Inequality, Demand Composition, and the Transmission of Monetary Policy

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Abstract

We argue that demand composition between tradable and non-tradeable goods and services affects monetary policy transmission in a monetary union. We document at the micro level that within Eurozone countries richer households allocate a greater share of their consumption basket to non-tradables. At the aggregate level, we show that in countries with greater income inequality, non-tradable goods account for a larger share of total consumption. Finally, we show that output responses to identified monetary policy shocks are larger for economies with lower non-tradable consumption shares. We rationalize our micro and macro findings using a two-country heterogeneous-agent model with non-homothetic preferences. We then study the implications for optimal stabilization policy in a currency union.

1 Introduction

As the Eurozone continues to expand in membership, the member states become more heterogeneous, both in terms of the levels of income per capita and household income inequality. How does the presence of both across- and within-country heterogeneity affect the efficacy and transmission of monetary policy within a currency union? In this paper, we seek to answer this question, both empirically using micro and macro data across Eurozone countries and within the context of a quantitative model of a currency union.

We begin by investigating the composition of household consumption in different countries, with a focus on the distinction between tradable and non-tradable goods. The research questions center around understanding the differences in consumption behavior across households of varying income levels and across countries with varying levels of income inequality and per capita income. In particular, we examine the extent to which higher-income households and countries with higher income inequality allocate a greater share of consumption to non-tradable goods. Additionally, we examine the transmission of monetary policy in countries with differing levels of non-tradable consumption.

The study makes use of micro-data on consumption for household income quintiles in European Union countries, allowing us to compute aggregate tradable and non-tradable consumption shares at the country level and evaluate the relationship between these shares and country-level income inequality. The empirical results show that higher-income households allocate a greater share of consumption to non-tradables, both within and across countries. Additionally, we find that the consumption share of non-tradables is higher in more unequal countries, even after controlling for per capita income. Finally, we find that the transmission of monetary policy is weaker in countries with a higher share of non-tradable in consumption.

The paper also presents a theoretical model with heterogeneous households and non-homothetic preferences to explain these results. The model, a small open economy with two sectors (tradable and non-tradable), and labor as the only factor of production, is based on previous work by Boppart (2014). The model replicates the empirical findings on the relationship between non-tradable share, income inequality, and the transmission of monetary policy. In conclusion, the results of this study provide insights into the relationship between household consumption, income inequality, and monetary policy transmission in different countries.

2 Empirical Analysis

We document three key empirical findings on the composition of demand across countries, and its implications for monetary policy. First, we show that the composition of demand varies significantly for households that are heterogeneous in their income, with richer households allocating a greater share of their consumption basket to non-tradables. This finding highlights the presence of non-homoteticity of preferences for the households in this sample. Second, at the aggregate level, in countries with greater income inequality non-tradable goods account for a larger share of total consumption. Third, we show that the composition of demand is systematically related to the effectiveness of monetary policy, as we document that output responses to monetary policy shocks are larger for economies with lower non-tradable consumption shares.

2.1 Data

We assemble data on the structure of household consumption expenditures and income levels for the 19 European Monetary Union (EMU) member states from 1999 to 2020. We use expenditure shares on three-digit COICOP consumption goods by household income quintiles from the Household Budget Survey (HBS). The HBS is collected every five years for all member states providing five years of observation over the last two decades. We match the household income quintiles with the respective disposable income levels from the European Union Statistics on Income and Living Conditions (EU-SILC) and European Community Household Panel (ECHP)[1]. We further take annual mean household expenditure shares from the HBS to calculate average country consumption shares over the last two decades. We classify consumption as tradable (T) and non-tradable (NT) based on the COICOP classification and calculate non-tradable and tradable consumption shares as

$$\omega_{i,t} = \frac{\sum^{N_i} C_{j,t}}{C_t}, \quad i \in (NT, T) \quad \text{and} \quad j \in (1, ..., N) \tag{1}$$

with consumption expenditure $C_{j,t}$ on consumption category j, the number of consumption categories classified as non-tradable N_{NT} and tradable N_T, and total non-tradable and tradable consumption C at time t. The detailed classification can be found in table 2. We abstain from including expenditure on housing (e.g. rents and imputed rents) in the calculation of

[1] The income statistics are given as top cut-off points for the respective decile. Since the income levels for the top decile is hence undefined, we match each income quintile with its mean decile counterpart (i.e. expenditures shares of the first income quintile are matched with the income level of the first decile and so on).

consumption shares in this paper. As further discussed below, we do so to abstract from any structural differences in the housing markets affecting the cross-country analysis.

We obtain income inequality measured by the gini coefficient from Eurostat and wealth inequality measured as wealth shares held by the bottom 50, top 10 and top 1 percent from the World Inequality Database (WID).

We collect quarterly country-level data on macroeconomic variables including 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 and non-tradable (and housing) based on the NACE classification matching the consumption COICOP classification.

2.2 Non-homothetic preferences

Figure 1 shows the consumption shares on non-tradables and tradables for households of each income quintile across the EMU member states averaged over the last two decades. The graphs reveal two empirical findings. First, European households have non-homothetic preferences related to nontradable consumption across income. Higher income is associated with a larger consumption share of non-tradables and a lower consumption share of tradables, respectively. Second, the non-homotheticity is visible both across and within countries. While there is considerable heterogeneity in income levels across countries, relatively richer households consume relatively more non-tradables irrespective of their country.

We further assess the non-homothetic preferences for each 2-digit COICOP category. We divide the categories that consist of both, tradable and non-tradable goods into their respective tradable and non-tradable shares and end up with 17 aggregated categories. The non-homotheticity is assessed using the regression

$$\omega_{t,i,n} = \alpha_i + \beta_i I_{t,n} + \phi_{i,n} + \psi_{i,t} + \epsilon_{t,i,n} \tag{2}$$

with consumption share ω for $i \in (NT, T)$ and country n in year t and income level I. We also include country ϕ and time ψ fixed effects to account for structural difference across countries and years. Figure 2 shows the coefficients on income. The x-axis shows the average consumption share of the respective category. Consumption of non-tradables represents about 30 percent of total consumption and is increasing in all but one category with higher income. Tradable consumption makes about 40 percent of total consumption and includes decreasing and increasing consumption shares with income. The income share spent on housing decreases with higher income.

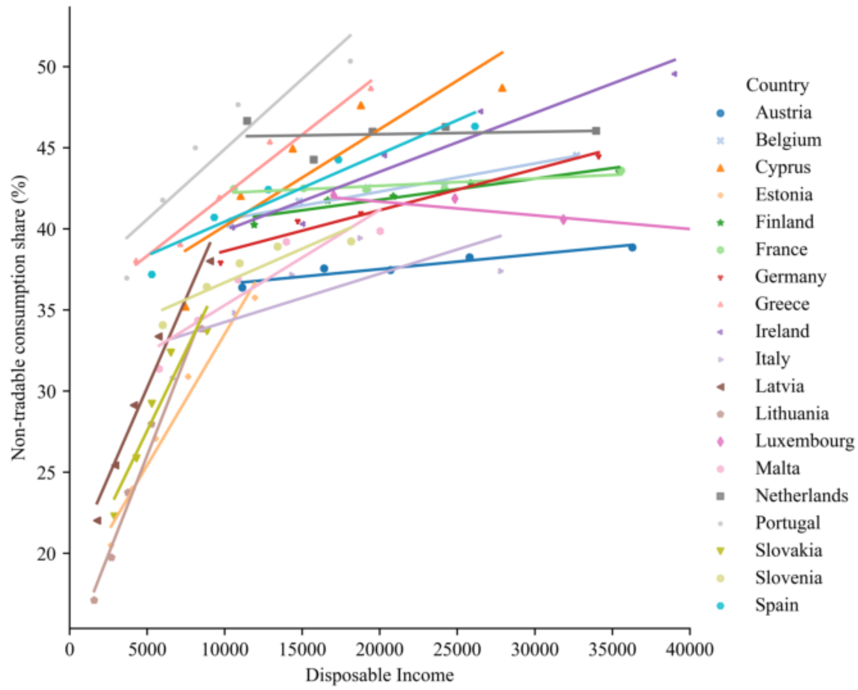


Figure 1: Non-tradable consumption shares by income level.

