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Abstract

This paper explores the optimal design of monetary policy in a multisector model where agents' preferences are non-homothetic. Non-homotheticity derives from the existence of a minimum consumption requirement for food, which households need to satisfy for subsistence. We find that the introduction of a minimum consumption requirement reduces the weight on food inflation in the optimal index that the monetary authority should target. We identify three motives for such prescription. First, non-homothetic preferences turn the stabilization of food inflation more costly, as it requires larger deviations of output from the efficient level. Second, proximity to the subsistence level turns the demand for food insensitive to monetary policy. Inflation in this sector thus becomes difficult to control. Third, non-homothetic preferences imply that households spend only a small share of any additional income on food. This means that prices in this sector have a reduced impact on aggregate consumption demand. Hence, responding to inflation in this sector becomes less relevant. Importantly, our results provide a rationale for targeting an index that excludes (or attaches a limited weight to) food inflation, a usual practice amongst central bankers.

Keywords: Inflation, Price Index, Monetary Policy.
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1 Introduction

From the structural change literature, we know that the sectoral composition of the economy varies as it grows, with the share of agricultural output falling as the country develops.[1] Changes in sectoral composition can be explained by agents' preferences featuring non-homotheticity, resulting from the existence of a minimum consumption requirement for food, which households need to satisfy for subsistence.[2] While the use of this type of preferences is widely extended in the growth literature, it has only received limited attention in work investigating the business cycle,[3] and within it, the monetary policy literature. Yet, the assumption that families have need of covering a minimum food consumption level appears sensible and, moreover, receives support from empirical work. In effect, Herrendorf et al. (2013) find that preferences incorporating a minimum consumption requirement for food provide a good fit to the US data, while Comin et al. (2021) provide evidence of non-homotheticity for a wider set of countries.

In this paper we analyze the implications for the conduct of monetary policy of preferences incorporating a sector specific minimum consumption requirement. To this end, we build a multisector model that combines features from the structural change and the New Keynesian literature. More specifically, we consider an economy with two sectors: food and nonfood. In the model, as a result of the introduction of a minimum consumption requirement for the former, food demand has an income elasticity that is lower than one, implying that households' average and marginal expenditure composition differ, and price elasticity is non-unitary. Regarding the New Keynesian features of the model, we consider an economy with sticky prices in both food and nonfood and flexible wages. In addition, we assume there is perfect labor mobility across sectors.

We find that the introduction of a minimum consumption requirement for food alters the optimal measure of inflation that the monetary authority should target. More precisely, non-homotheticity results in a reduced weight on food inflation in the optimal index. We identify three motives for such policy prescription. First, non-homothetic preferences turn the stabilization of food inflation more costly, as it requires larger deviations of output from the efficient level. Second, proximity to the subsistence level implies a low income elasticity in the demand for food. This translates into a reduced slope on aggregate output in the Phillips curve for food inflation. As a consequence, a more aggressive policy is required to control inflation in this sector, which imposes costs as a stronger response of the central bank can destabilize the rest of the economy. To put it in simple words, since the demand for food is very insensitive to monetary policy when its consumption is close to subsistence, inflation in this sector becomes difficult to control, rendering its stabilization overly costly. Finally, an additional channel

[1] See Herrendorf et al. (2014) for a review of the structural change literature.

[2] The minimum consumption requirement for food implies that its demand has an income elasticity that is lower than one. Hence, as the economy grows the share of food in total expenditure decreases.

[3] Notable exceptions are Da-Rocha et al. (2006), Rubini et al. (2019) and Storesletten et al. (2019).

relates to the effect of non-homotheticity on the composition of the marginal consumption basket. We will see that such preferences imply that households spend only a small share of any additional income on food. As food prices only affect food demand, which has a reduced participation in the marginal basket, it follows that aggregate demand turns more unresponsive to its evolution. Then, reacting to inflation in this sector becomes less relevant.

Importantly, our results provide a rationale for a target index that excludes (or attaches a limited weight to) food inflation. Excluding food prices from the target constitutes a usual practice amongst central bankers (see for instance Wynne (2008)) and is justified on the ground of the high volatility that characterizes them.[4] Theoretical research provides support to that policy by suggesting that central banks should react only to inflation of goods whose prices are rigid (e.g., Aoki (2001)). The reason for such prescription is that, conditional on prices being rigid, there is a positive link between inflation and price dispersion, the latter constituting a source of welfare losses. Yet, empirical studies challenge that positive link (e.g., Nakamura et al. (2018), Sheremirov (2019)). Broken the relation between inflation and price dispersion, the usual recommendation of disregarding prices from the target based on their flexibility cease to be valid. Based on our results, we provide a new, alternative, rationale for excluding food inflation from the target index, one that does not rely on the flexible nature of these prices.

Regarding the literature on optimal monetary policy in a multisector economy, Aoki (2001) provides one of the classical results. Using a model where one of the sectors has sticky prices while the other is characterized by price flexibility, he finds that stabilizing inflation in the former is sufficient to achieve the efficient allocation. This analysis was expanded in Mankiw and Reis (2003). In that paper, the authors ask what is the measure of inflation that central banks should target in order to stabilize the economy. They establish the difference between the consumption price index and the stabilization price index. The former is weighted by the share of each good in the budget of consumers and is used to measure the cost of living. The latter has an entirely different purpose. It assigns weights such that central banks can attain the maximum stability of economic activity. Their results indicate that central banks should weight a sector in the stabilization price index given its characteristics, which include not only price stickiness, but size, cyclical sensitivity and magnitude of sectoral shocks. In Benigno (2004), the optimal monetary policy in a two region economy is studied. He finds that, conditional on the degree of price stickiness being the same across regions, the central bank can replicate the optimal outcome by fully stabilizing a weighted average of regional inflations, with the weights coinciding with the size of the regions. Instead, if the degree of rigidities is different, a higher weight should be assigned to the region with a higher degree of stickiness.

More closely related to our work, Anand et al. (2015) and Portillo et al. (2016) analyze monetary policy in a multisector economy that incorporates a minimum consumption requirement for food. In

[4] The transitory, supply driven nature of food price developments is often noted as a motive to exclude them from central banks' target index (Mishkin (2007), Mishkin (2008)).

the former, the authors consider segmented labor and incomplete credit markets. That is, workers cannot move across sectors in the economy, while households in the food sector do not have access to banking services. They find that, under incomplete markets, it is optimal for the central bank to target headline inflation after a negative productivity shock in the food, flexible price, sector. The reason is that such a shock increases the labor income of households in this sector (due to a rise in the relative price of food). This in turn affects aggregate demand positively. To curb demand and price volatility, the central bank must include food prices in its target. Notably, the policy prescription put forward in Anand et al. (2015) for an economy characterized by non-homothetic preferences is at contrast with the conclusions in our paper. Portillo et al. (2016) for their part consider a two sector model, featuring a food sector with flexible prices and a nonfood sector with sticky prices. Their findings indicate that non-homotheticity does not alter the optimal policy prescription, since sticky price inflation targeting remains optimal when a minimum consumption requirement is included. As opposed to Portillo et al. (2016), we study an economy where prices are sticky in both food and nonfood.[5] As we will see, our assumption introduces a trade-off for the monetary authority, which turns the existence of sector specific minimum consumption requirements non-trivial,[6] thus departing from their results.

Finally, Galesi and Rachedi (2016) study the effect of structural change on the transmission of monetary policy. They argue that structural change is accompanied by a process of services deepening, that is, both manufacturing and services become more intensive in inputs from the service sector. They also argue that prices in services are more sticky than in manufacturing. Therefore, structural transformation from manufacturing to services dampens the response of aggregate and sectoral inflation to monetary policy shocks.

The rest of the paper is organized as follows. The next section introduces the model. Section 3 illustrates the dynamics of the economy absent price rigidities. Section 4 explores the implications of non-homotheticity for the conduct of monetary policy. Section 5 performs a quantitative exercise. Section 6 concludes.

2 The model

2.1 Firms

The economy consists of two sectors: food and nonfood, denoted by $s \in \{f, n\}$. In each sector there is a continuum of firms, indexed by $i \in [0, 1]$, each producing a single-differentiated good and with monopoly

[5]We consider rigid prices in food since this category comprises processed and unprocessed products (see for instance Alvarez et al. (2006)).

[6]In a setting with flexible food prices the optimal allocation is always achievable, irrespective of households preferences.

power to set prices. The production technology is given by

$$Y_{s,t}(i) = A_{s,t} N_{s,t}(i)^{1-\alpha},$$

where $Y_{s,t}(i)$ is output and $N_{s,t}(i)$ represents labor input demanded by firm i in sector s. Productivity level, denoted by $A_{s,t}$, is common across firms in the same sector.

In every period, firms in sector s reset prices with probability $(1-\theta_s)$, as in Calvo (1983). A firm in sector s that last reset prices in period t, chooses the price that maximizes the following sum of discounted profits

$$\sum_{k=0}^{\infty} \theta_s^k \mathbb{E}_t \left\{ Q_{t,t+k} \left(\overline{P}_{s,t} Y_{s,t+k|t} - TC_{t+k}(Y_{s,t+k|t}) \right) \right\},$$

subject to the demand constraint given by

$$Y_{s,t+k|t} = \left(\frac{\overline{P}_{s,t}}{P_{s,t+k}} \right)^{-\epsilon_p} C_{s,t+k},$$

where $\overline{P}_{s,t}$ is the price chosen by a firm that resets its price at t, $Y_{s,t+k|t}$ is the output of that firm, $P_{s,t+k}$ is a price index, which we define later, and $C_{s,t+k}$ indicates total demand for goods from sector s. ϵ_p is the elasticity of substitution across goods varieties, common across sectors. The total cost of producing $Y_{s,t+k|t}$ units of output is given by $TC_{t+k}(Y_{s,t+k|t}) = W_{t+k} N_{s,t+k|t}$ and $Q_{t,t+k}$ is the stochastic discount factor.

