Optimal Monetary Policy with Non-homothetic Preferences*

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We study optimal monetary policy in a multisector model where preferences are non-homothetic. We find that a lower-than-one income elasticity in food demand, due to non-homotheticity, reduces the weight on food inflation in the optimal index that the monetary authority should target. The reasons are threefold. First, food price stabilization requires large deviations of output from the efficient level. Second, food demand becomes insensitive to monetary policy. Third, the low sectoral marginal propensity to consume implies that food price volatility has a reduced impact on aggregate demand. These results provide a rationale for targeting an index that excludes food inflation.

JEL Codes: E31, E52.

1. Introduction

From the structural change literature, we know that the sectoral composition of the economy varies as it grows, with the share of food production falling as the country develops.[1] Changes in sectoral composition can be explained by agents' preferences featuring

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[1]See Herrendorf, Rogerson, and Valentinyi (2014) for a review of the structural change literature.

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 preference 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, Rogerson, and Valentinyi (2013) find that preferences incorporating a minimum consumption requirement for food provide a good fit to the U.S. data, while Comin, Lashkari, and Mestieri (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

[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 and Restuccia (2006), Rubini and Moro (2019), and Storesletten, Zhao, and Zilibotti (2019).

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 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.

The three channels described above are independent of each other, since introducing non-homothetic preferences affects different parts of the system of equations that describes the economy. The first channel results from the effect of preferences on the slope on relative prices in the sectoral Phillips curves. The second derives from the way preferences affect the slope on the output gap in the Phillips equations. And finally, the third depends on the effects of non-homotheticity on the price index that shows up in the Euler equation. These three channels reflect the fact that in the margin, the share of food in the consumption basket is low with non-homothetic preferences.

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,

[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, 2008).

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 2020). In the absence of a relationship between inflation and price dispersion, the usual recommendation of disregarding prices from the target based on their flexibility ceases 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.

We show that our findings are especially relevant for the policy design in developing countries, where food represents large shares of consumption expenditure. Particularly, we find that targeting headline inflation—that is, an index that includes food prices—is associated with losses of welfare that can be sizable in these economies.

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 also 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, Prasad, and Zhang (2015) and Portillo et al. (2016) analyze monetary policy in a multi-sector economy that incorporates a minimum consumption requirement for food. Anand, Prasad, and Zhang (2015) consider incomplete credit markets and heterogeneous sources of income in their analysis. Within their framework, households in the food (or informal) sector obtain income from that sector only and lack access to banking services, making them hand-to-mouth consumers. Their findings suggest that, under incomplete markets, it is optimal for the central bank to target headline inflation following a negative productivity shock in the flexible price food sector. The reason is that such a shock increases the relative price of food. Given a low price elasticity in the demand for food, resulting from the minimum consumption requirement, the higher relative price redistributes resources toward the food sector. Assuming income source heterogeneity, such that the fraction of households that produces the food good is the one that perceives income from this sector, the reallocation of resources toward the food sector leads to an income redistribution in favor of households engaged in food production. Due to financial constraints faced by these agents, their higher income results in an increase in aggregate demand. To curb demand from these households, the central bank must respond to food prices. Hence the desirability to target food inflation. Their policy recommendation is therefore driven by the interplay between incomplete markets, diverse income sources, and non-homotheticity derived from the minimum consumption requirement for food. In an extension of our baseline model, we show that these three factors are crucial to explain Anand, Prasad, and Zhang (2015)'s result. In contrast, our paper considers a representative agent economy and focuses entirely on the role of non-homothetic preferences. Therefore, we contribute to this literature by uncovering new channels through which non-homotheticity operates, resulting in a distinct policy recommendation.

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. In their setting with flexible prices in food, there are no distortions in that sector, so the central bank only needs to stabilize nonfood inflation, irrespective of the assumed preferences. That is, the result of excluding food prices from the target is a consequence of price flexibility in that sector. As opposed to Portillo et al. (2016), prices in food are sticky in our setting.[5] We find that it is still optimal to assign only a small weight to food inflation in spite of price rigidities in this sector. We show that the reason for such reduced weight is non-homotheticity.

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 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 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.

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

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

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

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 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 indices 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 weights goods by their shares in marginal expenditure.