Note: The consumption shares are calculated as $\omega_{NT} = \frac{C_{NT}}{C_{NT}+C_T}$ and are averaged over the last two decades.

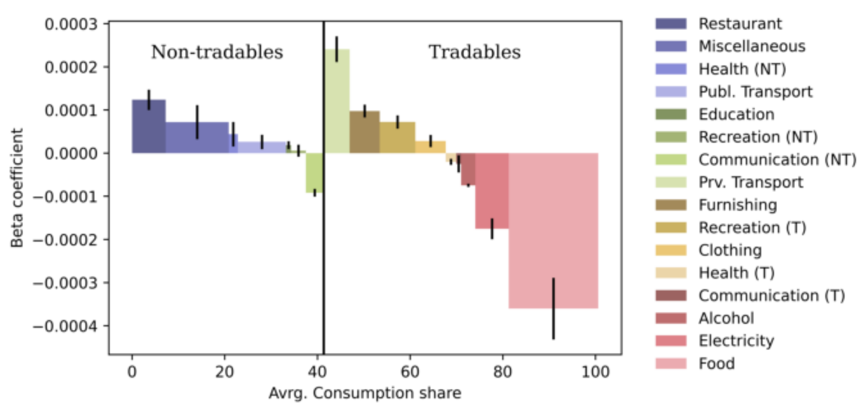


Figure 2: Beta coefficients on regression of consumption shares (excl. housing) on income.

Note: Whiskers show the 90th confidence interval based on clustered standard errors around country and year.

2.3 Inequality

With non-homothetic preferences across income, the distribution of income is directly linked to the aggregate consumption shares of an economy. Intuitively, in a relatively unequal country the small fraction of the population that has the major share of total income and expenditure drives the aggregate consumption share of the economy. Based on the increasing non-tradable consumption shares with income we have shown above, we thus expect relatively unequal countries to exhibit relatively high shares of aggregate non-tradable consumption. We test this using the regression

$$\bar{\omega}_{i,c} = \alpha_i + \beta_i \bar{Gini}_c + \gamma_i \bar{X}_{i,c} + \epsilon_{i,c} \tag{3}$$

with $\bar{\omega}$ as the average 2000 to 2020 consumption share with and $\bar{Gini}$ as the average 2000 to 2020 Gini on disposable income. The controls $\bar{X}$ include the trade balance, the old-age dependency ratio, the size of the government and GDP per capita, all averaged over 2000 to 2020. Figure 3 shows the corresponding relationship weighted by countries' GDP. The regression fit shows that greater income inequality is associated with with a higher non-tradable consumption shares after including the controls consistent with the finding of non-homothetic preferences across non-tradable consumption above.

2.4 Monetary policy

In order to estimate the effects of monetary policy to a variable of interest we merge the dataset with monetary policy shocks as identified by Jarociński and Karadi (2020). Jarocinski and Karadi (JK) identify shocks using high-frequency movements in Overnight Indexed Swaps around ECB announcements and decompose unexpected interest rate movements into central bank information and monetary policy surprises. We base our analysis on the latter only.[2]

We follow Jordà (2005) and Montiel Olea and Plagborg-Møller (2021) in estimating the output response to monetary policy shocks using the local projection (LP) approach. Impulse responses are constructed from the linear combination of β^h and γ^h from the estimated equations

$$y_{t+h,n} - y_{t-1,n} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_n) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,n} + \phi_n + u_{t+h,n} \tag{4}$$

[2] Note that the results hold also for aggregate unexpected interest rates movements (e.g. under the "poor man's sign restriction").

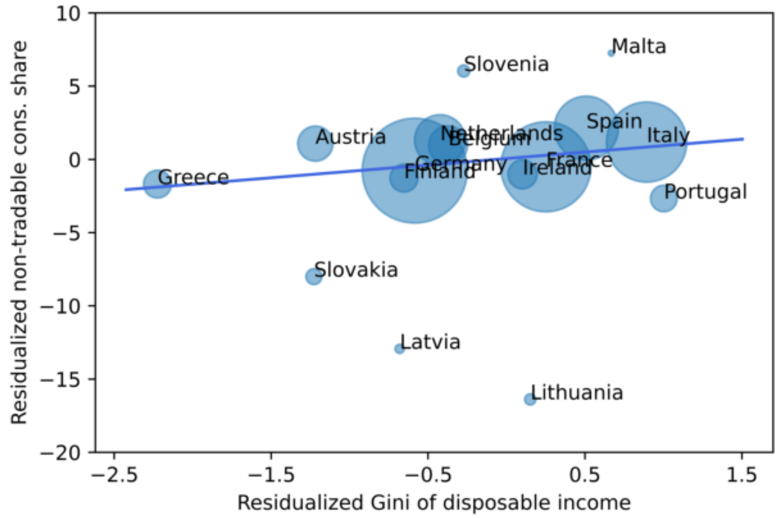
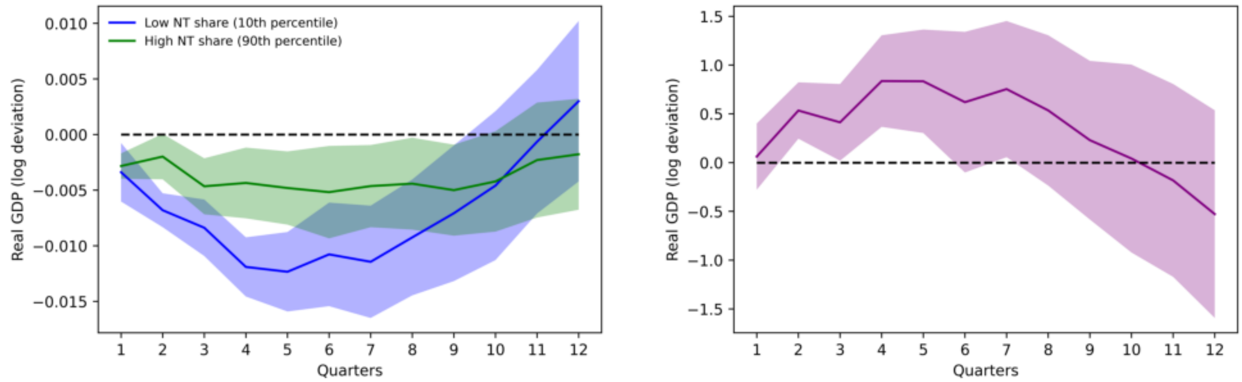


Figure 3: Weighted linear regression fit of residualized non-tradable consumption share on the Gini coefficient of disposable income averaged over 2000 to 2020.

Note: Weights are based on countries' 2000 to 2020 average GDP. The graphs exclude the tax havens Cyprus and Luxembourg as well as Estonia due to missing data.

where the left-hand side represents the deviation of the log-dependent variable from its initial value over the horizon of $H = 12$ quarters. The results may hence be interpreted as cumulative percentage deviations to a shock in year t. The right-hand side includes the JK monetary shock series i_t and its interaction with the average non-tradable consumption share ω in each country n. For inference, we further follow the lag-augmentation 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 cluster standard errors around countries. Finally, we also control for country fixed effects ϕ_n.