Maximization implies

$$\sum_{k=0}^{\infty} (\theta_s)^k \mathbb{E}_t \left\{ Q_{t,t+k} Y_{s,t+k|t} \left(\overline{P}_{s,t} - \mu_p MC_{s,t+k|t} \right) \right\} = 0, \tag{1}$$

where $MC_s \equiv \frac{\partial TC(Y_s)}{\partial Y_s}$ is the nominal marginal cost of producing one more unit of output in sector s and $\mu_p \equiv \frac{\epsilon_p}{\epsilon_p - 1}$ is the desired markup.

2.2 Households

Lifetime utility of the representative household is given by

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(C_t^*)^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right),$$

where C_t^* is a consumption index and N_t represents labor supply. Parameter σ is the inverse of the elasticity of intertemporal of substitution and φ is the inverse of the Frisch elasticity of labor supply.

The consumption index is an aggregate of food and nonfood goods, defined as

$$C_t^* \equiv \Xi \left(C_{f,t} - \tilde{C}_f\right)^{\omega} C_{n,t}^{1-\omega},$$

where $\Xi \equiv \left(\omega^{\omega}(1-\omega)^{1-\omega}\right)^{-1}$, while $C_{f,t}$ and $C_{n,t}$ are consumption indexes comprising the different varieties of goods available in each sector, defined as

$$C_{s,t} \equiv \left(\int_0^1 C_{s,t}(i)^{\frac{\epsilon_p - 1}{\epsilon_p}} di\right)^{\frac{\epsilon_p}{\epsilon_p - 1}},$$

where $C_{s,t}(i)$ denotes households' consumption of good variety i available in sector s.

Parameter ω is the utility weight of food and $\tilde{C}_f \geqslant 0$ is the food minimum consumption requirement. When $\tilde{C}_f > 0$, preferences are non-homothetic.

Households' budget constraint is given by

$$\int_0^1 P_{f,t}(i) C_{f,t}(i) di + \int_0^1 P_{n,t}(i) C_{n,t}(i) di + Q_t B_t = W_t N_t + B_{t-1} + \Pi_t.$$

They receive labor income, $W_t N_t$, and profits, Π_t, from equal ownership of firms. They spend income on consumption and to accumulate the asset B_t, valued at price Q_t.

2.2.1 Intratemporal optimization

In each period, households choose consumption of good i from sector s given total expenditure in that sector. Optimization implies the following demand function

$$C_{s,t}(i) = \left(\frac{P_{s,t}(i)}{P_{s,t}}\right)^{-\epsilon_p} C_{s,t}, \tag{2}$$

where the price index in sector s is defined as $P_{s,t} \equiv \left(\int_0^1 P_{s,t}(i)^{1-\epsilon_p} di\right)^{\frac{1}{1-\epsilon_p}}$.

In turn, households' total demand of good s is given by

$$C_{f,t} = \tilde{C}_f + \omega \left(\frac{P_{f,t}}{P_t^*}\right)^{-1} C_t^* \tag{3}$$

and

$$C_{n,t} = (1-\omega) \left(\frac{P_{n,t}}{P_t^*}\right)^{-1} C_t^*, \tag{4}$$

where the aggregate price index is defined as

$$P_t^* \equiv P_{f,t}^{\omega} P_{n,t}^{1-\omega}. \tag{5}$$

Notice from (3) that the existence of the food minimum consumption requirement, $\tilde{C}_f$, implies that price and income elasticities of demand for the food goods bundle are lower than one.

Using equation (2) we can derive the aggregate expenditure, E_t, as

$$E_t \equiv \int_0^1 P_{f,t}(i)C_{f,t}(i)di + \int_0^1 P_{n,t}(i)C_{n,t}(i)di = P_{f,t}C_{f,t} + P_{n,t}C_{n,t}.$$

From households' optimal allocation problem we obtain the following relation $P_t^* C_t^* = E_t - P_{f,t}\tilde{C}_f$. Using this expression, we can rewrite the budget constraint as

$$P_t^* C_t^* + Q_t B_t = W_t N_t + B_{t-1} + \Pi_t - P_{f,t}\tilde{C}_f, \tag{6}$$

where $P_t^* C_t^*$ is households' total expenditure excluding the value of the minimum consumption requirement, $P_{f,t}\tilde{C}_f$.

2.2.2 Average and marginal expenditure composition

Next, we explore the effect of the food minimum requirement on households' expenditure composition. From equations (3) and (4), we obtain the following expressions relating expenditure on food and nonfood with total expenditure

$$P_{f,t}\left(C_{f,t} - \tilde{C}_f\right) = \omega \tilde{E}_t$$

and

$$P_{n,t}C_{n,t} = (1-\omega)\,\tilde{E}_t.$$

where $\tilde{E}_t \equiv E_t - P_{f,t}\tilde{C}_f$ denotes income remaining after the food minimum consumption requirement has been covered. By differentiating the previous two expressions with respect to $\tilde{E}_t$, we get

$$\frac{\partial\left(P_{f,t}\left(C_{f,t} - \tilde{C}_f\right)\right)}{\partial \tilde{E}_t} = \omega$$

and

$$\frac{\partial\left(P_{n,t}C_{n,t}\right)}{\partial \tilde{E}_t} = 1 - \omega.$$

The above equations show that, once the minimum requirement of food has been covered, households spend a fraction ω of any additional income on food and the remaining fraction $1-\omega$ on nonfood. We call these the *marginal expenditure shares.*

Average expenditure composition, on the other hand, is given by

$$\eta_t = \frac{P_{f,t}\tilde{C}_f + \omega \tilde{E}_t}{E_t} = \omega + (1-\omega)\frac{P_{f,t}\tilde{C}_f}{E_t}$$

and

$$1-\eta_t = \frac{(1-\omega)\tilde{E}_t}{E_t} = (1-\omega) - (1-\omega)\frac{P_{f,t}\tilde{C}_f}{E_t},$$

where $\eta_t \equiv \frac{P_{f,t}C_{f,t}}{E_t}$ is the *average expenditure share* of food.

If $\tilde{C}_f > 0$ (and therefore $\tilde{E}_t < E_t$), the marginal expenditure share of food is smaller than its average expenditure share, i.e., $\frac{\partial\left(P_{f,t}\left(C_{f,t}-\tilde{C}_f\right)\right)}{\partial \tilde{E}_t} = \omega < \eta_t$. This occurs because households spend all their income on food up to the point where their subsistence needs are met, past that point they spend a fraction ω of any additional income on food.

The marginal expenditure share of nonfood, on the other hand, is larger than its average share, i.e., $\frac{\partial(P_{n,t}C_{n,t})}{\partial \tilde{E}_t} = 1-\omega > 1-\eta_t$. This occurs because households begin to spend a fraction $1-\omega$ of any additional income on nonfood only after they have covered their subsistence needs.

Notice that with homothetic preferences (i.e., $\tilde{C}_f = 0$) the marginal and average expenditure shares are the same, that is, $\omega = \eta_t$.

2.2.3 Intertemporal problem

Maximization of lifetime utility subject to (6) implies the following Euler equation

$$Q_t = \beta \mathbb{E}_t \left\{ \left(\frac{C^*_{t+1}}{C^*_t} \right)^{-\sigma} \frac{P^*_t}{P^*_{t+1}} \right\}. \tag{7}$$

Importantly, the relevant price index for households' intertemporal allocation is given by (5), which weights food and nonfood prices according to the composition of households' marginal, rather than average, consumption basket. Since for intertemporal allocation decisions agents care about the marginal utility of consumption over time, the relevant price index is that of the marginal consumption basket, given by P^*_t, which correctly weighs goods by their shares in marginal expenditure.

2.2.4 Labor supply

Intratemporal optimization implies

$$\frac{W_t}{P^*_t} = C_t^{*\sigma} N_t^{\varphi}. \tag{8}$$

For labor supply the relevant price index is also given by (5). Again, for labor supply decisions agents care about the marginal utility of consumption and, therefore, about the price of the marginal consumption basket.

2.3 Aggregate output and inflation

Due to the minimum consumption requirement, the index C_t^* is not a good measure of aggregate production. We thus introduce a measure of output, which we define as an index where sectoral production is weighted by its steady state relative price

$$Y_t \equiv \frac{P_f}{P} Y_{f,t} + \frac{P_n}{P} Y_{n,t},$$

where P is a measure of the aggregate price level, defined as the index of sectoral prices weighted by the corresponding steady state sectoral production levels, and given by

$$P_t \equiv \frac{Y_f}{Y} P_{f,t} + \frac{Y_n}{Y} P_{n,t}.$$

Differently from P_t^*, this measure weights sectoral prices according to the steady state (or average) rather than the marginal expenditure shares.

2.4 Central Bank

The central bank sets the nominal rate following a simple interest rate rule, given by

$$R_t = \frac{1}{\beta} \left(\frac{\Pi_t^T}{\Pi^T} \right)^{\phi_\pi}, \tag{9}$$

where $R_t = Q_t^{-1}$ is the nominal interest rate.

The measure of inflation that the central bank targets is defined as $\Pi_t^T \equiv \Pi_{f,t}^{\Omega} \Pi_{n,t}^{1-\Omega}$, where $\Pi_{s,t}$ denotes sectoral inflation and Ω is the weight assigned to food inflation.

2.5 Shocks

The model includes temporary shocks to food, nonfood and aggregate productivity. The exogenous process for sector s is given by

$$A_{s,t} = A_s e^{a_{s,t}}.$$

The shock $a_{s,t}$ evolves according to

$$a_{s,t} = \rho_s a_{s,t-1} + \nu_{s,t} + \nu_t,$$

where $\nu_{s,t}$ and ν_t are respectively the sectoral and aggregate IID innovations with zero mean and standard deviation σ_{vs} and σ_v. Parameter ρ_s determines shock persistence and A_s is the sectoral steady state productivity level.

2.6 The linearized system

In this section, we present the log-linear approximation (around the zero inflation steady state) of the system of equations that describes the economy.