2.2.4 Labor Supply

Intratemporal optimization implies

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

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 i.i.d. 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[6]

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

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 $\omega_t^* = log\,(W_t/P_t^*)$ 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 the 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 the appendix)

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

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

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

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

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 the appendix) absent nominal rigidities, the response of the economy to the sectoral productivity shocks is given by[7]

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

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

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

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

$$\hat{n}^n_{t} = \Upsilon_{n} a_{f,t}, \tag{14}$$

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

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

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

$$\Upsilon_{ff} < 1,\ \Upsilon_{nf} > 0,\ \Upsilon_p > 1,\ \Upsilon_n < 0,\ \Upsilon_y < \eta \text{ and } \Upsilon_\omega < \eta.$$[8]

Let us first consider the manner in which 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

[8] This relation holds for reasonable parameterizations of the model.

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[9,10]

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

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

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

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

[10] 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.

economy is close to subsistence. That implies a stronger increase in labor supply with this type of preference. 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 preference.

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 preference, 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. We begin by exploring the optimal policy under commitment, and subsequently proceed to examine optimal simple Taylor rules.

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. Following Aguiar and Gopinath (2007) and Garcia-Cicco, Pancrazi, and Uribe (2010), who consider a developing economy setup, we set the discount factor, β, to 0.98. 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 0.33. We assume $\theta_n = 0.75$, implying an average price duration of four quarters in the nonfood sector. 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 $\theta_f = 0.5$. We assume $\sigma = 1$ and $\varphi = 1$, which are common values in the literature.

For the non-homothetic economy we set parameter ω, the share of food in marginal expenditure, to 0.05, that is, households spend only 5 percent of any additional income in this sector. Parameter ω determines the share of food expenditure in the long term, as the economy becomes richer. Therefore, we set it to match the expenditure share of food in the U.S.[11] The minimum consumption requirement for food, $\tilde{C}_f$, is set such that the steady-state share of food in total expenditure is 40 percent. Such parameterization is consistent with the share of food consumption in developing economies (see Table 1). 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 $\omega = \eta = 0.4$, implying that the share of food, both on average and in the margin, is 40 percent.

We set the response to inflation in the Taylor rule, ϕ_π, to 1.5. The productivity shock parameters in the nonfood sector are set to $\rho_n = 0.9$ and $\sigma_{vn} = 0.02$. In the food sector the productivity process parameters are set to $\rho_f = 0.25$ and $\sigma_{vf} = 0.03$, reflecting large, short-lived, shocks, as in Anand, Prasad, and Zhang (2015) and Da-Rocha and Restuccia (2006).

[11]The expenditure share of food at home in the U.S. is 5 percent in 2021 (U.S. Department of Agriculture, Economic Research Service, Food Expenditure Series).

Table 1. Share of Food in Expenditure by Income Level

Income Level	Share of Food in Expenditure (%)
Low Income	40.4
Middle Income	26.9
High Income	15.0
Advanced Countries	10.6

Note: Low-income countries have 15 percent or less GDP per capita than the U.S., middle-income countries have GDP per capita between 15 percent and 45 percent of the U.S., high-income countries have GDP per capita between 45 percent and 90 percent of the U.S., and advanced countries have GDP per capita above 90 percent of the U.S. Data on food share are obtained from the U.S. Department of Agriculture (USDA) and the World Development Indicators database for the year 2016. The data on food expenditure include only food eaten at home.