(a) High and low non-tradable share

(b) Difference

Figure 4: Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares.

Note: 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.

Figure 4a presents impulse responses of real GDP for countries with relatively high vis-à-vis low non-tradable consumption shares. The IRFs are based on the linear combination of $\beta^h i_t + \gamma^h (i_t * \bar{\omega}_n)$ for a contractionary, one standard deviation monetary policy shock. The high and low non-tradable IRFs are based on the 90th and 10th percentile of non-tradable shares in the sample respectively.

The graphs reveal that a one standard deviation contractionary monetary policy shocks causes output to decline significantly more in countries with low non-tradable shares. After five quarters, output in low non-tradable economies has declined by 1.2 percent relative to 0.5 percent in high non-tradable economies. The difference given by the interaction term coefficient γ (figure 4b) across countries is significant until the 7th post-shock quarter.

We further assess how the results change when controlling for inequality. In particular, 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 as follows:

$$y_{t+h,n} - y_{t-1,n} = \alpha + \beta^h i_t + \gamma^h (i_t * \bar{\omega}_n) + \lambda^h (i_t * \bar{Gini_c}) + \sum_{s=1}^{p} \Gamma_s^h y_{t-s,n} + \phi_n + u_{t+h,n}. \quad (5)$$

Figure 5 presents the IRFs for countries of different non-tradable consumption share and income inequality based on the linear combination of β^h, γ^h and λ^h. Both, lower non-tradable consumption shares and lower inequality imply stronger responses to a monetary policy shock. The share of non-tradable consumption, however, seems to play a relatively more important role in driving the difference in responses than the degree of inequality.

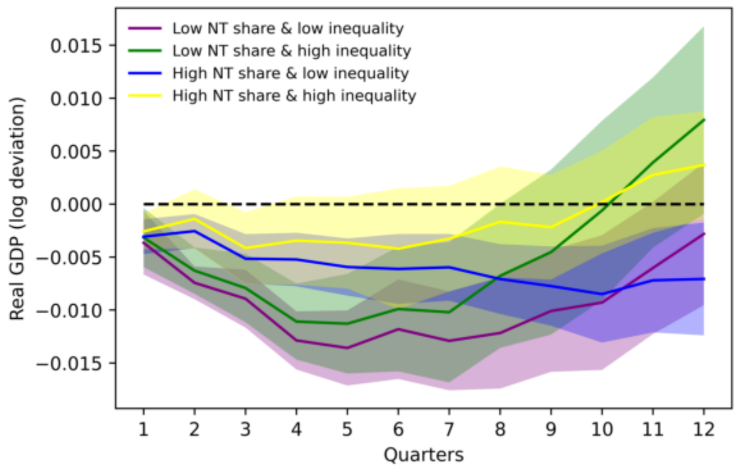
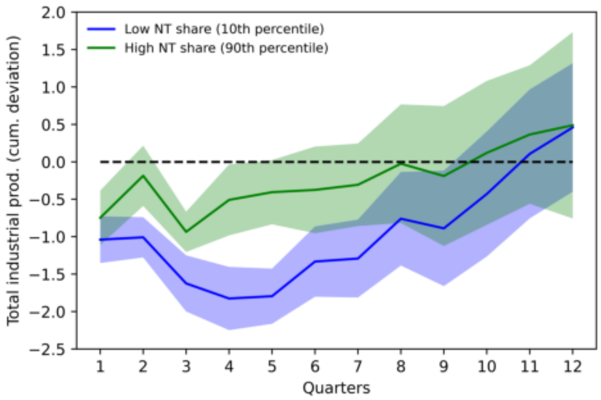


Figure 5: Impulse response functions of real GDP to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares and high and low income inequality.

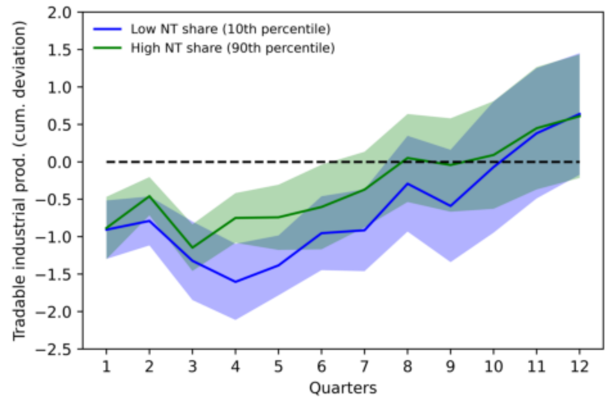
Note: The low non-tradable (NT) share as well as the gini coefficient are based on the 10th percentile of non-tradable shares in the sample and the high non-tradable share on the 90th percentile, respectively. The shaded areas represent 90th percent confidence intervals. Standard errors are clustered around countries.

2.5 Sectoral respones

We further analyse sectoral responses in industrial production, investment and price indeces. Figure 6b shows responses for industrial volumes produced in total and the tradable sector. The difference in responses observed in the total economy seem to be driven mainly by difference in non-tradable production. Similarly, differences in investment responses are largely due to investment in non-tradable assets as shown in figure 7. Figure 8 shows the difference in price developments for high- and low non-tradable consumption countries.



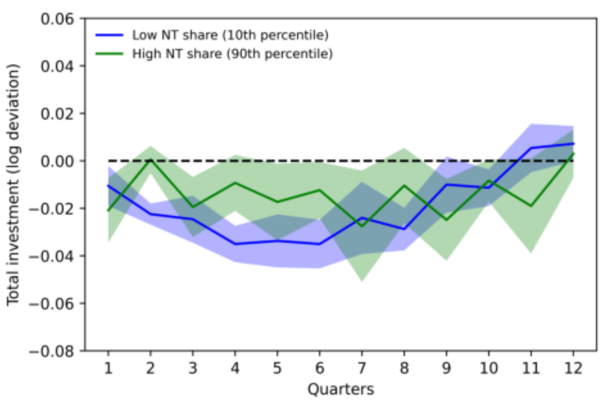
(a) Total industrial production



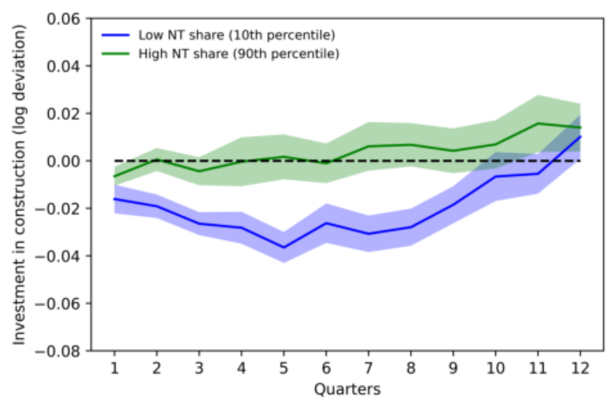
(b) Tradable industrial production

Figure 6: Impulse response functions of industrial production volumes to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares.

Note: ...