The sectoral Phillips curves and production functions are given by[7]

$$\pi_{s,t} = \lambda_s \widehat{mc}_{s,t} + \beta \mathbb{E}_t \pi_{s,t+1},$$

where $\lambda_s \equiv \frac{(1-\theta_s)(1-\beta\theta_s)}{\theta_s} \frac{1-\alpha}{1-\alpha+\alpha\epsilon_p}$, and

$$\hat{y}_{s,t} = a_{s,t} + (1-\alpha)\,\hat{n}_{s,t}.$$

Labor supply is

$$\hat{\omega}_t^* = \sigma \hat{c}_t^* + \varphi \hat{n}_t,$$

where $\omega_t^* = log\left(\frac{W_t}{P_t^*}\right)$ is the real wage. Aggregate employment is

$$\hat{n}_t = \frac{N_f}{N}\hat{n}_{f,t} + \frac{N_n}{N}\hat{n}_{n,t}.$$

The relation between aggregate output and the consumption index is (see Appendix)

$$\hat{c}_t^* = \frac{1-\omega}{1-\eta}\hat{y}_t,$$

where $\eta = \frac{P_f Y_f}{E}$ is the steady state share of food in total expenditure and $\frac{1-\omega}{1-\eta} > 1$.

Inflation associated with the price index P_t^* is given by

$$\pi_t^* = \omega \pi_{f,t} + (1-\omega)\,\pi_{n,t}.$$

Aggregate output and inflation associated with the price index P_t are (see Appendix)

$$\hat{y}_t = \eta \hat{y}_{f,t} + (1-\eta)\,\hat{y}_{n,t}$$

and

$$\pi_t = \eta \pi_{f,t} + (1-\eta)\,\pi_{n,t},$$

Notice that π_t is the model counterpart of the consumer price index (CPI) inflation as it aggregates sectoral inflation in accordance to the average expenditure shares.

The Euler equation is given by

[7] Lowercase variables indicate logs, while hats indicate log deviation from steady state.

$$\hat{c}_t^* = -\frac{1}{\sigma}\mathbb{E}_t\left(\hat{r}_t - \pi_{t+1}^*\right) + \mathbb{E}_t\hat{c}_{t+1}^* \tag{10}$$

and the sectoral demands are the following

$$\hat{c}_{f,t} = \frac{\omega(1-\eta)}{(1-\omega)\eta}\left(-(1-\omega)\hat{p}_{r,t} + \hat{c}_t^*\right)$$

and

$$\hat{c}_{n,t} = \omega\hat{p}_{r,t} + \hat{c}_t^*,$$

where $\frac{\omega(1-\eta)}{(1-\omega)\eta} < 1$ and $p_{r,t} \equiv p_{f,t} - p_{n,t}$ represents relative prices.

Finally, the policy rule is given by

$$\hat{r}_t = \phi_\pi\pi_t^T = \phi_\pi\left(\Omega\pi_{f,t} + (1-\Omega)\pi_{n,t}\right).$$

3 The flexible price economy

We begin by exploring the implications of the minimum consumption requirement in the flexible price economy. The following results provide insight on the effects of non-homotheticity on the economy and, additionally, they will prove useful for the optimal policy study, introduced in Section 4. One can show that (see Appendix) absent nominal rigidities the response of the economy to the sectoral productivity shocks is given by[8]

$$\hat{y}_{f,t}^n = \Upsilon_{ff}a_{f,t}, \tag{11}$$

$$\hat{y}_{n,t}^n = \Upsilon_{nf}a_{f,t} + a_{n,t}, \tag{12}$$

$$\hat{p}_{r,t}^n = -\Upsilon_p a_{f,t} + a_{n,t}, \tag{13}$$

$$\hat{n}_t^n = \Upsilon_n a_{f,t}, \tag{14}$$

$$\hat{y}_t^n = \Upsilon_y a_{f,t} + (1-\eta)a_{n,t}, \tag{15}$$

[8]In this section, we assume log utility to simplify the analysis.

$$(\hat{\omega}_t^*)^n = \Upsilon_\omega a_{f,t} + (1-\omega)\, a_{n,t}, \tag{16}$$

where $\Upsilon_{ff} \equiv \frac{1+\varphi}{\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)\varphi(1-\eta)+\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)+\varphi\eta+\alpha\varphi(1-\eta)+\alpha}$, $\Upsilon_{nf} \equiv \frac{\left(\frac{(1-\omega)\eta}{\omega(1-\eta)}-1\right)(1-\alpha)\varphi\eta}{\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)\varphi(1-\eta)+\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)+\varphi\eta+\alpha\varphi(1-\eta)+\alpha}$, $\Upsilon_p \equiv \frac{1-\alpha\left(\Upsilon_{ff}-\Upsilon_{nf}\right)}{1-\alpha}$, $\Upsilon_n \equiv \frac{\eta\Upsilon_{ff}+(1-\eta)\Upsilon_{nf}-\eta}{1-\alpha}$, $\Upsilon_y \equiv \eta\Upsilon_{ff} + (1-\eta)\,\Upsilon_{nf}$, $\Upsilon_\omega \equiv \frac{\omega}{1-\alpha}\left(1-\alpha(\Upsilon_{ff}+\frac{1-\omega}{\omega}\Upsilon_{nf})\right)$ and the superscript n denotes natural levels, i.e., variables under flexible prices.

From our discussion in section 2.2.2 we know that with homothetic preferences $\omega = \eta$ holds, hence

$$\Upsilon_{ff} = 1,\ \Upsilon_{nf} = 0,\ \Upsilon_p = 1,\ \Upsilon_n = 0,\ \Upsilon_y = \eta \text{ and } \Upsilon_\omega = \omega = \eta.$$

With non-homothetic preferences we have $\omega < \eta$, implying

$$\Upsilon_{ff} < 1,\ \Upsilon_{nf} > 0,\ \Upsilon_p > 1,\ \Upsilon_n < 0,\ \Upsilon_y < \eta \text{ and } \Upsilon_\omega < \eta^9.$$

Let us first consider the manner the minimum food consumption requirement alters the response of the flexible price economy to a negative shock to food productivity. In the economy with non-homothetic preferences, proximity to the minimum consumption requirement implies that it is costly for households to reduce food consumption. As a consequence, agents offset the effect of a lower productivity by moving labor from the nonfood to the food sector. This results in a contained fall in food production (equation (11)) at the expense of a larger contraction in nonfood output (equation (12)), relative to the economy characterized by homothetic preferences.

The dampened response of food production to the adverse shock implies a stronger increase in relative prices under non-homothetic preferences (equation (13)). Since food production remains high following the shock, so do marginal costs in that sector, which leads to a larger increase in the relative price of food. Note that the larger increase in relative prices under non-homothetic preferences requires $\alpha > 0$, since the link between sectoral output and sectoral marginal costs hinges on labor returns being decreasing.

Total employment is invariant with homothetic preferences, given the assumed log utility, while in the non-homothetic economy it goes up after the negative shock to food productivity (equation (14)). To clarify this result, we need to look at the labor supply and demand schedules, given respectively by[10,11]

$$(\hat{\omega}_t^*)^n = \frac{1-\omega}{1-\eta}\hat{y}_t^n + \varphi\hat{n}_t^n, \tag{17}$$

[9]This relation holds for reasonable parametrizations of the model.

[10]To simplify the analysis, the labor demand and supply equations are derived setting $\alpha = 0$.

[11]Equation (18) can be derived from the sectoral labor demand, given by

$$(\hat{\omega}_t^*)^n - (\hat{p}_{s,t}^*)^n = a_{s,t} = \widehat{mrt}_{s,t},$$

where $p_{s,t}^* = log\left(\frac{P_{s,t}}{P_t^*}\right)$ and $\widehat{mrt}_{s,t}$ denotes the sectoral marginal rate of transformation, that is, the rise in production in sector s when the labor input in the corresponding sector increases by one unit.

$$(\hat{\omega}_t^*)^n = \omega a_{f,t} + (1-\omega)\, a_{n,t} = \widehat{mrt}_t, \tag{18}$$

where $\hat{y}_t^n = \eta a_{f,t} + (1-\eta)\, a_{n,t} + \hat{n}_t^n$ and $\widehat{mrt}_t \equiv \omega \widehat{mrt}_{f,t} + (1-\omega)\, \widehat{mrt}_{n,t}$ denotes the aggregate marginal rate of transformation.

The aggregate marginal rate of transformation constitutes the relevant productivity measure for the production of one additional unit of the marginal composite consumption basket. Importantly, this measure of aggregate productivity weights sectoral productivities according to the marginal expenditure shares.

Equations (17) and (18) illustrate the reasons for the rise in employment in the non-homothetic case. On the one hand, given an equal steady state share of food in both economies (i.e., $\eta^{NH} = \eta^H$, where the superscripts H and NH denote homothetic and non-homothetic preferences, respectively), non-homotheticity amplifies the income effect of productivity changes, since $\omega^{NH} < \omega^H = \eta$. This is so because cutting consumption is highly costly when the economy is close to subsistence. That implies a stronger increase in labor supply with this type of preferences. On the other hand, given $\eta^{NH} = \eta^H$, non-homotheticity weakens the substitution effect. This is clear from (18), which illustrates that the aggregate marginal rate of transformation reduces by less with these preferences, since $\omega^{NH} < \omega^H = \eta$. The reason is that, at the margin, the share of food in the consumption basket is smaller under non-homotheticity, and hence, the aggregate marginal rate of transformation reduces by less after the fall in food productivity. The weaker substitution effect implies a contained reduction in employment relative to the homothetic case.

Assuming $\eta^{NH} = \eta^H$, the non-homothetic economy experiences a smaller drop in output, as is clear from (15). This is explained by the increase in employment with this type of preferences.

Finally, given $\eta^{NH} = \eta^H$, the real wage reduces by less after the adverse shock when preferences are non-homothetic (equation (16)). Clearly, this is explained by the smaller reduction in the aggregate marginal rate of transformation, which, as stated earlier, represents the relevant productivity measure for the production of one additional unit of the marginal composite consumption basket. Since this measure of aggregate productivity falls by less, the wage firms are willing to pay reduces more moderately.

