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# Optimal Policies When Price Fairness Matters*

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## ABSTRACT

This paper presents an analysis of optimal policies within a New Keynesian model that incorporates households' concerns regarding fair price markups. Fluctuations in inflation shape perceptions of fairness, which constitute a pivotal factor in the design of policies. The optimal fiscal policy is an income subsidy designed to address inefficiencies resulting from price markups; however, it is ineffective in mitigating households' perceptions of fair pricing. In the event that inflation targeting by the monetary authority is not sufficiently strict, the optimal policy shifts to a tax. The planner is thus able to mitigate both demand-driven inflation and concerns regarding the fairness of pricing, albeit at the cost of welfare losses. Furthermore, an analogous policy to price caps is examined, in which the planner determines an optimal markup path for firms in lieu of providing subsidies to households. This approach is demonstrated to be equivalent to a subsidy within this framework. Consequently, when fairness and inflationary pressures are relatively low to moderate, a price markup cap is an effective means of enhancing welfare. However, as these factors intensify, the planner sets a high markup, resulting in welfare losses.



*Keywords:* New Keynesian model, fair markups, optimal fiscal policy, price cap.

*JEL Classification:* D11, E10, E31, H21, H31.

# 1 Introduction

The inflationary period of 2021-2023 spurred policy debates and renewed academic interest in understanding the drivers of rising prices, particularly through the lens of so-called "greedflation" and "price gouging" (Bilbiie and Känzig, 2023; Scanlon, 2024). These phenomena are associated with firms' pricing strategies and consumer perceptions of pricing fairness. This concern over fairness may arise from the assumption that households are inclined to perceive price hikes as exploitative rather than as responses to underlying cost shifts (Campbell, 1999). Rotemberg (2005) and Eyster et al. (2021) have analyzed fair pricing and its implications for monetary policy. However, the intersection of fairness concerns and optimal fiscal policy remains underexplored. This paper addresses this gap by investigating the optimal fiscal policy within a New Keynesian (NK) framework with strict inflation-targeting, considering consumer perspectives on fair pricing.

The model incorporates three aspects of pricing fairness based on Eyster et al. (2021): (1) The household derives utility from the perception of fairness in pricing. (2) The household misinterprets price changes, erroneously attributing a portion of a price change to shifts in the markup when, in fact, the change is due to cost fluctuations. (3) This misinterpretation prompts the household to hold fairness concerns regarding the price markup, influencing its consumption decisions.

I analyze how these mechanisms alter the optimal fiscal policy and contrast it with the standard NK framework. In the latter framework, the optimal fiscal policy set by a Ramsey planner is an income subsidy to counteract the inefficiencies caused by monopolistic competition, which are the distortions stemming from wage and price markups (Zhu, 1992; Benigno and Woodford, 2006). This policy restores efficiency, representing the first-best allocations as defined in Blanchard and Galí (2007).

The findings of my analysis suggest that, when fairness pricing is taken into account, the optimal policy differs from the traditional recommendations. I demonstrate that the optimal decision for the planner is to implement a subsidy to address market inefficiencies, despite the inability of such an approach to eliminate fairness-related distortions. Nevertheless, the optimal subsidy level is less than that in the standard NK model, which precludes the possibility of restoring efficiency. This can be attributed to two principal factors. Firstly, the equilibrium price markup is lower in a fairness-based model, which reduces the required level of subsidy. Secondly, the planner must consider household preferences for fair pricing in conjunction with the resolution of market inefficiencies.

In this regard, I demonstrate that as distortions related to fairness increase in intensity, the subsidy is reduced. By reducing the level of subsidy, the planner seeks to mitigate demand-induced inflationary pressures, moderating the consequences associated with households' considerations of fairness. In other words, this policy is ineffective in addressing the underlying causes of the fairness issues, namely inflationary fluctuations. Accordingly, the planner's sole solution to alleviate these problems is to induce a reduction in household spending. Therefore, if the monetary authority's inflation-targeting strategy is not sufficiently stringent, the optimal policy may be to implement a tax rather than a subsidy to prevent inflation at all costs. This would result in a decline in consumption and, consequently, a loss of household welfare.

Given the connection between inflation fluctuations and fairness-related distortions, I investigate the impact of implementing a policy analogous to a price cap. In this approach, the planner is tasked with determining the optimal price markup path for the firm, as opposed to implementing a subsidy. In this context, I consider a price markup cap to be a scenario in which the planner implements an optimal markup level that is below that prevailing in the competitive equilibrium at a zero inflation steady state.

I demonstrate that providing an optimal subsidy is equivalent to imposing such an optimal cap on the price markup. This equivalence can be explained by the fact that when the household receives a subsidy, the firm consistently reduces its price markup, effectively implementing a self-price markup cap. Consequently, although a price markup cap addresses market inefficiencies to the same extent as a subsidy, the policy is unable to mitigate the consequence of inflation fluctuations on the household's fairness considerations.

Furthermore, in instances where the optimal policy entails a tax, the optimal price markup will exceed that of the competitive equilibrium at the steady state. In other words, when fair pricing is a primary concern for the household and the inflation-targeting stance is insufficiently stringent, the planner may opt to implement a negative price markup cap with the objective of reducing household spending to prevent inflation.

The paper is organized as follows: Section 2 introduces the illustrative fairness model, outlining the key mechanisms that govern household and firm behavior when fairness concerns are present. Section 3 determines the optimal subsidy policy and compares it with the standard NK model. Additionally, it explores the optimal price markup cap. Section 4 extends the model with a fully specified demand system and calibrates it to the euro area (EA) data. This section demonstrates how the optimal policy changes across different parameterizations. Lastly, Section 5 presents the conclusions.

# 2 Illustrative fairness model

Consider a standard general equilibrium model with monopolistic competition in the goods and labor markets and symmetry across households and firms (Dixit and Stiglitz, 1977; Blanchard and Kiyotaki, 1987). Under these assumptions, the decisions of a representative household and firm will be considered. Fairness is introduced based on Eyster et al. (2021), whereby the household is assumed to seek fair pricing of goods. Specifically, it misinterprets price changes, inaccurately attributing a portion of the change to shifts in the markup when it is actually due to cost variations. Consequently, the household holds fairness concerns regarding price changes and the price markup, ultimately impacting its demand for goods.

The household's expected lifetime utility is

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( u(C_t F_t) - v(L_t) \right)$$

where $\beta$ is the discount factor, $C_t$ is consumption, and $F_t$ are fairness judgments. These judgments are a function of a perceived price markup function such that $F_t = \mathbb{F}(m_t^{per})$, $m_t^{per} > 0 \forall t$; the function is continuous, twice differentiable, positive $\mathbb{F} > 0$, and satisfies $\mathbb{F}^{'} < 0$, and $\mathbb{F}^{''} \leq 0$.[1] The first derivative of the function indicates that the household deems a higher perceived price markup as more unfair, thereby increasing its fairness concerns.[2] Let $\mathcal{C}_t = C_t F_t$ denote the fairness-adjusted consumption. The budget constraint, in real terms, is

$$(1 - \tau_{l,t}) \frac{W_t}{\mathcal{P}_t} L_t + i_{t-1} \frac{B_{t-1}}{\mathcal{P}_t} + \Pi_t + T_t = \frac{B_t}{\mathcal{P}_t} + \mathcal{C}_t \tag{1}$$

where $B_t$ are risk-free bonds, $\Pi_t$ dividends, $\tau_{l,t}$ a fiscal instrument, and $T_t$ lump-sum taxes. The price index $\mathcal{P}_t = P_t / F_t$ is adjusted for fairness concerns. Aggregate labor demand is defined as $L^d = W_t^{-\nu_w}$; $\nu_w$ is the elasticity of substitutions between differentiated labor services. The household chooses $\mathcal{C}_t$,

[1] The model eschews a binary approach to fairness judgments, such as designating outcomes as "fair" or "unfair." Instead, fairness judgments are represented as a continuous function, akin to an evaluation. For clarity, the fairness judgment will be interpreted as a measure of fairness concerns.

[2] Furthermore, the second derivative illustrates that the loss of utility resulting from an increase in the perceived markup may exceed the gain resulting from a decrease.

$L_t$, $W_t$, and $B_t$ under the budget constraint and labor demand. The first-order conditions yield to

$$\begin{aligned} Euler: \quad & 1 = i_t \beta \mathbb{E}_t \left( \frac{u'(\mathcal{C}_{t+1})}{u'(\mathcal{C}_t)} \frac{\mathcal{P}_t}{\mathcal{P}_{t+1}} \right) \\ MRS: \quad & (1-\tau_{l,t}) w_t = \left( \frac{v'(L_t)}{u'(\mathcal{C}_t)} \right) m^{w,NK} \end{aligned}$$

where $w_t = W_t / \mathcal{P}_t$ is the real wage, and $m^{w,NK} = \frac{\nu_w}{\nu_w - 1}$ is the wage markup. Further details regarding the derivations are in Appendix A.1.

The representative firm produces output using labor such as $Y_t = A_t L_t$, where $A_t$ is a technology shock. The present value of its expected profits $\Pi_t$, in real terms, is

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \Gamma^t \left( (P_t - mc_t) \frac{Y_t}{\mathcal{P}_t} - \frac{\phi_p}{2} \left( \frac{P_t}{P_{t-1}} - 1 \right)^2 \mathcal{C}_t \right) \tag{2}$$

where $mc_t = W_t / A_t$ is the nominal marginal cost, $\Gamma^t$ the stochastic discount factor, and $\phi_p$ governs the degree of price adjustment costs (Rotemberg, 1982). The firm maximizes its discounted profit by choosing $P_t$, $Y_t$, and $mc_t^{per}$ subject to the aggregate good demand (3), and the inference function (defined below).

The aggregate good demand is as follows

$$Y_t = P_t^{-\nu_p} \left( \mathbb{F}(m_t^{per}) \right)^{\nu_p - 1} \tag{3}$$

where $\nu_p$ is the elasticity of substitutions between differentiated goods.

This demand for goods is illustrative of the influence of price markups on household spending decisions. In particular, it is the household's perception of the price markup that serves as the basis for its decision-making process. The latter is defined as the ratio of prices to a perceived marginal cost: $m_t^{per} = P_t / mc_t^{per}$. The denominator $mc_t^{per}$ is an inference; that is to say, it is assumed that the household deducts the cost of a good from its price. The mapping is defined by the following inference function: $mc_t^{per} = \mathbb{C}(P_t, mc_{t-1}^{per})$; the function is continuous, twice differentiable, positive $\mathbb{C}(.,.) > 0$, and satisfies $\mathbb{C}_i' > 0$, $\mathbb{C}_i'' < 0$ for $i \in \{P_t, mc_{t-1}^{per}\}$. This indicates that the household synthesizes information from prices and a past belief to infer the present marginal cost.

For example, consider that the inference function has the following form

$$mc_t^{per} = \left( \frac{\nu_p - 1}{\nu_p} P_t \right)^{1-\gamma_p} \left( mc_{t-1}^{per} \right)^{\gamma_p} \tag{4}$$

as in Eyster et al. (2021), where $\gamma_p$ governs the degree of subinference about the marginal cost. This form indicates that the household averages information from prices and a past evaluation of the marginal cost in order to infer the present marginal cost.

Under these assumptions, the equilibrium price markup evolves as

$$\Delta m_t^p \mathcal{E}_t + \Upsilon_t = 1 + \beta \mathbb{E}_t \left( \Delta m_{t+1}^p (\mathcal{E}_{t+1} - \varphi_p) + \gamma_p (\Upsilon_{t+1} - 1) \right) \tag{5}$$

where $\Delta m_t^p = \frac{m_t^p - 1}{m_t^p}$, $\Upsilon_t = \phi_p((\pi_t - 1)\pi_t - \beta \mathbb{E}_t(\pi_{t+1} - 1)\pi_{t+1})$ characterizes the effects of the price adjustment costs, and $\varphi_p = (1 - \gamma_p)\nu_p$.

In the standard NK model, the price elasticity of demand is a constant $\mathcal{E}_t^{NK} = -\frac{\partial \ln(Y_t)}{\partial \ln(P_t)} = \nu_p$, implying that the equilibrium price markup is also a constant $m_t^p = \frac{\nu_p - 1}{\nu_p}$. In contrast, formula (5) highlights that the price markup $m_t^p$ and the price elasticity of demand $\mathcal{E}_t$ are dynamic in this illustrative fairness model. The general formula for the price elasticity is then as follows

$$\mathcal{E}_t = \nu_p + (\nu_p - 1)\Psi_t$$

where $\Psi_t \triangleq -\frac{d \ln(F_t)}{d \ln(m_t^{per})} \left(1 - \frac{\partial \ln(mc_t^{per})}{\partial \ln(P_t)}\right)$. The latter governs the dynamic of price elasticity and characterizes the two primary fairness mechanisms of the model. Firstly, the term $-(\nu_p - 1)\frac{d \ln(F_t)}{d \ln(m_t^{per})}$ indicates that a price change directly affects household fairness considerations. In particular, an increase in price heightens fairness concerns, leading to a reduction in demand. Secondly, the term $(\nu_p - 1)\frac{d \ln(F_t)}{d \ln(m_t^{per})} \frac{\partial \ln(m_t^{per})}{\partial \ln(P_t)}$ illustrates that a price change also has an indirect impact on these considerations. More specifically, a price increase provides information and assists households in understanding the marginal cost, thereby reducing fairness concerns and the direct effect of a price change. However, the greater the degree of subinference $\gamma_p$, the weaker the indirect effect.

Monetary policy is set by a Taylor rule, with the sole objective of targeting inflation

$$i_t = \bar{i} \cdot \pi_t^{\psi_\pi}$$

where $i_t$ is the nominal interest rate, $\pi_t$ is the price inflation rate, and $\psi_\pi$ governs the degree of inflation response. A bar over a variable denotes a steady-state value. Furthermore, the government maintains a balanced budget at all times as follows

$$\mathcal{P}_t T_t = \tau_{l,t} W_t L_t$$

The optimal setting of the fiscal instrument $\tau_{l,t}$ is detailed in the following section.

The household's preferences are assumed to be: $u(C_tF_t) - v(L_t) = \ln(C_tF_t) - \frac{L_t^{1+\eta}}{1+\eta}$ to ensure analytical results. Moreover, goods market clearing is $C_t\chi_t = Y_t$, where $\chi_t = 1 + \frac{\phi_p}{2}(\pi_t - 1)^2$. After some variable substitutions, the equilibrium conditions are

$$
\begin{aligned}
MRS: &\quad (1-\tau_{l,t})w_t = L_t^{\eta} C_t m^{w,NK}, && (6)\\
Euler-inflation: &\quad 1 = \mathbb{E}_t \left( \frac{C_t}{C_{t+1}} \frac{\pi_t^{\psi_\pi}}{\pi_{t+1}} \right), && (7)\\
Market\ clearing: &\quad A_tL_t = C_t\chi_t, && (8)\\
Perceived\ markup: &\quad m_t^{per} = \left(m_{t-1}^{per}\right)^{\gamma_p} \left( \frac{\nu_p}{\nu_p - 1} \right)^{1-\gamma_p} (\pi_t)^{\gamma_p}, && (9)\\
Fairness\ concerns: &\quad F_t = \mathbb{F}(m_t^{per}), && (10)\\
Price\ markup: &\quad \Delta m_t^p \mathcal{E}_t + \Upsilon_t = 1 + \beta \mathbb{E}_t \left( \Delta m_{t+1}^p (\mathcal{E}_{t+1} - \varphi_p) + \gamma_p(\Upsilon_{t+1} - 1) \right), && (11)\\
Inflation\ cost: &\quad \Upsilon_t = \phi_p((\pi_t - 1)\pi_t - \beta \mathbb{E}_t(\pi_{t+1} - 1)\pi_{t+1}), && (12)\\
Price\ elasticity: &\quad \mathcal{E}_t = \nu_p + (\nu_p - 1)\gamma_p \mathcal{E}_{F_t}, && (13)\\
Real\ wage: &\quad m_t^p = \frac{A_t}{w_t}. && (14)
\end{aligned}
$$

where *MRS* stands for the marginal rate of substitution between consumption and labor.

It should be noted that the functional form assumed for the inference function (4), induces as special case for the price elasticity (13). In that formula $\mathcal{E}_{F_t} = -\frac{dF_t}{dm_t^{per}} \frac{m_t^{per}}{F_t}$ represents the perception elasticity of fairness which delineates the direct impact of a price change on the fairness considerations. The parameter $\gamma_p$ characterizes the indirect effect of a price change on these considerations.

The inflation-targeting stance implies a zero-inflation steady-state, and that: $\bar{m}^{per} = \frac{\nu_p}{\nu_p - 1}$ (see formula (9)). It can therefore be posited that households in this state are accustomed to price settings, and thus have no fairness concerns, i.e. $\bar{F} = 1$.[3] Under this assumption the steady-state price markup is

$$
\bar{m}^p = 1 + \frac{1}{(\nu_p - 1)\left(1 + \frac{(1-\beta)\gamma_p}{1-\beta\gamma_p} \bar{\mathcal{E}}_{\bar{F}}\right)}
$$

where $\bar{\mathcal{E}}_{\bar{F}} \triangleq -\left( \left( \frac{dF_t}{dm_t^{per}} \right) \Big|_{\substack{m_t^{per} = \frac{\nu_p}{\nu_p - 1} \\ F_t = 1}} \right) \cdot \left( \frac{\nu_p}{\nu_p - 1} \right) = \Xi \cdot \left( \frac{\nu_p}{\nu_p - 1} \right) > 0.$

At the zero-inflation steady-state, the perception elasticity of fairness is thus proportional to the perceived price markup by a factor denoted as $\Xi$. Provided that this factor is positive, the steady-state

[3] This aligns with the acclimation proposition put forth in Eyster et al. (2021).

value of the price markup in the fairness model is less than that of the NK model.[4] This has implications for the optimal subsidy, analyzed in the following section under standard values for $\beta = 0.99$, $\psi_\pi \geq 1.5$, $\nu_p > 1$, and $\nu_w > 1$ (Galí, 2015).

# 3 Optimal policy

An optimal policy can be defined as the solution to a Ramsey planner's problem of maximizing household welfare, (1), under the constraint of the equilibrium conditions (6)-(14). Accordingly, an optimal fiscal policy in the fairness model is a path for $\tau^*_{l,t}$ that solves that problem.

First, it is essential to recall the optimal (standard) subsidy in an NK model with price and wage markups to facilitate comparison with the alternative in the fairness model. The subsidy is defined as follows

**Reminder.** *In an NK model with price and wage markups, Rotemberg price adjustment costs, and inflation-targeting, Ramsey allocations and first-best decentralized equilibrium conditions are identical at a zero-inflation steady-state under the following optimal subsidy*

$$\tau_l^{*,NK} = 1 - m^{p,NK} m^{w,NK} \tag{15}$$

*where* $m^{p,NK} = \frac{\nu_p}{\nu_p - 1}$, $m^{w,NK} = \frac{\nu_w}{\nu_w - 1}$, $\nu_p > 1$, *and* $\nu_w > 1$. *Proof in Appendix A.2.1.*

This standard subsidy effectively addresses the inefficiencies resulting from market power in the labor and goods markets, given that $\bar{L} = \left( \frac{1-\tau_l^{*,NK}}{m^{p,NK} m^{w,NK}} \right)^{\frac{1}{1+\eta}} = \bar{Y} = \bar{C} = 1$. In contrast, the following proposition demonstrates that a Ramsey planner will establish a subsidy within the fairness model, albeit in a manner that differs from that in the standard NK model. Moreover, a corollary proves that the subsidy in question is unable to reinstate the first-best allocations.