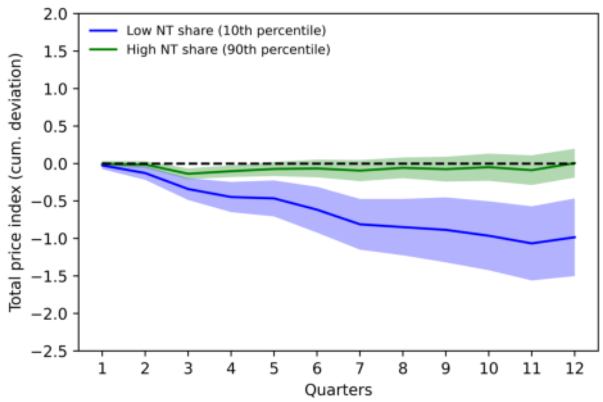
(a) Total investment in assets



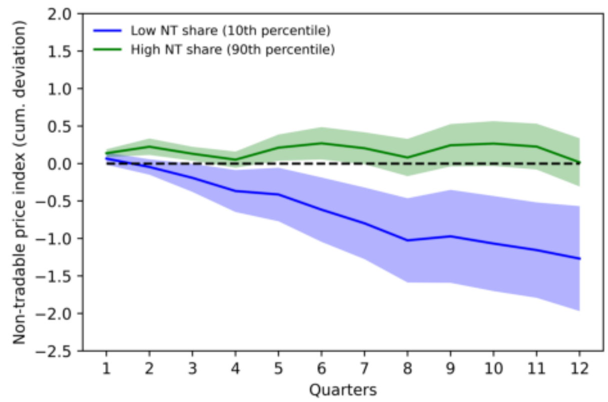
(b) Investment in non-tradable assets

Figure 7: Impulse response functions of gross fixed capital formation to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares.

Note: ...



(a) Total price index



(b) Non-tradable price index

Figure 8: Impulse response functions of price indeces to a contractionary monetary policy shock of one standard deviation for high and low non-tradable consumption shares.

Note: ...

3 Model

We introduce a model of a small open economy that can rationalize the empirical findings in section 2. Households derive utility from a tradable (T) and a non-tradable (N) consumption good. The former is traded at no cost between the SOE and the rest of the world, the latter is only produced domestically. The model features households with non-homothetic preferences. We assume that 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. Households differ in their income levels and in their ability to share risks on financial markets. Firms produce goods subject to a nominal rigidity, so that monetary policy shocks have real effects.

3.1 Households

There exists a unit mass of infinitely-lived households indexed by j. Their preferences over a stream of expenditures $\{e_{j,t}\}_{t=0}^{\infty}$ are represented by:

$$V_{j,0} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t v(e_{j,t}, P_t^T, P_t^N), \tag{6}$$

where $v(e, P^T, P^N)$ is intra-temporal indirect utility function for the consumption of the tradable and non-tradable good. Prices of the tradable and non-tradable good are denoted P_t^T and P_t^N respectively and expenditures satisfy $e_{j,t} = P_t^T c_{j,t}^T + P_t^N c_{j,t}^N$. We assume non-homothetic preferences of the Price Independent Generalized Linearity (PIGL) class defined by (Muellbauer 1975; Muellbauer 1976). We follow Boppart (2014) and adopt the following form of the PIGL indirect utility function:

$$v(e_{j,t}, P_t^T, P_t^N) = \frac{1}{\varepsilon}\left[\left(\frac{e_{j,t}}{P_t^N}\right)^{\varepsilon} - 1\right] - \frac{\nu}{\gamma}\left[\left(\frac{P_{i,t}^T}{P_{i,t}^N}\right)^{\gamma} - 1\right]. \tag{7}$$

with the parameters $\varepsilon, \gamma \in (0,1)$ and $\nu \geq 0$. As shown in Boppart (2014), this particular specification and the restrictions on the parameter values ensures that there exists a balanced growth path.

Regarding the intuition of the parameters ε, γ and ν, we can note the following. The parameter ε controls the degree of non-homotheticity between the tradable and non-tradable goods. In particular, the expenditure elasticity of tradable goods consumption is given by $1 - \varepsilon$, which is necessarily smaller than unity. Therefore, with these preferences the tradable good is a necessity good and the non-tradable good a luxury good. In the limit case when $\varepsilon \to 0$, we obtain homothetic preferences with an expenditure elasticity of one. The parameter γ controls the non-constant elasticity of substitution between the tradable and non-tradable goods, which is given by: $1 - \gamma - \frac{\omega_{j,t}^T}{\omega_{j,t}^N}(\gamma - \epsilon)$, where $\omega_{j,t}^T$ and $\omega_{j,t}^N$ are the expenditure shares of the tradable and non-tradable good defined further down in equation (15) and (16). Note that for the special case of $\gamma = \varepsilon$, the second term drops out and we obtain a constant elasticity of substitution between tradable and non-tradable goods. Thus, we nest a special case of the non-homothetic CES utility function as used in, for example, Comin, Lashkari, and Mestieri (2021). Consequently, we obtain Cobb-Douglas preferences for $\varepsilon = \gamma = 0$. Finally, the parameter ν is just a scale parameter that controls the level of demand for the tradable good. Note, we also obtain homothetic preferences for $\nu = 0$ and $\varepsilon \neq 0$, as all consumption is allocated to the non-tradable goods by the expenditure share equation in (15).

The household budget constraint is:

$$\begin{aligned} &P_t^T c_{j,t}^T + P_t^N c_{j,t}^N + P_t^T B_{j,t+1} + B_{j,t+1}^n \\ &\qquad = W_t l_{j,t} + \Pi_{j,t} + T_{j,t} + P_t^T R_{t-1} B_{j,t} + R_{t-1}^n B_{j,t}^n, \end{aligned} \tag{8}$$

where the left-hand side represents expenditures $e_{j,t}$ and future holdings of real and nominal bonds $B_{j,t+1}$ and $B_{j,t+1}^n$, and the right-hand side represents labor income $W_t l_{j,t}$, profits from the ownership of firms $\Pi_{j,t}$, government transfers $T_{j,t}$ and current holdings of real and nominal bonds $B_{j,t}$ and $B_{j,t}^n$, with gross return R_{t-1} and R_{t-1}^n respectively. Households are endowed with $l_{j,t}$ units of labor, where the idiosyncratic component $l_{i,j,t}$ is stochastic.

Markets are incomplete and households cannot perfectly insure against the idiosyncratic labor productivity shocks. They are only allowed to save and borrow in both the real and nominal bonds, but the total household debt level is constrained by the following borrowing constraint:

$$P_t^T B_{j,t+1} + B_{j,t+1}^n \geq -\lambda W, \tag{9}$$

where λ controls the fraction of the unconditional expected steady state labor income a household is allowed to borrow at any point in time.

Household j maximizes (6) subject to the budget constraint (8), the borrowing constraint (9) and two no-Ponzi-scheme constraints:

$$\lim_{t\to\infty}\left(P_t^T B_{j,t+1} \prod_{s=0}^{t} \frac{1}{R_s}\right) \geq 0 \qquad \text{and} \qquad \lim_{t\to\infty}\left(B_{j,t+1}^n \prod_{s=0}^{t} \frac{1}{R_s^n}\right) \geq 0 \tag{10}$$

by choosing a sequence of consumption $\{c^T_{j,t}, c^N_{j,t}\}_t$ and bond holdings $\{B_{j,t+1}, B^n_{j,t+1}\}_t$ taking prices $\{P^T_t, P^N_t, R_t, R^n_t, W_t\}_t$, profits $\{\Pi_{j,t}\}_t$ and initial bond holdings $\{B_{j,0}, B^n_{j,0}\}$ as given. Households have perfect foresight about the aggregate state of the economy, but face idiosyncratic uncertainty about their labor endowment $l_{j,t}$. They inelastically supply their entire labor endowment each period.

In order to solve the household problem, we can split it into two sub-problems: an inter-temporal problem for the consumption-savings decision and an intra-temporal problem for the consumption allocation between the tradable and non-tradable good.