Regarding the dynamics following a nonfood productivity shock, the responses of the economies featuring homothetic and non-homothetic preferences are identical, except for the real wage, which falls by more in the non-homothetic case. Since the marginal share of nonfood is higher with this type of preferences, productivity variations in this sector alter the aggregate marginal rate of transformation by more. Accordingly, after a negative shock in nonfood the real wage falls more strongly.

4 Monetary policy with non-homothetic preferences

In this section we study the conduct of monetary policy in an economy with non-homothetic preferences. To this end we compare the economy with preferences incorporating the minimum consumption requirement to a benchmark economy featuring homothetic preferences. To isolate the effects from non-homotheticity, we start by considering economies where the food and nonfood sectors are identical, except for the existence of the minimum consumption requirement in the former. In Section 5 we adopt a more realistic calibration to perform a quantitative exercise.

4.1 IRF analysis

As a prelude to the optimal policy analysis we explore the dynamics of the non-homothetic economy in response to shocks. For the baseline calibration we assume $\sigma = 1$ and $\varphi = 1$, which are common values in the literature. The discount factor, β, is set to 0.99, which implies an annual interest rate of 4%. The elasticity of substitution across goods varieties, ϵ_p, is set to 6, implying a markup of 1.2 in steady state. Parameter α is set to 0.25. We assume $\theta_f = \theta_n = 0.75$, implying an average price duration of four quarters.

For the non-homothetic economy we set parameter ω, the share of food in marginal expenditure, to 0.05[12], that is, households will spend only 5% of any additional income in this sector. The minimum consumption requirement for food, $\tilde{C}_f$, is set such that the steady state share of food in total expenditure is 50%. Our purpose is to compare this economy to another having the same steady state share of food in total expenditure but featuring homothetic preferences. Consequently, for the economy characterized by homothetic preferences we set $\omega = \eta = 0.5$, implying that the share of food, both on average and in the margin, is 50%.

We set the response to inflation in the Taylor rule, ϕ_π, to 1.5. The productivity shock parameters are set to $\rho_f = \rho_n = 0.9$ and $\sigma_{vf} = \sigma_{vn} = \sigma_v = 0.02$.

Figure 1 displays the IRFs to a negative shock to food productivity for the economies featuring homothetic and non-homothetic preferences. The central bank is assumed to follow a Taylor rule with weights on sectoral inflation coinciding with sectoral sizes ($\Omega = 0.5$). In the homothetic economy there is a large contraction in food output while nonfood production falls only moderately. This results from a rise in the policy rate, which responds to food inflation, and an increase in relative prices, which switches consumption from food to nonfood. Differently, in the non-homothetic case food production falls slightly, while output in nonfood experiences a large contraction. This results from the low income and price elasticities of demand for food. This behavior is in line with the preceding analysis of the flexible price economy. Given the proximity to the minimum consumption requirement, labor shifts to

[12]This value is close to Herrendorf et al. (2013), who estimate CES preferences incorporating a minimum consumption requirement for food using US data.

the food sector to prevent a fall in food consumption, but at the cost of a large contraction in nonfood.

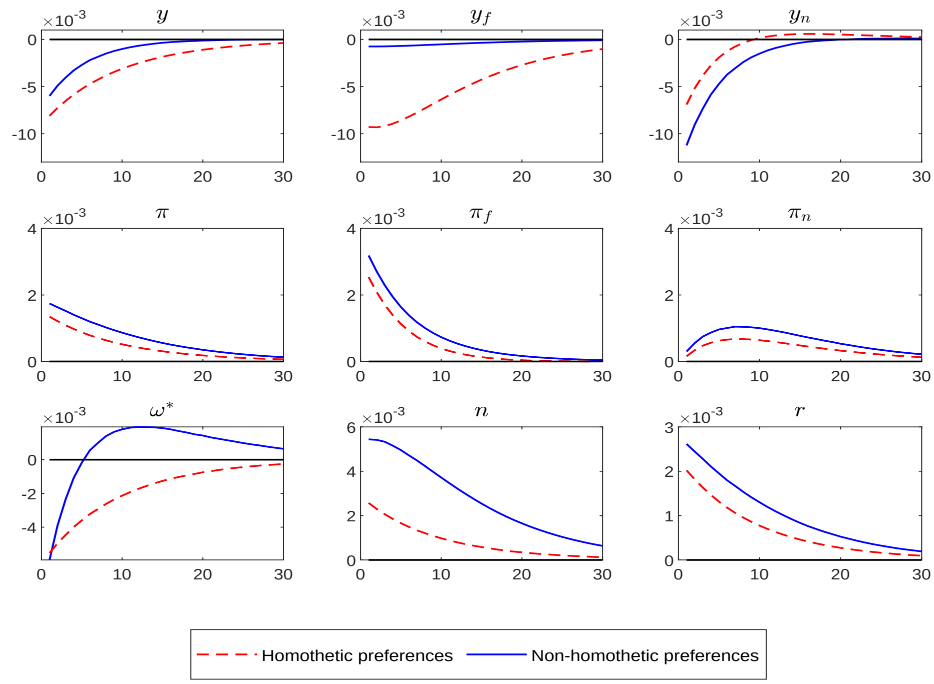


Figure 1: Shock to food productivity when the central bank follows a Taylor rule

In what follows we evaluate the implications of the minimum consumption requirement for the optimal design of monetary policy. We consider the optimal policy under commitment and the optimal choice of Ω under a Taylor rule.

4.2 Optimal policy under commitment: a special case

In this section we explore the optimal policy under commitment. To this end we derive the welfare loss function for the model economy incorporating a minimum consumption requirement. We assume $\alpha = 0$ to obtain an analytical expression for welfare losses. Later, we explore the general case where $\alpha > 0$. In addition, we assume a labor subsidy that corrects the inefficiency generated by monopolistic competition in the goods market. By performing a second order approximation of households' utility around the efficient steady state, welfare losses can be expressed as

$$L_t = -\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\int_0^1 (U_t - U)\, dj}{U_c Y} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{2} \left\{ \Xi_y \tilde{y}_t^2 + \Xi_p \tilde{p}_{r,t}^2 + \Xi_f \pi_{f,t}^2 + \Xi_n \pi_{n,t}^2 \right\},$$

where $\tilde{y}_t$ and $\tilde{p}_{r,t}$ represent output and relative prices in deviation from their natural levels, $\Xi_y \equiv \frac{1-\omega}{1-\eta} + \varphi$, $\Xi_p \equiv \omega (1 - \eta)$, $\Xi_f \equiv \eta \frac{\epsilon_p}{\lambda_f}$ and $\Xi_n \equiv (1 - \eta) \frac{\epsilon_p}{\lambda_n}$.

Welfare losses result from deviations of output and relative prices from their natural counterparts, as well as from sectoral inflation. We have seen that homothetic and non-homothetic preferences imply $\omega = \eta$ and $\omega < \eta$, respectively. Accordingly, the weight on the output gap is higher when preferences are non-homothetic, reflecting higher costs associated to output variations, which result from food consumption being close to its subsistence requirement. Given the food expenditure share η, the weight associated to the gap in relative prices is smaller with non-homothetic preferences. This results from a smaller degree of substitutability associated to these preferences. Also, given η, weights on sectoral inflation are not affected by the type of preferences. These weights are directly related to the degree of sectoral rigidities, reflected in λ_s, and the sectoral expenditure shares.

The loss function is minimized subject to the following constraints

$$\pi_{f,t} = \lambda_f \left(\frac{1-\omega}{1-\eta} + \varphi \right) \tilde{y}_t - \lambda_f \left(1-\omega\right) \tilde{p}_{r,t} + \beta \mathbb{E}_t \pi_{f,t+1}, \tag{19}$$

$$\pi_{n,t} = \lambda_n \left(\frac{1-\omega}{1-\eta} + \varphi \right) \tilde{y}_t + \lambda_n \omega \tilde{p}_{r,t} + \beta \mathbb{E}_t \pi_{n,t+1}, \tag{20}$$

$$\tilde{p}_{r,t} = \tilde{p}_{r,t-1} - \Delta p^n_{r,t} + \pi_{f,t} - \pi_{n,t}. \tag{21}$$

where $\Delta p^n_{r,t} = \Delta a_{n,t} - \Delta a_{f,t}$.

Equations (19) and (20) are the sectoral Phillips curves, while (21) reflects the evolution of the relative price gap. According to (21), the monetary authority faces a trade-off whenever a shock impacts natural relative prices. Namely, whenever $\Delta p^n_{r,t} \neq 0$ it is not possible to simultaneously stabilize sectoral inflation and the gap in relative prices. Given the implications of non-homotheticity for the relation between ω and η, the nature of preferences affects both the weights in the objective function and the constraints.

The FOCs of the minimization problem are the following

$$-\Xi_y \tilde{y}_t - \vartheta_{1,t} \lambda_f \left(\frac{1-\omega}{1-\eta} + \varphi \right) - \vartheta_{2,t} \lambda_n \left(\frac{1-\omega}{1-\eta} + \varphi \right) = 0,$$

$$-\Xi_f \pi_{f,t} + \vartheta_{1,t} - \vartheta_{1,t-1} - \vartheta_{3,t} = 0,$$

$$-\Xi_n \pi_{n,t} + \vartheta_{2,t} - \vartheta_{2,t-1} + \vartheta_{3,t} = 0,$$

$$-\Xi_{rp} \tilde{p}_{r,t} + \vartheta_{1,t} \lambda_f \left(1-\omega\right) - \vartheta_{2,t} \lambda_n \omega + \vartheta_{3,t} - \beta \mathbb{E}_t \vartheta_{3,t+1} = 0.$$

where $\vartheta_{1,t}$, $\vartheta_{2,t}$ and $\vartheta_{3,t}$ are the Lagrange multipliers associated to the constraints.

We impose equal degree of price stickiness across sectors, implying $\lambda_f = \lambda_n = \lambda$. Under this assumption the food minimum consumption requirement is the only source of sectoral heterogeneity.