**Proposition 1.** *In a fairness model with price and wage markups, Rotemberg price adjustment costs,*

[4] Furthermore, an increase in this factor will result in a reduction in the value of the price markup, $\frac{\partial \bar{m}^p}{\partial \Xi} = -\frac{1-\beta\gamma_p}{(1-\beta)\gamma_p \nu_p \Xi^2} < 0$. Further elaboration on the distinction between the steady-state value of the price markup in the fairness model and the NK model can be found in Appendix A.2.2.

*and inflation-targeting, the optimal subsidy at a zero-inflation steady-state is as follows*

$$\tau_l^{*,F} = 1 - (1 - \Phi_\tau^*)\bar{m}^p m^{w,NK} \tag{16}$$

*where* $\Phi_\tau^* = -\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \cdot \bar{\mathcal{E}}_{\bar{F}} > 0$, $\bar{m}^p = 1 + \frac{1}{(\nu_p - 1)\left(1+\frac{(1-\beta)\gamma_p}{1-\beta\gamma_p}\bar{\mathcal{E}}_{\bar{F}}\right)}$, *and,* $1 \leq \bar{m}^p < m^{p,NK}$. *Proof in Appendix A.2.2.*

The standard NK subsidy $\tau_l^{*,NK}$ and the subsidy in the fairness model $\tau_l^{*,F}$ are distinct in two ways. First, they differ by what I refer to as a fairness weight, $\Phi_\tau^* \in (0,1)$.[5] This weight reflects the fairness concerns through the elasticity of perception $\bar{\mathcal{E}}_{\bar{F}}$, and the inference about the marginal cost through the parameter $\gamma_p$. Furthermore, the fairness weight is contingent upon the parameter value, $\psi_\pi$, demonstrating that the inflation-targeting stance is a key factor in the subsidy level. This is because the fairness considerations impact pricing, as discussed in Section 2.[6] Second, the subsidies are distinct in that the steady-state price markup value is less than that of an NK model. These two distinctions give rise to the following corollary.

**Corollary 1.** *The optimal subsidy cannot restore the first-best allocations in the fairness model, because* $\tau_l^{*,F} > \tau_l^{*,NK}$. *Proof in Appendix A.2.3.*

In an NK model, the optimal subsidy effectively eliminates market inefficiencies, thereby ensuring the first-best steady state allocations $\bar{Y} = \bar{C} = \bar{L} = 1$. In contrast, the optimal subsidy in the fairness model results in the following level of labor distortion: $\bar{L} = \left(\frac{1-\tau_l^{*,NK}}{\bar{m}^p m^{w,NK}}\right)^{\frac{1}{1+\eta}} = (1-\Phi_\tau^*)^{\frac{1}{1+\eta}} < 1$. This distortion illustrates that although the subsidy can effectively mitigate markups, it cannot address the household's fairness considerations, characterized by the fairness weight $\Phi_\tau^*$.

Furthermore, if the fairness weight increases, provided that labor remains positive, it results in a reduction in the subsidy value and an increase in distortion.[7] When the increase in the fairness weight is significant, the second term in formula (16) illustrates that the optimal policy is a tax. This conse-

[5] More details in proofs A.2.3 and A.2.4

[6] It is also noteworthy that the price adjustment costs do not affect the subsidy setting. Thus, the proposition and its two corollaries remain identical in the absence of these costs, $\phi_p = 0$.

[7] For details regarding the parametric restriction that ensures positive steady-state labor, see Corollary A.2.3. In such cases, the fairness weight lies in $(0,1)$, and the optimal subsidy in $(\tau_{l,low}^{*,F}, 1)$ where $\tau_{l,low}^{*,F} = 1 - \bar{m}^p m^{w,NK}$.

quently gives rise to a second corollary.

**Corollary 2.** *The optimal policy may be a tax, $\tau_l^{*,F} > 0$, rather than a subsidy. Proof in Appendix A.2.4.*

The optimal policy is a tax, particularly in three cases: firstly, a case characterized by a high perception elasticity $\bar{\mathscr{E}}_{\bar{F}}$, derived from a high factor $\Xi$, giving rise to significant fairness concerns and a low markup; secondly, a case marked by a high $\gamma_p$, resulting in a substantial subinference and a low markup; thirdly, a case in which the inflation-targeting stance $\psi_\pi$ is not stringent enough (formal details are in Appendix A.2.4).

It is crucial to emphasize that the stringency of the inflation-targeting stance $\psi_\pi$ plays a pivotal role in the implementation and impact of the optimal fiscal policy. This is because the parameters governing the fairness considerations $\gamma_p$ and $\Xi$, impact both the equilibrium markup and the fairness weight. In contrast, the inflation-targeting stance influences the latter, but not the former.

Given a level of fairness considerations $\gamma_p$ and $\Xi$, a looser inflation-targeting stance will have the effect of increasing the fairness weight, as greater price fluctuations will lead to a higher frequency of the fairness pricing mechanisms. Therefore, in comparison to a scenario where the stance is more stringent, the optimal subsidy will be significantly reduced in order to restrict demand-side inflation and diminish the frequency of the fairness pricing mechanisms. This will result in substantial fairness-related distortions and significant welfare losses if the policy is required to be a tax.

In contrast, when a level of inflation-targeting stance $\psi_\pi$ is held constant, an increase in fairness considerations will result in a higher fairness weight but a lower price markup. Consequently, in comparison to a scenario with weaker fairness considerations, the optimal subsidy will be lower, but only moderately so, due to the reduced monopoly distortions. Therefore, if the level of inflation-targeting stance $\psi_\pi$, is strict enough, the optimal policy is very unlikely to be a tax, hence will not result in welfare losses.

An assertion has been made that, were the optimal policy to be a tax, this would result in welfare losses. A formal proof is provided in Appendix A.2.4. Specifically, within that framework, welfare is determined by the steady-state level of labor, $\bar{\mathscr{W}} = \frac{\ln(\bar{L}) - \frac{\bar{L}^{1+\eta}}{1+\eta}}{1-\beta}$.

In the absence of policy implementation, the level of labor is: $\bar{L} = \left(\frac{1}{\bar{m}^p m^{w,NK}}\right)^{\frac{1}{1+\eta}} < 1$. In contrast, the level of labor is: $\bar{L} = (1 - \Phi_\tau^*)^{\frac{1}{1+\eta}} < 1$ when a tax is introduced. Therefore, a welfare loss is incurred when: $1-\Phi_\tau^* < \frac{1}{\bar{m}^p m^{w,NK}}$. This may occur in the three cases previously outlined, but is certainly the case if the inflation-targeting stance is not stringent enough. The following section presents a numerical illustration of the aforementioned cases.

In light of the interrelationship between inflationary fluctuations and fairness-related distortions, it may be argued that an optimal price-cap-like policy represents a compelling proposition. Rather than implementing a fiscal response ($\tau_{l,t} = 0$), the planner is tasked with determining the optimal price markup path ($m_t^{p,*}$) for the firm.

Let $m^{gap} = \bar{m}^p - \bar{m}^{p,*}$ represent the steady-state price markup gap between the competitive equilibrium markup $\bar{m}^p$ and the optimal price markup $\bar{m}^{p,*}$ at zero inflation steady state. If that gap is positive, then $\bar{m}^{p,*}$ is considered a cap (or $\bar{m}^p > \bar{m}^{p,*}$). The following proposition and corollary demonstrate that establishing an optimal price markup cap is analogous to implementing an optimal subsidy within the fairness model.

**Proposition 2.** *In a fairness model with a price markup, Rotemberg price adjustment costs, and inflation-targeting, the optimal price markup at a zero-inflation steady-state is as follows*[8]

$$\bar{m}^{p,*} = \frac{1}{(1-\Phi_\tau^*)} \tag{17}$$

*where* $\Phi_\tau^* = -\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \cdot \bar{\varepsilon}_{\bar{F}} > 0$. *Proof in Appendix A.2.5.*

This optimal price markup implies that the level of labor is: $\bar{L} = \left(\frac{1}{\bar{m}^{p,*}}\right)^{\frac{1}{1+\eta}} = (1-\Phi_\tau^*)^{\frac{1}{1+\eta}} < 1$. In comparison, the level of labor in the event of an optimal subsidy is: $\bar{L} = \left(\frac{(1-\tau_l^{*,F})}{\bar{m}^{p,*}}\right)^{\frac{1}{1+\eta}} = (1-\Phi_\tau^*)^{\frac{1}{1+\eta}} < 1$. This equivalence gives rise to the following corollary

**Corollary 3.** *In the fairness model, establishing an optimal price-markup-cap $\bar{m}^p > \bar{m}^{p,*}$ is tantamount to implementing an optimal subsidy $\tau_l^{*,F} < 0$. Proof in Appendix A.2.6.*

This equivalence can be attributed to the fact that, in the case of these two policies, efficiency requires that the marginal rate of substitution between consumption and labor should be: $\bar{L}^\eta \bar{C} = (1-\Phi_\tau^*)$

[8]Without loss of generality, I consider that $m^{w,NK}$ is 1 to simplify the analysis. If $m^{w,NK} > 1$, the optimal price markup is $\bar{m}^{p,*} = \frac{1}{(1-\Phi_\tau^*)m^{w,NK}}$.

(details in proofs A.2.2 and A.2.5). To achieve this objective, the planner may choose to subsidize household labor income up to the price markup established by the firm. Alternatively, the planner may mandate that the firm set this markup at a cap below its desired level to stimulate household consumption and labor supply.

The following section presents numerical values for the optimal policy (subsidy/tax), calibrated to the EA economy. While the proposition about the optimal subsidy and its two corollaries remain valid in the EA model, some definitions of variables and parameters may be subject to change.

# 4 A fairness model for the euro area

## 4.1 Model summary

The following fairness model for the EA has two objectives. The first is to highlight how the equilibrium conditions of the illustrative model are analogous to a generalized and fully specified model. The second is to provide numerical values of the optimal fiscal policy under a calibration for the EA economy.

The economy is populated by a continuum of households indexed by $k \in [0,1]$ and a continuum of firms identified by $j \in [0,1]$. Households provide differentiated labor services. A labor agency centralizes these imperfectly substitutable services and makes them available to firms. Similarly, firms produce differentiated goods that are consumed by households. Consequently, the labor and goods markets are monopolistically competitive, resulting in wage and price markups.

The assumptions about the firms' pricing presented in the illustrative model, taken from Eyster et al. (2021), are maintained. Households have fairness concerns about price markups, due to a misperception of the causes generating price changes.

Monetary and fiscal policies are determined by a Taylor rule and a balanced budget through lump-sum taxes on households, as in the illustrative model. The equilibrium is characterized by 12 variables $m_t^p$, $m_t^{p,per}$, $\pi_t$, $i_t$, $Y_t$, $L_t$, $C_t$, $A_t$, $w_t$, $F_t$, $\mathcal{E}_t^p$, and $\Upsilon_t$. A Ramsey planner optimally sets the subsidy $\tau_{l,t}^*$. For a detailed account of the model's specifications and the derivations, refer to Appendix B.

## 4.2 Calibration, optimal policy, and welfare

### Calibration

The model was calibrated to represent a quarterly time frequency. Parameter values are reported in Table I. The discount factor $\beta$ has a standard value of 0.99 to achieve a 4% annual rate. The elasticity of substitution across goods 11.335 ($\nu_p$), the wage markup 1.20 $\left(m^{w,NK} = \frac{\nu_w}{\nu_w - 1}\right)$, the inverse Frisch elasticity 2.39 ($\eta$), the price adjustment cost 26.21 ($\phi_p$), and the response of nominal interest rate to inflation 2.282 ($\psi_\pi$) are taken in Cardani et al. (2022). The parameters related to the price markup fairness, namely the degrees of marginal cost subinference $\gamma_p$ and price markup fairness concerns $\theta_p$, were calibrated together to generate an instantaneous and two-year cost passthrough to prices of 0.4 and 0.7, respectively, as in Eyster et al. (2021). The three parameters $\{\theta_p, \gamma_p, \nu_p\}$ lead to a steady-state price markup ($\bar{m^p}$) of 1.07.

**Table I:** Parameter values

| Description | Symbol | Value | Source/Target |
|---|---|---|---|
| New Keynesian parameters | | | |
| Discount factor | $\beta$ | 0.99 | 4% annual rate |
| Elasticity of substitution across goods | $\nu_p$ | 11.33 | Cardani et al. (2022) |
| Elasticity of substitution across labor services | $\nu_w$ | 6 | $\bar{m^{w,NK}} = 1.2$, Cardani et al. (2022) |
| Inverse of Frisch elasticity | $\eta$ | 2.39 | Cardani et al. (2022) |
| Response to inflation | $\psi_\pi$ | 2.282 | Cardani et al. (2022) |
| Price adjustment cost | $\phi_p$ | 26.21 | Cardani et al. (2022) |
| Persistence of technology shock | $\rho_A$ | 0.9 | Standard |
| Fairness parameters | | | |
| Price markup fairness concern | $\theta_p$ | 9 | Eyster et al. (2021) |
| Degree of marginal cost subinference | $\gamma_p$ | 0.8 | Eyster et al. (2021) |

**Optimal policy and welfare**

At equilibrium, the perceived price markup $m_t^{p,per}$ and the price markup fairness concerns $F_t$ evolve as follows[9]

$$\begin{aligned} m_t^{p,per} &= \left(m_{t-1}^{p,per} \cdot \pi_t\right)^{\gamma_p} \left(\bar{m}^{p,per}\right)^{1-\gamma_p} \\ F_t &= 1 - \theta_p \left(m_t^{p,per} - \bar{m}^{p,per}\right) \end{aligned}$$

These dynamics highlight the necessity for the Ramsey planner to consider the inflation rate when formulating the optimal fiscal policy, given the impact of inflation on households' fairness concerns. It is also important to recall that the planner's policy can mitigate markups, yet cannot influence the fairness judgments that households make in response to price changes, as demonstrated in Section 3. This result also holds in this model (proof in Appendix A.3). Consequently, if the fairness considerations of the households are more pronounced, either in terms of the degree of subinference about the marginal cost $\gamma_p$ or the degree of concern $\theta_p$, then a reduction in the subsidy level will be necessary to prevent demand-induced inflation.

Now consider a zero inflation steady state, therefore the optimal policy is

$$\tau_l^{*,EA} = 1 - (1 - \Phi_\tau^{EA})\bar{m}^p m^{w,NK}$$

where $\Phi_\tau^{EA} = -\frac{\theta_p \gamma_p \bar{m}^{p,per}(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}$; Proof in Appendix A.3.

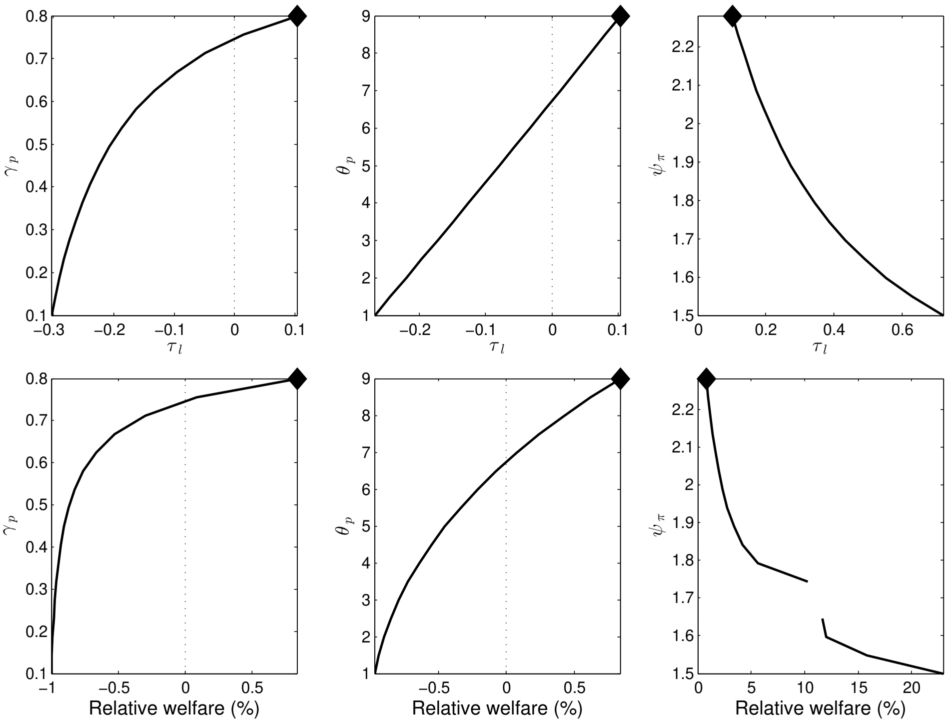
This optimal policy eliminates both markups. However, steady-state distortions persist and are contingent upon the fairness weight $\Phi_\tau^{EA}$. In the benchmark calibration with $\gamma_p = 0.8$, $\theta_p = 9$, and $\psi_\pi = 2.282$ the fairness weight is large. Consequently, the planner establishes a steady-state tax rate of approximately 10%. The corresponding steady-state optimal price markup is approximately 1.19, which is 0.12 points higher than the equilibrium markup. This is a negative cap policy designed to prevent inflation.

Furthermore, the top panels in Figure I illustrates that a decrease in $\gamma_p$ or $\theta_p$, would prompt a shift in policy towards a subsidy (a price markup cap). Moreover, the third top panel illustrates that a less stringent inflation-targeting, indicated by a lower $\psi_\pi$, results in elevated steady-state tax levels (up to 70% for a standard stance value of 1.5). This outcome highlights the potential efficacy of a fiscal and

[9] The functional forms for the perceived price markup and the fairness concerns are taken from Eyster et al. (2021).

monetary policy combination in preventing welfare losses that would occur at such a level of taxation.