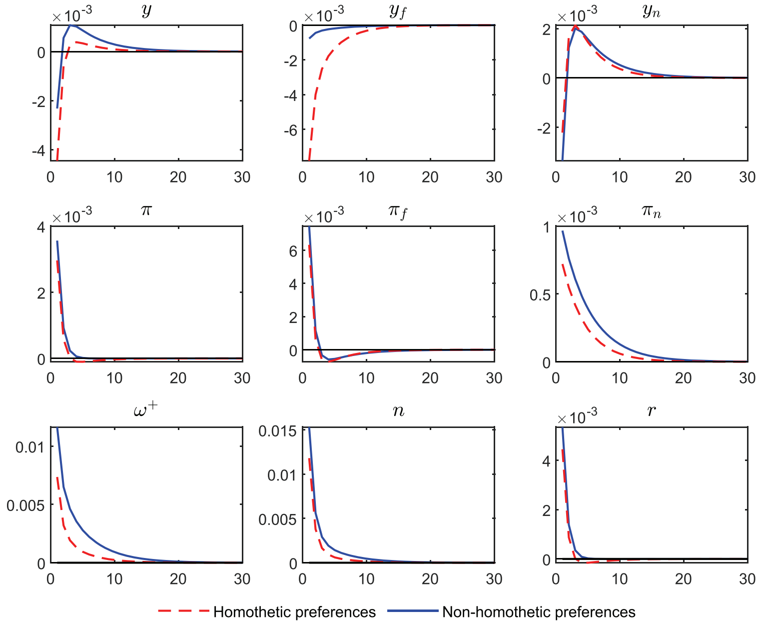
Figure 1 displays the impulse response functions (IRFs) to a negative shock to food productivity for the economies featuring homothetic and non-homothetic preferences. The central bank is assumed to follow a Taylor rule with weights on sectoral inflation coinciding with sectoral sizes ($\Omega = 0.4$). 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 the food sector to prevent a fall in food consumption, but at the cost of a large contraction in nonfood.

In what follows, we evaluate the implications of the minimum consumption requirement for the optimal design of monetary policy.

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. To obtain an

Figure 1. Shock to Food Productivity When the Central Bank Follows a Taylor Rule



analytical expression for welfare losses, we consider a special case with $\alpha = 0$. 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

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

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

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 with output variations, which result from food consumption being close to its subsistence requirement. Given the food expenditure share η, the weight associated with the gap in relative prices is smaller with non-homothetic preferences. This results from a smaller degree of substitutability associated with these preferences. Also, given η, weights on sectoral inflation are not affected by the type of preference. 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:

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

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

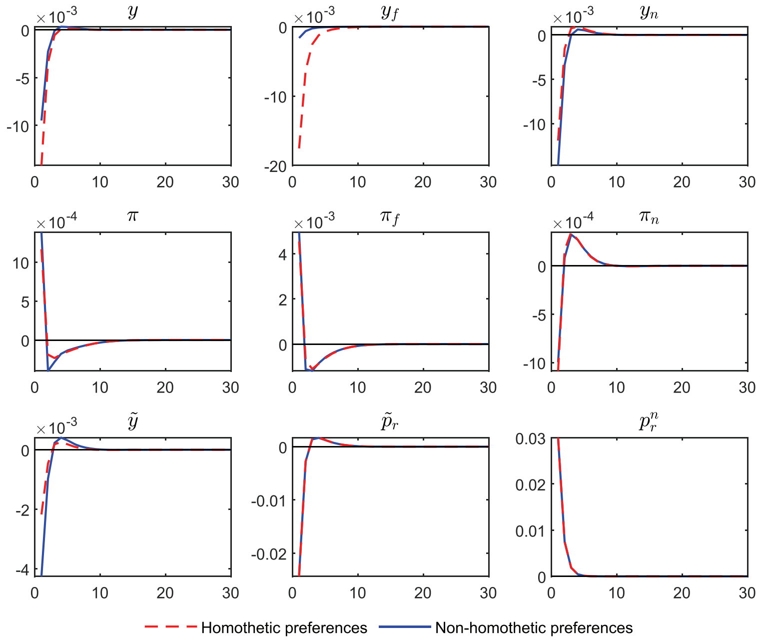
$$\tilde{p}_{r,t} = \tilde{p}_{r,t-1} - \Delta p^n_{r,t} + \pi_{f,t} - \pi_{n,t}, \tag{21}$$

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 affects 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.

Next, we compare 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

Figure 2. Optimal Policy under Commitment after a Shock to Food Productivity



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.

Comparing the homothetic and non-homothetic economies, two things are worth noting. First, with non-homothetic preferences the Ramsey policy prescribes to tolerate a relatively higher inflation in the food sector. This leads to more elevated CPI inflation. Second, despite allowing for a relatively higher inflation in food, a more negative output gap is required to moderate inflation in that sector.

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 ($\tilde{p}_{r,t} < 0$),[12] 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 output 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 preference. Then, conditional on output (and the real wage[13]) falling to their new natural levels, wages and thus inflationary pressures are higher in the economy with 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 needs to induce a large contraction of output below the efficient level to 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.