For this particular scenario the following optimality condition is derived from the FOCs

$$\pi_t = \eta \pi_{f,t} + (1-\eta)\,\pi_{n,t} = -\frac{1}{\epsilon_p}\Delta \tilde{y}_t. \tag{22}$$

Let us first focus on the optimal policy solution for the case of homothetic preferences. From the sectoral Phillips curves we derive the following Phillips equation for CPI inflation

$$\pi_t = \lambda \left(\tfrac{1-\omega}{1-\eta} + \varphi\right) \tilde{y}_t - \lambda\left(\eta\left(1-\omega\right) - \left(1-\eta\right)\omega\right)\tilde{p}_{r,t} + \beta \mathbb{E}_t \pi_{t+1}.$$

With homothetic preferences $\omega = \eta$ holds, thus the above expression reduces to

$$\pi_t = \lambda \left(\frac{1-\omega}{1-\eta} + \varphi\right)\tilde{y}_t + \beta \mathbb{E}_t \pi_{t+1}. \tag{23}$$

Equation (23) tells us that it is feasible for the monetary authority to simultaneously attain the full stabilization of CPI inflation and the output gap.

By solving the system of equations composed by (22) and (23) we get that the optimal policy under commitment effectively prescribes to set $\pi_t = \tilde{y}_t = 0\ \forall t$.

Notice that $\pi_t = 0$ implies $\eta\pi_{f,t} + (1-\eta)\,\pi_{n,t} = 0$, that is, the optimal policy prescribes to fully stabilize an inflation index with the weights coinciding the size of the sectors. This result accords the findings in Benigno (2004).

To asses whether policy prescriptions differ under non-homotheticity, we compare the IRFs under the Ramsey policy for the homothetic and non-homothetic cases. Figure 2 presents the dynamics after a negative shock to food productivity. After the adverse shock the central bank implements a contractive policy. Such response is desirable for two reasons. On the one hand, by containing wages, it offsets the effect of a lower productivity on food inflation, yet at the cost of provoking a deflation in nonfood. On the other hand, the contraction in activity is desirable by itself, since the adverse shock reduces the efficient level of output.

With homothetic preferences the optimal policy prescribes to contract output up to its new efficient level, i.e., a zero output gap is advised. This implies $\pi_{f,t} = -\pi_{n,t}$, that is, equal inflation volatility across sectors is prescribed by the optimal policy. Such outcome is in line with our previous results, namely, CPI inflation and the output gap are fully stabilized when preferences are homothetic. Given $\eta = 0.5$ (i.e., equal sectoral sizes), setting $\pi_t = 0$ implies $\pi_{f,t} = -\pi_{n,t}$. That is, equal inflation volatility across sectors is advised by the optimal policy. Importantly, this policy minimizes losses related to the output gap, since $\tilde{y} = 0$ under the Ramsey policy, and losses derived from sectoral inflation.[13]

Concerning the non-homothetic economy two things are worth noting. First, that the Ramsey policy prescribes to tolerate a relatively higher inflation in the food sector, as $\pi_{f,t} > -\pi_{n,t}$ is advised. Second,

[13]Given the convexity of the loss function, it is optimal to reduce food inflation up to the point where inflation in this sector equates deflation provoked in nonfood.

despite allowing for a relatively higher inflation in food, a more negative output gap has been required to moderate inflation in that sector.

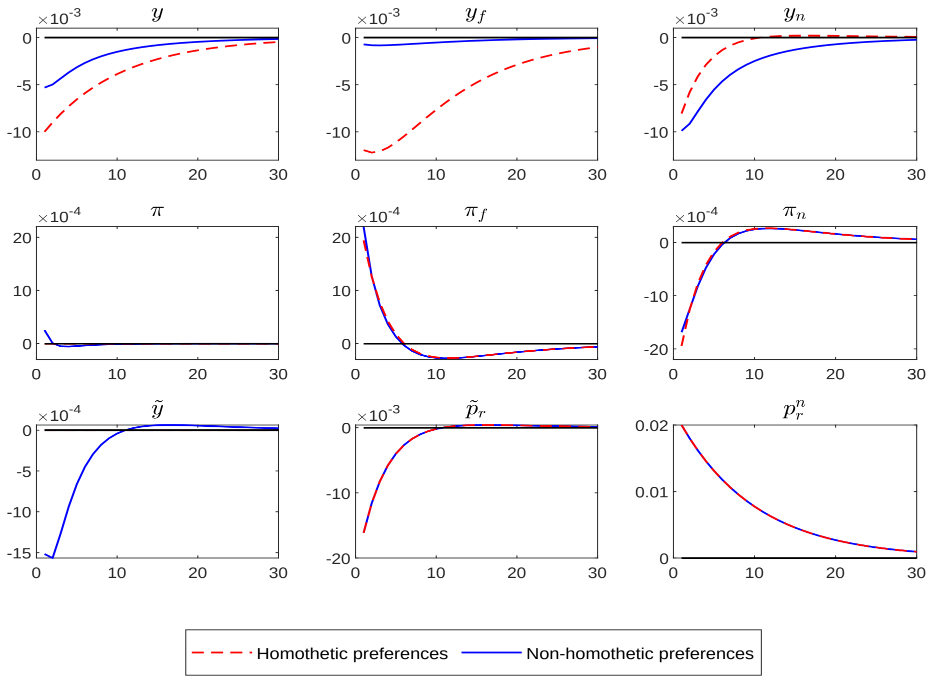


Figure 2: Optimal policy under commitment after a shock to food productivity

The different policy prescription under non-homothetic preferences can be understood by inspecting equations (19) and (20). Given $\omega^{NH} < \omega^{H}$, non-homotheticity increases (reduces) the slope on relative prices in the Phillips curve for food (nonfood) goods. Since the adverse shock to food productivity leads to a negative gap in relative prices ($\tilde{p}_{r,t} < 0$),[14] the latter implies that higher inflationary pressures in the food sector are experienced in the non-homothetic economy. This means that, relative to the homothetic case, a more negative output gap is required to contain inflation in this sector. Since containing food inflation requires larger contractions of output below the efficient level, the monetary authority ends up tolerating a relatively higher inflation in this sector.

The reason why a more negative gap is required in the non-homothetic economy is that reducing output to its new efficient level is more ineffective in containing costs in that environment. To see this, recall that in Section 3 we showed that the natural real wage falls by less after a negative shock to food productivity with this type of preferences. Then, conditional on output (and the real wage[15]) falling to their new natural levels, wages and thus inflationary pressures are higher in the economy with

[14]Natural food prices rise relative to natural nonfood prices due to the fall in productivity in the former, hence natural relative prices increase. Given price stickiness, the gap in relative prices falls.

[15]The following relation between the output and real wage gaps $\tilde{\omega}_t = \left(\frac{1-\omega}{1-\eta} + \varphi\right)\tilde{y}_t$ imply that when output is at its natural level, so is the real wage.

non-homothetic preferences. Looking at the labor demand side, the contained cut in wages is explained by a smaller drop in the aggregate marginal rate of transformation. As we stressed in Section 3, the smaller reduction in the relevant measure of aggregate productivity implies a smaller reduction in the wage firms are willing to pay. Looking at the labor supply side, a dampened drop in natural output in the non-homothetic economy implies that workers demand higher wages. As a consequence, the central bank will need to contract output below the efficient level to further contain costs and, therefore, inflationary pressures. Note that this is the first of the three reasons we stressed in the introduction for the desirability of a limited response to food inflation.

At last, notice that after a shock to nonfood productivity the optimal policy prescription for the non-homothetic economy is also biased towards the stabilization of nonfood inflation (not shown).[16]

The optimal simple rule

To provide more insight on the results in this section, we study the behavior of the economy under an optimized simple rule. We compute the optimal simple rule by allowing the central bank to choose the weight on food inflation in its target index, Ω, and the strength of the policy rate response to total inflation, ϕ_π. Shocks are to both food and nonfood productivity. We find that for the homothetic and non-homothetic cases welfare losses are minimized when the central bank fully stabilizes (at zero) the targeted inflation index, i.e., when $\phi_\pi \to \infty$, with Ω set to 0.5 and 0.46, respectively. Importantly, if sectoral shocks are considered separately the policy reaction function that delivers the optimal outcome is the same.

To better understand this result we compute losses associated to alternative choices of Ω, under the assumption that the central bank fully stabilizes the targeted index.

Figure 3 shows the results. The horizontal axis represents the weight on food inflation, Ω, while the vertical axis represents consumption equivalent welfare losses. Losses are decomposed according to their source.

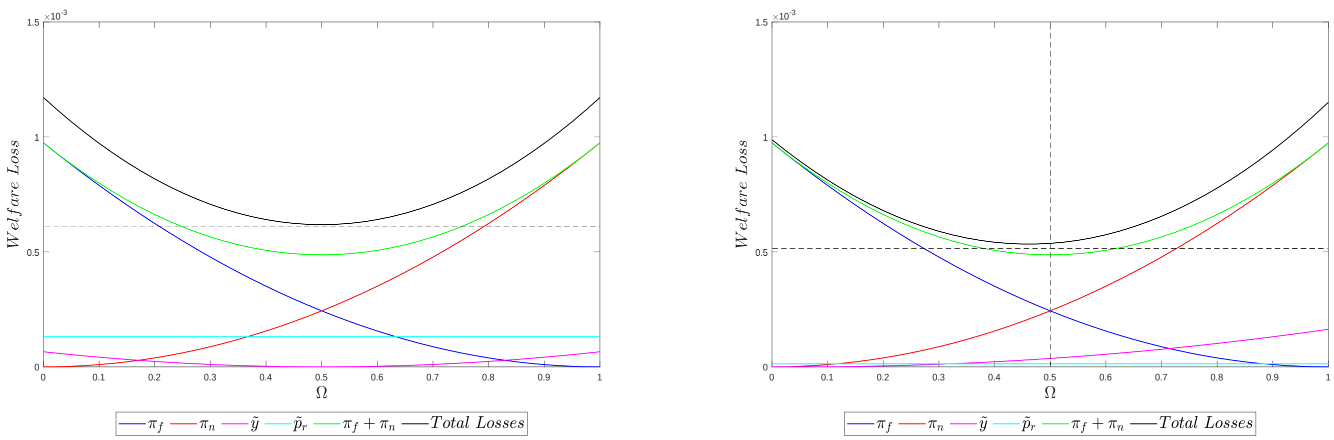
First, let us examine the results for the economy with homothetic preferences, presented in Figure 3 Panel (a). In line with findings in the previous section, setting $\Omega = 0.5$ minimizes losses related to both the output gap and inflation. Consider now the non-homothetic economy, presented in Figure 3 Panel (b). If the central bank only cared about minimizing losses related to inflation, setting $\Omega = 0.5$ would be optimal, just as in the homothetic case. Yet, if the central bank was uniquely concerned about losses related to the output gap it would be optimal to set $\Omega = 0.05$. Under this choice of Ω the output gap is