**Figure I:** Optimal subsidy/tax and relative welfare

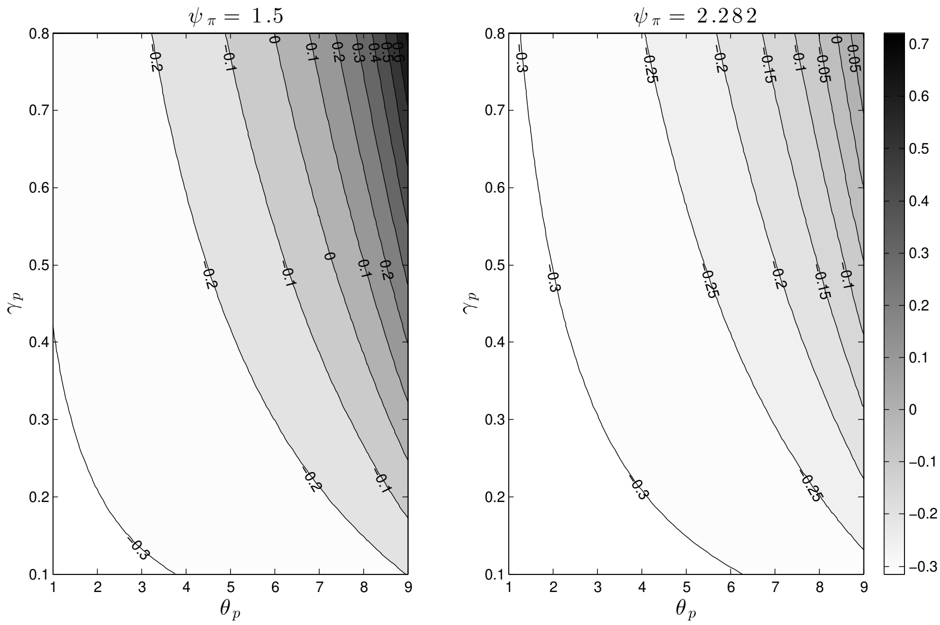



Note: The optimal policy and the associated relative welfare in the benchmark calibration are represented by diamonds ($\gamma_p = 0.8$, $\theta_p = 9$, and $\psi_\pi = 2.282$). Steps of 0.5 were used for $\theta_p$, representing 17 values $\in [1,9]$. In turn, 15 values were evenly sliced in $[0.1, 0.8]$ and $[1.5, 2.282]$ for $\gamma_p$ and $\psi_\pi$, respectively. The relative welfare when $\psi_\pi \approx 1.7$ is dropped because it leads to an outlier. Welfare is defined as: $\mathbb{E}_t(\mathcal{W}_t) = \mathbb{E}_t(\ln(\mathcal{C}_t) - L_t^{1+\eta}/(1+\eta) + \beta\mathbb{E}_t\mathcal{W}_{t+1})$ and the standard deviation of the technology shock is set to 1%. Relative welfare is calculated as $\exp((1-\beta)(\mathbb{E}_t(\mathcal{W}_t)^{nopol.} - \mathbb{E}_t(\mathcal{W}_t)^{EA})) - 1$ where $\mathbb{E}_t(\mathcal{W}_t)^{nopol.}$ is the welfare expectation in the EA model without subsidy/tax. Relative welfare represents the fairness-consumption percentage that households would be willing to forgo to remain in the fairness economy but free of subsidy/tax. In other words, if the relative welfare is positive (negative), the optimal policy results in a welfare loss (gain) relative to an economy with no policy.

With regard to the impact on welfare, the lower panels indicate the relative welfare, defined as the fairness-adjusted consumption percentage that households would be willing to forgo to be free of the subsidy or tax. The welfare loss, positive values of the relative welfare, is modest under the benchmark calibration (illustrated by diamonds), reaching approximately 0.75% of consumption. Households would be willing to forgo consumption because the optimal policy is a moderate tax (around 10%). When the policy becomes a subsidy—when households' fairness considerations becomes less pronounced—the first two panels illustrate that the welfare gains would reach at best 1%.

In contrast, welfare loss significantly grows for looser inflation targeting under pronounced households' fairness considerations ($\gamma_p = 0.8$, $\theta_p = 9$). To illustrate, under the standard inflation-targeting policy ($\psi_\pi = 1.5$), households would be willing to forego approximately 25% of their consumption in order to avoid the tax. As illustrated in the left panel of Figure II, in such a scenario, the tax rate

**Figure II:** Values for $\tau_l^{EA}$




Note: Steps of 0.1 were used for $\theta_p$, representing 17 values $\in [1,9]$. In turn, 80 values were evenly sliced in the interval $[0.1, 0.8]$ for $\gamma_p$. The color bar on the right-hand side indicates whether the optimal policy is a tax or a subsidy.

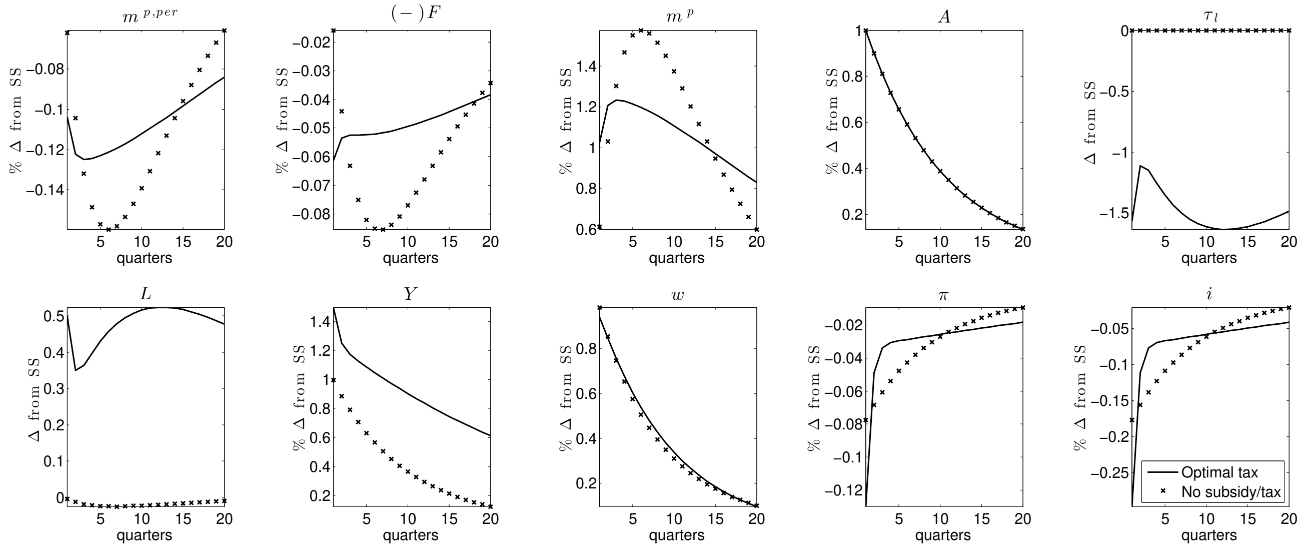
approaches 70%, resulting in considerable steady-state output distortion. This serves to reinforce the conclusion that the inflation-targeting stance is pivotal for the efficacy of the optimal fiscal policy in a fairness model.

Finally, Figure III depicts the model dynamic under the benchmark calibration following an unanticipated and transitory rise of 1% in the technology level.[10] It compares the key variable responses in an economy with no subsidy to those in an economy under the optimal policy (a steady-state tax of around 10%).

In both economies, the enhanced technology lowers marginal costs and prices. Households attribute some of these changes to lower price markups, which reduces their fairness concerns and increases their demand for goods. This sustained decline in prices is inconsistent with the planner's objectives. In response, a tax reduction is implemented to stimulate demand-side inflation, counteracting the decline in prices. This intervention reinforces the rise in output caused by the shock.

[10]The shock is defined as $\ln A_t = \rho_A \ln A_{t-1} - \varepsilon_A$, where $\varepsilon_A$ is calibrated to generate a 1% drop in technology on impact.

**Figure III:** Positive technology shock in the EA model




Note: "Optimal tax" refers to the variable responses to the technology shock under the Ramsey allocations (details in Appendix A.3). It should be noted that at steady-state, under the benchmark calibration, the optimal policy is a tax of about 10%. "No subsidy/tax" refers to the variable responses to the shock in the EA model under the same calibration but without a subsidy/tax. Both models are calibrated similarly, with parameter values given in Table I. The negative sign $(-)F$ reflects a reversal of the original sign, aiding interpretation in terms of fairness concerns.

# 5 Conclusion

This paper examines the design of optimal policies in a New Keynesian framework, taking into account the implications of consumer considerations for fair pricing. In the model, the household derives utility from pricing that is perceived as fair. Furthermore, the household misinterprets the fundamental causes of price fluctuations, ascribing an exaggerated significance to the price markup. As a result of these erroneous beliefs, the household holds fairness concerns that distort its spending decisions. Consequently, the firm modifies its pricing strategy by setting a price markup below its desired level in the absence of considerations about fairness.

The analysis initially demonstrates that the optimal fiscal policy within that framework is a subsidy. In contrast to the standard New Keynesian model, in which the subsidy is only designed to rectify distortions resulting from market power, the introduction of fairness considerations modifies the function of the policy. I prove that an optimal subsidy can address the distortions induced by the degree of monopolistic competition. However, it cannot mitigate the distortions that arise from the extent of fairness considerations. Moreover, when these considerations and inflation fluctuations are particularly pronounced, the Ramsey planner deems it more appropriate to implement a tax than a policy. This is done to forestall demand-driven inflation, thus limiting the implications of price changes on fairness concerns. Nevertheless, this decision results in a welfare loss. Furthermore, I generalize the model and calibrate it to euro area data to assess the range of values the optimal subsidy and welfare may take.

In conclusion, given the connection between inflation fluctuations and fairness-related distortions, I examine the consequences of implementing a policy that is analogous to a price cap. The planner is responsible for determining the optimal price markup path for the firm, as opposed to implementing a subsidy. I demonstrate that, in this framework, providing an optimal subsidy is equivalent to imposing an optimal cap on the price markup. Therefore, when the consideration of the household for fair pricing is minimal to moderate, a markup price cap is an effective means of enhancing welfare. However, when considerations are pronounced, the planner selects a higher price markup level than that desired by the firm, which results in a welfare loss. These findings offer promising avenues for further research into this equivalence and and the implications of its cessation.

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# Appendix A

## A.1 Illustrative fairness model: Derivations

The household's expected lifetime utility is

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( u(\mathcal{C}_t) - v(L_t) \right)$$

The budget constraint, in real terms, is

$$(1-\tau_{l,t})\frac{W_t}{\mathcal{P}_t}L_t + i_{t-1}\frac{B_{t-1}}{\mathcal{P}_t} + \Pi_t + T_t = \frac{B_t}{\mathcal{P}_t} + \mathcal{C}_t \tag{A1}$$

The household chooses $\mathcal{C}_t = C_t F_t$, $L_t$, $W_t$, and $B_t$ under the budget constraint and labor demand, $L_t = W_t^{-\nu_w}$. FOCs,

$$\begin{aligned}
\mathcal{C}_t: &\qquad \lambda_t^c = u'(\mathcal{C}_t),\\
B_t: &\qquad \lambda_t^c = i_t \beta \mathbb{E}_t \left( \lambda_{t+1}^c \frac{\mathcal{P}_t}{\mathcal{P}_{t+1}} \right),\\
L_t: &\qquad \mu_t^c = -v'(L_t) + \lambda_t^c (1-\tau_{l,t}) \frac{W_t}{\mathcal{P}_t},\\
W_t: &\qquad \nu_w \mu_t^c \frac{L_t}{W_t} = \lambda_t^c (1-\tau_{l,t}) \frac{L_t}{\mathcal{P}_t}
\end{aligned}$$

then,

$$\begin{aligned}
B_t: &\qquad 1 = i_t \beta \mathbb{E}_t \left( \frac{u'(\mathcal{C}_{t+1})}{u'(\mathcal{C}_t)} \frac{\mathcal{P}_t}{\mathcal{P}_{t+1}} \right),\\
L_t: &\qquad \frac{1}{v'(L_t)} \mu_t^c = -1 + \frac{u'(\mathcal{C}_t)}{v'(L_t)} (1-\tau_{l,t}) \frac{W_t}{\mathcal{P}_t},\\
W_t: &\qquad \frac{\nu_w}{v'(L_t)} \mu_t^c = \frac{u'(\mathcal{C}_t)}{v'(L_t)} (1-\tau_{l,t}) \frac{W_t}{\mathcal{P}_t}
\end{aligned}$$

let $m^{w,NK} = \frac{u'(\mathcal{C}_t)}{v'(L_t)}(1-\tau_{l,t})w_t$, where $w_t = \frac{W_t}{\mathcal{P}_t}$,

$$\begin{aligned}
L_t: &\qquad \frac{1}{v'(L_t)} \mu_t^c = -1 + m^{w,NK},\\
W_t: &\qquad \nu_w(-1 + m^{w,NK}) = m^{w,NK}
\end{aligned}$$

consequently, $m^{w,NK} = \frac{\nu_w}{\nu_w - 1}$.

The representative firm produces output under a simple technology $Y_t = A_t L_t$, where $A_t$ is a technology shock. The present value of its expected profits ($\Pi_t$), in real terms, is

$$
\begin{aligned}
& \mathbb{E}_0 \sum_{t=0}^{\infty} \Gamma^t \left( \frac{P_t}{\mathcal{P}_t} Y_t - \frac{W_t}{\mathcal{P}_t} L_t - \frac{\phi_p}{2} \left( \frac{P_t}{P_{t-1}} - 1 \right)^2 \mathcal{C}_t \right) \\
\triangleq \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \Gamma^t \left( (P_t - mc_t) \frac{Y_t}{\mathcal{P}_t} - \frac{\phi_p}{2} \left( \frac{P_t}{P_{t-1}} - 1 \right)^2 \mathcal{C}_t \right)
\end{aligned}
$$

where $mc_t = \frac{W_t}{A_t}$. The firm maximizes its discounted profit by choosing $P_t$, $Y_t$, and $mc_t^{per}$ subject to the good demand, $Y_t = P_t^{-\nu_p} \left( \mathbb{F}(m_t^{per}) \right)^{\nu_p - 1}$, and the inference function, $mc_t^{per} = \mathbb{C}(P_t, mc_{t-1}^{per})$. FOCs,

$$
\begin{aligned}
Y_t : \quad & \lambda_t = \frac{P_t}{\mathcal{P}_t} - \frac{mc_t}{\mathcal{P}_t} = \frac{P_t}{\mathcal{P}_t} \Delta m_t, \\
P_t : \quad & 0 = \frac{Y_t}{\mathcal{P}_t} + \lambda_t \frac{\partial Y_t}{\partial P_t} + \mu_t \frac{\partial mc_t^{per}}{\partial P_t} - \phi_p \left( \frac{P_t}{P_{t-1}} - 1 \right) \frac{\mathcal{C}_t}{P_{t-1}} + \phi_p \mathbb{E}_t \Gamma_t \left( \left( \frac{P_{t+1}}{P_t} - 1 \right) \frac{P_{t+1} \mathcal{C}_{t+1}}{P_t^2} \right), \\
mc_t^{per} : \quad & \mu_t = \mathbb{E}_t \left( \Gamma_t \left( \mu_{t+1} \frac{\partial mc_{t+1}^{per}}{\partial mc_t^{per}} + \lambda_{t+1} \frac{\partial Y_{t+1}}{\partial mc_t^{per}} \right) \right)
\end{aligned}
$$

where, $\Delta m_t = \frac{m_t - 1}{m_t}$. Multiply the second condition by $-\frac{\mathcal{P}_t}{Y_t}$,

$$
\begin{aligned}
P_t : \quad 1 &= -\lambda_t \frac{\partial Y_t}{\partial P_t} \frac{\mathcal{P}_t}{Y_t} - \mu_t \frac{\partial mc_t^{per}}{\partial P_t} \frac{\mathcal{P}_t}{Y_t} + \phi_p \left( \frac{P_t}{P_{t-1}} - 1 \right) \frac{\mathcal{P}_t}{P_{t-1}} \frac{\mathcal{C}_t}{Y_t} - \phi_p \mathbb{E}_t \Gamma_t \left( \left( \frac{P_{t+1}}{P_t} - 1 \right) \frac{P_{t+1} \mathcal{P}_t}{P_t^2} \frac{\mathcal{C}_{t+1}}{Y_t} \right), \\
1 &= -\Delta m_t \frac{\partial \ln(Y_t)}{\partial \ln(P_t)} - \mu_t \frac{\partial mc_t^{per}}{\partial P_t} \frac{\mathcal{P}_t}{Y_t} + \Upsilon_t,
\end{aligned}
$$

where $\Upsilon_t = \phi_p \frac{C_t}{Y_t} \left( (\pi_t - 1) \pi_t - \beta \mathbb{E}_t (\pi_{t+1} - 1) \pi_{t+1} \right)$. Then,

$$
\begin{aligned}
P_t : \quad & 1 = -\Delta m_t \frac{\partial \ln(Y_t)}{\partial \ln(P_t)} - \mu_t \frac{\partial mc_t^{per}}{\partial P_t} \frac{\mathcal{P}_t}{Y_t} + \Upsilon_t, \\
mc_t^{per} : \quad & \mu_t = \mathbb{E}_t \left( \Gamma_t \left( \mu_{t+1} \frac{\partial mc_{t+1}^{per}}{\partial mc_t^{per}} + \lambda_{t+1} \frac{\partial Y_{t+1}}{\partial mc_t^{per}} \right) \right)
\end{aligned}
$$

define $\mathcal{E}_t = -\frac{\partial \ln(Y_t)}{\partial \ln(P_t)} = \nu_p + (\nu_p - 1)\Psi_t$, where $\Psi_t = -\frac{d \ln(F_t)}{d \ln(m_t^{per})} \left( 1 - \frac{\partial \ln(mc_t^{per})}{\partial \ln(P_t)} \right)$, and $m_t^{per} = \mathbb{M}(P_t, mc_{t-1}^{per})$; continuous, twice differentiable, positive $\mathbb{M}(.,.) > 0$, and satisfies $\mathbb{M}_p^{'} > 0$, $\mathbb{M}_p^{''} < 0$, $\mathbb{M}_{mc}^{'} < 0$, $\mathbb{M}_{mc}^{''} > 0$.

Let me consider that the inference function of the perceived marginal cost is an iso-elastic function with an elasticity $\gamma_p \in (0,1)$ as in Eyster et al. (2021): $mc_t^{per} = \left( \frac{\nu_p - 1}{\nu_p} P_t \right)^{1-\gamma_p} \left( mc_{t-1}^{per} \right)^{\gamma_p}$.