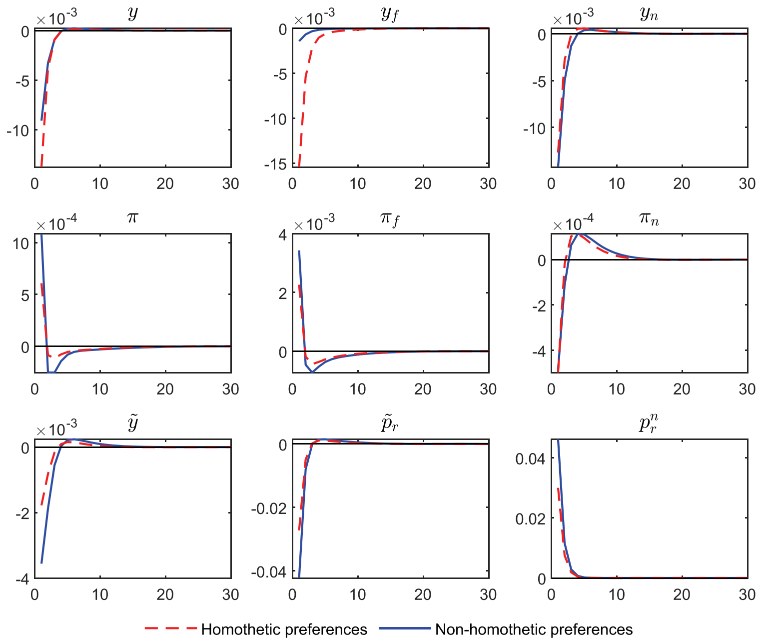
At last, notice that after a shock to nonfood productivity, non-homotheticity also reduces the desirability of stabilizing of food inflation (not shown).[14]

[12]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.

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

[14]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 ($\tilde{p}_{r,t} > 0$), implying stronger deflationary pressures on food prices in the non-homothetic

Figure 3. Optimal Policy under Commitment after a Shock to Food Productivity ($\alpha > 0$)



4.3 Optimal Policy under Commitment: The General Case

In this section we study the optimal policy under commitment for the general case when $\alpha > 0$.[15] Figure 3 presents the response to a negative shock to food productivity under the Ramsey policy.[16] Notably,

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relative to the homothetic economy. Further containing food deflation would be costly, as it requires inducing a larger (positive) gap in output in the non-homothetic case. 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.

[15] We set $\alpha = 0.33$, as in the baseline calibration.

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

when $\alpha > 0$, the central bank tolerates a significantly higher inflation in food with non-homothetic relative to homothetic preferences.

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

$$\pi_{f,t} = \lambda_f \left(\frac{1-\omega}{1-\eta} + \varphi \frac{1}{1-\alpha} + \frac{\alpha}{1-\alpha} \frac{\omega}{\eta} \right) \tilde{y}_t \\ - \lambda_f \left(1 + \frac{\alpha}{1-\alpha} \frac{\omega(1-\eta)}{(1-\omega)\eta} \right) (1-\omega) \tilde{p}_{r,t} + \beta \mathbb{E}_t \pi_{f,t+1}, \quad (22)$$

$$\pi_{n,t} = \lambda_n \left(\frac{1-\omega}{1-\eta} + \varphi \frac{1}{1-\alpha} + \frac{\alpha}{1-\alpha} \frac{1-\omega}{1-\eta} \right) \tilde{y}_t \\ + \lambda_n \left(1 + \frac{\alpha}{1-\alpha} \right) \omega \tilde{p}_{r,t} + \beta \mathbb{E}_t \pi_{n,t+1}. \quad (23)$$

Equations (22) and (23) 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).[17] 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 3, this means that inducing a negative gap in output will translate into small gains in terms of containing food inflation relative to losses associated with 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

[17]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.

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 with 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 non-homotheticity also reduces the desirability of stabilizing of food inflation following a shock to nonfood productivity (not shown).

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 0.35 to food inflation, below the 0.45 prescribed under homothetic preferences. We conclude that non-homotheticity also reduces the desirability of stabilizing food inflation when the central bank follows a Taylor rule. Next, we seek to understand this result.

4.4.1 The Role of Inflation Expectations

We now explore an additional role of preferences. From (10) we know that a modified Euler equation arises under non-homotheticity. This equation tells 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.[18]

To assess 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 0.2 with both homothetic and non-homothetic preferences. We verify that preferences have a smaller impact on the optimal weight assigned to food inflation. 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

$$\hat{p}^n_{r,t} = (1 - \Upsilon_p)\, a_t.^{19}$$

[18]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 macrovariables. 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.