The inter-temporal problem. In the first stage, the household decides on total expenditures $e_{j,t}$ and the amount of bonds to hold in each period. This gives rise to an Euler equation and a no-arbitrage condition for all unconstrained agents:

$$\frac{v_e(e_{j,t}, P^T_t, P^N_t)}{v_e(e_{j,t+1}, P^T_{t+1}, P^N_{t+1})} = \left(\frac{e_{j,t+1}}{e_{j,t}}\right)^{1-\varepsilon} \left(\frac{P^N_{t+1}}{P^N_t}\right)^{\varepsilon} = \beta R^n_t, \tag{11}$$

$$R^n_t = R_t \frac{P^T_{t+1}}{P^T_t}. \tag{12}$$

Apart from controlling the degree of non-homotheticity, the parameter ε also plays a crucial role in controlling the relative risk aversion (RRA) and the inter-temporal elasticity of substitution (EIS). The RRA in our model with these preferences is given by $1-\varepsilon$ and the EIS is given by $\frac{1}{1-\varepsilon}$. Given our assumed restriction on the range of values for ε, the RRA is below one and the EIS larger than one.[3]

The intra-temporal problem. By Roy's identity, we get the demand functions for the consumption of tradable and non-tradable goods as:

$$c^T_{j,t} = -\frac{\dfrac{\partial v}{\partial P^T_t}}{\dfrac{\partial v}{\partial e_{j,t}}} = \frac{e_{j,t}}{P^T_t}\left[\nu \left(\frac{P^N_t}{e_{j,t}}\right)^{\varepsilon} \left(\frac{P^T_{i,t}}{P^N_{i,t}}\right)^{\gamma}\right], \tag{13}$$

$$c^N_{j,t} = -\frac{\dfrac{\partial v}{\partial P^N_t}}{\dfrac{\partial v}{\partial e_{j,t}}} = \frac{e_{j,t}}{P^N_t}\left[1 - \nu \left(\frac{P^N_{i,t}}{e_{j,t}}\right)^{\varepsilon} \left(\frac{P^T_t}{P^N_t}\right)^{\gamma}\right] \tag{14}$$

[3] In principle, we could allow for $\varepsilon < 0$ to obtain a RRA larger than one and a EIS below one, but Alder, Boppart, and Müller (2022) showed that this does not permit a balanced growth path any longer.

and the corresponding expenditure shares as:

$$\omega_{j,t}^T \equiv \frac{P_t^T c_t^T}{e_{j,t}} = \nu \left(\frac{P_t^N}{e_{i,j,t}}\right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N}\right)^{\gamma}, \tag{15}$$

$$\omega_{j,t}^N \equiv \frac{P_t^N c_t^N}{e_{j,t}} = 1 - \nu \left(\frac{P_t^N}{e_{j,t}}\right)^{\varepsilon} \left(\frac{P_t^T}{P_t^N}\right)^{\gamma}. \tag{16}$$

3.2 Firms and Production

There are two sectors of production: one for the tradable and one for the non-tradable good. Labor is perfectly mobile across the two sectors, but cannot be imported or exported from abroad.

Non-tradable Goods Sector. The non-tradable good is produced by a large number of competitive firms. Labor is the only factor of production and the common production function is:

$$Y_t^N = L_t^N, \tag{17}$$

where L_t^N is the labor allocated to the production of non-tradable goods. Profits are given by $P_t^N Y_t^N - W_t L_t^N$. Firms' optimality and free entry of firms in the non-tradable sector imply that $P_t^N = W_t$ in equilibrium.

The Tradable Goods Sector. The tradable good is produced by a representative firm with a decreasing returns to scale production technology. Again, labor is the only factor of production, but output is concave in labor according to the production function:

$$Y_t^T = \left(L_t^T\right)^{\alpha}, \tag{18}$$

where L_t^T is the labor allocated to the production of tradable goods. The labor share in the tradable sector is denoted by $0 < \alpha < 1$ and the complement share $1 - \alpha$ goes to firms as profits. Profit maximization implies:

$$\alpha P_t^T \left(L_t^T\right)^{\alpha - 1} = W_t \tag{19}$$

where the optimality condition holds with an inequality if the firm would like to employ more labor than available on the labor market at the prevailing constant wage rate. Profits are given by:

$$\Pi_t = P_t^T \left(L_t^T\right)^{\alpha} - W_t L_t^T. \tag{20}$$

3.3 Monetary Policy

The monetary authority can directly control the gross return on the nominal bonds, R_t^n. Later, we will analyze a shock to R_t and assume that the monetary policy regime is such that R_t^n exactly follows R_t, i.e. P_t^T is assumed to be constant.

3.4 Market Clearing

Labor market clearing implies that

$$\int l_{j,t} dj = L \geq L_t^N + L_t^T, \tag{21}$$

where involuntary unemployment can arise due to the fact that wages are rigid and firms demand less labor.

The household's no-arbitrage condition implies that they are indifferent between holding real and nominal bonds. To resolve this indeterminacy, we impose the equilibrium condition that the nominal bonds are in zero net supply:

$$\int B_{j,t}^n dj = B_t^n = 0 \quad \text{for all } t. \tag{22}$$

Thus, this implies that the net foreign asset position is given by:

$$NFA_t = B_{t+1} + \int B_{j,t+1} dj. \tag{23}$$

Market clearing for the non-tradable consumption good requires:

$$\int c_{j,t}^N dj = Y_t^N = L_t^N \tag{24}$$

and market clearing for the tradable good requires:

$$\int c_{j,t}^T dj = Y_t^T + R_{t-1} B_t - B_{t+1}, \tag{25}$$

which can be rearranged to obtain the law of motion for the stock of net foreign assets, i.e. the current account:

$$NFA_t - NFA_{t-1} = CA_t = Y_t^T - C_t^T + B_t(R_{t-1} - 1) \tag{26}$$

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

We are now ready to define a competitive equilibrium. Given an exogenous path for $\{R_t, P_t^T\}_t$ and initial conditions B_0, a competitive equilibrium consists of a path of real allocations

$$\{C_t^T, C_t^N, L_t^T, L_t^N, B_{t+1}\}_t, \tag{27}$$

prices $\{P_t^T, P_t^N, W_t\}_t$ and nominal interest rates $\{R_t^n\}_t$ satisfying the household's utility maximization: (12), (13), (14), (11) and (8); the firm's profit maximization: (17) and (19); and market clearing conditions (21), (22), (24) and (25).

4 Two-Agent Model

In this section we make a series of simplifying assumptions to illustrate the core mechanism of the model. In particular, the simple model shows that non-homothetic preferences give rise to an aggregate share of non-tradable good in consumption that increases in the degree of income inequality. Moreover, the simple model also shows that the joint interaction of two key model features, non-homothetic preferences and market incompleteness, can determine weaker effects of monetary policy in countries with a higher share of non-tradables in aggregate consumption. The model features only two types of agents without idiosyncratic productivity shocks. One type is hand-to-mouth and cannot change its financial asset position. The other type is Ricardian and does not face a borrowing constraint. First, we characterize the steady state of the model economy, and we detail the relationship between income inequality and the share of non-tradables in aggregate consumption. Second, we consider a contractionary monetary policy shock. We evaluate the magnitude of the response of output to the shock, dempending on the severity of income inequality, on the level of debt owed by hand-to-mouth agents, and on the type of household preferences.