Consequently, $m_t^{per} = \left( \frac{\nu_p}{\nu_p - 1} \right)^{1-\gamma_p} \left( \frac{P_t}{mc_{t-1}^{per}} \right)^{\gamma_p}$, and $\frac{\partial \ln(m_t^{per})}{\partial \ln(P_t)} = -\frac{\partial \ln(m_t^{per})}{\partial \ln(mc_{t-1}^{per})} = const.$; evidently all derivatives conditions are satisfied. In turn, this allows to derive, $\frac{\partial \ln(Y_t)}{\partial \ln(mc_{t-1}^{per})} = (\nu_p - 1)\Psi_t = \mathcal{E}_t - \nu_p$. Therefore,

$$
\begin{aligned}
P_t: \qquad & \mu_t \frac{(1-\gamma_p) mc_t^{per} \mathcal{P}_t}{Y_t P_t} = \Delta m_t \mathcal{E}_t - 1 + \Upsilon_t, \\
mc_t^{per}: \qquad & \mu_t = \mathbb{E}_t \left( \Gamma_t \left( \mu_{t+1} \gamma_p \frac{mc_{t+1}^{per}}{mc_t^{per}} + \frac{P_{t+1}}{\mathcal{P}_{t+1}} \Delta m_{t+1} (\mathcal{E}_{t+1} - \nu_p) \frac{Y_{t+1}}{mc_t^{per}} \right) \right)
\end{aligned}
$$

then,

$$
\begin{aligned}
mc_t^{per}: \quad \Delta m_t \mathcal{E}_t - 1 + \Upsilon_t &= (1-\gamma_p)\mathbb{E}_t \left( \Gamma_t \left( \mu_{t+1} \gamma_p \frac{mc_{t+1}^{per} \mathcal{P}_t}{Y_t P_t} + \Delta m_{t+1} (\mathcal{E}_{t+1} - \nu_p) \frac{Y_{t+1} P_{t+1} \mathcal{P}_t}{Y_t P_t \mathcal{P}_{t+1}} \right) \right) \\
&= (1-\gamma_p)\mathbb{E}_t \left( \Gamma_t \frac{Y_{t+1} P_{t+1} \mathcal{P}_t}{Y_t P_t \mathcal{P}_{t+1}} \left( \frac{\gamma_p}{(1-\gamma_p)} (\Delta m_{t+1} \mathcal{E}_{t+1} - 1 + \Upsilon_{t+1}) \right.\right. \\
&\quad \left.\left. + \Delta m_{t+1} (\mathcal{E}_{t+1} - \nu_p) \right) \right) \\
&= \beta \mathbb{E}_t \left( \mathcal{Y}_{t;t+1} \left( \Delta m_{t+1} (\mathcal{E}_{t+1} - (1-\gamma_p)\nu_p) + \gamma_p (\Upsilon_{t+1} - 1) \right) \right)
\end{aligned}
$$

where $\mathcal{Y}_{t;t+1} = \frac{C_t Y_{t+1}}{C_{t+1} Y_t}$. Note that the last equality holds given that $\mathcal{P}_t = \frac{P_t}{F_t}$, and assuming that $u(C_t F_t) = \ln(C_t F_t)$; therefore $\Gamma_t = \beta \frac{u'(C_{t+1})}{u'(C_t)} = \beta \frac{C_t F_t}{C_{t+1} F_{t+1}}$. In equilibrium, the good market clearing is $C_t(1 + \frac{\phi_p}{2}(\pi_t - 1)^2) = Y_t$. In section 2, I assumed that $C_t = Y_t$, such that $\mathcal{Y}_{t;t+1} = 1$ for simplifying the algebra. This simplification does not change the proposition regarding the optimal policy.

## A.2 Illustrative fairness model: Proofs

### A.2.1 Reminder.

Proof of the reminder. In an NK model with Rotemberg price cost adjustments and inflation-targeting, the optimal subsidy can be determined by solving the following Ramsey problem

$$\begin{aligned}\mathcal{L}_R^{NK} &= \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \ln(C_t) - \frac{L_t^{1+\eta}}{1+\eta} \right) \\ &\quad + \lambda_{1,t} \left( \frac{1}{C_t} - \mathbb{E}_t \frac{\pi_t^{\psi_\pi}}{\pi_{t+1} C_{t+1}} \right) \\ &\quad + \lambda_{2,t} \left( A_t L_t - C_t \chi_t \right)\end{aligned}$$

where $\chi_t = (1 + \frac{\phi_p}{2}(\pi_t - 1)^2)$, $\Phi_{t;t+1} \triangleq \frac{1}{m^{p,NK}} + \frac{\phi_p}{\nu_p}\left((\pi_t - 1)\pi_t - \beta \mathbb{E}_t (\pi_{t+1} - 1)\pi_{t+1}\right)$, $m^{p,NK} = \frac{\nu_p}{(\nu_p - 1)}$, $m^{w,NK} = \frac{\nu_w}{(\nu_w - 1)}$. In that problem $\tau_{l,t}$ will freely adjust, thereby rendering the condition, $m^{w,NK} L_t^{\eta} C_t = -A_t(1 - \tau_{l,t})\mathbb{E}_t \Phi_{t,t+1}$, a non-binding constraint. The first-order conditions are (for $t > 0$),

$$\begin{aligned}C_t: \quad 0 &= \frac{1}{C_t} - \lambda_{1,t} \frac{1}{C_t^2} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{\pi_t C_t^2} - \lambda_{2,t} \chi_t, \\ L_t: \quad 0 &= -L_t^{\eta} + \lambda_{2,t} A_t, \\ \pi_t: \quad 0 &= -\lambda_{1,t} \mathbb{E}_t \frac{\psi_\pi \pi_t^{\psi_\pi - 1}}{\pi_{t+1} C_{t+1}} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{C_t \pi_t^2} - \lambda_{2,t} C_t \phi_p (\pi_t - 1).\end{aligned}$$

Consider a zero inflation steady-state, $\bar{\pi} = 1$. Evidently, $\lambda_1 = 0$, therefore,

$$\begin{aligned}\bar{C}: \quad 0 &= \frac{1}{\bar{C}} - \lambda_2, \\ \bar{L}: \quad \bar{L}^{\eta} &= \lambda_2.\end{aligned}$$

consequently $\bar{L}^{\eta} \bar{C} = 1$ restores efficiency (first-best allocations, Blanchard and Galí (2007)). Now given that $\bar{L}^{\eta} \bar{C} = \frac{(1-\tau_l)}{m^{p,NK} m^{w,NK}}$ at the steady-state of the competitive equilibrium, it follows that the optimal subsidy is

$$\begin{aligned}\frac{(1 - \tau_l^{*,NK})}{m^{p,NK} m^{w,NK}} &= \bar{L}^{\eta} \bar{C} = 1, \\ \tau_l^{*,NK} &= 1 - m^{p,NK} m^{w,NK}, \quad \blacksquare\end{aligned}$$

### A.2.2 Proposition 1

Proof of Proposition 1. In a fairness model with Rotemberg price cost adjustments and inflation-targeting, the optimal subsidy can be determined by solving the following Ramsey problem

$$
\begin{aligned}
\mathcal{L}_R^{illus.} \quad = \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \ln(C_t F_t) - \frac{L_t^{1+\eta}}{1+\eta} \right) \\
& + \lambda_{1,t} \left( \frac{1}{C_t} - \mathbb{E}_t \frac{\pi_t^{\psi_\pi}}{\pi_{t+1} C_{t+1}} \right) \\
& + \lambda_{2,t} \left( A_t L_t - C_t \chi_t \right) \\
& + \lambda_{3,t} \left( m_t^{per} - \left( m_{t-1}^{per} \right)^{\gamma_p} \left( \frac{\nu_p}{\nu_p - 1} \right)^{1-\gamma_p} (\pi_t)^{\gamma_p} \right) \\
& + \lambda_{4,t} \left( F_t - \mathbb{F}(m_t^{per}) \right) \\
& + \lambda_{5,t} \left( (m_t^p - 1)\mathcal{E}_t + m_t^p \Upsilon_t - m_t^p \left( 1 + \beta \mathbb{E}_t \left( \Delta m_{t+1}^p (\mathcal{E}_{t+1} - \varphi_p) + \gamma_p \left( \Upsilon_{t+1} - 1 \right) \right) \right) \right) \\
& + \lambda_{6,t} \left( \Upsilon_t - \phi_p \left( (\pi_t - 1)\, \pi_t - \beta \mathbb{E}_t \left( \pi_{t+1} - 1 \right) \pi_{t+1} \right) \right) \\
& + \lambda_{7,t} \left( (\mathcal{E}_t - \nu_p) F_t + (\nu_p - 1) \gamma_p m_t^{per} \frac{dF_t}{dm_t^{per}} \right) \\
& + \lambda_{8,t} \left( m_t^p w_t - A_t \right)
\end{aligned}
$$

in that problem $\tau_{l,t}$ will freely adjust, thereby rendering the condition, $(1-\tau_{l,t})w_t = L_t^{\eta} C_t m^{w,NK}$, a non-binding constraint. The first-order conditions are (for $t > 0$),

$$
\begin{aligned}
C_t: \quad 0 &= \frac{1}{C_t} - \lambda_{1,t}\frac{1}{C_t^2} + \lambda_{1,t-1}\mathbb{E}_{t-1}\beta^{-1}\frac{\pi_{t-1}^{\psi_\pi}}{\pi_t C_t^2} - \lambda_{2,t}\chi_t, \\
L_t: \quad 0 &= -L_t^{\eta} + \lambda_{2,t}A_t, \\
\pi_t: \quad 0 &= -\lambda_{1,t}\mathbb{E}_t\frac{\psi_\pi \pi_t^{\psi_\pi - 1}}{\pi_{t+1}C_{t+1}} + \lambda_{1,t-1}\mathbb{E}_{t-1}\beta^{-1}\frac{\pi_{t-1}^{\psi_\pi}}{\pi_t^2 C_t} - \lambda_{2,t}C_t\phi_p(\pi_t - 1) \\
&\quad -\lambda_{3,t}\gamma_p\frac{m_t^{per}}{\pi_t} + \lambda_{6,t}(\phi_p - 2\phi_p\pi_t) + \lambda_{6,t-1}\mathbb{E}_{t-1}\phi_p(2\pi_t - 1), \\
F_t: \quad 0 &= \frac{1}{F_t} + \lambda_{4,t} + \lambda_{7,t}\left(\mathcal{E}_t - \nu_p + (\nu_p - 1)\gamma_p m_t^{per}\frac{\partial}{\partial F_t}\left(\frac{dF_t}{dm_t^{per}}\right)\right), \\
m_t^{per}: \quad 0 &= \lambda_{3,t} - \beta\lambda_{3,t+1}\mathbb{E}_t\gamma_p\frac{m_{t+1}^{p,per}}{m_t^{per}} - \lambda_{4,t}\frac{dF_t}{dm_t^{per}} + \lambda_{7,t}(\nu_p - 1)\gamma_p\left(m_t^{per}\frac{d^2F_t}{d(m_t^{per})^2} + \frac{dF_t}{dm_t^{per}}\right), \\
m_t^p: \quad 0 &= w_t\lambda_{8,t} + \lambda_{5,t}\left(\mathcal{E}_t + \Upsilon_t - \left(1 + \beta\mathbb{E}_t\left(\Delta m_{t+1}^p(\mathcal{E}_{t+1}^p - \varphi_p) + \gamma_p(\Upsilon_{t+1} - 1)\right)\right)\right) \\
&\quad +\lambda_{5,t-1}\mathbb{E}_{t-1}m_{t-1}^p(\varphi_p - \mathcal{E}_t^p)\frac{1}{m_t^p m_t^p}, \\
\mathcal{E}_t: \quad 0 &= \lambda_{7,t}F_t + \lambda_{5,t}(m_t^p - 1) - \lambda_{5,t-1}\mathbb{E}_{t-1}m_{t-1}^p\Delta m_t^p, \\
\Upsilon_t: \quad 0 &= \lambda_{5,t}m_t^p - \lambda_{5,t-1}\mathbb{E}_{t-1}m_{t-1}^p\gamma_p + \lambda_{6,t}, \\
w_t: \quad 0 &= \lambda_{8,t}m_t^p.
\end{aligned}
$$

Consider a zero inflation steady-state, $\bar{\pi} = 1$, therefore

$$
\begin{aligned}
\bar{C}: \quad 0 &= \frac{1}{\bar{C}} - \lambda_1\frac{1}{\bar{C}^2} + \lambda_1\beta^{-1}\frac{1}{\bar{C}^2} - \lambda_2, \\
\bar{L}: \quad 0 &= -\bar{L}^{\eta} + \lambda_2, \\
\bar{\pi}: \quad 0 &= \lambda_1\frac{1}{\bar{C}}(\beta^{-1} - \psi_\pi) - \lambda_3\gamma_p\bar{m}^{per}, \\
\bar{F}: \quad 0 &= \frac{1}{\bar{F}} + \lambda_4 + \lambda_7\left(\bar{\mathcal{E}}^p - \nu_p + (\nu_p - 1)\gamma_p\bar{m}^{per}\frac{\partial}{\partial F_t}\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}}\right), \\
\bar{m}^{per}: \quad 0 &= \lambda_3 - \lambda_3\beta\gamma_p - \lambda_4\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}} \\
&\quad +\lambda_7(\nu_p - 1)\gamma_p\left(\bar{m}^{per}\frac{d^2F_t}{d(m_t^{per})^2}\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}} + \frac{dF_t}{dm_t^{per}}\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}}\right), \\
\bar{m}^p: \quad 0 &= \bar{w}\lambda_8 + \lambda_5\left(\bar{\mathcal{E}}^p - \left(1 + \beta\left(\Delta\bar{m}^p(\bar{\mathcal{E}}^p - \varphi_p) - \gamma_p\right)\right)\right) + \lambda_5(\varphi_p - \bar{\mathcal{E}}^p)\frac{1}{\bar{m}^p}, \\
\bar{\mathcal{E}}: \quad 0 &= \lambda_7\bar{F}, \\
\bar{\Upsilon}: \quad 0 &= \lambda_5\bar{m}^p - \lambda_5\bar{m}^p\gamma_p + \lambda_6, \\
\bar{w}: \quad 0 &= \lambda_8\bar{m}^p.
\end{aligned}
$$

Evidently, $\lambda_{5:8} = 0$,

$$
\begin{aligned}
\bar{C}: \quad & 0 &=& \; 1-\lambda_1\frac{1}{\bar{C}}+\lambda_1\beta^{-1}\frac{1}{\bar{C}}-\bar{C}\lambda_2, \\
\bar{L}: \quad & \lambda_2 &=& \; \bar{L}^{\eta}, \\
\bar{\pi}: \quad & \lambda_1 &=& \; \lambda_3\frac{\gamma_p\bar{m}^{per}\bar{C}}{(\beta^{-1}-\psi_\pi)}, \\
\bar{F}^p: \quad & \lambda_4 &=& \; -\frac{1}{\bar{F}}, \\
\bar{m}^{per}: \quad & \lambda_3 &=& \; -\frac{\lambda_4\Xi}{(1-\beta\gamma_p)}.
\end{aligned}
$$

where $\Xi \triangleq -\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}}$,

$$
\begin{aligned}
\bar{C}: \quad & \bar{L}^{\eta}\bar{C} &=& \; 1+\lambda_1\frac{1}{\bar{C}}(\beta^{-1}-1), \\
\bar{\pi}: \quad & \lambda_1 &=& \; \frac{\Xi\gamma_p\bar{m}^{per}\bar{C}}{\bar{F}(1-\beta\gamma_p)(\beta^{-1}-\psi_\pi)}.
\end{aligned}
$$

consequently,

$$
\begin{aligned}
\bar{L}^{\eta}\bar{C} &= 1+\frac{\Xi\gamma_p\bar{m}^{per}(\beta^{-1}-1)}{\bar{F}(1-\beta\gamma_p)(\beta^{-1}-\psi_\pi)} \\
&= 1+\frac{\Xi\bar{m}^{per}}{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \\
&= 1+\bar{\mathcal{E}}_{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}
\end{aligned}
$$

where $\bar{\mathcal{E}}_{\bar{F}} \triangleq -\left(\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\frac{v_p}{v_p-1}\\ F_t=1}}\right)\cdot\left(\frac{v_p}{v_p-1}\right) = \Xi\cdot\left(\frac{v_p}{v_p-1}\right) > 0$ (given that $F_t > 0$, $m_t^{per} > 0$, and $F_t' < 0$ as defined in section 2). Now given that $\bar{L}^{\eta}\bar{C} = \frac{(1-\tau_l)}{m^{w,NK}\bar{m}^p}$ at the steady-state of the competitive equilibrium, it follows that the optimal subsidy is

$$
\begin{aligned}
\tau_l^{*,F} &= 1-\left(1+\bar{\mathcal{E}}_{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}\right)\bar{m}^p m^{w,NK} \\
&= 1-(1-\Phi_\tau^*)\bar{m}^p m^{w,NK}, \quad \blacksquare
\end{aligned}
$$

where $\Phi_{\tau}^{*} = -\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \cdot \bar{\mathcal{E}}_{\bar{F}} > 0$, given that $(1-\beta\psi_\pi) < 0$, and $m^{w,NK} = \frac{\nu_w}{(\nu_w-1)}$. Note that the steady-state of the price elasticity of demand is

$$\begin{aligned} \bar{\mathcal{E}} &= \nu_p + (\nu_p - 1)\gamma_p \frac{\bar{m}^{per}}{\bar{F}} \Xi \\ &= \nu_p + (\nu_p - 1)\gamma_p \bar{\mathcal{E}}_{\bar{F}} \end{aligned}$$

and the steady-state of the price markup is

$$\begin{aligned} &\Delta\bar{m}^p \bar{\mathcal{E}} = 1 + \beta\left(\Delta\bar{m}^p(\bar{\mathcal{E}} - \varphi_p) - \gamma_p\right) \\ &\bar{m}^p(\bar{\mathcal{E}}(1-\beta) + \beta\varphi_p - (1-\beta\gamma_p)) = \bar{\mathcal{E}}(1-\beta) + \beta\varphi_p \\ &\bar{m}^p = \frac{\bar{\mathcal{E}}(1-\beta) + \beta\varphi_p}{\bar{\mathcal{E}}(1-\beta) + \beta\varphi_p - (1-\beta\gamma_p)} \\ &\bar{m}^p = 1 + \frac{1-\beta\gamma_p}{\bar{\mathcal{E}}(1-\beta) + \beta\varphi_p - (1-\beta\gamma_p)} \\ &\bar{m}^p = 1 + \frac{1-\beta\gamma_p}{\left(\nu_p + (\nu_p-1)\gamma_p\bar{\mathcal{E}}_{\bar{F}}\right)(1-\beta) + \beta(1-\gamma_p)\nu_p - (1-\beta\gamma_p)} \\ &\bar{m}^p = 1 + \frac{1-\beta\gamma_p}{(\nu_p-1)((1-\beta\gamma_p) + (1-\beta)\gamma_p\bar{\mathcal{E}}_{\bar{F}})} \\ &\bar{m}^p = 1 + \frac{1}{(\nu_p-1)\left(1 + \frac{(1-\beta)\gamma_p}{1-\beta\gamma_p}\bar{\mathcal{E}}_{\bar{F}}\right)}. \end{aligned}$$

considering that $\beta = 0.99$, $\nu_p > 1$, $\gamma_p \in (0,1)$, $\bar{\mathcal{E}}_{\bar{F}} > 0$, $\bar{m}^p$ ranges in $(1+\varepsilon_F, \frac{\nu_p}{\nu_p-1})$ where $\varepsilon_F = \frac{1}{(\nu_p-1)\left(1+\bar{\mathcal{E}}_{\bar{F}}\right)}$. Moreover, when $\bar{\mathcal{E}}_{\bar{F}} \to \infty$, $\bar{m}^p \to 1$.

