Initial-period consumption decreases with external assets, while consumption in the second period and beyond increases with them.

In the initial period, a rise in the price of tradable goods relaxes nominal wage rigidities, boosting tradable output. This higher output raises household income, leading to higher non-tradable consumption and output, which in turn further raises income and non-tradable consumption. This higher income ultimately results in higher tradable consumption for Ricardian households, in the parameter range we consider.[21]

From the second period onward, quantities are independent of nominal variables, including Ricardian tradable consumption. Thus, without loss of generality, we set the price of tradable goods from $t = 2$ onward to equal the initial-period price augmented by the central bank's inflation target: $P_2^T = \bar{\Pi} P_1^T$, as tradable inflation equals overall inflation and the target of the central bank when $\gamma = 0$.

Second, we define the Euler equation error associated with a given pair of external assets and tradable good price, $\left(b_{k,2}, P_1^T\right)$. The consumption levels we characterize in the simplified static equilibria generally do not satisfy the Euler equation for tradables (10), resulting in an Euler equation error:

$$EulerErr_k\left(b_k, P_1^T\right) = \beta R_1^M - \frac{c_{R,2,k}^T\left(b_k, \bar{\Pi} P_1^T\right)}{c_{R,1,k}^T\left(b_k, P_1^T\right)}.$$

This error increases with the price of tradables and decreases with the level of external assets.

Third, we implicitly define the level of external assets $b_k\left(P_1^T\right)$ that corresponds to a zero Euler equation error for a given initial-period tradable price:

$$EulerErr_k\left(b_k\left(P_1^T\right), P_1^T\right) = 0.$$

The implicit function $b_k\left(P_1^T\right)$ increases with the price of tradables, as the Euler equation error increases in the price of tradables and decreases with the level of external assets. Importantly, this function equals zero at the initial-period tradable price consistent with the closed-economy equilibrium: $b_k\left(P_{1,k,CE}^T\right) = 0$. In a closed economy, the tradable price that clears the market in the unequal country is higher than in the equal country. At the closed-economy price of the unequal country, the total assets accumulated by the two groups of countries are positive because $b_{Un}\left(P_{1,Un,CE}^T\right) = 0$ and $b_{Eq}\left(P_{1,Un,CE}^T\right) > 0$. Conversely, at the closed-economy price of the equal country, total assets are negative, as $b_{Un}\left(P_{1,Eq,CE}^T\right) < 0$ and $b_{Eq}\left(P_{1,Eq,CE}^T\right) = 0$. Figure 10 illustrates this function for the two

[21] Appendix B.4 details this parametrization. With non-homothetic preferences, higher income may reduce the tradable expenditure share and, in some cases, tradable consumption. We focus on a parametrization where both goods are normal, so that higher income increases consumption of both goods.

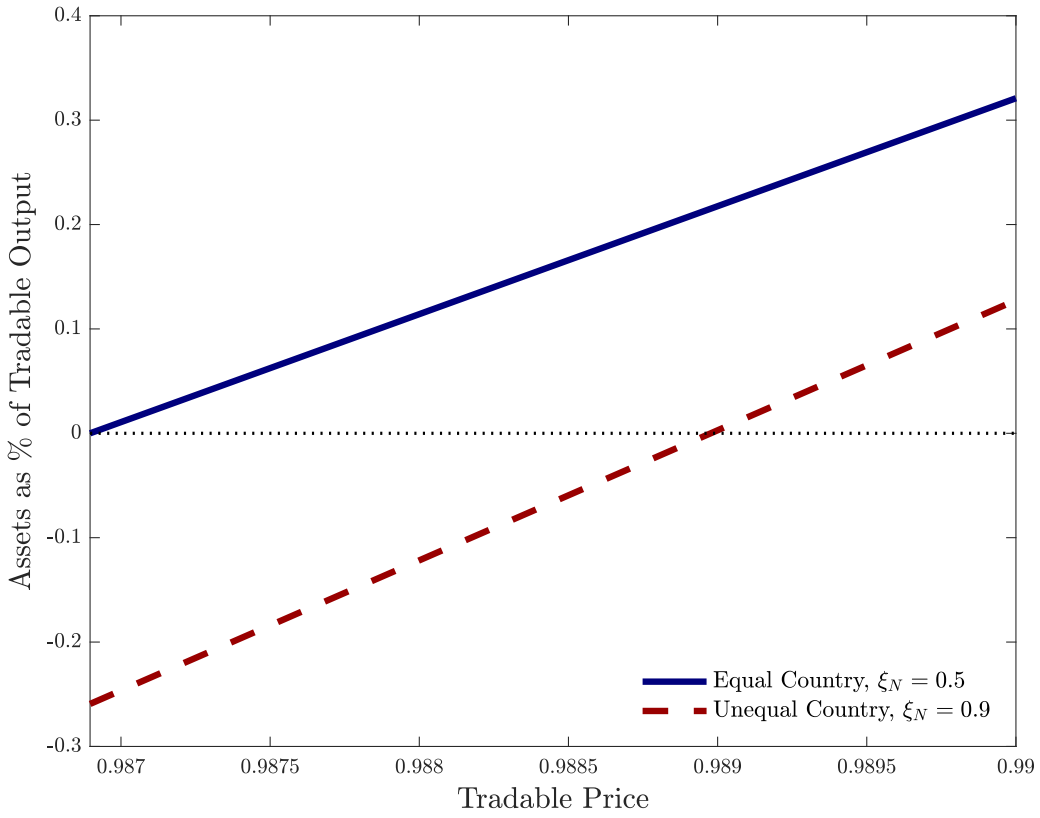


Figure 10: **Asset purchases consistent with zero Euler Equation error, as function of tradable good price.** The figure displays the level of external assets that corresponds to a zero Euler equation error for a given initial-period tradable price. The function equals zero at the initial-period tradable price consistent with the closed-economy equilibrium.

countries.

Fourth, for the asset market to clear in the monetary union, the sum of assets purchased by the two groups of countries must equal zero:

$$b_{Un}\left(P_1^T\right) + b_{Eq}\left(P_1^T\right) = 0.$$

Since both functions are monotonically increasing, their sum is also increasing. Furthermore, the sum of assets is negative at the low price of tradables that corresponds to the closed-economy equilibrium in the equal countries, and positive at the high price of tradables that corresponds to the closed-economy equilibrium in the unequal countries. Therefore, the sum of assets must cross zero at some point, implying that the equilibrium price of tradables in the monetary union lies between the two equilibrium prices of the closed economies.

The above results are sufficient to establish Analytical Result 4. The equilibrium of the monetary union entails a positive amount of liabilities issued by the unequal countries, whose closed-economy equilibrium price is higher, and a positive amount of assets purchased by the equal countries, whose closed-economy equilibrium price is lower. Con-

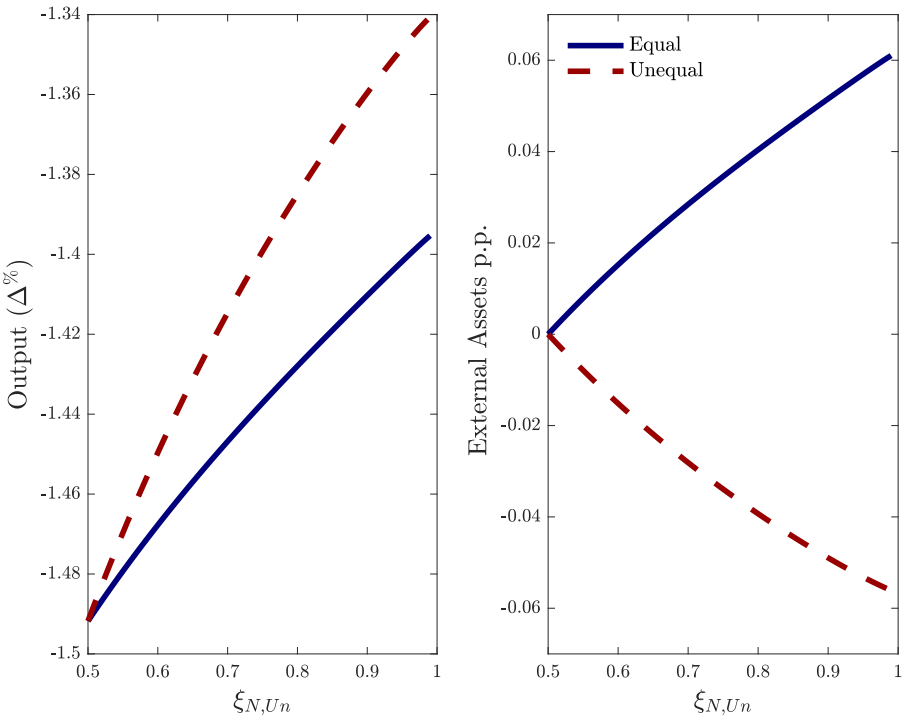


Figure 11: **Contractionary monetary policy in union of heterogenous countries. Effects of monetary policy shock on total output and trade balance.** Effects for Equal and Unequal countries are displayed as function of the share of non-tradable sector output accruing to the Ricardian household in the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

sequently, unequal countries run a trade deficit, while equal countries run a trade surplus upon the contractionary monetary policy shock.