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

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.

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.

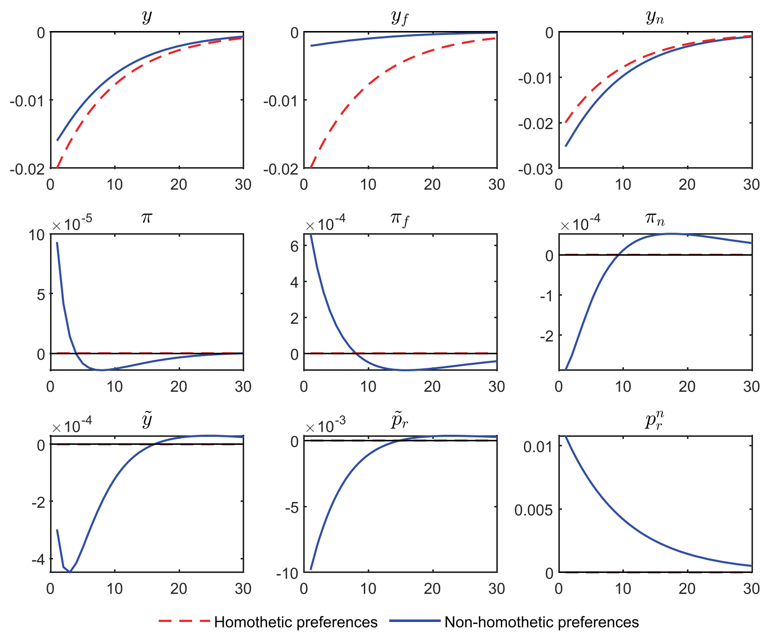
Next, let us consider the response of the economy to a negative shock to aggregate productivity under the Ramsey policy, presented in Figure 4.[20] In the economy with homothetic preferences the central bank can fully stabilize the gaps in output and relative prices as well as sectoral inflation. In 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 non-homotheticity reduces the desirability of stabilizing food inflation.

4.6 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 criterion,

[20]To simulate the aggregate shock, we make the assumption that the food and nonfood sectors are identical. Specifically, we set the values $\theta_f = \theta_n = 0.75$ and $\rho_f = \rho_n = 0.9$.

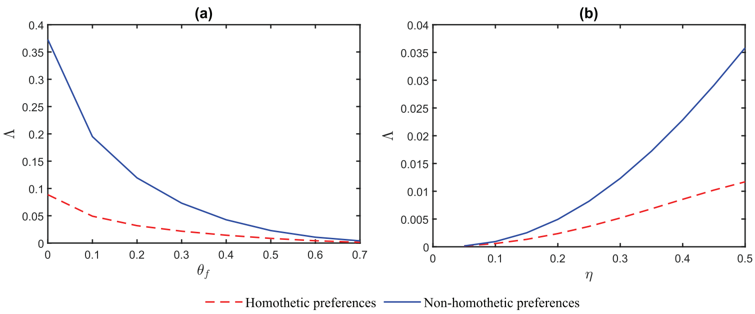
Figure 4. Optimal Policy under Commitment after a Shock to Aggregate Productivity



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 $\Omega = \eta$ to reflect the share of food in total households' expenditure.

We compute households' welfare under headline relative to core inflation targeting. We denote by Λ the utility loss associated with a target on headline inflation relative to a rule that targets core inflation. More precisely, as in Schmitt-Grohe and Uribe (2007), Λ is defined as the fraction of consumption under the baseline policy (core targeting) that households should renounce such that welfare under this policy and the alternative regime (headline targeting) are equated, i.e.,

Figure 5. Consumption-Equivalent Welfare Losses: Headline vs. Core



Note: Panel A shows consumption-equivalent welfare losses when shifting from core to headline targeting as a function of the degree of price rigidities in food (θ_f), while panel B shows them as a function of the size of the food sector (η). In all cases the optimal Ω is zero.

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

where H and C denote variables under the headline and core targeting regimes, respectively.