Furthermore, the denominator of the second term is $(\nu_p-1)\left(1+\frac{(1-\beta)\gamma_p}{1-\beta\gamma_p}\bar{\mathcal{E}}_{\bar{F}}\right) > 1$. Since $m^{p,NK} = \frac{\nu_p}{\nu_p-1} = 1 + \frac{1}{\nu_p-1}$. Consequently,

$$\bar{m}^p < 1 + \frac{1}{\nu_p - 1} = m^{p,NK}. \tag{A2}$$

### A.2.3 Corollary 1.

To simplify the proof, consider standard values for $\beta = 0.99$, $\psi_\pi \geq 1.5$, $\nu_p > 1$, $\nu_w > 1$, (Galí, 2015). Assume that $\bar{F} = 1$ for the reasons exposed in section 2. Evidently, under these assumptions (A2) still holds.

The proposition that $\tau_l^{*,F} > \tau_l^{*,NK}$ leads to the following inequality

$$(1-\Phi_\tau^*)\bar{m}^p < m^{p,NK} \tag{A3}$$

Rewrite $\bar{m}^p$ as

$$\bar{m}^p = 1 + \frac{1}{(\nu_p - 1)(1+\mathscr{A})}$$

where $\mathscr{A} = \frac{(1-\beta)\gamma_p}{1-\beta\gamma_p} \cdot \Xi \cdot \left(\frac{\nu_p}{\nu_p - 1}\right) > 0$. The inequality (A3) becomes

$$(1-\Phi_\tau^*)\left(1 + \frac{1}{(\nu_p - 1)(1+\mathscr{A})}\right) < 1 + \frac{1}{(\nu_p - 1)} \tag{A4}$$

as demonstrated by (A2) inequality (A4) is satisfied when $\Phi_\tau^* = 0$. Consequently, given that $\Phi_\tau^* = -\frac{\mathscr{A}}{1-\beta\psi_\pi} > 0$, (A4) is also satisfied, thereby proving that $\tau_l^{*,F} > \tau_l^{*,NK}$, ■.

In a zero-inflation steady-state, market power in goods and labor markets represents the sole source of inefficiency in an NK model. In this state, Proposition 1 indicates that first-best allocations (efficiency) are determined when the MRS is: $(\bar{L}^{NK})^\eta \cdot \bar{C}^{NK} = 1$. This condition is guaranteed when the Ramsey planner sets a subsidy as follows: $\tau_l^{*,NK} = 1 - m^{w,NK}\bar{m}^{p,NK}$ (for further elaboration on efficient allocations, see Blanchard and Galí (2007); Galí (2015)). Consequently $\bar{L}^{NK} = \left(\frac{1-\tau_l^{*,NK}}{m^{w,NK}\bar{m}^{p,NK}}\right)^{\frac{1}{1+\eta}} = 1 = \bar{C}^{NK} = \bar{Y}^{NK}$.

In the fairness model, the price markup fairness concerns and the marginal cost subinference represent additional sources of inefficiency beyond market power. In a zero-inflation steady-state, Proposition 2 indicates that the Ramsey choices can only yield second-best allocations, characterized by the following MRS condition: $\bar{L}^\eta\bar{C} = 1 + \bar{\mathscr{E}}_{\bar{F}} \cdot \frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}$. This condition is guaranteed when the Ramsey planner sets a subsidy as follows: $\tau_l^{*,F} = 1-(1-\Phi_\tau^*)\bar{m}^p m^{w,NK}$. Consequently $\bar{L} = \left(\frac{1-\tau_l^{*,F}}{m^{w,NK}\bar{m}^p}\right)^{\frac{1}{1+\eta}} = (1-\Phi_\tau^*)^{\frac{1}{1+\eta}} = \bar{C} = \bar{Y} < 1$, demonstrating that the Ramsey planner is unable to restore the first-best allocations within a fairness model, ■.

Importantly, for $\bar{L} > 0$, it must be that $\tau_l^{*,F} < 1$. This leads to the following parametric restriction

$$-\frac{(1-\beta)\gamma_p}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \cdot \left(\frac{\nu_p}{\nu_p - 1}\right) > \frac{1}{\Xi} \tag{A5}$$

implying that $\Phi_\tau^* \in (0,1)$, and $0 < \bar{L} < 1$.

### A.2.4 Corollary 2.

The same parameter values and assumptions as those considered in Corollary 1 are used here: $\beta = 0.99$, $\psi_\pi \geq 1.5$, $\nu_p > 1$, $\nu_w > 1$, $\gamma_p \in (0,1)$, $\bar{m}^{per} = \frac{\nu_p}{\nu_p - 1}$, and $\bar{F} = 1$. It thus follows that restriction (A5) must be satisfied, thereby implying that $\Phi_\tau^* \in (0,1)$.

In the case where $\Phi_\tau^* \to 1$, $\tau_l^{*,F} \to 1$.
In the case where $0 > \Phi_\tau^* > 1$, $\tau_l^{*,F} > 0$ if the following inequality holds

$$(1 - \Phi_\tau^*)\bar{m}^p m^{w,NK} < 1, \quad \blacksquare \tag{A6}$$

Furthermore, let $\mathbb{T}(\gamma_p, \nu_p, \Xi, \psi_\pi) = (1 - \Phi_\tau^*)\left(1 + \frac{1}{(\nu_p - 1)(1 + \mathcal{A})}\right) = (1 - \Phi_\tau^*)\bar{m}^p$. The partial derivatives for $\mathcal{A}$ are

$$\begin{aligned}
\frac{\partial \mathcal{A}}{\partial \gamma_p} &= -\frac{(\beta - 1)}{(\beta\gamma_p - 1)^2} \cdot \left(\Xi \cdot \left(\frac{\nu_p}{\nu_p - 1}\right)\right) > 0 \\
\frac{\partial \mathcal{A}}{\partial \nu_p} &= -\frac{(\beta - 1)\gamma_p}{\beta\gamma_p - 1} \cdot \left(\Xi \cdot \frac{1}{(\nu_p - 1)^2}\right) < 0 \\
\frac{\partial \mathcal{A}}{\partial \Xi} &= \frac{(1 - \beta)\gamma_p}{1 - \beta\gamma_p} \cdot \left(\frac{\nu_p}{\nu_p - 1}\right) > 0
\end{aligned}$$

The partial derivatives for $\bar{m}^p$ are

$$\begin{aligned}
\frac{\partial \bar{m}^p}{\partial \gamma_p} &= -\frac{1}{(\nu_p - 1)(1 + \mathcal{A})^2}\frac{\partial \mathcal{A}}{\partial \gamma_p} < 0 \\
\frac{\partial \bar{m}^p}{\partial \nu_p} &= -\frac{1}{(\nu_p - 1)(1 + \mathcal{A})^2}\frac{\partial \mathcal{A}}{\partial \nu_p} - \frac{1}{(\nu_p - 1)^2(1 + \mathcal{A})} < 0 \\
\frac{\partial \bar{m}^p}{\partial \Xi} &= -\frac{1}{(\nu_p - 1)(1 + \mathcal{A})^2}\frac{\partial \mathcal{A}}{\partial \Xi} < 0
\end{aligned}$$

The partial derivatives for $\Phi_\tau^*$ are

$$\begin{aligned}
\frac{\partial \Phi_\tau^*}{\partial \gamma_p} &= -\frac{1}{1 - \beta\psi_\pi} \cdot \frac{\partial \mathcal{A}}{\partial \gamma_p} > 0 \\
\frac{\partial \Phi_\tau^*}{\partial \nu_p} &= -\frac{1}{1 - \beta\psi_\pi} \cdot \frac{\partial \mathcal{A}}{\partial \nu_p} < 0 \\
\frac{\partial \Phi_\tau^*}{\partial \Xi} &= -\frac{1}{1 - \beta\psi_\pi} \cdot \frac{\partial \mathcal{A}}{\partial \Xi} > 0 \\
\frac{\partial \Phi_\tau^*}{\partial \psi_\pi} &= -\frac{\mathcal{A}\beta}{(1 - \beta\psi_\pi)^2} < 0
\end{aligned}$$

given that $\frac{1}{1-\beta\psi_\pi} < 0$. The partial derivatives for $\mathbb{T}$ are

$$\begin{aligned}
\frac{\partial \mathbb{T}}{\partial \gamma_p} &= -\frac{\partial \Phi_\tau^*}{\partial \gamma_p}\bar{m}^p - \frac{\Phi_\tau^* \frac{\partial \mathcal{A}}{\partial \gamma_p}}{(\nu_p - 1)(1+\mathcal{A})^2} \\
&= \left(\frac{\bar{m}^p}{1-\beta\psi_\pi} - \frac{\Phi_\tau^*}{(\nu_p-1)(1+\mathcal{A})^2}\right)\frac{\partial \mathcal{A}}{\partial \gamma_p} < 0 \\
\frac{\partial \mathbb{T}}{\partial \nu_p} &= -\frac{\partial \Phi_\tau^*}{\partial \nu_p}\bar{m}^p - \left(\frac{\frac{\partial \mathcal{A}}{\partial \gamma_p}}{(\nu_p - 1)(1+\mathcal{A})^2} + \frac{1}{(\nu_p-1)^2(1+\mathcal{A})}\right)\Phi_\tau^* \\
&= \left(\frac{\bar{m}^p}{1-\beta\psi_\pi} - \frac{\Phi_\tau^*}{(\nu_p-1)(1+\mathcal{A})^2}\right)\frac{\partial \mathcal{A}}{\partial \nu_p} - \frac{\Phi_\tau^*}{(\nu_p-1)^2(1+\mathcal{A})} < 0 \\
\frac{\partial \mathbb{T}}{\partial \Xi} &= -\frac{\partial \Phi_\tau^*}{\partial \Xi}\bar{m}^p - \frac{\Phi_\tau^* \frac{\partial \mathcal{A}}{\partial \Xi}}{(\nu_p - 1)(1+\mathcal{A})^2} \\
&= \left(\frac{\bar{m}^p}{1-\beta\psi_\pi} - \frac{\Phi_\tau^*}{(\nu_p-1)(1+\mathcal{A})^2}\right)\frac{\partial \mathcal{A}}{\partial \Xi} < 0 \\
\frac{\partial \mathbb{T}}{\partial \psi_\pi} &= \frac{\mathcal{A}\beta\bar{m}^p}{(1-\beta\psi_\pi)^2} > 0
\end{aligned}$$

Consequently $\boxed{\frac{\partial \tau_l^{*,F}}{\partial \gamma_p} > 0,\ \frac{\partial \tau_l^{*,F}}{\partial \nu_p} > 0,\ \frac{\partial \tau_l^{*,F}}{\partial \Xi} > 0, \text{ and } \frac{\partial \tau_l^{*,F}}{\partial \psi_\pi} < 0}$.

Let me now consider welfare recursively as the expected discounted present value of the flow of the household utility

$$\mathcal{W}_t = \mathcal{U}_t + \beta\mathbb{E}_t\mathcal{W}_{t+1}$$

where $\mathcal{U}_t = \ln(\mathcal{C}_t) - \frac{L_t^{1+\eta}}{1+\eta}$. At zero-inflation steady-state, and $\bar{F} = 1$, the welfare is

$$\bar{\mathcal{W}} = \frac{\ln(\bar{L}) - \frac{\bar{L}^{1+\eta}}{1+\eta}}{1-\beta}$$

given that $\bar{C} = \bar{L}$. Consider for all the following cases that $\bar{L} > 0$, $\beta = 0.99$, and $m^{w,NK} > 1$, $\bar{m}^p > 1$. Furthermore, let $\bar{\mathcal{W}}^{F,N}$ be the welfare in the absence of the subsidy in the fairness model, and $\bar{\mathcal{W}}^{F,\tau_l^*}$ be the welfare in the fairness model with optimal subsidy. In absence of subsidy, $\bar{L} = \left(\frac{1}{m^{w,NK}\bar{m}^p}\right)^{\frac{1}{1+\eta}} \in (0,1)$. In contrast, with optimal subsidy, $\bar{L} = \left(\frac{1-\tau_l^{*,F}}{m^{w,NK}\bar{m}^p}\right)^{\frac{1}{1+\eta}} = (1-\Phi_\tau^*)^{\frac{1}{1+\eta}} \in (0,1)$. In both cases

$\bar{L} \in (0,1)$, a domain within which the welfare functions exhibit the following properties

$$\bar{\mathcal{W}} < 0, \quad \in (0,1),$$
$$\frac{d\bar{\mathcal{W}}}{d\bar{L}} = (1/\bar{L} - \bar{L}^{\eta})/(1-\beta) > 0, \quad \in (0,1),$$
$$\frac{d^2\bar{\mathcal{W}}}{d\bar{L}^2} = (-1/\bar{L}^2 - \eta\bar{L}^{\eta-1})/(1-\beta) < 0, \quad \in (0,1)$$

Given these properties, $|\bar{\mathcal{W}}^{F,N}| < |\bar{\mathcal{W}}^{F,\tau_l^*}|$ characterizes a welfare loss. This inequality is equivalent to the following

$$(1-\Phi_\tau^*) < \frac{1}{\bar{m}^p m^{w,NK}}$$

This is the case if $\tau_l^{*,F} > 0$, as demonstrated by (A6), ■.

### A.2.5 Proposition 2

Proof of Proposition 2. Without loss of generality, consider that $m^{w,NK} = 1$ is entirely subsidized, thereby $w_t = L_t^{\eta} C_t$. In a fairness model with Rotemberg price cost adjustments and inflation-targeting, the optimal price markup can be determined by solving the following Ramsey problem

$$\begin{aligned}
\mathcal{L}_R^{markup} \quad = \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \ln(C_t F_t) - \frac{L_t^{1+\eta}}{1+\eta} \right) \\
& + \lambda_{1,t} \left( \frac{1}{C_t} - \mathbb{E}_t \frac{\pi_t^{\psi_\pi}}{\pi_{t+1} C_{t+1}} \right) \\
& + \lambda_{2,t} \left( A_t L_t - C_t \chi_t \right) \\
& + \lambda_{3,t} \left( m_t^{per} - (m_{t-1}^{per})^{\gamma_p} \left( \frac{\nu_p}{\nu_p - 1} \right)^{1-\gamma_p} (\pi_t)^{\gamma_p} \right) \\
& + \lambda_{4,t} \left( F_t - \mathbb{F}(m_t^{per}) \right) \\
& + \lambda_{5,t} \left( w_t - L_t^{\eta} C_t \right) \\
& + \lambda_{6,t} \left( \Upsilon_t - \phi_p \left( (\pi_t - 1) \pi_t - \beta \mathbb{E}_t (\pi_{t+1} - 1) \pi_{t+1} \right) \right) \\
& + \lambda_{7,t} \left( (\mathcal{E}_t - \nu_p) F_t + (\nu_p - 1) \gamma_p m_t^{per} \frac{dF_t}{dm_t^{per}} \right) \\
& + \lambda_{8,t} \left( m_t^p w_t - A_t \right)
\end{aligned}$$

in that problem $m_t^p$ will freely adjust, thereby rendering the condition (11), a non-binding constraint. The first-order conditions are (for $t > 0$),

$$\begin{aligned}
C_t: \quad 0 \quad = \quad & \frac{1}{C_t} - \lambda_{1,t} \frac{1}{C_t^2} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{\pi_t C_t^2} - \lambda_{2,t} \chi_t - \lambda_{5,t} L_t^{\eta}, \\
L_t: \quad 0 \quad = \quad & -L_t^{\eta} + \lambda_{2,t} A_t - \lambda_{5,t} \eta L_t^{\eta-1} C_t, \\
\pi_t: \quad 0 \quad = \quad & -\lambda_{1,t} \mathbb{E}_t \frac{\psi_\pi \pi_t^{\psi_\pi - 1}}{\pi_{t+1} C_{t+1}} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{\pi_t^2 C_t} - \lambda_{2,t} C_t \phi_p (\pi_t - 1) \\
& -\lambda_{3,t} \gamma_p \frac{m_t^{per}}{\pi_t} + \lambda_{6,t} (\phi_p - 2\phi_p \pi_t) + \lambda_{6,t-1} \mathbb{E}_{t-1} \phi_p (2\pi_t - 1), \\
F_t: \quad 0 \quad = \quad & \frac{1}{F_t} + \lambda_{4,t} + \lambda_{7,t} \left( \mathcal{E}_t - \nu_p + (\nu_p - 1) \gamma_p m_t^{per} \frac{\partial}{\partial F_t} \left( \frac{dF_t}{dm_t^{per}} \right) \right), \\
m_t^{per}: \quad 0 \quad = \quad & \lambda_{3,t} - \beta \lambda_{3,t+1} \mathbb{E}_t \gamma_p \frac{m_{t+1}^{p,per}}{m_t^{per}} - \lambda_{4,t} \frac{dF_t}{dm_t^{per}} + \lambda_{7,t} (\nu_p - 1) \gamma_p \left( m_t^{per} \frac{d^2 F_t}{d(m_t^{per})^2} + \frac{dF_t}{dm_t^{per}} \right), \\
m_t^p: \quad 0 \quad = \quad & \lambda_{8,t} w_t, \\
\mathcal{E}_t: \quad 0 \quad = \quad & \lambda_{7,t} F_t, \\
\Upsilon_t: \quad 0 \quad = \quad & \lambda_{6,t}, \\
w_t: \quad 0 \quad = \quad & \lambda_{8,t} m_t^p + \lambda_{5,t}.
\end{aligned}$$

Consider a zero inflation steady-state, $\bar{\pi}=1$, $\bar{F}=1$. Evidently $\lambda_{5:8}=0$, then

$$\begin{aligned}
\bar{C}: \quad 0 &= 1-\lambda_1\frac{1}{\bar{C}}+\lambda_1\beta^{-1}\frac{1}{\bar{C}}-\bar{C}\lambda_2, \\
\bar{L}: \quad \lambda_2 &= \bar{L}^{\eta}, \\
\bar{\pi}: \quad \lambda_1 &= \lambda_3\frac{\gamma_p\bar{m}^{per}\bar{C}}{(\beta^{-1}-\psi_\pi)}, \\
\bar{F}^p: \quad \lambda_4 &= -1, \\
\bar{m}^{per}: \quad \lambda_3 &= -\frac{\lambda_4\Xi}{(1-\beta\gamma_p)}.
\end{aligned}$$

where $\Xi \triangleq -\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\bar{m}^{per}\\ F_t=\bar{F}}}$,

$$\begin{aligned}
\bar{C}: \quad \bar{L}^{\eta}\bar{C} &= 1+\lambda_1\frac{1}{\bar{C}}(\beta^{-1}-1), \\
\bar{\pi}: \quad \lambda_1 &= \frac{\Xi\gamma_p\bar{m}^{per}\bar{C}}{(1-\beta\gamma_p)(\beta^{-1}-\psi_\pi)}.
\end{aligned}$$

consequently,

$$\begin{aligned}
\bar{L}^{\eta}\bar{C} &= 1+\frac{\Xi\gamma_p\bar{m}^{per}(\beta^{-1}-1)}{\bar{F}(1-\beta\gamma_p)(\beta^{-1}-\psi_\pi)} \\
&= 1+\frac{\Xi\bar{m}^{per}}{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)} \\
&= 1+\bar{\mathcal{E}}_{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}
\end{aligned}$$

where $\bar{\mathcal{E}}_{\bar{F}} \triangleq -\left(\left(\frac{dF_t}{dm_t^{per}}\right)\Big|_{\substack{m_t^{per}=\frac{\nu_p}{\nu_p-1}\\ F_t=1}}\right)\cdot\left(\frac{\nu_p}{\nu_p-1}\right)=\Xi\cdot\left(\frac{\nu_p}{\nu_p-1}\right)>0$. Now given that $\bar{L}^{\eta}\bar{C}=\frac{1}{\bar{m}^p}$ ($m^{w,NK}$ being subsidized) at the steady-state of the competitive equilibrium, it follows that the optimal price markup is

$$\begin{aligned}
\frac{1}{\bar{m}^{p,*}} &= \left(1+\bar{\mathcal{E}}_{\bar{F}}\cdot\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}\right) \Leftrightarrow \\
\bar{m}^{p,*} &= \frac{1}{(1-\Phi_\tau^*)}, \quad \blacksquare
\end{aligned}$$

where $\Phi_\tau^*=-\frac{\gamma_p(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}\cdot\bar{\mathcal{E}}_{\bar{F}}>0$.