4.1 Two-Agent Environment

Hand-to-mouth. Let the hand-to-mouth agent be indexed by $j = H$. This agent receives labor income from her labor endowment $W_t l_{H,t}$, profits from the tradable-sector firm $\Pi_{H,t}$. B_H denotes the financial asset position of the hand-to-mouth. The hand-to-mouth cannot change her financial position in any period, but she receives or pays interest on her assets of debt. Thus, the budget constraint of the hand-to-mouth writes as:

$$P_t^T c_{H,t}^T + P_t^N c_{H,t}^N = W_t l_{H,t} + \Pi_{H,t} + P_t^T (R_{t-1} - 1) B_H. \tag{28}$$

The mass of hand-to-mouth agents equals 1/2.

Ricardian. Let the Ricardian agent be indexed by $j = R$. As with the hand-to-mouth agent, this agent receives labor income, profits and has an initial financial asset position $B_{R,0}$, which she can adjust in each period. Therefore, the budget constraint writes:

$$P_t^T c_{R,t}^T + P_t^N c_{R,t}^N + P_t^T B_{R,t+1} = W_t l_{R,t} + \Pi_{R,t} + P_t^T R_{t-1} B_{R,t-1} \tag{29}$$

This agent does not face the borrowing constraint in (9), but is only subject to the no-Ponzi-scheme constraints. The mass of Ricardian agents is also equal to 1/2, as for the hand-to-mouth.

Income Inequality. To further simplify the analysis, we assume that a a fixed share φ_H of aggregate income goes to the hand-to-mouth agent, while the share $\varphi_R = 1 - \varphi_H$ goes to the Ricardian agent. Aggregate income in this economy equals $Y_t = P_t^N L_t^N + P_t^T \left(L_t^T\right)^\alpha$. In order to achieve the desired distribution of income, we use the fact that wages are equal across sectors and set the labor endowment of the two agents to:

$$l_{j,t} = 2\varphi_j \left(L_t^N + L_t^T\right) \tag{30}$$

and profits to:

$$\Pi_{j,t} = 2\varphi_j (1-\alpha) P_t^T \left(L_t^T\right)^\alpha \tag{31}$$

where the factor 2 comes from the fact that both agents have a mass of 1/2 and the labor market clearing condition needs to hold:

$$\frac{1}{2} \sum_{j \in \{H,R\}} l_{j,t} = L_t^N + L_t^T. \tag{32}$$

4.2 Two-Agent Results

4.2.1 Steady state

Under fixed exchange rates, the price of the tradable good P^T is exogenous, and we normalize it to unity. Noting that $W = P^N$. Then, the following set of equations implicitly define the

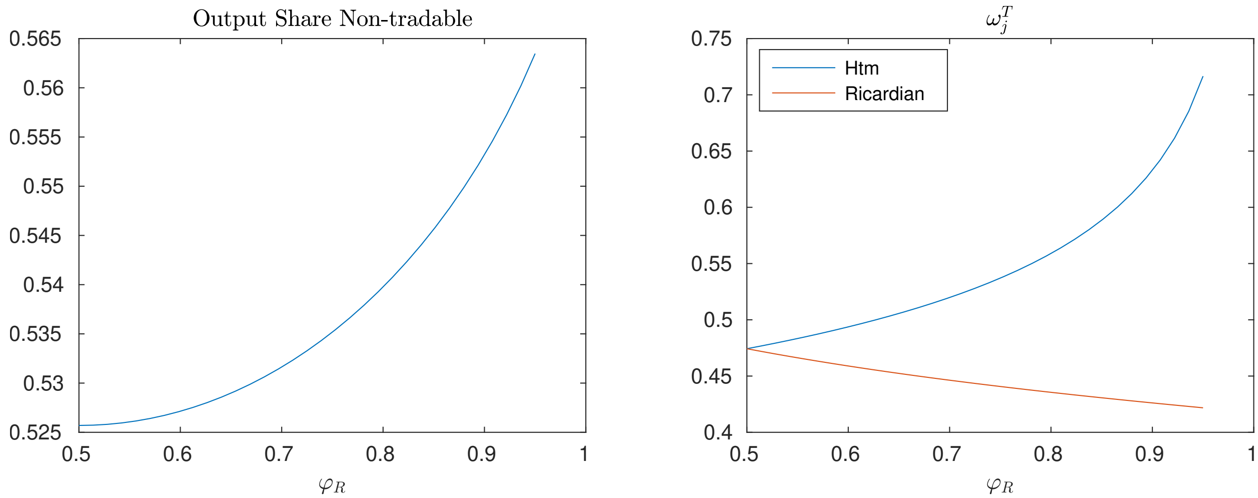


Figure 9: Steady state values by varying levels of output going to the Ricardian agent φ_R.

steady state:

$$R = \frac{1}{\beta} = R^n \tag{33}$$

$$c_j^T = \nu e_j^{1-\varepsilon} \left(P^N\right)^{\varepsilon-\gamma} \tag{34}$$

$$e_j = 2\varphi_j P^N \left(L^N + L^T\right) + 2\varphi_j(1-\alpha)\left(L^T\right)^{\alpha} + (R-1)B_j \tag{35}$$

$$L = \frac{1}{2}\sum_{j\in\{H,R\}} l_{j,t} = L^N + L^T \tag{36}$$

First, we set the gross real interest rate in units of tradables R to the inverse of the subjective discount factor, so that expenditure is constant in steady state. Second, for each agent, consumption of tradable goods rises as total expenditure rises, but with an elasticity lower than one, if preferences are non-homothetic ($\varepsilon > 0$), as this good is a necessity. Third, expenditure of each agent is equal to their total income from labor and profits, plus interest on financial assets. Finally, the labor market clears, as the total endowment of labor is employed by firms in the tradable and non-tradable sector.

Figure 9 shows the steady-state output share of the non-tradable good and the expenditure share on the tradable good for the two agents as a function of the fraction of total income going to the Ricardian agent, φ_R. We can note that a simple re-distribution of total income away from the hand-to-mouth agent towards the Ricardian agent increases the aggregate output share of non-tradable goods in the economy. This happens because the Ricardian agent receives more of aggregate income and spends a higher share of it on non-tradable consumption. Further, we can note that as the hand-to-mouth agent becomes extremely poor (as φ_R is getting closer to 0.95), the expenditure share on tradable goods increases quite rapidly and much quicker than it falls for the Ricardian agent. However, despite this the output share of non-tradable goods increases as the Ricardian stands for a higher share of aggregate consumption.

4.2.2 Inequality and the composition of demand

We examine the impact of inequality on the share of non-tradable good in total consumption, in steady state. Figure 10 presents the results. The Ricardian agent has zero intitial assets, and the hand-to-mouth agent has either zero assets or positive debt. For this exercise, we vary the share of income that goes to the Ricardian agent, starting from an equal distribution of income. As the share of income to the Ricardian agent increases, the degree of income inequality also increases. We evaluate the share of non-tradable good in total consumption as a function of the Ricardian income share. Our results show that the higher the income share to the Ricardian agent, the higher the share of non-tradable good in consumption. This is because the non-tradable good is a luxury and the higher the income of the Ricardian agent, the higher the share of non-tradable good in their own consumption. On the other hand, the lower the income of the hand-to-mouth agent, the lower the share of non-tradable good in their consumption. The higher the share of income accrued by the Ricardian agent, the closer aggregate consumption shares are to the Ricardian agent's consumption shares. On the other hand, the higher the debt owed by the hand-to-mouth agent, the lower the aggregate non-tradable good consumption share. This is because the more indebted the hand-to-mouth agent are, the lower the share of non-tradable good in their consumption. There is no change in consumption patterns for the Ricardian agent, hence the higher the debt of the hand-to-mouth agent, the lower the aggregate non-tradable good share in consumption.