Λ can by computed according to the following formula:[21]

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

Results are shown in Figure 5. As before, we compare an economy featuring non-homotheticity with a benchmark economy characterized by homothetic preferences. Panel A displays the simulations for alternative calibrations of the Calvo parameter in the food sector. Particularly, we consider parameterizations in the range $0.7 \geq \theta_f \geq 0$.[22] For the case of the baseline calibration ($\theta_f = 0.5$), we can observe that moving from core to headline targeting is costlier in the economy with non-homothetic preferences relative to the

[21] V_0^H and V_0^C are approximated by computing the second-order accurate solution of the model.

[22] Higher degrees of flexibility could reflect a food sector which predominantly produces unprocessed goods.

benchmark economy. More precisely, losses increase by 0.008 percent and 0.023 percent of steady-state consumption when switching to headline targeting in the homothetic and non-homothetic economies, respectively.[23] This outcome is not surprising taking into account our discussion in previous sections. Namely, the combination of more flexible prices and a minimum consumption requirement in the food sector turn the response to food inflation particularly costly when preferences are non-homothetic. We can also confirm that results are robust to the assumed degree of rigidities in food. Importantly, the simulations illustrate that sticky prices in food, while useful to uncover the mechanisms through which non-homotheticity operates, are not a necessary assumption for the results obtained. In fact, when prices in food are fully flexible ($\theta_f = 0$), welfare losses from switching to headline targeting are even larger in the non-homothetic case (0.37 percent) relative to the homothetic case (0.09 percent).[24]

Panel B considers alternative calibrations of the size of the food sector, η. For a parameterization compatible with low- and middle-income countries (see Table 1), moving from core to headline targeting remains largely costlier when preferences are non-homothetic. For smaller values of η, however, welfare losses associated with a switch to headline targeting become similar in both considered economies. As should be clear from our previous analysis, the effects of non-homotheticity weaken as $\eta \to \omega$, which explains the results obtained. We conclude that the effects of the minimum consumption requirement are particularly relevant for policy design in developing economies, where food represents sizable shares of households' expenditure.

Finally, we check how sensitive our results are to variations in the baseline calibration of the model (see Table 2). We find that changes in the inverse of the elasticity of intertemporal substitution (σ), changes in the inverse of the Frisch elasticity of labor

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[23] 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.

[24] Headline targeting is also costlier under non-homothetic preferences when price stickiness in food approximates the degree of stickiness in nonfood. In particular, when $\theta_f = 0.7$, welfare losses from switching to headline targeting are 0.0014 percent and 0.0040 percent with homothetic and non-homothetic preferences, respectively.

Table 2. Consumption-Equivalent Welfare Losses: Headline vs. Core

	$\varphi = 1$	$\varphi = 2$	$\varphi = 5$
Homothetic	0.0085	0.0098	–0.0002
Non-homothetic	0.0228	0.0363	0.0373
	$\rho_f = 0.25$	$\rho_f = 0.5$	$\rho_f = 0.9$
Homothetic	0.0085	0.0286	0.0885
Non-homothetic	0.0228	0.0703	0.3315
	$\rho_r = 0$	$\rho_r = 0.5$	$\rho_r = 0.7$
Homothetic	0.0085	–0.0004	–0.0024
Non-homothetic	0.0228	0.0067	0.0011

Note: The table shows consumption-equivalent welfare losses when shifting from core to headline targeting as a function of the inverse of the Frisch elasticity of labor supply (φ), the persistence of the shock in the food sector (ρ_f), and the degree of persistence in the Taylor rule (ρ_r). Results are also robust to changes in the inverse of the elasticity of intertemporal substitution (σ). With $\sigma = 1$, welfare reduces by 0.4 (2) with homothetic (non-homothetic) preferences when shifting to headline targeting, while with $\sigma = 2$, the corresponding welfare loss is 6 (11).

supply (φ), changes in the persistence of the shock in the food sector (ρ_f), and considering a Taylor rule with persistence have no effect on our results.[25]

4.7 Non-homothetic Preferences and Incomplete Asset Markets

Anand, Prasad, and Zhang (2015) investigate monetary policy in an economy with a minimum consumption requirement for food and incomplete asset markets. Their findings indicate that non-homotheticity renders headline inflation targeting optimal following a productivity shock in the flexible price food sector. Thus, the policy advice provided in Anand, Prasad, and Zhang (2015) for an economy with non-homothetic preferences differs from the conclusions drawn

[25] In particular, we consider the Taylor rule $R_t = R^{1-\rho_r} (R_{t-1})^{\rho_r} \left(\frac{\Pi_t^T}{\Pi^T}\right)^{\phi_\pi(1-\rho_r)}$, where ρ_r measures the degree of interest rate smoothing.

in our paper. This can be attributed to the distinct model setup that each study considers. In effect, two key assumptions underlie their result: a heterogeneous agent structure characterized by borrowing constraints and heterogeneity in income sources across households. To illustrate the role of these features, we investigate the implications of non-homotheticity in a modified version of our model.