Analytical Result 3 closely relates to Lemma 6. The common price of tradables in the monetary union results in an identical decline in tradable output across countries. However, total tradable consumption declines less in the unequal countries, as they run a trade deficit in response to the contractionary shock. This milder decline in tradable consumption reduces the contraction in non-tradable consumption in the unequal countries, leading to a smaller decline in non-tradable output. Consequently, total output falls by less in the unequal countries compared to the equal countries, as stated in Analytical Result 3. Figure 11 graphically illustrates the decline in total output experienced by the two groups of countries and the widening of trade imbalances in the monetary union as a function of the severity of inequality in the unequal countries, measured by the share of output in the non-tradable sector accruing to the Ricardian household, $\xi_{N,Un}$.

4.3 Empirical Validation and Sensitivity Analysis

We discuss in this section the sensitivity of our model results and their empirical validity by conducting three main exercises. First, we analyze the sensitivity of our results on the

effects of monetary policy across countries with different income distributions to a range of alternative modeling assumptions. Second, we analyze the empirical relevance of our key model hypothesis that international differences in income inequality are driven by greater shares of non-tradable sector output accruing to Ricardian households in unequal countries. Third, we perform extensive robustness checks and extensions to the three key empirical facts discussed in Section 2.

4.3.1 Sensitivity of Model Results to Assumptions

We analyze the sensitivity of our model results by studying the role of the elasticity of substitution between tradable and non-tradable goods and numerically illustrate the homogeneous impact of a contractionary monetary policy shock under homothetic preferences. We also explore the implications of alternative assumptions about cross-country differences in income distribution, and we consider the potential effects of extending the model to consider a continuum of heterogeneous households.

The elasticity of substitution between tradable and non-tradable goods significantly influences how market incompleteness and non-homotheticity dampen the effects of monetary policy on output. Figure 13 shows the output paths for equal and unequal countries in a monetary union under the assumption that $\gamma \neq \epsilon$, for various values of the elasticity of substitution. In all cases shown, the elasticity of substitution is lower than in the main benchmark case. The alternative cases considered are those for a unitary elasticity of substitution, for $\gamma = \epsilon = 0.18$, leading to an elasticity of substitution of 0.82 as in Boppart (2014), and an elasticity of substitution of 0.44, a value in the low end of the range of estimates reviewed by Akinci (2011).

When tradable and non-tradable goods are close substitutes (high γ), as in the benchmark setting, demand for non-tradable goods falls sharply in a recession, leading to a large contraction in the relative value of non-tradable output. By contrast, when tradable and non-tradable goods are less substitutable, demand for non-tradable goods declines less sharply during a recession, resulting in a smaller contraction in the relative value of non-tradable output. These milder fluctuations in the relative demand for non-tradable goods dampen the cyclicality of inequality and weaken the role of income distribution in shaping the effects of monetary policy on output.

As in the benchmark economy, a higher share of output from the non-tradable sector accruing to the Ricardian household mitigates the effects of a contractionary monetary policy shock. However, with lower elasticity, this mitigating effect is reduced. For sufficiently low elasticity of substitution (low γ), the decline in relative demand for non-tradable goods is so mild that the relative value of non-tradable output does not fall during a recession. In this case, a higher share of output from the non-tradable sector accruing to the Ricardian

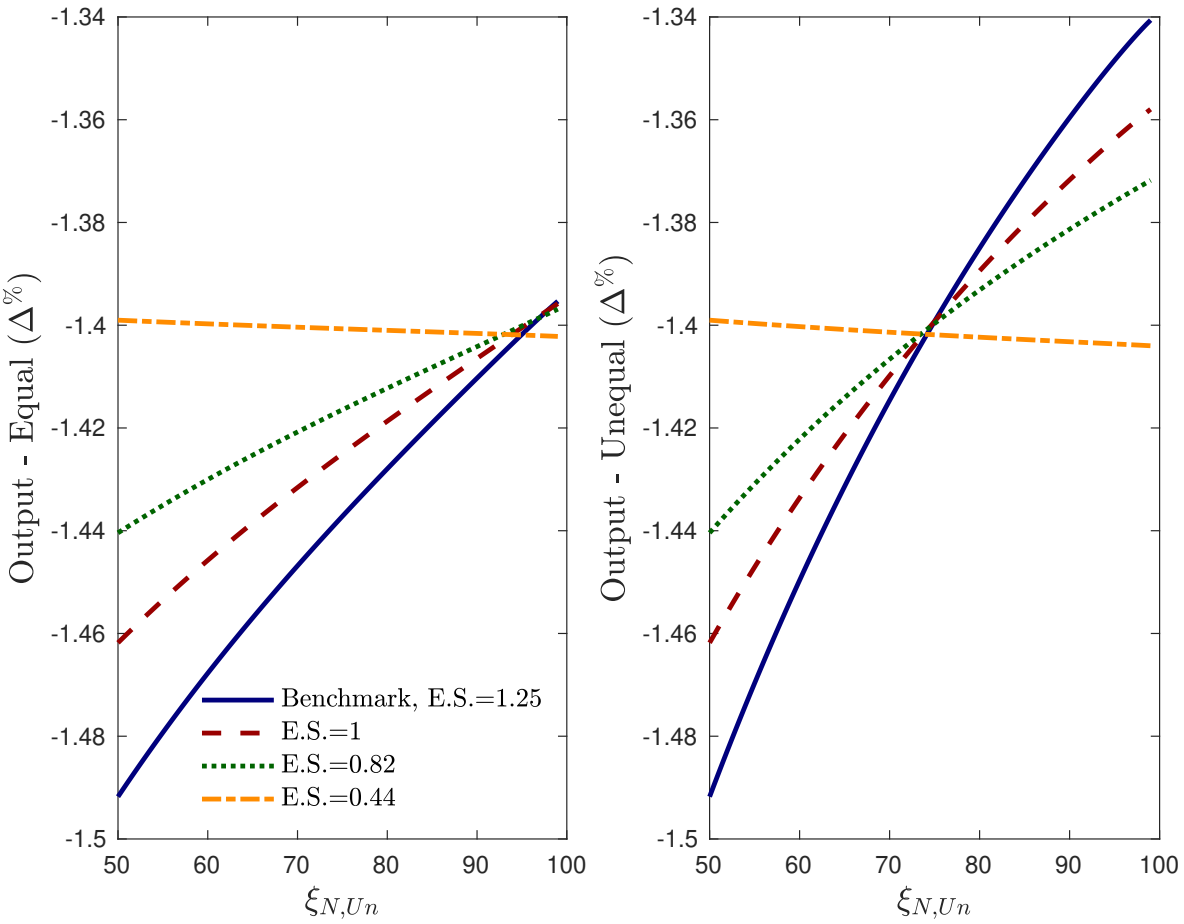


Figure 12: **Contractionary monetary policy in union of heterogenous countries. Alternative values for elasticity of substitution.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of non-tradable sector output accruing to the Ricardian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

household amplifies the effects of a contractionary monetary policy shock on output.

These results across various values of the elasticity of substitution between tradable and non-tradable goods confirm that our analytical findings are robust to alternative assumptions regarding this parameter, except for very low values.

A **higher degree of non-homotheticity in preferences** amplifies the effects of a monetary policy shock relative to our benchmark case, while also making the weakening of these effects in more unequal countries more pronounced.

Figure 13 illustrates these results by increasing the parameter governing non-homothetic preferences, setting $\epsilon = 0.22$ and keeping $\gamma = 0.18$.