4.2.3 Inequality and the transmission of monetary policy

We study the effect of inequality on the impact of monetary policy by considering a monetary policy shock in a fixed-exchange rate setting. The shock involves an increase in the nominal interest rate in the initial period, followed by a return to the steady-state nominal interest rate in all subsequent periods. The increase in the nominal interest rate is equivalent to an increase in the real interest rate in units of the tradable good, because the exchante rate is fixed. In the exercise, we vary the share of income that goes to the Ricardian agent and the level of hand-to-mouth agent debt. We then evaluate the magnitude of the output contraction following the interest rate shock. Figure 11 presents the results.

The results show that absent hand-to-mouth debt, the greater the share of income that

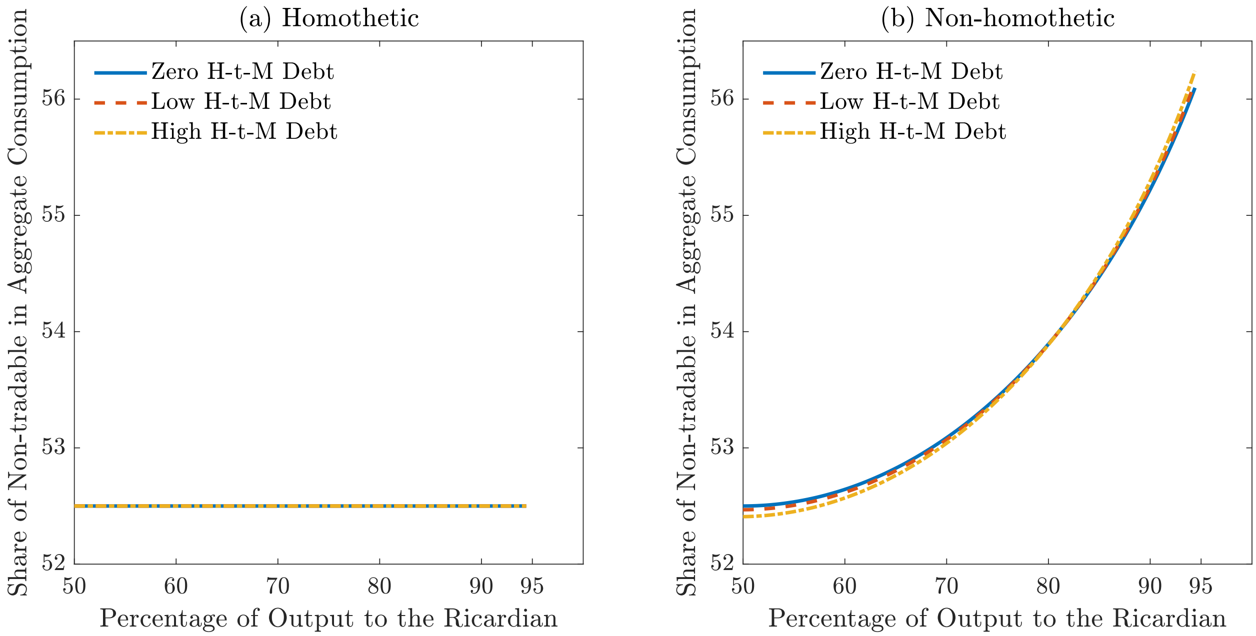


Figure 10: Inequality and the composition of demand.

goes to the Ricardian agent, the stronger the effect of monetary policy. The interest rate shock has a direct effect on the intertemporal allocation of consumption of the Ricardian agent. Hence, the greater is the share of income accruing to the Ricardian agent, the bigger is the direct effect of the shock on the economy. In the absence of debt, the only effect of the shock on the hand-to-mouth agent is the indirect one due to the contraction of her labor income. Labor income of the hand-to-mouth agent contracts because the Ricardian agent reduces her consumption, and thus demand for non-tradable good contracts. The lower demand for non-tradable good implies that non-tradable output and employment contract, reducing total employment and income. The initial effect of the shock then causes a further contraction in demand, amplifying the shock in the typical Keynesian fashion. When preferences are not homothetic, the higher is income of the Ricardian agent, the greater is her overall consumption and the share of such consumption allocated to the non-tradable good. As a result, the indirect impact of the shock on the hand-to-mouth agent's income will be stronger.

When the hand-to-mouth agent owes debt, monetary policy is more powerful, ceteris paribus, as the interest rate shock directly impacts both the Ricardian and hand-to-mouth agents. When the hand-to-mouth agent has debt, she is now directly affected by the shock: As the interest rate increases, the hand-to-mouth agent must make higher interest payments on her debt in each period. As a result, she will reduce their consumption, causing a further contraction in output.

With a large enough debt of the hand-to-mouth, monetary policy becomes weaker the larger the share of income that goes to the Ricardian agent. If preferences are homothetic, this result emerges when the hand-to-mouth agent owes a large amount of debt. When the hand-to-mouth agent owes a significant amount of debt, the direct impact of monetary policy on her is greater than the direct impact on the Ricardian agent. Therefore, the larger the proportion of income that goes to the Ricardian agent, the weaker the effect of monetary policy will be.

In the case of non-homothetic preferences, the above result emerges for lower levels of hand-to-mouth debt, when the Ricardian agent's income share is high, because of two additional forces at play.

When the hand-to-mouth agent has low income, the share of her consumption accounted for by the non-tradable good is low. Hence, the monetary policy shock has a small effect on the demand for non-tradable good coming from the hand-to-mouth. In addition, when the Ricardian agent has a high income, a significant portion of her consumption is accounted for by non-tradable goods. This implies that a change in the interest rate, measured in units of tradable goods, does not significantly affect the total consumption of the Ricardian. Therefore, the greater the share of income that goes to the Ricardian agent, the weaker the response of output to the monetary policy shock becomes. This outcome is only possible if the difference in the direct effects of monetary policy on the Ricardian and hand-to-mouth agents is not too large, which is the case if the hand-to-mouth agent has some debt.

4.2.4 Demand composition and the transmission of monetary policy

We now consider the relationship between the composition of demand and the strenth of the effects of monetary policy.

Figure 12 presents the reduction in output following a monetary policy shock against the aggregate steady-state share of non-tradable good in consumption. The figure shows that to generate a weaker response of monetary policy in economies with a higher share of non-tradable good in aggregate consumption, as observed in the data, the economy must feature a positive amount of debt owed by the hand-to-mouth. In economies where hand-to-mouth agents do not owe debt, the higher is the steady-state non-tradable share, the stronger is the response of output to a monetary policy shock. The contrary is true in an economy with a high level of hand-to-mouth agents' debt, and when hand-to-mouth agents' debt is low but inequality is relatively high.