Following Anand, Prasad, and Zhang (2015), we assume that the economy is populated by two types of agents, which differ in their access to credit and income source. There is a fraction $1-\lambda$ of unconstrained households (denoted by u), who have full access to asset markets and produce the nonfood good. They maximize their lifetime utility subject to the following budget constraint:

$$\int_0^1 P_{f,t}(i)C^u_{f,t}(i)di + \int_0^1 P_{n,t}(i)C^u_{n,t}(i)di + Q_t B^u_t = W_{n,t}N^u_t + B^u_{t-1} + \frac{1}{1-\lambda}\Pi_{n,t}.$$

Unconstrained households are employed in the nonfood sector, hence their labor income is $W_{n,t}N^u_t$, where $W_{n,t}$ is wage in the nonfood sector. Additionally, they perceive profits from nonfood firms, $\Pi_{n,t}$. They spend income on consumption and to accumulate the asset B_t. Given their unrestricted access to bonds, unconstrained households' consumption follows a standard Euler equation.

The remaining fraction λ of households are constrained (denoted by c). They produce the food good and can trade assets subject to a bond portfolio adjustment cost.[26] Their budget constraint is given by

$$\int_0^1 P_{f,t}(i)C^c_{f,t}(i)di + \int_0^1 P_{n,t}(i)C^c_{n,t}(i)di + Q_t B^c_t + \frac{\psi}{2}\left(B^c_t - B^c\right)^2 = W_{f,t}N^c_t + B^c_{t-1}.$$

As in Anand, Prasad, and Zhang (2015), food sector is assumed to be competitive, hence profits in this sector are zero.[27] Therefore,

[26] The modeling of the portfolio adjustment cost follows Cantore and Freund (2021).

[27] Competitive markets are assumed to reflect the flexible nature of prices in the food sector. This assumption, however, is not essential for the results.

constrained households' income consists only of labor remuneration, $W_{f,t}N_t^c$. Parameter ψ determines the strength of credit frictions. Constrained households' consumption is given by the following Euler equation:

$$(1+\psi\left(B_t^c - B^c\right)) Q_t = \beta \mathbb{E}_t \left\{ \left(\frac{C_{t+1}^{c,*}}{C_t^{c,*}} \right)^{-\sigma} \frac{P_t^*}{P_{t+1}^*} \right\}. \tag{24}$$

When $\psi = 0$, constrained households can save and borrow at no cost, and the Euler equation (24) adopts its usual form. In the limiting case with infinite portfolio adjustment costs ($\psi \to \infty$), constrained households are hand to mouth, and their consumption is equal to their labor income

$$\int_0^1 P_{f,t}(i) C_{f,t}^c(i) di + \int_0^1 P_{n,t}(i) C_{n,t}^c(i) di = W_{f,t} N_t^c. \tag{25}$$

Next, we examine how the effects of non-homothetic preferences in a model with borrowing constraints and heterogeneity in income sources compare to our baseline model results. Table 3 replicates the simulations in Section 4.6. Shocks are to food productivity. The first and second rows show the effects of non-homotheticity in the representative agent setting. In line with results in previous sections, non-homothetic preferences worsen losses associated with including food prices in the target.