First, in the setting with a higher degree of non-homotheticity, the same contractionary monetary policy shock generates a larger output contraction. A higher degree of non-homotheticity causes a larger drop in demand for non-tradable goods, which suffer from more severe nominal rigidities. This larger demand contraction leads to a greater decline

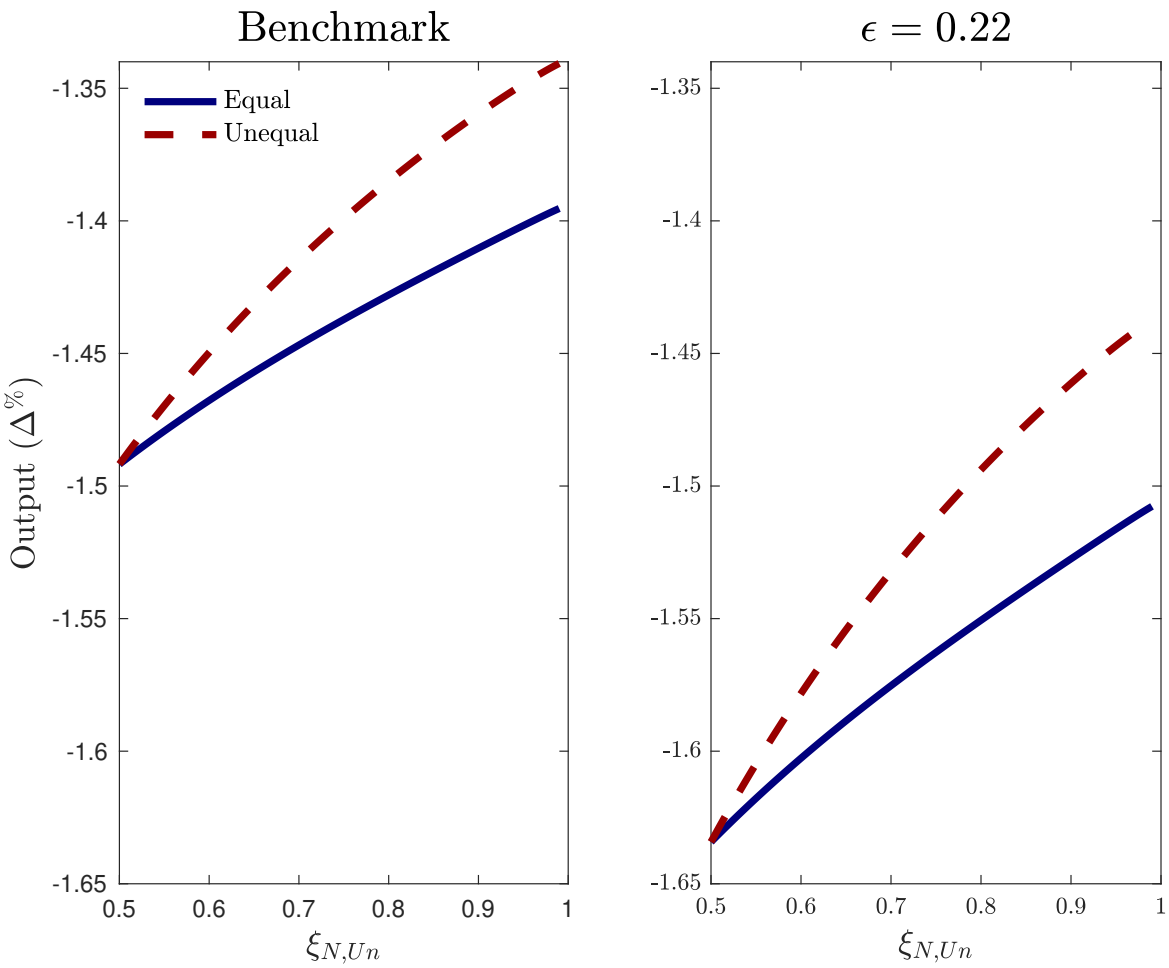


Figure 13: **Contractionary monetary policy in union of heterogenous countries. Higher degree of non-homotheticity.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of non-tradable sector output accruing to the Ricardian household in the Unequal countries ($\xi_{N,Un}$). 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%.

in non-tradable output and, consequently, total output.

Second, a higher degree of non-homotheticity widens the difference in the output decline between unequal and equal countries following a contractionary monetary policy shock. As a country becomes more unequal, the effects of monetary policy weaken. This weakening is stronger the higher is the degree of non-homotheticity, as the larger decline in non-tradable consumption amplifies the pro-cyclicality of income inequality, thus dampening the effects of monetary policy in unequal countries.

Alternative assumptions about the distribution of income across households in the two countries would change the implications of inequality for the effects of monetary policy.

First, we consider a setting where the two groups of countries in the union differ in terms of ξ_T, rather than ξ_N. As shown in Figure 14, under this assumption, the effects of monetary

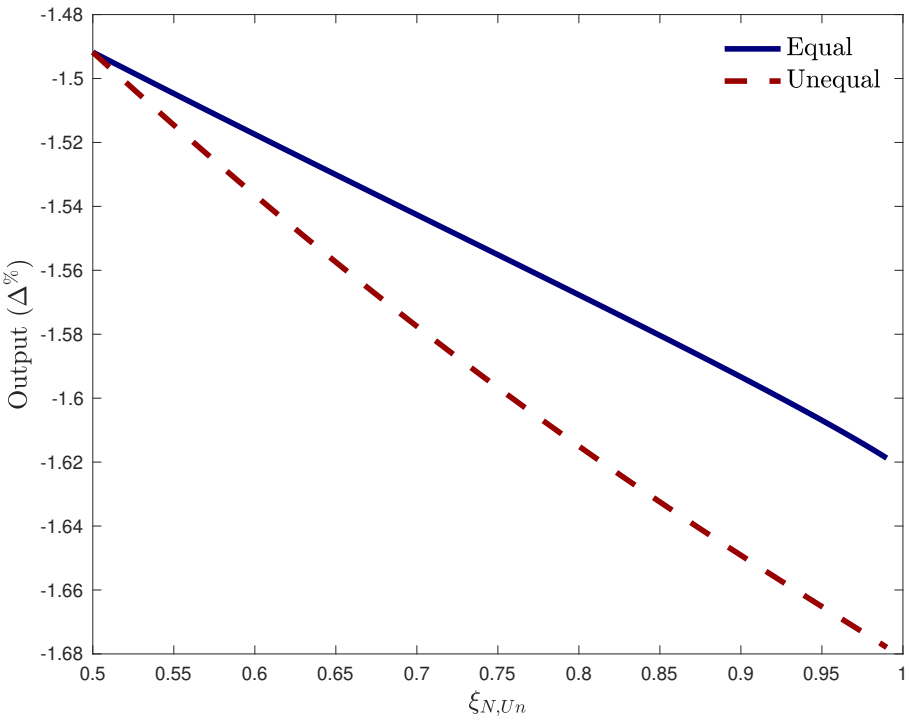


Figure 14: **Contractionary monetary policy in union of heterogenous countries. Inequality stemming from tradable sector.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of tradable sector output accruing to the Ricardian household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

policy on output are stronger, rather than milder, in the unequal group of countries. This result underscores the importance of the source of income inequality in generating the heterogeneous impact of monetary policy across countries, consistent with the empirical findings presented in Section 2.2. If differences in income inequality primarily arose from the distribution of income in the tradable sector, Ricardian households in unequal countries would experience milder fluctuations in income. Consequently, the contraction in their consumption would be smaller than the overall decline in aggregate consumption, leading to a sharper decline in output in unequal countries. Section 2.2 provides further empirical evidence in support of the assumption that differences in income inequality across countries arise from international differences in the distribution of income from the non-tradable sector.

Next, we consider a setting where, as in our baseline model, countries differ in the distribution of income from the non-tradable sector (ξ_N), but where income from the tradable sector is also unequally distributed across households ($\xi_T \neq 0.5$). Figure 15 shows that the results remain consistent with those of the baseline setting, reinforcing the crucial role of cross-country differences in the relative sensitivity of the two households' incomes to the business cycle, rather than the level of inequality *per se*.