[16] This result can also be explained by the slopes on the relative price gap. The negative shock to nonfood leads to a positive gap in relative prices ($\tilde{p}_{r,t} > 0$), which, conditional on $\tilde{y}_t = 0$, implies $-\pi_{f,t} > \pi_{n,t}$. Further containing food deflation would be costly, as it requires inducing a (positive) gap in output. The analysis of the flexible price economy can also provide an intuition for this result. With shocks to nonfood productivity, the aggregate marginal rate of transformation and, therefore, the natural real wage, become more responsive when preferences are non-homothetic. Accordingly, after a negative shock in nonfood the natural real wage falls by more. Then, deflationary pressures in the food sector are higher.

fully stabilized. Here we can observe the same trade-off noticed in the previous section. Conditional on output being at its natural level, inflationary pressures in the food sector are too high, then the central bank needs to induce a gap in output in order to further stabilize it. Taking into account all sources of losses we get an optimal Ω of 0.46, which lies very close to the value under homothetic preferences. A much higher weight in the loss function on sectoral inflation relative to the output gap explains that the optimal Ω is closer to the value that minimizes looses related to inflation.

An important corollary from our analysis is that if the monetary authority were to concede a more important role to output volatility in the design of its loss function, the case for a limited response to food prices could be considerable strengthened.[17] To illustrate this point, we perform an experiment where we recompute the optimal rule when equal weighting in the loss function on output and inflation is assumed. In such a case, setting $\Omega = 0.2$ delivers the best outcome.

At last, observe that under the optimized reaction function the Ramsey optimal allocation is replicated under homothetic preferences. In the non-homothetic case the optimal allocation is not replicated, yet welfare losses are close to the Ramsey outcome.



(a) Homothetic preferences (b) Non-homothetic preferences

Figure 3: Optimal simple rule

Note: The blue and red lines represent losses resulting from inflation in the food and nonfood sectors, respectively, while the green line indicates the sum of sectoral inflation related losses. The purple and light blue lines correspond to losses associated to the gaps in output and relative prices and the black line represents total losses. The vertical dashed line indicates the optimal Ω under homothetic preferences while the horizontal dashed line represents losses under the Ramsey policy.

[17]In our model the weight on output relative to inflation in the loss function is smaller by a factor of 0.0415. Relative weightings of that magnitude are standard in the New Keynesian literature, yet they are not robust feature. For instance, in the context of a estimated medium-scale model for the U.S., Debortoli et al. (2018) find that the output gap should have an equal or even larger role than inflation when designing a loss function.

4.3 Optimal policy under commitment: the general case

In this section we study the optimal policy under commitment for the general case when $\alpha > 0$.[18] Figure 4 presents the response to a negative shock to food productivity under the Ramsey policy.[19] Notably, the figure illustrates that the bias towards the stabilization of nonfood inflation exacerbates when $\alpha > 0$.

To shed light on this result, we need to look at the sectoral Phillips curves, now given by

$$\pi_{f,t} = \lambda\left(\frac{1-\omega}{1-\eta} + \varphi\frac{1}{1-\alpha} + \frac{\alpha}{1-\alpha}\frac{\omega}{\eta}\right)\tilde{y}_t - \lambda\left(1 + \frac{\alpha}{1-\alpha}\frac{\omega\,(1-\eta)}{(1-\omega)\,\eta}\right)(1-\omega)\,\tilde{p}_{r,t} + \beta\mathbb{E}_t\pi_{f,t+1}, \tag{24}$$

$$\pi_{n,t} = \lambda\left(\frac{1-\omega}{1-\eta} + \varphi\frac{1}{1-\alpha} + \frac{\alpha}{1-\alpha}\frac{1-\omega}{1-\eta}\right)\tilde{y}_t + \lambda\left(1 + \frac{\alpha}{1-\alpha}\right)\omega\tilde{p}_{r,t} + \beta\mathbb{E}_t\pi_{n,t+1}. \tag{25}$$

Equations (24) and (25) show that, conditional on $\alpha > 0$, non-homotheticity reduces the slope on the output gap for food relative to nonfood inflation (since $\omega^{NH} < \omega^{H}$). The reason is that non-homothetic preferences turn the demand for food more income inelastic relative to nonfood. Decreasing returns for their part create a link between sectoral output and sectoral marginal costs (and hence, sectoral inflation).[20] Since food demand is relatively less sensitive to income so are food prices, hence the reduced slope of the Phillips curve for food. Going back to Figure 4, this means that inducing a negative gap in output will translate into small gains in terms of containing food inflation relative to losses associated to deflation in the nonfood sector that the output contraction would provoke. As a consequence, stabilizing food inflation becomes less desirable. This is the second reason we highlighted in the introduction for the optimality of a limited response to food inflation: as the demand for food becomes insensitive to monetary policy, food inflation becomes difficult to control, which renders its stabilization overly costly.

Decreasing returns are fundamental for our outcome as they imply a comovement between sectoral marginal cost and sectoral output. Notice however that they are not a necessary condition to obtain such comovement. For instance, relaxing our assumption of perfect labor mobility or introducing sector specific capital would be associated to a positive correlation between sectoral output and sectoral factor costs. This in turn implies a positive relation between sectoral output and sectoral marginal costs, even in a model featuring constant returns to scale.

As a last remark, notice that a bias towards the stabilization of nonfood inflation is also advised after a shock to nonfood productivity (not shown).

[18] We set $\alpha = 0.25$, as in the baseline calibration.

[19] The optimal Ramsey policy is computed by maximizing households' lifetime utility subject to the non-linear system describing the private sector optimality conditions.

[20] When $\alpha = 0$ sectoral marginal costs depend on aggregate rather than sectoral output. This is so because, under our assumption of perfect labor mobility, wages (and hence marginal costs) in sector s depend on aggregate employment (and output), rather than employment in the corresponding sector.

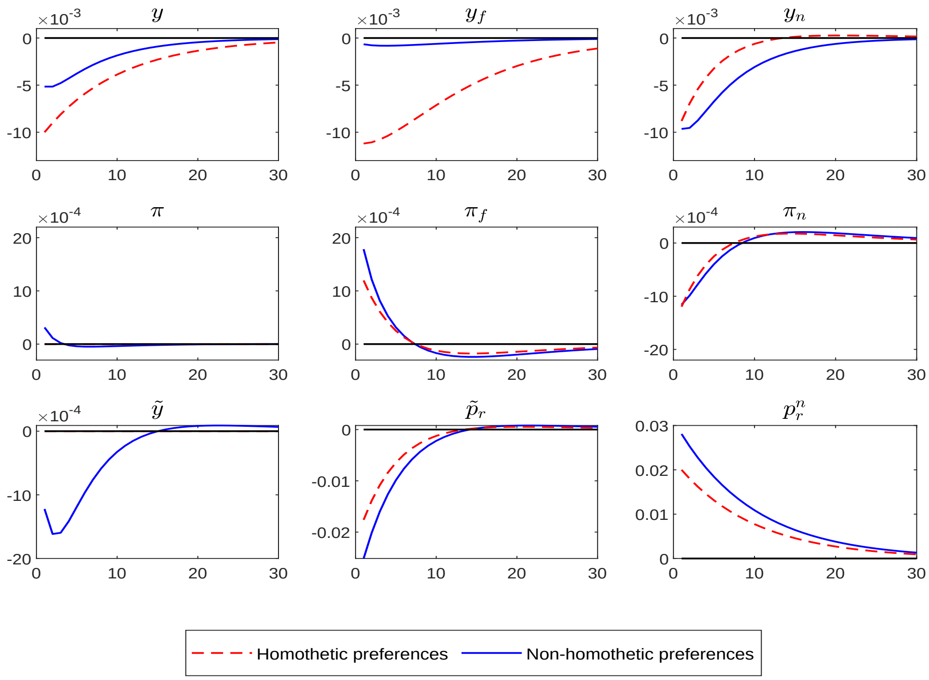


Figure 4: Optimal policy under commitment after a shock to food productivity ($\alpha > 0$)

4.4 The optimal Taylor rule

In this section we compute the optimal Ω assuming that the central bank follows a Taylor rule. More precisely, the central bank chooses the weight on food inflation in the target index while ϕ_π is kept fixed to its baseline calibration. We allow for both food and nonfood productivity shocks as sources of fluctuations.

The optimal policy assigns a weight of only 0.28 to food inflation, significantly below the 0.5 prescribed under homothetic preferences. We conclude that a bias towards the stabilization of nonfood inflation is also advised when the central bank follows a Taylor rule. Next, we seek to understand this result.