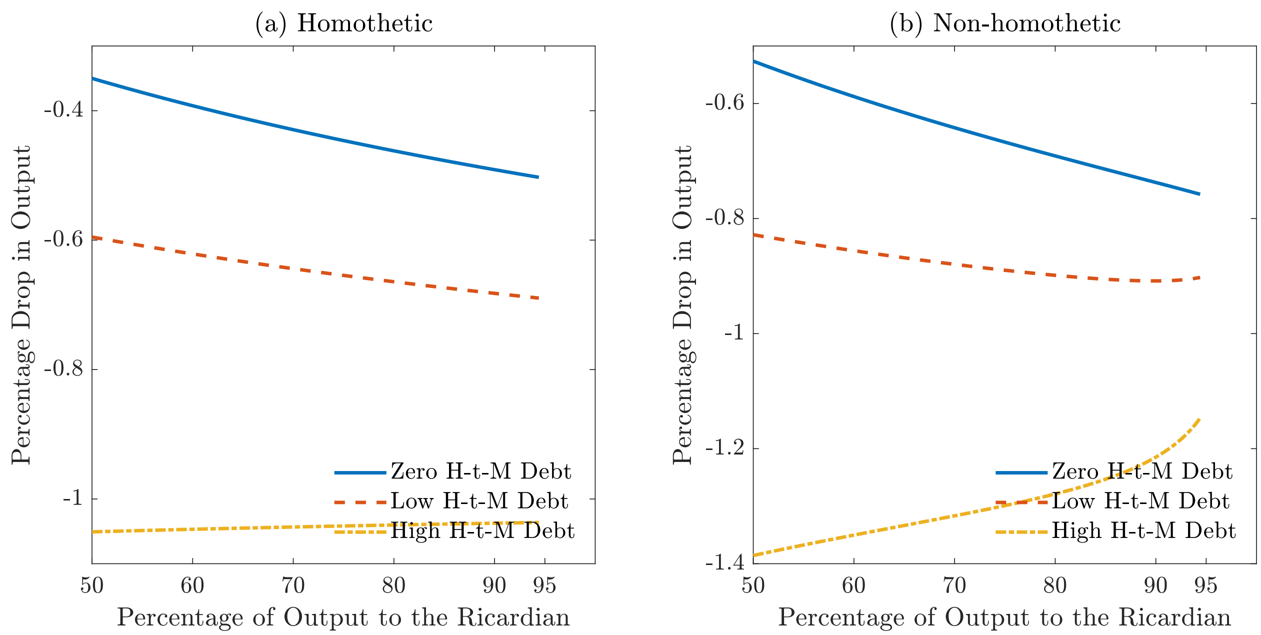


Figure 11: Inequality and the transmission of monetary policy.

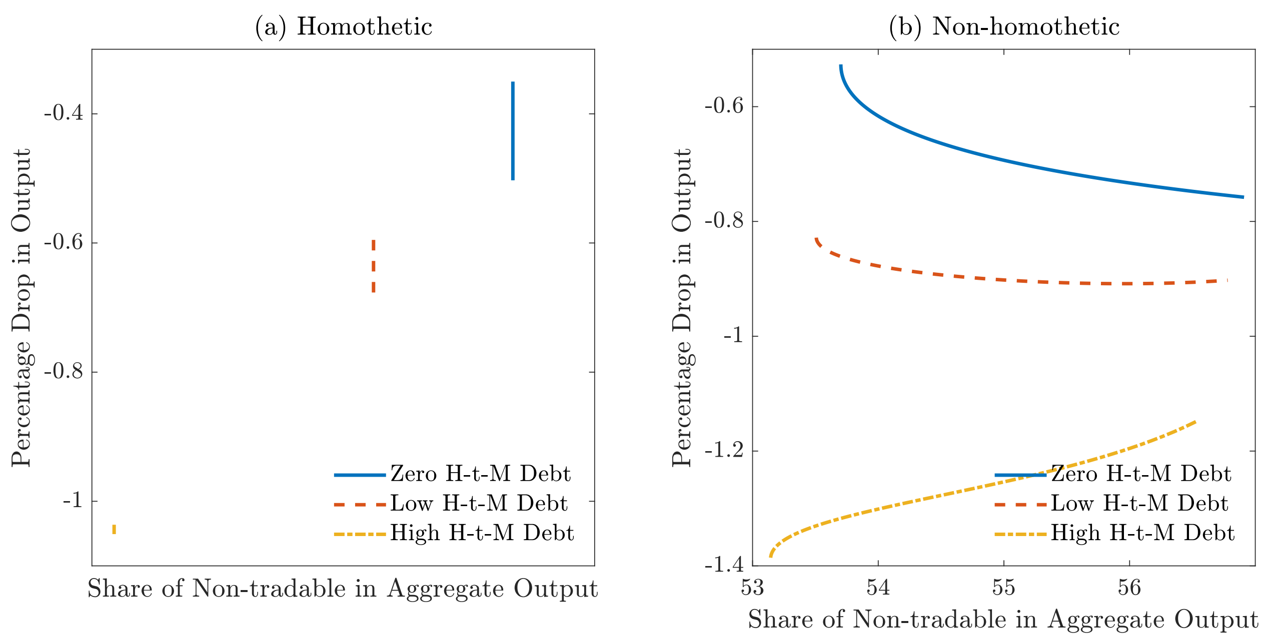


Figure 12: Demand composition and the transmission of monetary policy.

5 Calibration

Preference Parameters. In order to pin down the preference parameters in the PIGL indirect utility function, we will make use of the aggregation feature of these preferences and estimate ε and γ from aggregate time-series data on expenditures and prices of tradable and non-tradable goods for the Euro Area countries. We will denote countries with the subscript i.

In particular we estimate the expenditure share equation in (15). In doing so, we will make a series of assumptions: 1) we assume that there are no constrained households, such that we can make use of the aggregation feature of PIGL preferences; 2) we assume that inequality within a country summarized in the scale-invariant dispersion measure κ_i is constant over time, but can vary from country to country. Under these assumptions, we can take logs of (15) and run the following regression:

$$\ln \omega_{i,t}^T = \alpha_i + \varepsilon \ln \left(\frac{P_{i,t}^N}{E_{i,t}} \right) + \gamma \ln \left(\frac{P_{i,t}^T}{P_{i,t}^N} \right) + \epsilon_{i,t} \tag{37}$$

where $\alpha_i = \nu \kappa_i$ represents country fixed effects and $\epsilon_{i,t}$ is the residual.

Thus, all the data we need are the aggregate expenditure share on tradable goods $\omega_{i,t}^T$, the total expenditures on tradable and non-tradable goods $E_{i,t}$ and the corresponding prices on the tradable and non-tradable goods $P_{i,t}^T$ and $P_{i,t}^N$. The identification of both ε and γ comes from the time-series variation within a country.

The aggregate expenditure shares and total expenditures come directly from Eurostat. In order to obtain $P_{i,t}^T$ and $P_{i,t}^N$, we classify consumption categories into tradable and non-tradable goods and then compute country-specific Sato-Vartia price indices for each of the two groups.

We estimate that $\varepsilon = 0.13$ and $\gamma = 0.45$ and use ν to target the steady state expenditure share of the tradable good to the empirically observed level for the country of interest.

Other Parameters. Regarding the other parameters, we set $\alpha = 2/3$. Further, we normalize P^T to one and set the steady state interest rate, R, to 4 %, annually. The normalization of P^T and the fact that we adopt a quarterly calibration implies that $R^n = R = 1.04^{1/4}$. Given that the interest rate is set exogenously, we use β to target the steady state level of the initial bond holdings of the country $B_{i,0}$. The scaling parameter in the borrowing constraint, λ is set to 50 % of average annual steady state labor income of country i, which implies a value of 2 in our quarterly calibration. For simplicity, we set the aggregate labor productivity, L_i, to one. The idiosyncratic productivity component follows the calibration in Krueger, Mitman, and Perri (2016). In particular we discretize this process using a ten state Markov Chain with persistence $\rho = 0.9695$ and standard deviation of $\sigma = 0.1025$.

Table 1 summarizes the calibration and lists all parameters:

Table 1: Calibration

Parameter	Value
α	2/3
ε	0.18
γ	0.29
ν	0.475
η	0
R	$1.04^{1/4}$
$B_{i,0}$	0
L_i	1
λ	2
ρ	0.9695
σ	0.1025

6 Conclusion

7 References

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Appendix

A Consumption classification

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 2: Tradability of COICOP categories