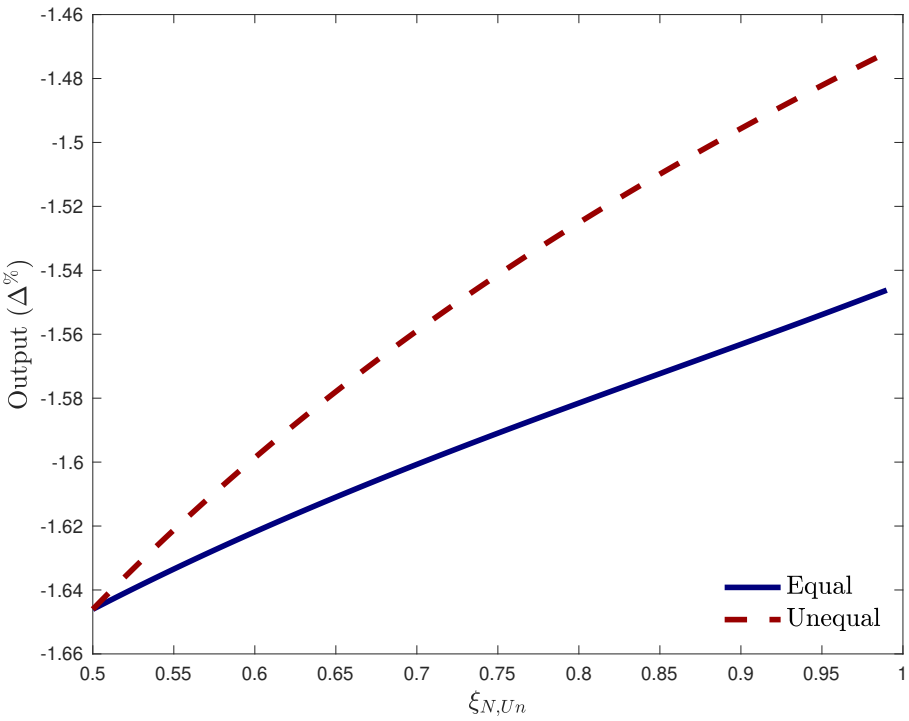


Figure 15: **Contractionary monetary policy in union of heterogenous countries. Inequality in both sectors.** Effects of monetary policy shock on total output in Equal and Unequal countries, displayed as function of the share of non-tradable sector output accruing to the Ricardian household in the Unequal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

Finally, **household heterogeneity** in the model is limited to a two-agent framework. While this setting is sufficiently rich to capture complex dynamics across heterogeneous households, sectors, and countries, extending the analysis to a continuum of ex-ante identical agents would be an interesting avenue for further study. In such a model, heterogeneous exposure to different productive sectors would emerge endogenously among households that differ in income, wealth, and sensitivity to monetary policy shocks. Empirically estimated income processes for the tradable and non-tradable sectors would generate differences in wealth accumulation and consumption-saving behavior for households employed in, or holding equity in, firms operating in these sectors. Cross-country differences in these processes would endogenize the income distributions analyzed here. Moreover, such differences would introduce cross-country heterogeneity in additional economic forces, including the strength of the precautionary saving motive. As a result, heterogeneity in the transmission of monetary policy would arise from a combination of of many forces, with the key mechanism highlighted here interacting with other dimensions of cross-country heterogeneity in this richer setting.

4.3.2 Robustness of Empirical Results

We run multiple extensions of the baseline local projection to assess additional channels that may be at play, and to evaluate the heterogeneous impact of monetary policy more broadly than just on real GDP. We discuss here the role of income inequality, hand-to-mouth households, government spending, durable goods, housing expenditure, and the effects of monetary policy shocks across countries on relative prices, the trade balance, consumption, and sectoral output. Appendix A.7 provides a detailed description of all these extensions.

Income inequality may affect the response of real GDP through various channels - in addition to the non-homothetic preferences channel that is the main focus of this paper. However, we find that controlling explicitly for income inequality does not alter the effect of the expenditure shares on the response of output to monetary policy shocks, as shown in Figure 19.

The share of hand-to-mouth households, which differs across countries, may impact on the response of output to shocks. We find that our baseline results are not significantly affected by controlling for differences in the share of hand-to-mouth households. We present these results in Figure 20, using estimates from Almgren et al. (2022) for the share of hand-to-mouth households.

Government services are part of non-tradable expenditure in our baseline estimation. Countries with high non-tradable expenditure shares might react by less to a monetary policy due to a high share of government services, which may be relatively unresponsive to monetary policy. We find no evidence for this channel, however, as shown in Figure 21.

Durable consumption is highly pro-cyclical and volatile. Durable goods are typically tradable.[22] Hence, the presence of durable goods may confound the interpretation of our empirical results. However, the point estimate of our key effect is practically unaffected by the inclusion of the share of durables in expenditure among control variables. The standard errors increase due to the inclusion of an additional variable, so that the significance of the estimates is lower.

Housing and non-tradable expenditure may correlate. Our empirical results might suffer from omitted variable bias if a higher housing expenditure share, rather than higher non-tradable share, dampens the effect of monetary policy shocks on output, and if the two are correlated. However, the data show no correlation between the housing and non-tradable expenditure shares. Figure 24 provides further details.

Tradable and non-tradable output may respond differently to monetary policy shocks

[22] Casalis and Krustev (2020) show that the volatility of durable expenditure in the euro area is sharper than that of non-durable consumption and of GDP. Berger and Vavra (2015) show similar evidence for the United States. Tradability of durables plays an important role in Engel and Wang (2011), Levchenko et al. (2010), Eaton et al. (2016).

across countries. We observe that, consistent with our findings on total output, non-tradable output contracts more sharply in countries with a low non-tradable expenditure share after a monetary policy shock. In contrast, in countries with a high non-tradable expenditure share, non-tradable output does not contract. Similarly, tradable output shows a sharper response in low non-tradable expenditure share countries, although the difference across the two groups is less pronounced. Figure 25 presents these results.

Consumption and real GDP react similarly to monetary policy shocks. Countries with high non-tradable expenditure share experience milder effects of monetary policy shocks on aggregate consumption. When disaggregating consumption by categories, we observe that consumption of durables, semi-durables, and services falls by less in countries with high non-tradable expenditure shares. Hence, households in countries with high non-tradable expenditure share reduce their consumption of both goods and services by less. Figure 26 shows the impulse response function of the monetary policy shock in countries with high and low non-tradable expenditure share for total consumption, durables, semi-durables, non-durables and services.

The trade balance responds differently to monetary policy shocks across countries. We observe that countries with low non-tradable expenditure share run a trade surplus in response to a contractionary monetary policy shock. Conversely, the trade balance mildly deteriorates in countries with high non-tradable expenditure share, but this deterioration is not always statistically significant. Figure 27 displays the results.

Tradable and non-tradable prices respond differently to monetary policy shocks. We find that non-tradable prices respond more slowly and weakly than tradable prices, as shown in Figure 28. This finding aligns with Gautier et al. (2024), who highlight stronger nominal rigidities in non-tradable sectors.

4.3.3 Sectoral Income Distribution and Inequality

A key hypothesis in our model is that differences across countries in income inequality arise from differences in sectoral income distribution, with Ricardian households earning more from the non-tradable sector in more unequal countries. To test this hypothesis, we study whether income inequality correlates systematically with sectoral income shares across households with different access to financial markets. We find that countries with higher inequality tend to have a larger non-tradable income share for Ricardian households compared to Hand-to-Mouth households.

To estimate this relationship, we proceed in three steps. First, we follow Almgren et al. (2022) in classifying households in the HFCS data as Ricardian and Hand-to-Mouth. A household is categorized as living hand-to-mouth if its liquid wealth is less than half of its monthly income, such that $0 \leq m_i \leq \frac{y_i}{2}$, where m_i represents liquid assets. Next, we

classify households as "tradable" or "non-tradable" based on the industry from which they derive their primary income.[23] Finally, we compute the share of income earned in each sector $s \in (N, T)$ by household type $j \in (R, H)$ in country k as follows:[24]

$$\eta_{k,s,j} = \frac{\sum_i y_{i,s,j,k}}{\sum_i \sum_j y_{i,s,j,k}}. \tag{25}$$

We define the difference in income shares generated in the non-tradable sector between Ricardian and Hand-to-Mouth households as:

$$\tilde{\eta}_k = \eta_{k,N,R} - \eta_{k,N,H}. \tag{26}$$

Using this measure of the difference in sectoral income shares across households, we estimate the relationship between aggregate income inequality and the composition of income across household types with the following regression:

$$\tilde{\eta_{k,t}} = \alpha + \gamma_t + \beta I_{k,t} + \epsilon_{k,t} \tag{27}$$

where $I_{k,t}$ denotes a measure of income inequality. Table 2 reports the results from the estimation, which indicate that higher income inequality is associated with a larger non-tradable income share for Ricardian households. Specifically, in countries where Ricardian households derive a greater share of income from the non-tradable sector compared to Hand-to-Mouth households, income inequality tends to be higher. Furthermore, we find that the non-tradable income share increases with income across all countries, as shown in Appendix A.3.