The role of inflation expectations

This subsection explores an additional role of preferences. From (10) we know that a modified Euler equation arises under non-homotheticity. The Euler relation tell us that aggregate consumption demand responds to expected inflation, here given by $\mathbb{E}_t \pi^*_{t+1}$, for it determines the real interest rate. As noted earlier, the inflation index that is relevant for intertemporal allocation, π^*_t, weights sectoral inflation according to the marginal rather than the average expenditure shares. It follows that in a non-homothetic economy the expected evolution of food inflation has a reduced impact on aggregate demand (given

$\omega^{NH} < \omega^{H}$). This is logical, as the path of food prices only affects food demand, which has a reduced participation in the marginal consumption basket. Against this background, we seek to test whether the implied low sensitivity of aggregate demand to the evolution of food prices reduces the desirability of reacting to inflation in that sector. In such a case, the implications of non-homotheticity for the index that shapes households' aggregate demand might constitute a factor that explains the optimality of attaching a low weight to food in the target index. We explore this channel next.[21]

To asses whether inflation expectations play a role, we perform the following exercise. Consider a setup where the central bank neutralizes any effect from inflation expectations on households demand by moving the nominal rate one to one with the latter. In particular, let us assume a reaction function of the form $\hat{r}_t = \mathbb{E}_t \pi^*_{t+1} + \phi_\pi \left(\Omega \pi_{f,t} + (1-\Omega)\, \pi_{n,t}\right)$. By computing the optimal weight on food inflation in this setting we obtain an optimal Ω of 0.55, that is, the bias towards the stabilization of nonfood inflation vanishes.[22] Our results thus indicate that preferences play an additional role by shaping the relevant price index for intertemporal allocation. This is the third reason we stressed in the introduction for the desirability of a limited response to food inflation: as aggregate demand turns less responsive to the evolution of food prices, reacting to inflation in this sector becomes less important.

4.5 Optimal policy with aggregate shocks

Next we explore the implications of the minimum consumption requirement when shocks to aggregate productivity hit the economy. With aggregate shocks, non-homotheticity alters the behavior of the economy due to its effects on the dynamics of natural relative prices. More precisely, assuming a common shock the natural relative price is given by

$$\hat{p}^n_{r,t} = (1 - \Upsilon_p)\, a_t.$$[23]

When preferences are homothetic we have $\Upsilon_p = 1$, and therefore, $\hat{p}^n_{r,t} = 0$. Differently, with non-homothetic preferences $\Upsilon_p > 1$ holds, and thus, $\hat{p}^n_{r,t} \neq 0$.

Intuitively, non-homotheticity results in variations of the natural relative price as it entails a differentiated sensitivity of sectoral outputs to the shock. Since the economy is close to subsistence, food output is less responsive than production in the nonfood sector. Given the decreasing returns to labor, this implies that marginal costs and, therefore, prices in the food sector are relatively less sensitive. Then, the natural relative price varies.

[21]Notice that in the Ramsey policy analysis this feature of non-homotheticity was irrelevant since the Euler equation does not affect the optimal path of macro variables. In such policy exercise, the Euler equation uniquely determines the path of the policy rate required to implement the Ramsey prescription. When the central bank follows a Taylor rule, however, the Euler equation determines the equilibrium dynamics after a shock.

[22]The fact that the optimal Ω goes beyond 0.5 indicates the existence of an additional force associated with non-homotheticity whose effect opposes that of expectations.

[23]Here we assume $a_t = a_{f,t} = a_{n,t}$.

Given this result, equation (21) tells us that the optimal allocation is achievable when preferences are homothetic. By contrast, if preferences are non-homothetic aggregate shocks alter the natural relative price, which gives rise to a trade-off for the monetary authority.

Next, let us consider the response of the economy to a negative shock to aggregate productivity under the Ramsey policy, presented in Figure 5. In the economy with homothetic preferences the central bank can fully stabilize the gaps in output and relative prices as well as sectoral inflation. In the economy with non-homothetic preferences the natural relative price rises, since the natural level of output falls by less in the food sector. Thus, inflationary pressures are higher for food relative to nonfood. Stabilizing food inflation then requires to induce a deflation in the nonfood sector. Analogous to the case with sectoral shocks, notice that the Ramsey policy prescribes a bias towards the stabilization of nonfood inflation.

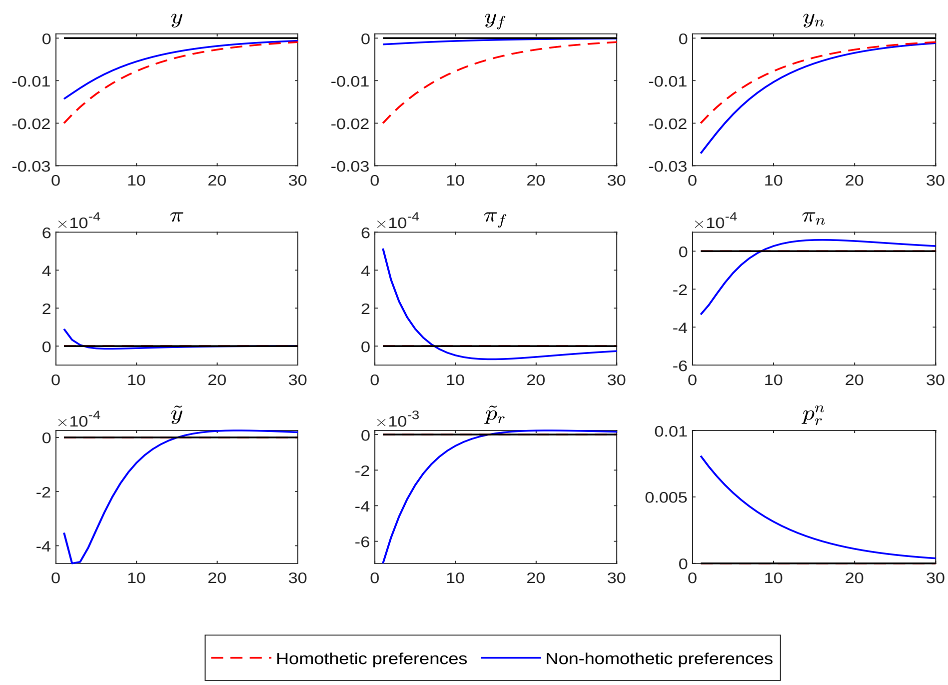


Figure 5: Optimal policy under commitment after a shock to aggregate productivity

5 Quantitative simulations

5.1 Calibration

In previous sections we imposed symmetry across sectors to isolate the effect of the minimum consumption requirement. In this section we adopt a more realistic calibration with the purpose to quantitatively assess the relevance of policy prescriptions under non-homotheticity. Particularly, we assume that food prices are more flexible relative to nonfood. Based on results in Alvarez et al. (2006), who find that food prices (including processed and unprocessed products) are revised roughly twice as frequently as nonfood prices, we set $\theta_f = 0.5$ and $\theta_n = 0.75$. Following Anand et al. (2015) we set $\eta = 0.4$, i.e., we study an economy where the share of food in total expenditure is 40%. Such parametrization is consistent with the share of food consumption in emerging economies. We consider shocks to food productivity. The productivity process parameters are set to $\rho_f = 0.7$ and $\sigma_{vf} = 0.04$, reflecting large, short lived, shocks in the food sector. The remaining parameters are set as in the baseline calibration.

5.2 Core versus headline inflation

One of the key tasks of central bankers is to define a measure of inflation to target. There is a debate on whether a response to inflation from sectors characterized by highly volatile prices is desirable (see for instance Wynne (2008)). One of such sectors showing high price variability is food production. Taking volatility as a criteria, two typical target measures emerge: core inflation, which excludes highly volatile prices, and headline inflation, which includes prices of the entire consumption basket. Given this debate, in the following exercise we compare core versus headline inflation targeting within our framework. Under the core targeting regime a zero weight is assigned in the Taylor rule to food, which is the sector characterized by higher price flexibility. When targeting headline inflation, we set $\Omega = 0.4$ to reflect the share of food in total households' expenditure.

We compute households' welfare under the two different regimes relative to the Ramsey optimal policy. We denote by Λ the utility loss associated to the adoption of a particular Taylor rule relative to the optimal Ramsey policy. More precisely, as in Schmitt-Grohe and Uribe (2007), Λ is defined as the fraction of consumption under the Ramsey policy that households' should renounce for welfare under the optimal policy and the alternative regime to be equated, i.e.,

$$V_0^T = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(log \left(\left(1 - \Lambda\right) C_t^R \right) - \frac{(N_t^R)^{1+\varphi}}{1+\varphi} \right),$$

where T and R denote variables under the Taylor rule and the Ramsey policy regimes, respectively.

Λ can by computed according to the following formula[24]

$$\Lambda = 1 - e^{(1-\beta)\left(V_0^T - V_0^R\right)}.$$

Results are shown in Table 1. As before, we compare an economy featuring non-homotheticity to a benchmark economy characterized by homothetic preferences. We can observe that moving from core to headline targeting is significantly costlier in the economy with non-homothetic preferences relative

[24] V_0^T and V_0^R are approximated by computing the second order accurate solution of the model.

to our benchmark economy. More precisely, losses increase respectively by 0.27%[25] and 0.1% of steady state consumption when switching to headline targeting. This outcome is not surprising taking into account our discussion in previous sections. Namely, the combination of flexible prices and a minimum consumption requirement in the food sector turn the response to food inflation particularly costly when preferences are non-homothetic.

Table 1 also displays the simulations for an alternative calibration of the Calvo parameter in the food sector. Particularly, we assume a higher degree of price flexibility in food.[26] Similar results than under the baseline calibration are obtained.

Calvo parameter in sector f	Preferences	Core inflation target	Headline inflation target	Difference
$\theta_f = 0.5\%$	Homothetic	0.1%	0.2%	0.1%
	Non-homothetic	0.15%	0.42%	0.27%
$\theta_f = 0.25\%$	Homothetic	0.06%	0.26%	0.2%
	Non-homothetic	0.14%	0.69%	0.45%

Table 1: Consumption equivalent losses under core and headline inflation targeting

6 Conclusion

In this paper we study how monetary policy should be conducted in a multisector model where agents' preferences are non-homothetic. Non-homotheticity derives from the existence of a minimum consumption requirement for food, which households need to satisfy for subsistence. The minimum requirement results in a lower-than-one income elasticity, implying that households average and marginal expenditure composition differ, and a non-unitary price elasticity.