### A.2.6 Corollary 3

Define a price markup gap as $\boxed{\bar{m}^{p,gap} = \bar{m}^p - \bar{m}^{p,*}}$ where $\bar{m}^p$ is the value of the price markup in the competitive equilibrium. Now consider two cases. In the first case, consider that $\boxed{\bar{m}^{p,*} > \bar{m}^p}$, consequently the following inequality holds

$$(1 - \Phi_\tau^*) < \frac{1}{\bar{m}^p} \tag{A7}$$

In this case, the optimal price markup is equivalent to a tax $\tau_l^{*,F} > 0$, given that (A6) $\equiv$ (A7) (considering that $m^{w,NK} = 1$), resulting in a welfare loss as demonstrated in Corollary A.2.4, $\blacksquare$.

In the second case, consider that $\boxed{\bar{m}^{p,*} < \bar{m}^p}$, a price markup cap, consequently the following inequality holds

$$(1 - \Phi_\tau^*) > \frac{1}{\bar{m}^p} \tag{A8}$$

Furthermore, proposition A.2.2 establishes that the optimal fiscal policy in the illustrative model is given by

$$\tau_l^{*,F} = 1 - (1 - \Phi_\tau^*)\bar{m}^p$$

when $m^{w,NK} = 1$. This policy is a subsidy $\tau_l^{*,F} < 0$ if

$$(1 - \Phi_\tau^*) > \frac{1}{\bar{m}^p} \tag{A9}$$

(A8) $\equiv$ (A9) establishing that an optimal price markup cap is equivalent to an optimal subsidy in the fairness model. As a result, the price markup cap yields welfare gain as demonstrated in Corollary A.2.4, $\blacksquare$.

## A.3 Proof: Optimal subsidy in the EA fairness model

In the fairness model for EA with Rotemberg price cost adjustments and inflation-targeting, the optimal subsidy can be determined by solving the following Ramsey problem

$$
\begin{aligned}
\mathcal{L}_R^{EA} \;=\;& \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \ln(C_t F_t) - \frac{L_t^{1+\eta}}{1+\eta} \right) \\
&+\lambda_{1,t} \left( \frac{1}{C_t} - \mathbb{E}_t \frac{\pi_t^{\psi_\pi}}{\pi_{t+1} C_{t+1}} \right) \\
&+\lambda_{2,t} \left( A_t L_t - C_t \chi_t \right) \\
&+\lambda_{3,t} \left( m_t^{p,per} - \left( \left( m_{t-1}^{p,per} \right)^{\gamma_p} \left( \frac{\nu_p}{\nu_p - 1} \right)^{1-\gamma_p} (\pi_t)^{\gamma_p} \right) \right) \\
&+\lambda_{4,t} \left( F_t - \left( 1 - \theta_p \left( m_t^{p,per} - \bar{m}_t^{p,per} \right) \right) \right) \\
&+\lambda_{5,t} \left( (m_t^p - 1) \mathcal{E}_t^p + m_t^p \Upsilon_t - m_t^p \left( 1 + \beta \mathbb{E}_t \left( \Delta m_{t+1}^p (\mathcal{E}_{t+1}^p - \varphi_p) + \gamma_p (\Upsilon_{t+1} - 1) \right) \right) \right) \\
&+\lambda_{6,t} \left( \Upsilon_t - \left( \phi_p \left( (\pi_t - 1) \pi_t - \beta \mathbb{E}_t (\pi_{t+1} - 1) \pi_{t+1} \right) \right) \right) \\
&+\lambda_{7,t} \left( \mathcal{E}_t^p F_t - \left( F_t \nu_p + (\nu_p - 1) \theta_p \gamma_p m_t^{p,per} \right) \right) \\
&+\lambda_{8,t} \left( m_t^p w_t - A_t \right)
\end{aligned}
$$

The first-order conditions are (for $t > 0$),

$$
\begin{aligned}
C_t: \quad 0 &= \frac{1}{C_t} - \lambda_{1,t} \frac{1}{C_t^2} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{\pi_t C_t^2} - \lambda_{2,t} \chi_t, \\
L_t: \quad 0 &= -L_t^\eta + \lambda_{2,t} A_t \\
\pi_t: \quad 0 &= -\lambda_{1,t} \mathbb{E}_t \frac{\psi_\pi \pi_t^{\psi_\pi - 1}}{\pi_{t+1} C_{t+1}} + \lambda_{1,t-1} \mathbb{E}_{t-1} \beta^{-1} \frac{\pi_{t-1}^{\psi_\pi}}{C_t \pi_t^2} - \lambda_{2,t} C_t \phi_p (\pi_t - 1) \\
&\quad - \lambda_{3,t} \gamma_p \frac{m_t^{p,per}}{\pi_t} + \lambda_{6,t} (\phi_p - 2\phi_p \pi_t) + \lambda_{6,t-1} \mathbb{E}_{t-1} \phi_p (2\pi_t - 1), \\
F_t: \quad 0 &= \frac{1}{F_t} + \lambda_{4,t} + \lambda_{7,t} (\mathcal{E}_t^p - \nu_p), \\
m_t^{p,per}: \quad 0 &= \lambda_{3,t} - \beta \lambda_{3,t+1} \mathbb{E}_t \gamma_p \frac{m_{t+1}^{p,per}}{m_t^{p,per}} + \theta_p \lambda_{4,t} - \lambda_{7,t} (\nu_p - 1) \theta_p \gamma_p, \\
m_t^p: \quad 0 &= w_t \lambda_{8,t} + \lambda_{5,t} \left( \mathcal{E}_t^p + \Upsilon_t - \left( 1 + \beta \mathbb{E}_t \left( \Delta m_{t+1}^p (\mathcal{E}_{t+1}^p - \varphi_p) + \gamma_p (\Upsilon_{t+1} - 1) \right) \right) \right) \\
&\quad + \lambda_{5,t-1} \mathbb{E}_{t-1} m_{t-1}^p (\varphi_p - \mathcal{E}_t^p) \frac{1}{m_t^p m_t^p}, \\
\mathcal{E}_t^p: \quad 0 &= \lambda_{7,t} F_t + \lambda_{5,t} (m_t^p - 1) - \lambda_{5,t-1} \mathbb{E}_{t-1} m_{t-1}^p \Delta m_t^p, \\
\Upsilon_t: \quad 0 &= \lambda_{5,t} m_t^p - \lambda_{5,t-1} \mathbb{E}_{t-1} m_{t-1}^p \gamma_p + \lambda_{6,t}, \\
w_t: \quad 0 &= \lambda_{8,t} m_t^p.
\end{aligned}
$$

Consider the steady-state of the competitive equilibrium with zero inflation, $\bar{\pi} = 1$, consequently

$$
\begin{aligned}
\bar{C}: \quad & 0 &=& \frac{1}{\bar{C}} - \lambda_1 \frac{1}{\bar{C}^2} + \lambda_1 \beta^{-1} \frac{1}{\bar{C}^2} - \lambda_2, \\
\bar{L}: \quad & 0 &=& -\bar{L}^{\eta} + \lambda_2, \\
\bar{\pi}: \quad & 0 &=& \lambda_1 \frac{1}{\bar{C}} (\beta^{-1} - \psi_{\pi}) - \lambda_3 \gamma_p \bar{m}^{p,per}, \\
\bar{F}^p: \quad & 0 &=& 1 + \lambda_4 + \lambda_7 (\bar{\mathcal{E}}^p - \nu_p), \\
\bar{m}^{p,per}: \quad & 0 &=& \lambda_3 - \lambda_3 \beta \gamma_p + \theta_p \lambda_4 - \lambda_7 (\nu_p - 1) \theta_p \gamma_p, \\
\bar{m}^p: \quad & 0 &=& \bar{w} \lambda_8 + \lambda_5 \left( \bar{\mathcal{E}}^p - \left( 1 + \beta \left( \Delta \bar{m}^p (\bar{\mathcal{E}}^p - \varphi_p) - \gamma_p \right) \right) \right) + \lambda_5 (\bar{\mathcal{E}}^p - \varphi_p) \frac{1}{\bar{m}^p}, \\
\bar{\mathcal{E}}^p: \quad & 0 &=& \lambda_7 + \lambda_5 (\bar{m}^p - 1) - \lambda_5 \bar{m}^p \Delta \bar{m}^p, \\
\bar{\mathcal{U}}: \quad & 0 &=& \lambda_5 \bar{m}^p - \lambda_5 \bar{m}^p \gamma_p + \lambda_6, \\
\bar{w}: \quad & 0 &=& \lambda_8 \bar{m}^p.
\end{aligned}
$$

Evidently, $\lambda_{5:8} = 0$,

$$
\begin{aligned}
\bar{C}: \quad & 0 &=& 1 - \lambda_1 \frac{1}{\bar{C}} + \lambda_1 \beta^{-1} \frac{1}{\bar{C}} - \bar{C} \lambda_2, \\
\bar{L}: \quad & \lambda_2 &=& \bar{L}^{\eta}, \\
\bar{\pi}: \quad & \lambda_1 &=& \lambda_3 \frac{\gamma_p \bar{m}^{p,per} \bar{C}}{(\beta^{-1} - \psi_{\pi})}, \\
\bar{F}^p: \quad & \lambda_4 &=& -1, \\
\bar{m}^{p,per}: \quad & \lambda_3 &=& \frac{\theta_p}{(1 - \beta \gamma_p)}
\end{aligned}
$$

leading to,

$$
\begin{aligned}
\bar{C}: \quad & \bar{L}^{\eta} \bar{C} &=& 1 + \lambda_1 \frac{1}{\bar{C}} (\beta^{-1} - 1), \\
\bar{\pi}: \quad & \lambda_1 &=& \frac{\theta_p \gamma_p \bar{m}^{p,per} \bar{C}}{(1 - \beta \gamma_p)(\beta^{-1} - \psi_{\pi})}.
\end{aligned}
$$

then,

$$
\begin{aligned}
\bar{L}^{\eta} \bar{C} &= 1 + \frac{\theta_p \gamma_p \bar{m}^{p,per} (\beta^{-1} - 1)}{(1 - \beta \gamma_p)(\beta^{-1} - \psi_{\pi})} \\
&= 1 + \frac{\theta_p \gamma_p \bar{m}^{p,per} (1 - \beta)}{(1 - \beta \gamma_p)(1 - \beta \psi_{\pi})}
\end{aligned}
$$

given that $\bar{L}^{\eta}\bar{C} = \frac{\bar{w}(1-\tau_l)}{m^{w,NK}} = \frac{(1-\tau_l)}{m^{w,NK}\bar{m}^p}$, the optimal subsidy is

$$\begin{aligned} \tau_l^{*,EA} &= 1 - \left(1 + \frac{\theta_p \gamma_p \bar{m}^{p,per}(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}\right) \bar{m}^p m^{w,NK} \\ &= 1 - (1-\Phi_\tau^{EA})\bar{m}^p m^{w,NK}, \quad \blacksquare \end{aligned}$$

where $\Phi_\tau^{EA} = -\frac{\theta_p \gamma_p \bar{m}^{p,per}(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}$.

Moreover, $\bar{L} = \left(\frac{1-\tau_l^{*,EA}}{\bar{m}^p m^{w,NK}}\right)^{\frac{1}{1+\eta}} = \left(1-\Phi_\tau^{EA}\right)^{\frac{1}{1+\eta}} = \bar{C} = \bar{Y} < 1$, demonstrating that the fairness weight $\Phi_\tau^{EA}$ cannot be eliminated by the planner, $\blacksquare$.

### A.3.1 EA optimal subsidy: Analysis

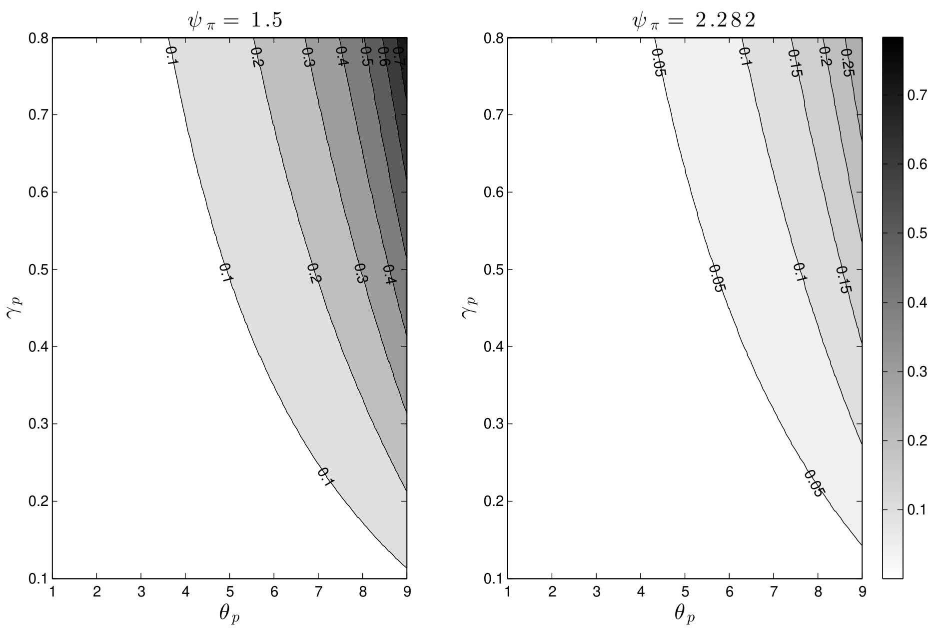
To analyze the impact of the deep parameters on the optimal subsidy/tax, consider the function $\Phi_{\tau}^{EA}(\theta_p, \gamma_p, \psi_\pi) = -\frac{\theta_p \gamma_p \bar{m}^{p,per}(1-\beta)}{(1-\beta\gamma_p)(1-\beta\psi_\pi)}$. Under the baseline calibration $\beta = 0.99$, and $\bar{m}^{p,per} = \frac{v_p}{v_p - 1} = 1.0968$. I now restrict $\Phi_{\tau}^{EA}$'s domain such that the parametric inequality (A5) holds, i.e. to obtain feasible subsidy/tax values. The restrictions are the following: $\theta_p \in [1, 9]$, $\gamma_p \in (0, 0.8]$ (values to align with a cost-pass-through range of 0 to 40% (Eyster et al., 2021)), and $\psi_\pi \in [1.5, 2.282]$ (ranging from the standard NK value of 1.5 to the estimate provided in (Cardani et al., 2022)).

- The numerator is always positive given that $(1-\beta) > 0$, $\gamma_p > 0$, $\theta_p > 0$ and $\bar{m}^{p,per} > 1$.
- The denominator is always negative given that $(1-\beta\gamma_p) > 0$ and $(1-\beta\psi_\pi) < 0$. Moreover, $\frac{\partial \Phi_{\tau}^{EA}}{\partial \psi_\pi} = -\frac{\theta_p \gamma_p \bar{m}^{p,per}(1-\beta)\beta}{(1-\beta\gamma_p)(1-\beta\psi_\pi)^2} < 0$.
- The function reaches a maximum when $\theta_p = 9$, $\gamma_p = 0.8$, and $\psi_\pi = 1.5$.

Conclusion: $\Phi_{\tau}^{EA}$'s lower bound $\to 0$ and its upper bound is $\Phi_{\tau}^{EA}(9, 0.8, 1.5) \approx 0.78$.

Two graphs of the function for distinct values of $\gamma_p$ and $\theta_p$, with $\psi_\pi$ fixed at 1.5 and 2.282, are presented in Figure A.1.

**Figure A.1:** EA fairness weight $\Phi_{\tau}^{EA}$




Note: Steps of 0.1 were used for $\theta_p$, representing 17 values $\in [1, 9]$. In turn, 80 values were evenly sliced in the interval $[0.1, 0.8]$ for $\gamma_p$. The color bar on the right-hand side indicates the values of $\Phi_{\tau}^{EA}$.