	Gini	p90p10	p75p25	p90p50
$\tilde{\eta_c}$	0.153*	8.863**	0.536	-0.261
	(-0.0712)	(-3.042)	(-0.33)	(-0.367)
N	46	46	46	46
adj. R-sq	0.097	0.215	0.183	0.015

Table 2: **Coefficient Estimates from Regression (27).** The table reports OLS estimates weighted by countries GDP and controlling for time fixed effects. The regression is based on an unbalanced panel of countries between wave 1, 2 and 3 of the HFCS dataset.

[23] Income is defined here as the sum of total salary, wages, and self-employment income. We categorize industries according to the NACE 2.0 classification.

[24] Note that we omit time subscripts for clarity.

5 Concluding Remarks

In this paper, we empirically established that euro-area countries with a larger share of non-tradable consumption expenditure exhibit smaller output responses to identified monetary policy shocks compared to those with smaller non-tradable consumption shares. Additionally, we document that in these countries, the consumption expenditure share increases with both country-level inequality and household-level income. We also show that in countries with greater inequality, households with better access to financial markets earn a larger share of their income from the non-tradable sector.

We rationalize these empirical findings using a heterogeneous-agent model with non-homothetic preferences over tradable and non-tradable consumption. The model generates a weaker impact of monetary policy shocks on output in countries with larger non-tradable expenditure shares, despite more severe nominal rigidities in this sector. The combination of non-homothetic preferences and market incompleteness is critical to this result. Procyclical inequality, driven by Ricardian households' exposure to the volatile non-tradable sector, weakens the indirect effects of monetary policy, resulting in a milder overall impact on output.

In future work, we plan to use this framework to study optimal monetary policy in a currency union. Additionally, we aim to extend the model to incorporate a richer treatment of inequality, where households' sectoral exposures arise endogenously.

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A Appendix - Empirical Analysis

A.1 Non-tradable consumption shares by income and country

Figure 2 shows the average 2000-2020 non-tradable 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 non-tradables increases with income revealing non-homothetic preferences. Table 3 further summarizes the graph showing the slope of the linear fit as well as the average disposable income and non-tradable expenditure share for each country.

Country	Slope	Disposable Income	NT 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 3: **Summary statistics on countries income and consumption.** The slope corresponds to the linear fit of the non-tradable expenditure share on the level of disposable income at every income quintile.

A.2 Inequality and Consumption Baskets

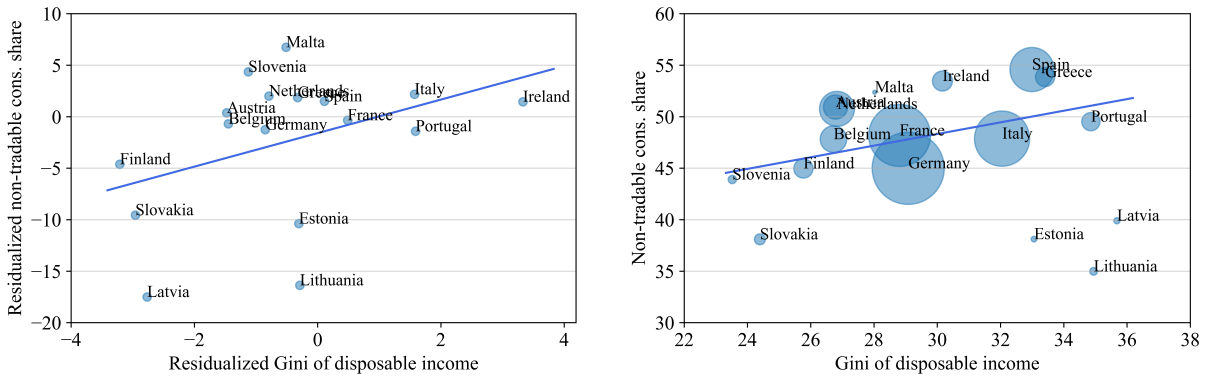
We show that non-tradable expenditure share increase with income inequality at the country level. Table 4 shows the regression results of the following specification:

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

where ω_k is the average 2000-2020 non-tradable 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 unwneighted regression as well as the regression excluding controls.

	NT 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 4: **Regression table of equation 2.** 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 non-tradable 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 non-tradable sectors increases with the income level. We then further discriminate between ricardian and hand-to-mouth households to pin down the diference 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 vs hand-to-mouth based on their wealth-income composition.

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

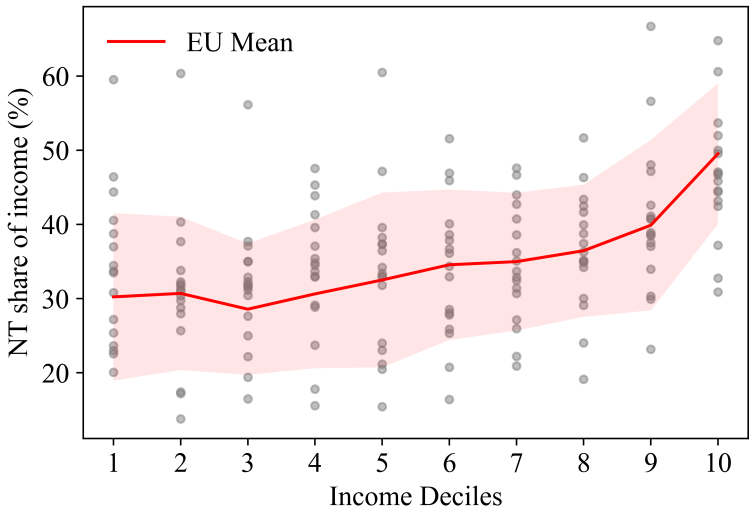


Figure 17: **Non-tradable income shares by decile.** This graphs shows the non-tradable share of income by income decile across EU members and on average. The red shaded area represents one standard deviation.

A.4 COICOP consumption classification

Table 5 lists all three-digit COICOP consumption categories in the household budget survey and their classification by tradability.

COICOP		Name	Tradable
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 5: Tradability of COICOP categories

A.5 NACE Rv.2 classification

Table 6 lists all two-digit NACE categories and their classification by tradability.

Non-tradables	Tradables	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		

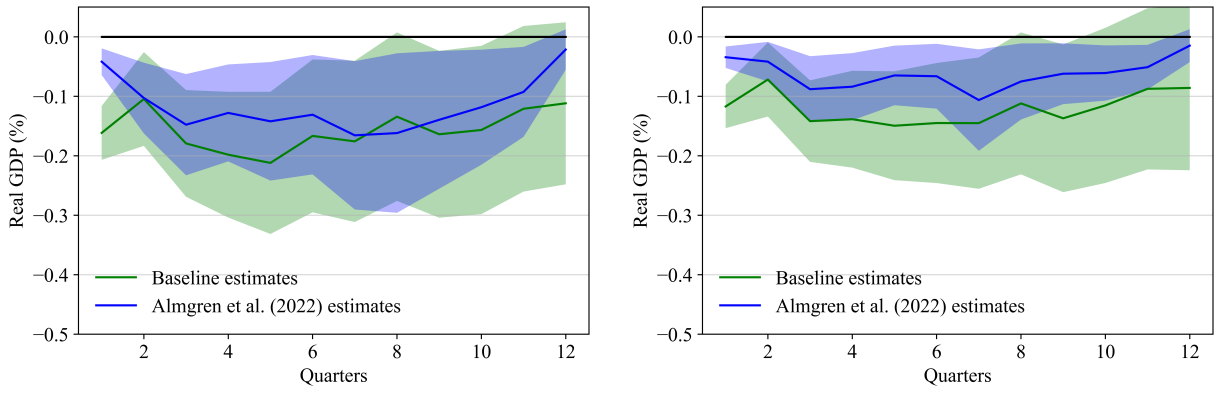
Table 6: Tradability of NACE categories

A.6 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:

$$y_{t+h,k} - y_{t-1,k} = \alpha + \beta^h i_t + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,k} + u_{t+h,k}. \tag{28}$$

Figure 18 plots our estimates relative 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.