The following rows show the results in a setting with borrowing constraints and heterogeneity in income sources. We first consider the case where households producing the food good are fully constrained ($\psi \to \infty$), hence their consumption is given by (25). In this setting, headline inflation targeting is welfare improving with non-homothetic preferences. This is shown in rows 3 and 4 of Table 3. The third row corresponds to the model with homothetic preferences. In this scenario, moving from core to headline targeting increases welfare losses. The fourth row corresponds to the model with non-homothetic preferences. Now, including food inflation in the target index is desirable, as moving from core to headline targeting reduces welfare losses. The reason for this result is provided in Anand, Prasad, and Zhang (2015). Shocks to food productivity increase the relative price of food. With non-homothetic preferences, food demand has a low price elasticity. Consequently, when

Table 3. Consumption-Equivalent Welfare Losses with Incomplete Credit Markets: Headline vs. Core

Model	**Preferences**	**Consumption-Equivalent Welfare Losses**
Baseline	Homothetic Non-homothetic	0.003% 0.015%
BC+IH ($\psi \to \infty$)	Homothetic Non-homothetic	0.006% –0.057%
BC+IH ($\psi = 0.22$)	Homothetic Non-homothetic	0.006% 0.157%

Note: The table shows consumption-equivalent welfare losses when shifting from core to headline targeting. The first two rows correspond to the baseline representative agent model. The following rows correspond to the two-agent model characterized by borrowing constraints (BC) and income source heterogeneity (IH). For this exercise we consider a Taylor rule with persistence. Given the assumption of competitive markets, prices in food are flexible.

the relative price of food increases, households' expenditure on food rises. Since constrained households produce the food good, their income increases. Because these agents are hand to mouth, aggregate demand rises. The central bank mitigates the rise in demand and price volatility by including food prices in its target.

To further clarify the role of credit frictions, we consider next a scenario where households producing the food good are not fully excluded from credit markets. For these simulations we set $\psi = 0.22$.[28] As shown by rows 5 and 6 of Table 3, when credit constraints are less severe, headline inflation targeting is no longer welfare improving under non-homothetic preferences.

This exercise shows that the policy recommendation proposed in Anand, Prasad, and Zhang (2015) is motivated by the interplay among incomplete markets, diverse income sources, and the minimum consumption requirement for food. Conversely, our paper focuses exclusively on the role of non-homothetic preferences in a

[28]For this calibration we follow Cantore and Freund (2021), that is, we set $y = 0.22$ to deliver an average quarterly marginal propensity to consume on impact of 0.2 (see Cantore and Freund 2021, Online Appendix).

representative agent economy. Accordingly, the channels we highlight in this paper are distinct from that in Anand, Prasad, and Zhang (2015). In that paper, low price elasticity derived from non-homothetic preferences is crucial, because changes in relative prices generate a redistribution of income that affects aggregate demand (given income source heterogeneity and incomplete markets). In contrast, the channels we highlight are independent from redistributive effects and depend crucially on the low income elasticity associated with non-homotheticity. Finally, an additional contribution relative to Anand, Prasad, and Zhang (2015) is that while income source heterogeneity and incomplete markets might be relevant for lower-income countries, they are less likely so for middle-income economies. Therefore, our paper may provide a more accurate depiction of middle-income developing countries with a large agricultural sector.

5. 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 of preference 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 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.

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 first-order conditions 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

$$\frac{P^*C^*}{E}\hat{c}_t^* = \frac{P_f\left(C_f - \tilde{C}_f\right)}{E}\hat{p}_{f,t}^* + \frac{P_nC_n}{E}\hat{p}_{n,t}^* + \frac{P_fC_f}{E}\hat{c}_{f,t} + \frac{P_nC_n}{E}\hat{c}_{n,t},$$

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

$$\frac{P^*C^*}{E}\hat{c}_t^* = \frac{\tilde{E}}{E}\left(\frac{P_f\left(C_f - \tilde{C}_f\right)}{\tilde{E}}\left(1-\omega\right)\hat{p}_{r,t} - \frac{P_nC_n}{\tilde{E}}\omega\hat{p}_{r,t}\right) + \hat{y}_t.$$

Given $\frac{P_f\left(C_f - \tilde{C}_f\right)}{\tilde{E}} = \omega$ and $\frac{P_nC_n}{\tilde{E}} = 1-\omega$, the previous relation can by rewritten as

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

Since $\frac{E}{P^*C^*} = \frac{E}{\tilde{E}} = \frac{\frac{P_nY_n}{E}}{\frac{P_nY_n}{\tilde{E}}} = \frac{1-\omega}{1-\eta}$, 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

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

The labor supply schedule is given by

$$(\hat{\omega}_t^*)^n = (\hat{c}_t^*)^n + \varphi \hat{n}_t^n.$$

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

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