# Appendix B EA fairness model

## Good demand under price markup fairness concerns

Subsequently, differentiated consumption goods $j$ are produced and supplied to a continuum of households indexed by $k$, both with a measure of 1. The consumption of a variety of goods by a given household is as follows

$$\mathcal{C}_{k,t} = \left[\int_0^1 \mathcal{C}_{jk,t}^{\frac{\nu_p-1}{\nu_p}}\, dj\right]^{\frac{\nu_p}{\nu_p-1}} \tag{B1}$$

where $\nu_p > 0$ is the elasticity of substitution between goods. The demand for goods is distorted by firms' price markup fairness concerns $F_{j,t}$, such that

$$\mathcal{C}_{jk,t} = C_{jk,t}F_{j,t} \tag{B2}$$

where $C_{jk,t}$ is the consumption of each type of good. Households seek to maximize consumption of differentiated goods within a total budget constraint, denoted by $\mathcal{T}_{k,t}$. The price of a good $P_{j,t}$ is given. The problem to be solved is as follows

$$\max_{C_{jk,t}} \mathcal{C}_{k,t} - \mu_{k,t}\left(\int_0^1 P_{j,t}C_{jk,t}\, dj - \mathcal{T}_{k,t}\right)$$

The first-order condition is

$$\begin{aligned}
\frac{\nu_p}{\nu_p-1}\left[\int_0^1 \mathcal{C}_{jk,t}^{\frac{\nu_p-1}{\nu_p}}\, dj\right]^{\frac{\nu_p}{\nu_p-1}-1} \frac{\nu_p-1}{\nu_p}\frac{\left(C_{jk,t}F_{j,t}\right)^{\frac{\nu_p-1}{\nu_p}}}{C_{jk,t}} &= \mu_{k,t}P_{j,t} \\
\left[\int_0^1 \mathcal{C}_{jk,t}^{\frac{\nu_p-1}{\nu_p}}\, dj\right]^{\frac{1}{\nu_p-1}} \frac{\mathcal{C}_{jk,t}^{\frac{\nu_p-1}{\nu_p}}F_{j,t}}{\mathcal{C}_{jk,t}} &= \mu_{k,t}P_{j,t} \\
\mathcal{C}_{k,t}^{\frac{1}{\nu_p}}\left(\mathcal{C}_{jk,t}\right)^{\frac{-1}{\nu_p}}F_{j,t} &= \mu_{k,t}P_{j,t} \\
\left(\frac{\mathcal{C}_{jk,t}}{\mathcal{C}_{k,t}}\right)^{\frac{-1}{\nu_p}}F_{j,t} &= \mu_{k,t}P_{j,t} \\
\left(\frac{\mathcal{C}_{jk,t}}{\mathcal{C}_{k,t}}\right)^{\frac{\nu_p-1}{\nu_p}} &= \mu_{k,t}^{1-\nu_p}\left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} \qquad \text{(B3)}
\end{aligned}$$

integrating over $j$, and using (B1)

$$\begin{aligned}
\int_0^1 \left(\mathcal{C}_{jk,t}\right)^{\frac{\nu_p-1}{\nu_p}} dj \left(\frac{1}{\mathcal{C}_{k,t}}\right)^{\frac{\nu_p-1}{\nu_p}} &= \mu_{k,t}^{1-\nu_p} \int_0^1 \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} dj \\
\left(\int_0^1 \left(\mathcal{C}_{jk,t}\right)^{\frac{\nu_p-1}{\nu_p}} dj\right)^{\frac{\nu_p}{\nu_p-1}} \left(\frac{1}{\mathcal{C}_{k,t}}\right) &= \left(\frac{1}{\mu_{k,t}}\right)^{\nu_p} \left(\int_0^1 \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} dj\right)^{\frac{\nu_p}{\nu_p-1}} \\
1 &= \left(\frac{1}{\mu_{k,t}}\right)^{\nu_p} \left(\int_0^1 \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} dj\right)^{\frac{\nu_p}{\nu_p-1}} \\
\mu_{k,t} &= \left(\int_0^1 \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} dj\right)^{\frac{1}{\nu_p-1}} \\
\mu_{k,t}^{-1} &= \left(\int_0^1 \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} dj\right)^{\frac{1}{1-\nu_p}} \triangleq \mathcal{P}_t \qquad \text{(B4)}
\end{aligned}$$

where $\mathcal{P}_t$ is the aggregate price index. Substituting the multiplier $\mu_{k,t}$ and integrating over $k$ yields the following demand for a good $j$

$$\begin{aligned}
\left(\frac{\mathcal{C}_{jk,t}}{\mathcal{C}_{k,t}}\right)^{\frac{\nu_p-1}{\nu_p}} &= \mu_{k,t}^{1-\nu_p} \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} \\
\left(\frac{\mathcal{C}_{jk,t}}{\mathcal{C}_{k,t}}\right)^{\frac{\nu_p-1}{\nu_p}} &= \left(\frac{1}{\mathcal{P}_t}\right)^{1-\nu_p} \left(\frac{P_{j,t}}{F_{j,t}}\right)^{1-\nu_p} \\
\left(C_{jk,t}F_{j,t}\right)^{\frac{\nu_p-1}{\nu_p}} \left(\frac{1}{\mathcal{C}_{k,t}}\right)^{\frac{\nu_p-1}{\nu_p}} &= \left(\frac{1}{\mathcal{P}_t}\right)^{-(\nu_p-1)} \left(\frac{P_{j,t}}{F_{j,t}}\right)^{-(\nu_p-1)} \\
\left(C_{jk,t}F_{j,t}\right) \left(\frac{1}{\mathcal{C}_{k,t}}\right) &= \left(\frac{1}{\mathcal{P}_t}\right)^{-\nu_p} \left(\frac{P_{j,t}}{F_{j,t}}\right)^{-\nu_p} \\
C_{jk,t} &= \left(\frac{P_{j,t}}{\mathcal{P}_t}\right)^{-\nu_p} \left(F_{j,t}\right)^{\nu_p-1} \mathcal{C}_{k,t} \\
C_{j,t} &= \left(\frac{P_{j,t}}{\mathcal{P}_t}\right)^{-\nu_p} \left(F_{j,t}\right)^{\nu_p-1} \mathcal{C}_t \qquad \text{(B5)}
\end{aligned}$$

where $C_{j,t} = \int_0^1 C_{jk,t}\, dk$ and $\mathcal{C}_t = \int_0^1 \mathcal{C}_{k,t}\, dk$. Further assuming that $C_{j,t} = Y_{j,t}$,

$$Y_{j,t} = \left(\frac{P_{j,t}}{\mathcal{P}_t}\right)^{-\nu_p} \left(F_{j,t}\right)^{\nu_p-1} \mathcal{C}_t \qquad \text{(B6)}$$

## Derivations

### Households

A household problem is (in real terms)

$$\begin{aligned}\mathcal{L}_k &= \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \ln(\mathcal{C}_{k,t}) - \frac{L_{k,t}^{1+\eta}}{1+\eta} \right) \\ &+ \lambda_{k,t}^1 \left( (1-\tau_{l,t}) \frac{W_{k,t} L_{k,t}}{\mathcal{P}_t} + i_{t-1} \frac{B_{k,t-1}}{\mathcal{P}_t} + \Pi_{k,t} + T_{k,t} - \frac{B_{k,t}}{\mathcal{P}_t} - \mathcal{C}_{k,t} \right) \\ &+ \lambda_{k,t}^2 \left( L_t \left( \frac{W_{k,t}}{\mathcal{W}_t} \right)^{-\nu_w} - L_{k,t} \right)\end{aligned}$$

Note that $\mathcal{C}_{k,t}$ in the real budget constraint arises from

$$\begin{aligned}\int_0^1 P_{j,t} C_{jk,t} dj &= \int_0^1 P_{j,t} \left( \frac{P_{j,t}}{\mathcal{P}_t F_{j,t}} \right)^{-\nu_p} \frac{\mathcal{C}_{k,t}}{F_{j,t}} dj \\ &= \mathcal{P}_t^{\nu_p} \mathcal{C}_{k,t} \int_0^1 \left( \frac{P_{j,t}}{F_{j,t}} \right)^{1-\nu_p} dj \\ &= \mathcal{P}_t^{\nu_p} \mathcal{C}_{k,t} \mathcal{P}_t^{1-\nu_p} \\ &= \mathcal{P}_t \mathcal{C}_{k,t}\end{aligned}$$

and $\mathcal{P}_t \triangleq \left( \int_0^1 \left( \frac{P_{j,t}}{F_{j,t}} \right)^{1-\nu_p} dj \right)^{\frac{1}{1-\nu_p}}$.

The first-order conditions relative to the household problem are

FOC $\frac{\partial \mathcal{L}_k}{\partial \mathcal{C}_{k,t}}$

$$\lambda_{k,t}^1 = \frac{1}{\mathcal{C}_{k,t}} \tag{B7}$$

FOC $\frac{\partial \mathcal{L}_k}{\partial B_{k,t}}$, and replace $\lambda_{k,t,t+1}^1$ using (B7)

$$\frac{\lambda_{k,t}^1}{\mathcal{P}_t} = i_t \beta \mathbb{E}_t \left( \frac{\lambda_{k,t+1}^1}{\mathcal{P}_{t+1}} \right)$$

$$\frac{1}{i_t} = \beta \mathbb{E}_t \left( \frac{\mathcal{P}_t \mathcal{C}_{k,t}}{\mathcal{P}_{t+1} \mathcal{C}_{k,t+1}} \right) \tag{B8}$$

FOC $\frac{\partial \mathcal{L}_k}{\partial W_{k,t}}$

$$0 = \lambda^1_{k,t}(1-\tau_{l,t})\frac{L_{k,t}}{\mathcal{P}_t} - \nu_w \lambda^2_{k,t}\frac{L_{k,t}}{W_{k,t}}$$

multiple by $-\frac{W_{k,t}}{L_{k,t}}$, and replace $\lambda^1_{k,t}$ using (B7)

$$\begin{aligned}
\lambda^1_{k,t}(1-\tau_{l,t})\frac{W_{k,t}}{\mathcal{P}_t} &= \nu_w \lambda^2_{k,t} \\
\frac{(1-\tau_{l,t})W_{k,t}}{\mathcal{P}_t C_{k,t}} &= \nu_w \lambda^2_{k,t} \\
m^{w,NK}_{k,t} &= \lambda^2_{k,t}\frac{\nu_w}{L^{\eta}_{k,t}} \qquad \text{(B9)}
\end{aligned}$$

where $m^{w,NK}_t = \frac{(1-\tau_{l,t})W_{k,t}}{\mathcal{P}_t C_{k,t} L^{\eta}_{k,t}}$.

FOC $\frac{\partial \mathcal{L}_k}{\partial L_{k,t}}$

$$\begin{aligned}
L^{\eta}_{k,t} &= \lambda^1_{k,t}(1-\tau_{l,t})\frac{W_{k,t}}{\mathcal{P}_t} - \lambda^2_{k,t} \\
L^{\eta}_{k,t} &= \frac{(1-\tau_{l,t})W_{k,t}}{\mathcal{P}_t C_{k,t}} - \lambda^2_{k,t} \\
1 &= m^{w,NK}_{k,t} - \frac{\lambda^2_{k,t}}{L^{\eta}_{k,t}} \\
\frac{\lambda^2_{k,t}}{L^{\eta}_{k,t}} &= m^{w,NK}_{k,t} - 1 \\
\lambda^2_{k,t} &= (m^{w,NK}_{k,t} - 1)L^{\eta}_{k,t} \qquad \text{(B10)}
\end{aligned}$$

replace $\lambda^2_{k,t}$ in (B9),

$$\begin{aligned}
m^{w,NK}_{k,t} &= \nu_w(m^{w,NK}_{k,t} - 1) \\
(1-\nu_w)m^{w,NK}_{k,t} &= -\nu_w \\
m^{w,NK}_{k,t} &= \frac{\nu_w}{\nu_w - 1} \qquad \text{(B11)}
\end{aligned}$$

**Firms**

A firm problem with price markup fairness concerns and price rigidity is (in real terms)

$$\begin{aligned}
\mathcal{L}_j &= \mathbb{E}_0 \sum_{t=0}^{\infty} \Gamma^t \left( \frac{P_{j,t}}{\mathcal{P}_t} Y_{j,t} - \frac{1}{\mathcal{P}_t} \int_0^1 W_{k,t} L_{jk,t} dk - \frac{\phi_p}{2} \left( \frac{P_{j,t}}{P_{j,t-1}} - 1 \right)^2 \mathcal{C}_t \right) \\
&+ \lambda^1_{j,t} \left( \mathcal{C}_t \left( \frac{P_{j,t}}{\mathcal{P}_t} \right)^{-\nu_p} \left( F_{j,t} \right)^{\nu_p - 1} - Y_{j,t} \right) \\
&+ \lambda^2_{j,t} \left( A_{j,t} L_{j,t} - Y_{j,t} \right) \\
&+ \lambda^3_{j,t} \left( \left( mc^{per}_{j,t-1} \right)^{\gamma_p} \left( \frac{(\nu_p - 1)}{\nu_p} P_{j,t} \right)^{1-\gamma_p} - mc^{per}_{j,t} \right)
\end{aligned}$$

One can also rewrite $\int_0^1 W_{k,t} L_{jk,t}\, dk$ as

$$\begin{aligned}
\int_0^1 W_{k,t} L_{jk,t}\, dk &= \int_0^1 W_{k,t} \left( \frac{W_{k,t}}{\mathcal{W}_t} \right)^{-\nu_w} L_{j,t}\, dk \\
&= \mathcal{W}_t^{\nu_w} L_{j,t} \int_0^1 \left( W_{k,t} \right)^{1-\nu_w} dk \\
&= \mathcal{W}_t^{\nu_w} L_{j,t} \mathcal{W}_t^{1-\nu_w} \\
&= \mathcal{W}_t L_{j,t}
\end{aligned}$$

Consider that households infer a price markup as a function of price and perceived nominal marginal cost $mc^{per}$

$$m^{per}_{j,t} = \frac{P_{j,t}}{mc^{per}_{j,t}} \tag{B12}$$

Consider that the price markup fairness concerns evolve as follows

$$F_{j,t} = 1 - \theta_p \left( m^{p,per}_{j,t} - \bar{m}^{p,per} \right) \tag{B13}$$

Consider a law of motion for the perceived real marginal cost as follows

$$mc^{per}_{j,t} = \left( mc^{per}_{j,t-1} \right)^{\gamma_p} \left( \frac{(\nu_p - 1)}{\nu_p} P_{j,t} \right)^{1-\gamma_p} \tag{B14}$$

As in a standard NK model, the price markup is defined as $m^p_{j,t} = \frac{P_{j,t}}{mc_{j,t}}$.

Note that, by plugging (B12) into the law of motion of perceived marginal cost one obtains

$$
\begin{aligned}
\frac{P_{j,t}}{m_{j,t}^{p,per}} &= \left(mc_{j,t-1}^{per}\right)^{\gamma_p}\left(\frac{(\nu_p-1)}{\nu_p}P_{j,t}\right)^{1-\gamma_p}\\
\frac{m_{j,t}^{p,per}}{P_{j,t}} &= \left(mc_{j,t-1}^{per}\right)^{-\gamma_p}\left(\frac{(\nu_p-1)}{\nu_p}P_{j,t}\right)^{\gamma_p-1}\\
m_{j,t}^{p,per} &= \left(mc_{j,t-1}^{per}\right)^{-\gamma_p}\left(\frac{(\nu_p-1)}{\nu_p}\right)^{\gamma_p-1}\left(P_{j,t}\right)^{\gamma_p}\\
m_{j,t}^{p,per} &= \left(\frac{1}{mc_{j,t-1}^{per}}\right)^{\gamma_p}\left(\frac{\nu_p}{\nu_p-1}\right)^{1-\gamma_p}\left(P_{j,t}\right)^{\gamma_p}
\end{aligned}
$$

Highlighting that price markup fairness concerns and good demand are functions of $mc_{j,t-1}^{per}$. Derive the following elasticity

$$
\frac{-d\ln F_{j,t}}{d\ln m_{j,t}^{p,per}} = \theta_p\frac{m_{j,t}^{p,per}}{F_{j,t}}
$$

Derive the following two partial derivatives

$$
\begin{aligned}
\frac{\partial Y_{j,t}}{\partial P_{j,t}} &= -\nu_p\frac{Y_{j,t}}{P_{j,t}}-\gamma_p(\nu_p-1)\theta_p\frac{Y_{j,t}m_{j,t}^{p,per}}{F_{j,t}P_{j,t}}\\
-\frac{P_{j,t}}{Y_{j,t}}\frac{\partial Y_{j,t}}{\partial P_{j,t}} &= \nu_p+\gamma_p(\nu_p-1)\theta_p\frac{m_{j,t}^{p,per}}{F_{j,t}}\\
\frac{-\partial\ln Y_{j,t}}{\partial\ln P_{j,t}} &\triangleq \mathcal{E}_{j,t}^{p}
\end{aligned}
$$

and,

$$
\begin{aligned}
\frac{\partial Y_{j,t}}{\partial mc_{j,t-1}^{per}} &= \gamma_p\theta_p(\nu_p-1)\frac{Y_{j,t}m_{j,t}^{p,per}}{F_{j,t}mc_{j,t-1}^{per}}\\
\frac{mc_{j,t-1}^{per}}{Y_{j,t}}\frac{\partial Y_{j,t}}{\partial mc_{j,t-1}^{per}} &= \gamma_p\theta_p(\nu_p-1)\frac{m_{j,t}^{p,per}}{F_{j,t}}\\
\frac{\partial\ln Y_{j,t}}{\partial\ln mc_{j,t-1}^{per}} &\triangleq \mathcal{E}_{j,t}^{p}-\nu_p
\end{aligned}
$$

The first-order conditions relative to the firm problem are

FOC $\frac{\partial\mathcal{L}_j}{\partial L_{j,t}}$

$$
\frac{\mathcal{W}_t}{\mathcal{P}_t} = \lambda_{j,t}^{2}A_{j,t} \qquad \text{(B15)}
$$

FOC $\frac{\partial \mathcal{L}_j}{\partial Y_{j,t}}$

$$\frac{P_{j,t}}{\mathcal{P}_t} = \lambda^1_{j,t} + \lambda^2_{j,t}$$

replace $\lambda^2_{j,t}$ by using (B15)

$$\begin{aligned}
\lambda^1_{j,t} &= \frac{P_{j,t}}{\mathcal{P}_t} - \frac{\mathcal{W}_t}{\mathcal{P}_t A_{j,t}} \triangleq \frac{P_{j,t}}{\mathcal{P}_t} - \frac{mc_{j,t}}{\mathcal{P}_t} \\
\lambda^1_{j,t}\frac{\mathcal{P}_t}{P_{j,t}} &= 1 - \frac{mc_{j,t}}{P_{j,t}} \\
\lambda^1_{j,t}\frac{\mathcal{P}_t}{P_{j,t}} &= \frac{m^p_{j,t}-1}{m^p_{j,t}} \qquad \text{(B16)}
\end{aligned}$$

where $mc_{j,t} = \frac{\mathcal{W}_t}{A_{j,t}}$ is the nominal marginal cost.

FOC $\frac{\partial \mathcal{L}_j}{\partial P_{j,t}}$:

$$\begin{aligned}
0 &= \frac{Y_{j,t}}{\mathcal{P}_t} + \lambda^1_{j,t}\left(-\nu_p\frac{Y_{j,t}}{P_{j,t}} - \gamma_p(\nu_p-1)\theta_p\frac{Y_{j,t}m^{p,per}_{j,t}}{F_{j,t}P_{j,t}}\right) + \lambda^3_{j,t}(1-\gamma_p)\frac{mc^{per}_{j,t}}{P_{j,t}} \\
&\quad -\phi_p\left(\frac{P_{j,t}}{P_{j,t-1}}-1\right)\frac{\mathcal{C}_t}{P_{j,t-1}} + \mathbb{E}_t\Gamma^t\phi_p\left(\frac{P_{j,t+1}}{P_{j,t}}-1\right)\mathcal{C}_{t+1}\frac{P_{j,t+1}}{P^2_{j,t}} \\
0 &= -\frac{1}{\mathcal{P}_t} + \lambda^1_{j,t}\frac{\mathcal{E}^p_{j,t}}{P_{j,t}} - \lambda^3_{j,t}(1-\gamma_p)\frac{1}{m^{p,per}_{j,t}Y_{j,t}} \\
&\quad +\phi_p\left(\frac{P_{j,t}}{P_{j,t-1}}-1\right)\frac{\mathcal{C}_t}{Y_{j,t}P_{j,t-1}} - \mathbb{E}_t\Gamma^t\phi_p\left(\frac{P_{j,t+1}}{P_{j,t}}-1\right)\frac{\mathcal{C}_{t+1}}{Y_{j,t}}\frac{P_{j,t+1}}{P^2_{j,t}} \\
1 &= \mathcal{E}^p_{j,t}\frac{(m^p_{j,t}-1)}{m^p_{j,t}} - \lambda^3_{j,t}(1-\gamma_p)\frac{\mathcal{P}_t}{m^{p,per}_{j,t}Y_{j,t}} \\
&\quad +\phi_p\left(\frac{P_{j,t}}{P_{j,t-1}}-1\right)\frac{\mathcal{C}_t\mathcal{P}_t}{Y_{j,t}P_{j,t-1}} - \mathbb{E}_t\Gamma^t\phi_p\left(\frac{P_{j,t+1}}{P_{j,t}}-1\right)\frac{\mathcal{C}_{t+1}}{Y_{j,t}}\frac{P_{j,t+1}\mathcal{P}_t}{P^2_{j,t}} \\
&\lambda^3_{j,t}\frac{(1-\gamma_p)\mathcal{P}_t}{m^{p,per}_{j,t}Y_{j,t}} = \left(\frac{m^p_{j,t}-1}{m^p_{j,t}}\right)\mathcal{E}^p_{j,t} - 1 + \Upsilon_{j,t} \qquad \text{(B17)}
\end{aligned}$$

where $\Upsilon_{j,t} \triangleq \phi_p\left(\frac{P_{j,t}}{P_{j,t-1}}-1\right)\frac{\mathcal{C}_t\mathcal{P}_t}{C_{j,t}P_{j,t-1}} - \mathbb{E}_t\Gamma^t\phi_p\left(\frac{P_{j,t+1}}{P_{j,t}}-1\right)\frac{\mathcal{C}_{t+1}}{C_{j,t}}\frac{P_{j,t+1}\mathcal{P}_t}{P^2_{j,t}}$ and assuming that $C_{j,t} \triangleq Y_{j,t}$.