(a) Germany

(b) Netherlands

Figure 18: **Impulse response functions for individual countries.**

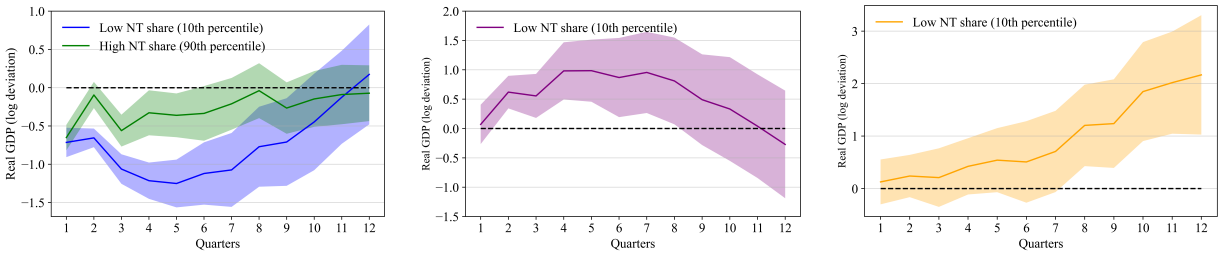
A.7 Empirical Extensions

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 non-tradable 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:

$$y_{t+h,k} - y_{t-1,k} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_k) + \lambda^h (i_t * \overline{Gini}_k) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,k} + \phi_k + u_{t+h,k}. \quad (29)$$

Figure 19 presents the IRFs for countries of different non-tradable consumption share 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 non-tradable 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) Non-tradable share (b) Gamma Difference (c) Lambda Difference

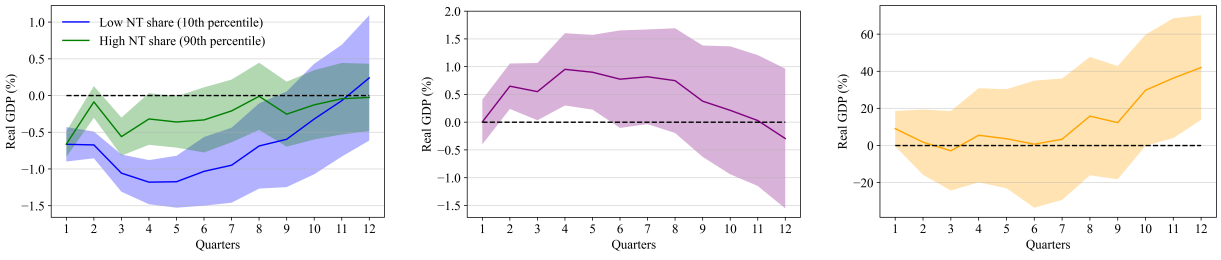
Figure 19: **Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares controlling for income inequality.** In graph a), the low non-tradable (N) share line is based on the 10th percentile of non-tradable shares in the sample and the high non-tradable 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 is considered to play 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:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_c) + \lambda^h (i_t * HtM_c) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c}. \quad (30)$$

Figure 20 presents the IRFs for countries of different non-tradable 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.



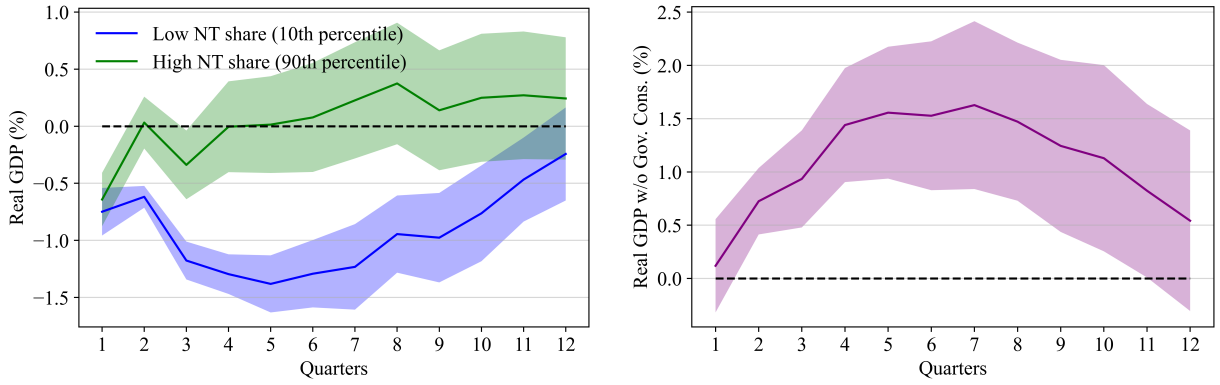
(a) Non-tradable share (b) Gamma Difference (c) Lambda Difference

Figure 20: **Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares controlling for the share of HtM agents.** In graph a), the low non-tradable (N) share line is based on the 10th percentile of non-tradable shares in the sample and the high non-tradable 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 non-tradable expenditure share in our baseline estimation. One potential reason countries with high non-tradable 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 non-tradable expenditure shares, however, we do not find evidence for this channel as shown in Figure 21. The corresponding specification is as follows:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t * \tilde{\omega}_c) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c}. \quad (31)$$

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

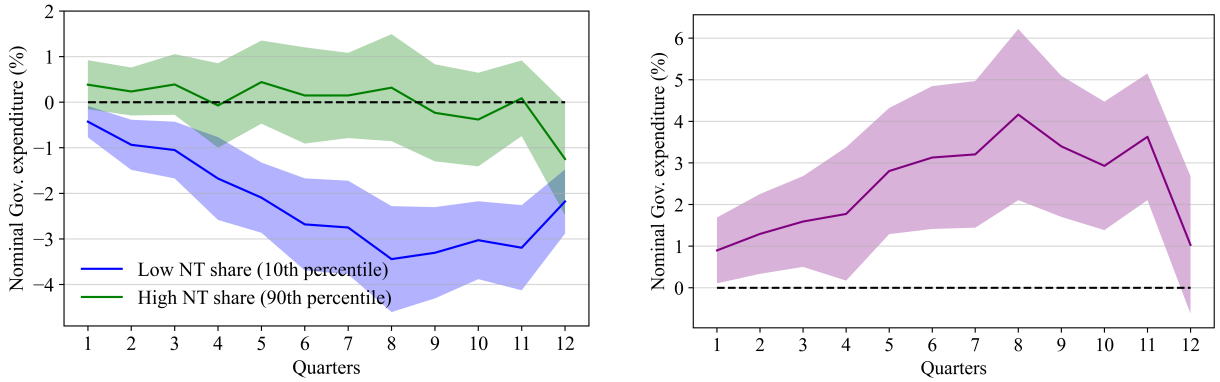


(a) Expenditures shares shares excl. public services

(b) Difference

Figure 21: **Impulse response functions**

Government expenditure responses are shown in Figure 22. shows the difference in responses of nominal government expenditure across countries with high and low non-tradable expenditure shares.



(a) High and low non-tradable share

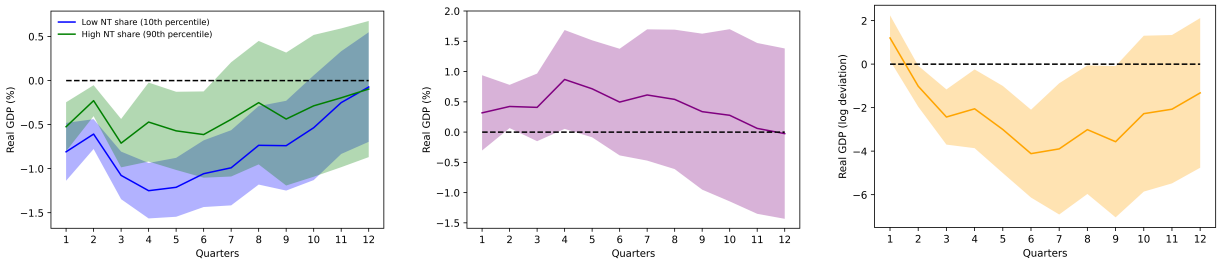
(b) Difference

Figure 22: **Impulse response functions of nominal government expenditure to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares.** In graph a), the low non-tradable (NT) share line is based on the 10th percentile of non-tradable shares in the sample and the high non-tradable 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:

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_c) + \lambda (i_t * \bar{\omega}_{durable}) \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c} \quad (32)$$

where we define $\omega_{durable}$ as the average 2000-2020 share of durable goods. The impulse response functions are plotted in Figure 23. High consumption of durable goods amplify the monetary policy shock. However, the sign and shape of the interaction terms between non-tradable expenditure share and monetary policy shock is almost unchanged.



(a) Non-durables vs durables (b) Gamma difference (c) Lambda difference

Figure 23: **Non-durables vs durables**

Relationship between non-tradable expenditure and housing expenditure shares When computing the non-tradable 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 yer fixed effects and σ corresponds to the housing expenditure shares for country k. Figure 24 shows the linear fit in a binned scatter plot. There is no significant relationship between our measure of non-tradable expenditure shares and housing expenditure shares.