We find that the introduction of the minimum consumption requirement alters the measure of inflation that the monetary authority should target. More precisely, non-homotheticity results in a reduced weight on food inflation in the optimal index. We identify three motives for such prescription. First, this type preferences turns the stabilization of food inflation costlier, as this requires larger deviations of output from the efficient level. Second, proximity to the subsistence level implies a low income elasticity for food. This translates into a reduced slope on output in the Phillips curve for food inflation. As

[25]Consumption equivalent welfare losses are computed in terms of steady state output Y. To this end, Λ is adjusted according to the relation between C^* and Y.

[26]This could reflect a food sector which predominantly produces unprocessed goods.

a consequence, a more aggressive policy is required to control inflation in this sector. This imposes costs, as a stronger response of the central bank can destabilize the rest of the economy. Finally, an additional channel relates to the composition of the marginal consumption basket. We have seen that non-homotheticity implies that households spend only a small share of any additional income on food. As food prices only affect food demand, which has a reduced participation in the marginal basket, it follows that aggregate demand turns more unresponsive to its evolution. Responding to inflation in this sector thus becomes less important.

Our results in this paper thus provide a rationale for targeting an index that excludes (or attaches a limited weight to) food inflation, a usual practice amongst central bankers.

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Appendix

Households optimal consumption allocation

Households maximize the consumption index C_t^* conditional on the expenditure level E_t

$$\max_{\{C_{f,t},C_{n,t}\}} \Xi\left(C_{f,t}-\tilde{C}_f\right)^{\omega} C_{n,t}^{1-\omega} - \aleph\left(P_{f,t}C_{f,t}+P_{n,t}C_{n,t}-E_t\right).$$

From the FOCs we obtain

$$\frac{P_{f,t}\left(C_{f,t}-\tilde{C}_f\right)}{P_{n,t}C_{n,t}} = \frac{\omega}{1-\omega}.$$

Plugging the optimality condition into the budget constraint yields

$$C_{f,t} = \tilde{C}_f + \omega\frac{E_t - P_{f,t}\tilde{C}_f}{P_{f,t}}$$

and

$$C_{n,t} = (1-\omega)\frac{E_t - P_{f,t}\tilde{C}_f}{P_{n,t}}.$$

Plugging the above expressions in the consumption index we get

$$P_t^* C_t^* = E_t - P_{f,t}\tilde{C}_f,$$

where $P_t^* \equiv P_{f,t}^{\omega} P_{n,t}^{1-\omega}$.

The demand for sectoral goods can then be expressed as

$$C_{f,t} = \tilde{C}_f + \omega\left(\frac{P_{f,t}}{P_t^*}\right)^{-1} C_t^*$$

and

$$C_{n,t} = (1-\omega)\left(\frac{P_{n,t}}{P_t^*}\right)^{-1} C_t^*.$$

Aggregate output

Aggregate output is defined as follows

$$Y_t \equiv \frac{P_f}{P} Y_{f,t} + \frac{P_n}{P} Y_{n,t},$$

which can be expressed in log-deviation from steady state as

$$\hat{y}_t = \frac{P_f Y_f}{PY} \hat{y}_{f,t} + \frac{P_n Y_n}{PY} \hat{y}_{n,t}.$$

We know that in steady state $Y = \frac{P_f}{P} Y_f + \frac{P_n}{P} Y_n$ or, equivalently, $PY = P_f Y_f + P_n Y_n = E$. Then

$$\hat{y}_t = \frac{P_f Y_f}{E} \hat{y}_{f,t} + \frac{P_n Y_n}{E} \hat{y}_{n,t}.$$

By defining $\eta \equiv \frac{P_f Y_f}{E}$ we obtain

$$\hat{y}_t = \eta \hat{y}_{f,t} + (1 - \eta) \hat{y}_{n,t}.$$

The aggregate price index

The aggregate price index is defined as follows

$$P_t \equiv \frac{Y_f}{Y} P_{f,t} + \frac{Y_n}{Y} P_{n,t},$$

which can be expressed in log-deviation from steady state as

$$1 = \frac{P_f Y_f}{PY} (\pi_{f,t} - \pi_t) + \frac{P_n Y_n}{PY} (\pi_{n,t} - \pi_t).$$

Since $PY = E$ we obtain

$$\pi_t = \eta \pi_{f,t} + (1 - \eta) \pi_{n,t}.$$

The relation between $\hat{y}_t$ and $\hat{c}_t^*$

We know that

$$P_t^* C_t^* + P_{f,t} \tilde{C}_f = P_{f,t} C_{f,t} + P_{n,t} C_{n,t},$$

which can be expressed in log-deviation from steady state as

$$\frac{P^{*}C^{*}}{E}\hat{c}_{t}^{*}=\frac{P_{f}\left(C_{f}-\tilde{C}_{f}\right)}{E}\hat{p}_{f,t}^{*}+\frac{P_{n}C_{n}}{E}\hat{p}_{n,t}^{*}+\frac{P_{f}C_{f}}{E}\hat{c}_{f,t}+\frac{P_{n}C_{n}}{E}\hat{c}_{n,t},$$

where $\hat{p}_{s,t}^{*}\equiv log\left(\frac{P_{s,t}}{P_{t}^{*}}\right)-log\left(\frac{P_{s}}{P^{*}}\right)$.

The above expression can be rewritten as

$$\frac{P^{*}C^{*}}{E}\hat{c}_{t}^{*}=\frac{\tilde{E}}{E}\left(\frac{P_{f}\left(C_{f}-\tilde{C}_{f}\right)}{\tilde{E}}\left(1-\omega\right)\hat{p}_{r,t}-\frac{P_{n}C_{n}}{\tilde{E}}\omega\hat{p}_{r,t}\right)+\hat{y}_{t}.$$

Given $\frac{P_{f}\left(C_{f}-\tilde{C}_{f}\right)}{\tilde{E}}=\omega$ and $\frac{P_{n}C_{n}}{\tilde{E}}=1-\omega$ the previous relation can by rewritten as

$$\hat{c}_{t}^{*}=\frac{E}{P^{*}C^{*}}\hat{y}_{t}.$$

Since $\frac{E}{P^{*}C^{*}}=\frac{E}{\tilde{E}}=\frac{\frac{P_{n}Y_{n}}{E}}{\frac{P_{n}Y_{n}}{\tilde{E}}}=\frac{1-\omega}{1-\eta}$, we obtain the following expression relating aggregate output and the consumption index

$$\hat{c}_{t}^{*}=\frac{1-\omega}{1-\eta}\hat{y}_{t}.$$

The flexible price economy

Absent nominal rigidities, and assuming $\sigma=1$ and $\alpha_{f}=\alpha_{n}=\alpha$, our economy is described by the system below, where the superscript n denotes natural levels.

Firms optimal pricing conditions are

$$\left(\hat{\omega}_{t}^{*}\right)^{n}=\hat{y}_{f,t}^{n}-\hat{n}_{f,t}^{n}+\left(1-\omega\right)\hat{p}_{r,t}^{n}$$

and

$$\left(\hat{\omega}_{t}^{*}\right)^{n}=\hat{y}_{n,t}^{n}-\hat{n}_{n,t}^{n}-\omega\hat{p}_{r,t}^{n}.$$

The labor supply schedule is given by

$$\left(\hat{\omega}_{t}^{*}\right)^{n}=\left(\hat{c}_{t}^{*}\right)^{n}+\varphi\hat{n}_{t}^{n}.$$

Aggregate employment is

$$\hat{n}_t^n = \eta \hat{n}_{f,t}^n + (1-\eta)\,\hat{n}_{n,t}^n.$$

The sectoral production function is

$$\hat{y}_{s,t}^n = a_{s,t} + (1-\alpha)\,\hat{n}_{s,t}^n.$$

The sectoral demand functions are

$$\hat{c}_{f,t}^n = \frac{\omega(1-\eta)}{(1-\omega)\,\eta}\left(-(1-\omega)\,\hat{p}_{r,t}^n + (\hat{c}_t^*)^n\right)$$

and

$$\hat{c}_{n,t}^n = \omega \hat{p}_{r,t}^n + (\hat{c}_t^*)^n.$$

The final good market clearing condition for sector s is

$$\hat{y}_{s,t}^n = \hat{c}_{s,t}^n.$$

By solving the previous system we obtain the following expressions characterizing the response of the flexible price economy to shocks

$$\hat{y}_{f,t}^n = \Upsilon_{ff} a_{f,t},$$

$$\hat{y}_{n,t}^n = \Upsilon_{nf} a_{f,t} + a_{n,t},$$

$$\hat{p}_{r,t}^n = -\Upsilon_p a_{f,t} + a_{n,t},$$

$$\hat{n}_t^n = \Upsilon_n a_{f,t},$$

$$\hat{y}_t^n = \Upsilon_y a_{f,t} + (1-\eta)\,a_{n,t},$$

$$(\hat{\omega}_t^*)^n = \Upsilon_\omega a_{f,t} + (1-\omega)\,a_{n,t},$$

where $\Upsilon_{ff} \equiv \frac{1+\varphi}{\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)\varphi(1-\eta)+\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)+\varphi\eta+\alpha\varphi(1-\eta)+\alpha}$, $\Upsilon_{nf} \equiv \frac{\left(\frac{(1-\omega)\eta}{\omega(1-\eta)}-1\right)(1-\alpha)\varphi\eta}{\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)\varphi(1-\eta)+\frac{(1-\omega)\eta}{\omega(1-\eta)}(1-\alpha)+\varphi\eta+\alpha\varphi(1-\eta)+\alpha}$, $\Upsilon_p \equiv \frac{1-\alpha\left(\Upsilon_{ff}-\Upsilon_{nf}\right)}{1-\alpha}$, $\Upsilon_n \equiv \frac{\eta\Upsilon_{ff}+(1-\eta)\Upsilon_{nf}-\eta}{1-\alpha}$, $\Upsilon_y \equiv \eta\Upsilon_{ff}+(1-\eta)\,\Upsilon_{nf}$ and $\Upsilon_\omega \equiv \frac{\omega}{1-\alpha}\left(1-\alpha(\Upsilon_{ff}+\frac{1-\omega}{\omega}\Upsilon_{nf})\right)$.