FOC $\frac{\partial \mathcal{L}_j}{\partial mc_{j,t}^{per}}$

$$\lambda_{j,t}^3 - \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^3\gamma_p\frac{mc_{j,t+1}^{per}}{mc_{j,t}^{per}}\right) \;=\; \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^1\theta_p(\nu_p-1)\gamma_p\frac{Y_{j,t+1}m_{j,t+1}^{p,per}}{F_{j,t+1}^p mc_{p,t}^{per}}\right) \tag{B18}$$

multiply by $\frac{mc_{j,t}^{per}}{Y_{j,t+1}}$, $(1-\gamma_p)\mathcal{P}_t Y_{j,t+1}$

$$\begin{aligned}
&\lambda_{j,t}^3\frac{mc_{j,t}^{per}}{Y_{j,t+1}} - \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^3\gamma_p\frac{mc_{j,t+1}^{per}}{Y_{j,t+1}}\right) = \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^1(\mathcal{E}_{j,t+1}^p-\nu_p)\right)\\
&\lambda_{j,t}^3 mc_{j,t}^{per}(1-\gamma_p)\mathcal{P}_t - \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^3\gamma_p mc_{j,t+1}^{per}(1-\gamma_p)\mathcal{P}_t\right)\\
&= \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^1\mathcal{P}_t(\mathcal{E}_{j,t+1}^p-\nu_p)(1-\gamma_p)Y_{j,t+1}\right)\\
&\lambda_{j,t}^3\frac{P_{j,t}}{m_{j,t}^{p,per}Y_{j,t}}(1-\gamma_p)\mathcal{P}_t - \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^3\gamma_p\frac{P_{j,t+1}}{m_{j,t+1}^{p,per}Y_{j,t}}(1-\gamma_p)\mathcal{P}_t\right)\\
&= \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^1\mathcal{P}_t(\mathcal{E}_{j,t+1}^p-\nu_p)(1-\gamma_p)\frac{Y_{j,t+1}}{Y_{j,t}}\right)\\
&\lambda_{j,t}^3\frac{(1-\gamma_p)\mathcal{P}_t}{m_{j,t}^{p,per}Y_{j,t}} - \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^3\gamma_p\frac{P_{j,t+1}}{P_{j,t}m_{j,t+1}^{p,per}Y_{j,t}}(1-\gamma_p)\mathcal{P}_t\right)\\
&= \mathbb{E}_t\Gamma^t\left(\lambda_{j,t+1}^1(\mathcal{E}_{j,t+1}^p-\nu_p)(1-\gamma_p)\frac{\mathcal{P}_tY_{j,t+1}}{P_{j,t}Y_{j,t}}\right)
\end{aligned}$$

work on the LHS, replace $\lambda_{j,t,t+1}^3$ using (B17)

$$\left(\frac{m_{j,t}^p-1}{m_{j,t}^p}\right)\mathcal{E}_{j,t}^p - 1 + \Upsilon_{j,t} - \gamma_p\mathbb{E}_t\Gamma^t\left(\left(\left(\frac{m_{j,t+1}^p-1}{m_{j,t+1}^p}\right)\mathcal{E}_{j,t+1}^p - 1 + \Upsilon_{j,t+1}\right)\frac{Y_{j,t+1}}{Y_{j,t}}\frac{P_{j,t+1}}{P_{j,t}}\frac{\mathcal{P}_t}{\mathcal{P}_{t+1}}\right) \tag{B19}$$

work on the RHS, replace $\lambda_{j,t+1}^1$ using (B16)

$$\mathbb{E}_t\Gamma^t\left(\left(\frac{m_{j,t+1}^p-1}{m_{j,t+1}^p}\right)(\mathcal{E}_{j,t+1}^p-\nu_p)(1-\gamma_p)\frac{Y_{j,t+1}}{Y_{j,t}}\frac{P_{j,t+1}}{P_{j,t}}\frac{\mathcal{P}_t}{\mathcal{P}_{t+1}}\right) \tag{B20}$$

define $\mathcal{Y}_{t,t+1} \triangleq \frac{Y_{j,t+1}}{Y_{j,t}} \frac{P_{j,t+1}}{P_{j,t}} \frac{\mathcal{P}_t}{\mathcal{P}_{t+1}} = \frac{C_{j,t+1}}{C_{j,t}} \frac{P_{j,t+1}}{P_{j,t}} \frac{\mathcal{P}_t}{\mathcal{P}_{t+1}}$ and regroup both sides

$$\left(\frac{m^p_{j,t}-1}{m^p_{j,t}}\right)\mathcal{E}^p_{j,t} - 1 + \Upsilon_{j,t} - \gamma_p \mathbb{E}_t \Gamma^t \left(\left(\left(\frac{m^p_{j,t+1}-1}{m^p_{j,t+1}}\right)\mathcal{E}^p_{j,t+1} - 1 + \Upsilon_{j,t+1}\right)\mathcal{Y}_{t,t+1}\right)$$
$$= \mathbb{E}_t \Gamma^t \left(\left(\frac{m^p_{j,t+1}-1}{m^p_{j,t+1}}\right)(\mathcal{E}^p_{j,t+1} - \nu_p)(1-\gamma_p)\mathcal{Y}_{t,t+1}\right)$$
$$\left(\frac{m^p_{j,t}-1}{m^p_{j,t}}\right)\mathcal{E}^p_{j,t} - 1 + \Upsilon_{j,t} = \mathbb{E}_t \Gamma^t \left(\mathcal{Y}_{t,t+1}\left(\left(\frac{m^p_{j,t+1}-1}{m^p_{j,t+1}}\right)(\mathcal{E}^p_{j,t+1} - (1-\gamma_p)\nu_p) + \gamma_p\left(\Upsilon_{j,t+1}-1\right)\right)\right)$$
$$\Delta m^p_{j,t}\mathcal{E}^p_{j,t} + \Upsilon_{j,t} = 1 + \mathbb{E}_t \Gamma^t \left(\mathcal{Y}_{t,t+1}\left(\Delta m^p_{j,t}(\mathcal{E}^p_{j,t+1} - \varphi_p + \gamma_p\left(\Upsilon_{j,t+1}-1\right)\right)\right)$$

where $\Delta m^p_{j,t} = \left(\frac{m^p_{j,t}-1}{m^p_{j,t}}\right)$ and $\varphi_p = (1-\gamma_p)\nu_p$.

**Equilibrium**

Consider a symmetric equilibrium. Therefore, the subscripts $k$ and $j$ can be dropped, resulting in $\mathcal{W}_t = W_t$, $\mathcal{P}_t = \frac{P_t}{F_t}$, and $\mathcal{C}_t = C_t F_t$.

Inflation cost

$$\begin{aligned}
\Upsilon_t &= \phi_p\left(\frac{P_t}{P_{t-1}} - 1\right)\frac{\mathcal{C}_t \mathcal{P}_t}{C_t P_{t-1}} - \mathbb{E}_t \Gamma^t \phi_p \left(\frac{P_{t+1}}{P_t} - 1\right)\frac{\mathcal{C}_{t+1}}{C_t}\frac{P_{t+1}\mathcal{P}_t}{P_t^2} \\
\Upsilon_t &= \phi_p\left(\frac{P_t}{P_{t-1}} - 1\right)\frac{P_t}{P_{t-1}} - \mathbb{E}_t \Gamma^t \phi_p \left(\frac{P_{t+1}}{P_t} - 1\right)\frac{C_{t+1}F^p_{t+1}}{C_t F_t}\frac{P_{t+1}}{P_t} \\
\Upsilon_t &= \phi_p\left(\left(\pi_t - 1\right)\pi_t - \beta \mathbb{E}_t\left(\pi_{t+1}-1\right)\pi_{t+1}\right) \qquad \text{(B21)}
\end{aligned}$$

given that $\Gamma^t = \beta \frac{\mathcal{C}_t}{\mathcal{C}_{t+1}} = \beta \frac{C_t F_t}{C_{t+1} F^p_{t+1}}$.

Price markup dynamic

$$\Delta m^p_t \mathcal{E}^p_t + \Upsilon_t = 1 + \mathbb{E}_t \Gamma^t \left(\mathcal{Y}_{t,t+1}\left(\Delta m^p_t(\mathcal{E}^p_{t+1} - (1-\gamma_p)\nu_p) + \gamma_p\left(\Upsilon_{t+1}-1\right)\right)\right)$$
$$\Delta m^p_t \mathcal{E}^p_t + \Upsilon_t = 1 + \mathbb{E}_t \Gamma^t \left(\frac{C_{t+1}}{C_t}\frac{P_{t+1}}{P_t}\frac{\mathcal{P}_t}{\mathcal{P}_{t+1}}\left(\Delta m^p_t(\mathcal{E}^p_{t+1} - (1-\gamma_p)\nu_p) + \gamma_p\left(\Upsilon_{t+1}-1\right)\right)\right)$$
$$\Delta m^p_t \mathcal{E}^p_t + \Upsilon_t = 1 + \mathbb{E}_t \beta \frac{C_t F_t}{C_{t+1}F^p_{t+1}} \left(\frac{C_{t+1}}{C_t}\frac{P_{t+1}}{P_t}\frac{\mathcal{P}_t}{\mathcal{P}_{t+1}}\left(\Delta m^p_t(\mathcal{E}^p_{t+1} - (1-\gamma_p)\nu_p) + \gamma_p\left(\Upsilon_{t+1}-1\right)\right)\right)$$
$$\Delta m^p_t \mathcal{E}^p_t + \Upsilon_t = 1 + \beta \mathbb{E}_t \left(\Delta m^p_{t+1}(\mathcal{E}^p_{t+1} - \varphi_p + \gamma_p\left(\Upsilon_{t+1}-1\right)\right)$$

where $\varphi_p = (1-\gamma_p)\nu_p$).

Production function

$$Y_t = A_t L_t \tag{B22}$$

Wage markup

$$m_t^{w,NK} = \frac{W_t(1-\tau_{l,t})}{\mathcal{P}_t mrs_t}$$
$$m_t^{w,NK} = \frac{W_t(1-\tau_{l,t})F_t}{P_t mrs_t}$$
$$m_t^{w,NK} = \frac{W_t(1-\tau_{l,t})F_t}{P_t \mathcal{C}_t L_t^{\eta}}$$
$$m_t^{w,NK} = \frac{W_t(1-\tau_{l,t})}{P_t C_t L_t^{\eta}}$$
$$m_t^{w,NK} = \frac{w_t(1-\tau_{l,t})}{C_t L_t^{\eta}} = \frac{\nu_w}{\nu_w - 1} \tag{B23}$$

Price markup

$$m_t^p = \frac{P_t}{mc_t}$$
$$m_t^p = \frac{P_t A_t}{\mathcal{W}_t}$$
$$m_t^p = \frac{A_t}{w_t} \tag{B24}$$

Price elasticity

$$\mathcal{E}_t^p = \nu_p + (\nu_p - 1)\theta_p \gamma_p \frac{m_t^{p,per}}{F_t} \tag{B25}$$

Price markup fairness concerns

$$F_t = 1 - \theta_p \left( m_t^{p,per} - \bar{m}^{p,per} \right) \tag{B26}$$

Law of motion of perceived marginal cost

$$mc_{j,t}^{per} = \left( mc_{j,t-1}^{per} \right)^{\gamma_p} \left( \frac{(\nu_p - 1)}{\nu_p} P_{j,t} \right)^{1-\gamma_p} \tag{B27}$$

implying,

$$
\begin{aligned}
\frac{P_t}{m_t^{p,per}} &= \left(\frac{P_{t-1}}{m_{t-1}^{p,per}}\right)^{\gamma_p}\left(\frac{(\nu_p-1)}{\nu_p}P_t\right)^{1-\gamma_p} \\
\frac{m_t^{p,per}}{P_t} &= \left(\frac{P_{t-1}}{m_{t-1}^{p,per}}\right)^{-\gamma_p}\left(\frac{(\nu_p-1)}{\nu_p}P_t\right)^{\gamma_p-1} \\
m_t^{p,per} &= \left(\frac{1}{m_{t-1}^{p,per}}\right)^{-\gamma_p}\left(\frac{\nu_p-1}{\nu_p}\right)^{-(1-\gamma_p)}(\pi_t)^{\gamma_p} \\
m_t^{p,per} &= \left(m_{t-1}^{p,per}\right)^{\gamma_p}\left(\frac{\nu_p}{\nu_p-1}\right)^{1-\gamma_p}(\pi_t)^{\gamma_p} \qquad \text{(B28)}
\end{aligned}
$$

where $\pi_t = \frac{P_t}{P_{t-1}}$.

Euler equation

$$\beta\mathbb{E}_t\left(\frac{C_t P_t}{C_{t+1}P_{t+1}}\right) = \frac{1}{i_t} \qquad \text{(B29)}$$

Taylor rule

$$i_t = \bar{i}\cdot\pi_t^{\psi_\pi} \qquad \text{(B30)}$$

Aggregate resource constraint

$$Y_t = C_t\left(1+\frac{\phi_p}{2}(\pi_t-1)^2\right) \qquad \text{(B31)}$$

**Steady state**

Wage markup

$$\bar{m}^w = \frac{\bar{w}(1-\bar{\tau}_l)}{\bar{C}\bar{L}^\eta} \qquad \text{(B32)}$$

Price markup, note that $\bar{A} = 1$

$$\bar{m}^p = \frac{(1-\bar{\tau}_l)}{\bar{C}\bar{L}^\eta\bar{m}^w} \qquad \text{(B33)}$$

Production function, note that $\bar{\pi} = 1$

$$\bar{Y} = \bar{L} = \bar{C} = \left(\frac{(1-\bar{\tau}_l)}{\bar{m}^p\bar{m}^w}\right)^{\frac{1}{1+\eta}} \qquad \text{(B34)}$$

Price markup growth

$$
\begin{aligned}
\Delta\bar{m}^p\bar{\mathcal{E}}^p &= 1-\beta\gamma_p+\beta\Delta\bar{m}^p\left(\bar{\mathcal{E}}^p-\varphi_p\right) \\
(\bar{m}^p-1)\bar{\mathcal{E}}^p &= \bar{m}^p-\beta\gamma_p\bar{m}^p+\beta(\bar{m}^p-1)\left(\bar{\mathcal{E}}^p-\varphi_p\right) \\
\left(\bar{\mathcal{E}}^p-\beta\left(\bar{\mathcal{E}}^p-\varphi_p\right)\right) &= \bar{m}^p\left(\bar{\mathcal{E}}^p-1+\beta\gamma_p-\beta\left(\bar{\mathcal{E}}^p-\varphi_p\right)\right) \\
\left((1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p\right) &= \bar{m}^p\left((1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p-(1-\beta\gamma_p)\right) \\
\bar{m}^p &= \frac{(1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p}{(1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p-(1-\beta\gamma_p)}
\end{aligned}
$$

Price elasticity

$$
\bar{\mathcal{E}}^p = \nu_p+(\nu_p-1)\theta_p\gamma_p\frac{\bar{m}^{p,per}}{\bar{F}} \tag{B35}
$$

Law of motion of perceived price markup

$$
\begin{aligned}
\bar{m}^{p,per} &= (\bar{m}^{p,per})^{\gamma_p}\left(\frac{\nu_p}{\nu_p-1}\right)^{1-\gamma_p}(\bar{\pi})^{\gamma_p} \\
\bar{m}^{p,per} &= (\bar{m}^{p,per})^{\gamma_p}\left(\frac{\nu_p}{\nu_p-1}\right)^{1-\gamma_p} \\
\bar{m}^{p,per} &= \frac{\nu_p}{\nu_p-1} \qquad \text{(B36)}
\end{aligned}
$$

Price markup fairness concerns

$$
\begin{aligned}
\bar{F} &= 1-\theta_p\left(\bar{m}^{p,per}-\frac{\nu_p}{\nu_p-1}\right) \\
\bar{F} &= 1 \qquad \text{(B37)}
\end{aligned}
$$

Replacing the elasticity, the fairness, and the perceived wage markup in (B35):

$$
\begin{aligned}
\bar{m}^p &= \frac{(1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p}{(1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p-(1-\beta\gamma_p)} \\
\bar{m}^p &= 1+\frac{(1-\beta\gamma_p)}{(1-\beta)\bar{\mathcal{E}}^p+\beta\varphi_p-(1-\beta\gamma_p)} \\
\bar{m}^p &= 1+\frac{(1-\beta\gamma_p)}{(1-\beta)(\nu_p+(\nu_p-1)\theta_p\gamma_p\frac{\bar{m}^{p,per}}{\bar{F}})+\beta\varphi_p-(1-\beta\gamma_p)} \\
\bar{m}^p &= 1+\frac{(1-\beta\gamma_p)}{(\nu_p-1)\left((1-\beta\gamma_p)+(1-\beta)\theta_p\gamma_p\bar{m}^{p,per}\right)} \\
\bar{m}^p &= 1+\frac{1}{(\nu_p-1)\left(1+\frac{(1-\beta)\gamma_p}{(1-\beta\gamma_p)}\theta_p\bar{m}^{p,per}\right)} \qquad \text{(B38)}
\end{aligned}
$$

note that if $\theta_p = 0$ or $\gamma_p = 0$, therefore $\bar{m}^p = \bar{m}^{p,per} = \frac{v_p}{v_p - 1}$, otherwise $\bar{m}^{p,per} > \bar{m}^p$, if $\theta_p > 0$ and $\gamma_p > 0$. The linearized model is available upon request.