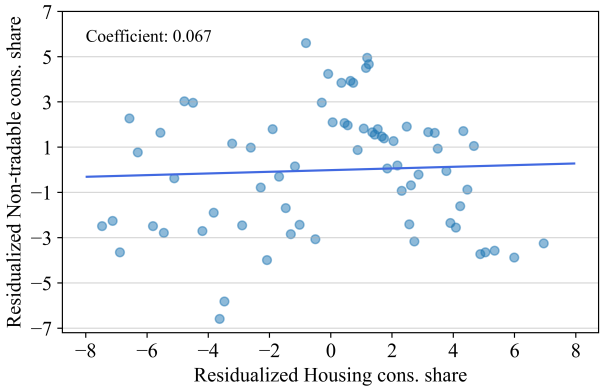


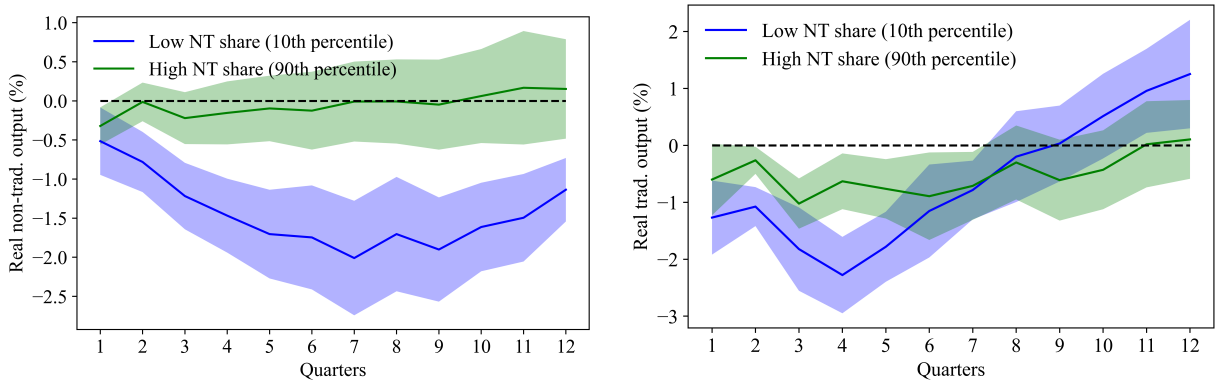
Figure 24: **Non-tradable vs housing expenditure shares.**

Tradable and non-tradable output. We estimate the following local projection:

$$y^{\iota}_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_c) + \sum_{s=1}^{p} \Gamma^h_s y^{\iota}_{t-s,c} + \phi_k + u_{t+h,c} \tag{33}$$

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

Figure 25 shows the impulse responses function deriving from equation (33). The reaction of non-tradable output to a monetary policy shock depends substantially on non-tradable expenditure share. Countries with high-non tradable expenditure share non-tradable output and do not react much to a monetary policy shock, while non-tradable output contracts substantially in countries with low non-tradable expenditure share. Instead, tradable output reacts more similarly to a monetary policy shock in countries with different non-tradable expenditure share.



(a) Non-tradable output

(b) Tradable Output

Figure 25: **Impulse response functions of tradable and non tradable output to a contractionary monetary policy shock of one standard deviation.**

Consumption by sector. Figure 26 shows the difference in consumption responses across sectors for countries with high and low non-tradable expenditure shares. The graphs reveal two key findings. First, total consumption resembles output, with weaker responses in countries with higher non-tradable 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 non-tradable consumption shares, the difference is smaller for semi-durable goods and becomes insignificant for services (i.e. non-tradable).

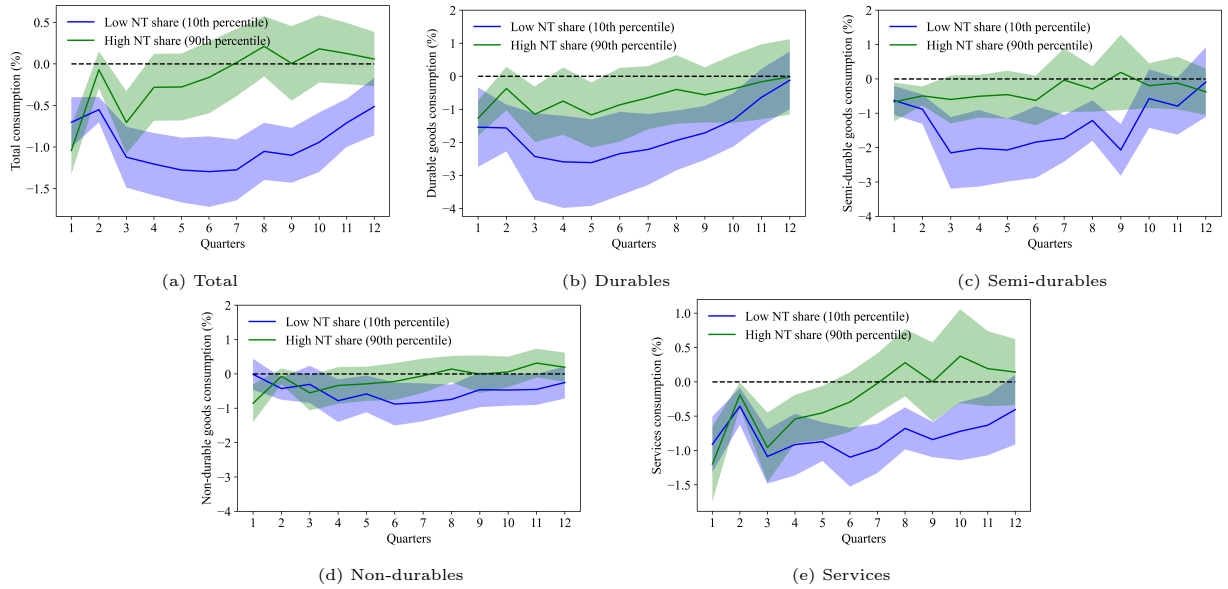
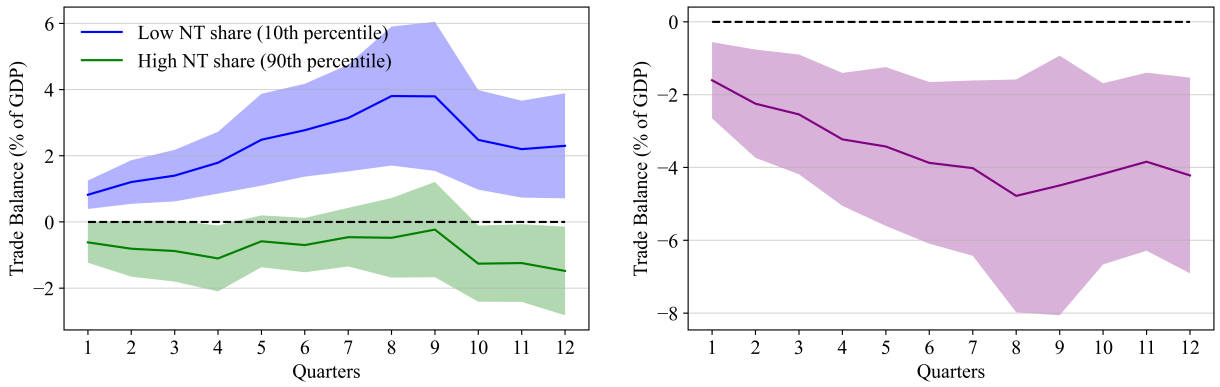


Figure 26: **Impulse response functions of real consumption by sector to a contractionary monetary policy shock of one standard deviation.**

The Trade Balance (% of GDP) reacts different for the two groups of states as shown in Figure 27. 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:

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

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-tradabable expenditure share $\bar{\omega}_c$. Countries with relatively low non-tradable consumption shares experience a larger increase in the trade balance than countries with high non-tradable 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 non-tradable consumption share as low as the 10th percentile of non-tradable consumption shares in the sample.



(a) High and low non-tradable share

(b) Difference

Figure 27: **Cumulative impulse response functions**

Tradable and non-tradable prices are important determinants of responses to monetary policy shocks. In particular, we find that non-tradable prices react slower and weaker than tradable prices. This finding is in line with *(reference here)* highlighting the stronger nominal rigidities in non-tradable sectors. Figure 28 shows the differences in responses of non-tradable and tradable price indices to a contractionary monetary policy shock. The IRFs are constructed from the following local projection exercise

$$y_{t+h,c} - y_{t-1,c} = \alpha + \beta^h i_t + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,c} + \phi_k + u_{t+h,c} \tag{34}$$

where the left-hand side is the deviation in the price index (2015=100) from its initial value. The graphs reveal that in line with existing empirical research (e.g. Uribe Schmitt-Grohe) tradable prices are more flexible in response to shocks. While tradable prices adjustment downward immediately, non-tradable prices show a significant adjustment only after 4 and 8 quarters.[25]

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

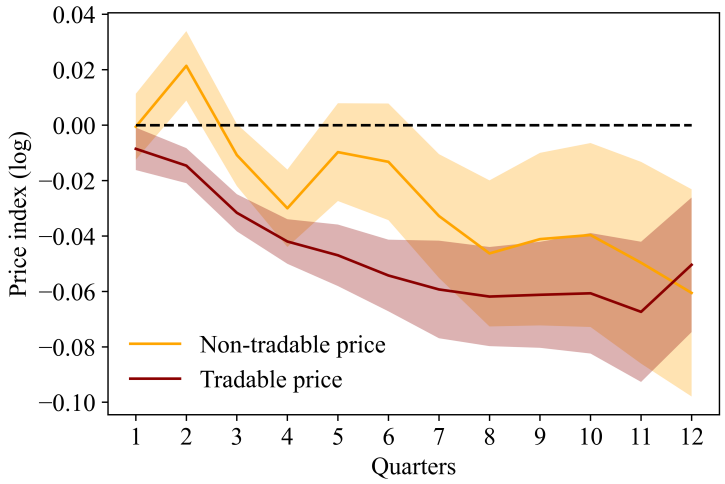


Figure 28: **Impulse response of log tradable, and non-tradable price indices.**

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 goods $P_t^N = P^N$ and $P_t^T = P^T$, 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 housheold in the stationary allocation.

The stationary-allocation expenditure by the Ricardian household thus equals

$$e_R = W_R l_R + \Psi_R + (R-1)B_R \tag{35}$$

and for the Hand-to-Mouth:

$$e_H = W_H l_H + \Psi_H \tag{36}$$

From firms' demand for labor and allocation of profits across the two households, incomes of the two agents are given by $W_R l_R + \Psi_R = \xi_N y^N + \xi_T y^T$ and $W_H l_H + \Psi_H = (1-\xi_N)y^N + (1-\xi_T)y^T$. Hence, expenditure of the two households writes as:

$$e_R = \xi_N y^N + \xi_T y^T + (R-1)B_R, \text{ and } e_H = (1-\xi_N)y^N + (1-\xi_T)y^T. \tag{37}$$

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 (8) and (7). The aggregate demand for nontradables is

given by the sum of the two households' demand, as follows:

$$y^N = c_H^N + c_R^N = e_H \omega_H^N + e_R \omega_R^N \tag{38}$$

which yields:

$$y^N = (y^T - TB)\frac{P^T}{P^N}\frac{\left[\omega_H^N(1-\xi_T) + \omega_R^N(\xi_T)\right]}{\left[1 - \omega_H^N(1-\xi_N) - \omega_R^N(\xi_N)\right]}. \tag{39}$$

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

$$\frac{l_H^N}{l_H^T} = \frac{\alpha_N}{\alpha_T}\frac{1-\xi_N}{1-\xi_T} \equiv x_H^N \frac{P^N y^N}{P^T y^T} \text{ and } \frac{l_R^N}{l_R^T} = \frac{\alpha_N}{\alpha_T}\frac{\xi_N}{\xi_T}\frac{P^N y^N}{P^T y^T} \equiv x_R^N. \tag{40}$$

Hence, labor input in the two sectors satisfies

$$l_H^N = \frac{x_H^N}{1+x_H^N} l_H, \text{ and } l_R^N = \frac{x_R^N}{1+x_R^N} l_R, l_H^T = \frac{1}{1+x_H^N} l_H, \text{ and } l_R^T = \frac{1}{1+x_R^N} l_R. \tag{41}$$

B.2 Pro-Cyclical Relative Value of Non-Tradable Output

We show in this appendix that the relative value of non-tradable 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 T good. To do so, note that total T-output can be written as, omitting time-subscripts:

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

In turn, expenditure of the two households writes as:

$$e_R = \xi_N P^N y^N + \xi_T P^T y^T \text{ and } (1-\xi_N) P^N y^N + (1-\xi_T) P^T y^T.$$

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

$$\frac{P^N y^N}{P^T y^T} = \frac{1 - \omega_R^T \xi_T - \omega_H^T (1-\xi_T)}{\omega_R^T \xi_N + \omega_H^T (1-\xi_N)}.$$

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 the tradable good, i.e. $\omega_{j,1}^T > \omega_{j,2}^T$ for $j \in \{H, R\}$. As the expression for the relative value of output is decreasing in the two tradable expenditure shares, an aggregate contraction leads to a reduction in the relative value of non-tradable output, and vice-versa.

B.3 Effects of Monetary Policy on Total Output, Tradable Price and Non-Tradable Output

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

$$P_1^T = \frac{\bar{W}^T}{\alpha_T} \left(y_1^T\right)^{\frac{1-\alpha_T}{\alpha_T}} \tag{42}$$

Second, consider the impact of monetary policy on output of non-tradable good. Under Cobb-Douglas preferences, the fall in N-output is proportional to the fall in the value of T-output and given by:

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

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

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

$$y_1^N = \zeta(P_1^T y_1^T, y_1^N) \frac{P_1^T y_1^T}{P_1^N}, \tag{43}$$

where $\zeta(P_1^T Y_1^T, Y_1^N) = \frac{P_{N,1} y_{N,1}}{P_{T,1} y_{T,1}}$ is a shifter that reflects the country's preference for non-tradable goods. This shifter is procyclical under the conditions stated in Analytical Result 1, as Appendix B.2 shows. Thus, non-tradable 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 N and therefore on total output.

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

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

$$c_{R,1}^T = \left(\xi_T y_1^T + \xi_N \frac{P_t^N}{P_t^T} y_1^N - b_{R,2}\right)^{(1-\epsilon)} (P_1^T)^{-\epsilon}. \tag{44}$$

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

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

$$c_{R,1}^T = \left(\left(\xi_T + \xi_N \frac{1-\nu}{\nu}\right) y_1^T - \left(1 + \xi_N \frac{1-\nu}{\nu}\right) b_{R,2}\right)^{(1-\epsilon)} (P_1^T)^{-\epsilon}. \tag{45}$$

Finally, we can use (42) to write the tradable output as a function of the prices of tradable goods:

$$y_1^T = \left(\frac{\alpha_T P_1^T}{W_1^T}\right)^{\frac{\alpha_T}{1-\alpha_T}}, \tag{46}$$

and plug in (45):

$$c_{R,1}^T = \left(\left(\xi_T + \xi_N \frac{1-\nu}{\nu}\right) \left(\frac{\alpha_T P_1^T}{W_1^T}\right)^{\frac{\alpha_T}{1-\alpha_T}} - \left(1 + \xi_N \frac{1-\nu}{\nu}\right) b_{R,2}\right)^{(1-\epsilon)} (P_1^T)^{-\epsilon}. \tag{47}$$

Ricardian consumption of tradable goods is a function of tradable prices: if the price of tradable goods increases, tradable output increases too. Higher tradable prices also increase consumption and output of non-tradable goods. Thus, the income and consumption of Ricardian household would increase,too. However, as expenditure increases, the Ricardian household reduces the tradable share of its expenditure, in additional to the conventional substitution effect. Therefore, higher tradable prices can also reduce tradable consumption.

Differentiating $c_{R,1}^T$ with respect to P_1^T, for a given value of $b_{R,2}$ we obtain:

$$\frac{dc_{R,1}^T}{dP_1^T} = \frac{(1-\epsilon)\frac{\alpha_T}{1-\alpha_T}\left(\xi_T + \xi_N \frac{1-\nu}{\nu}\right)\frac{y_1^T}{P_1^T}}{\left(\xi_T + \xi_N \frac{1-\nu}{\nu}\right) y_1^T - \left(1 + \xi_N \frac{1-\nu}{\nu}\right) b_{R,2}} - \frac{\epsilon}{P_1^T} > 0. \tag{48}$$

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

$$-\frac{b_{R,2}}{y_1^T} > \frac{\alpha - \epsilon}{\epsilon(1-\alpha)} \frac{\xi_T + \xi_N \frac{1-\nu}{\nu}}{1 + \xi_N \frac{1-\nu}{\nu}}. \tag{49}$$

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