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Abstract

In this paper we incorporate the two most prominent approaches of inequality aversion, i.e. Fehr and Schmidt (1999) and Bolton and Ockenfels (2000) into an otherwise standard New Keynesian macro model and compare them with respect to their influence on the long-run effectiveness of monetary policy. We find that the choice for Fehr and Schmidt or Bolton and Ockenfels like preferences is of importance only for the quantitative - but not the qualitative - effectiveness of monetary policy in the long-run.

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1 Introduction

In this paper we study the long-term effects of monetary policy when two types of income inequality aversion are incorporated into an otherwise standard dynamic general equilibrium (DGE) model of New Keynesian type with Taylor (1979) nominal wage contracts and positive trend inflation.

Recently, models of inequality aversion - i.e. disutility in the form of envy and guilt arising from disadvantageous and advantageous deviations in an agents's payoff from the payoffs of other agents within her reference group - have become a popular tool for explaining non-selfish behavior observed from numerous economic experiments. In particular, two approaches are prodominent in this literatur: *A Theory of Fairness, Competition and Cooperation* by Fehr and Schmidt (1999) [henceforth: FS] and *ERC: A th*eory of *Equity, Reciprocity, and Competition* by Bolton and Ockenfels (2000) [henceforth: BO].[1] While both

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[1] Bergh (2008) shows that by May 2007, the combined citation impact of FS and BO relative to other significant contributions in the field of other-regarding preferences had been approximately 84%. Individually, FS and BO had accounted for 46% and 38%, respectively.

contributions stress the importance of other-regarding preferences, the major difference between the two approaches lies in the treatment of the reference group. In FS agents compare themselves to each other agent in their reference group bilaterally. In BO agents compare themselves to the average of all other agents in their reference group. Intuitively, in our macro model these two approaches lead to different implications of income inequality aversion for utility. For instance, a middle-income worker does not suffer from any inequality aversion when using group comparison, while the same worker suffers substantially from both - envy and guilt - under bilateral comparison. Thus, in an BO world workers exclusively care about their relative position to the average income, where in a FS world workers care about the income distribution per se.[2]

In a recent contribution, Ahrens and Snower (2012) show that inequality aversion with respect to real incomes is able generate a significant trade-off between inflation and aggregate real variables due to what they term the envy-guilt-effect. In the presence of staggered nominal wage contracts, higher inflation implies greater wage dispersion and thus greater dispersion of incomes, generating more envy and guilt. Since workers seek to mitigate envy and guilt, they adjust their employment accordingly. Those who experience envy seek to raise their income and do so by increasing their employment, where those who experience guilt reduce their employment. Since experimental evidence suggests that envy is stronger than guilt, the envy effect dominates the guilt effect. Therefore, higher inflation is associated with greater employment and output, thereby generating a long-run Phillips curve tradeoff. Thus, monetary policy is effective in the long-run.

In this paper we compare the influence of the two particular concepts of FS and BO on the effectiveness of monetary policy. Our analysis only applies to workers within a particular reference group. We then use the representative worker model to generate macroeconomic results along new Keynesian lines. We find that the choice for BO or FS preferences is of importance only for the quantitative - but not the qualitative - effectiveness of monetary policy in the long-run. The intuitive reason is straightforward. Since envy and guilt are asymmetric, in group comparison, workers overweight the role of positive deviations in disadvantageous situations and underweigh the role of negative deviations in advantageous situations. This weighing-effect mitigates the dominance of the envy effect over the guilt effect and therefore induces a weakened net reaction of employment to income inequality.

The remainder of this paper is structures as follows: In section 2 we describe the model economy, juxtaposing FS and BO preferences. In section 3 we conduct the calibrated simulation exercise and discuss the results. Finally, section 4 concludes.

[2] In a simple one-shot distribution game, Engelmann and Strobel (2004) test experimentally whether agents behave according to the preferences indiated by FS or whether they apply BO preferences. They find that in general more agents comply with the predictions of FS preferences relative to BO preferences.

2 The Model Economy

We incorporate inequality aversion in a dynamic general equilibrium model with staggered wage contracts and positive trend inflation. The economy is inhabited by a continuum of monopolistic competitive workers, each being infinitely lived and supplying a differentiated labor type. Wages are sticky according to the Taylor (1979) staggered contracts scheme. Firms are perfect competitiors and they produce a homogenous consumption good. The government prints money, issues risk-free bonds and rebates seignorage gains in equal shares to the workers. Monetary policy is conducted by steering the growth rate of the nominal money supply $\frac{M_{t+1}}{M_t}$, which determines long-run inflation[3] π.

2.1 Firms

The economy inhabits a large number of identical firms. Each firm produces a homogenous good using a Dixit and Stiglitz (1977) CES production technology

$$y_t = \left[\sum_{h=0}^{N-1} n_t(h)^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{1}$$

where y_t is output, $n_t(h)$ is differentiated labor input, and θ denotes the elasticity of substitution between the different labor types. Firms minimize costs subject to the production function (1). Thus, firms' demand function for the individual labor type is given by

$$n_{t+i}(h) = w_{t,t+i}(h)^{-\theta} n_{t+i} \qquad \text{for} \qquad 0 < i < N-1, \tag{2}$$

where $w_{t,t+i}(h) = \frac{w_{t,t}(h)}{(1+\pi)^i}$ is the period-$t+i$ real value of the nominal contract wage set in period t by a workers from cohort h. There is perfect competition in the product market. Therefore, firms are wage and price takers and production takes place at the level where the price equals marginal costs. Consequently, the firms markup is zero and the aggregate real wage is constant at unity.

2.2 Workers

Workers are competitive monopolists, maximizing utility subject to their individual labor demand curves (2). Wages are sticky according the Taylor (1979) staggered contracts scheme: Workers are grouped into N different wage setting cohorts h for $h = 1...N$. Each period, one cohort writes a new wage contract, which remains fixed for N periods.[4] Therefore, wage contracts are uniformly staggered. A worker's time endowment is normalized to unity and can be allocated across labor and leisure. The worker derives positive utility from consumption $c_t(h)$ and negative utility from labor services $n_t(h)$. In addition, the

[3] See Nelson (2008).

[4] According to evidence on wage stickyness by Taylor (1999), the frequency of periods is chosen such that N periods are one year.

worker dislikes deviations of her actual income from her reference income. The worker's social utility function is

$$U(c,n,\mathcal{I}) = c_t(h) - \zeta\frac{n_t(h)^{1+\eta}}{1+\eta} - \mathcal{I}_t(h,k), \tag{3}$$

where $\mathcal{I}_t(h,k)$ denotes the disutility from income inequality between workers from cohort h and their reference point k. Worker h's period-i budget constraint is given by

$$\begin{aligned} & c_{t+i}(h) + m_{t+1+i}(h) + b_{t+1+i}(h) \\ = \quad & w_{t,t+i}(h)n_{t+i}(h) + \frac{R_{t+i}b_{t+i}(h) + m_{t+i}(h)}{1+\pi} + \tau_{t+i}(h), \end{aligned} \tag{4}$$

with $m(h)$ and $b(h)$ being real money and bond holdings and R is the nominal interest rate. Lump sum transfers from the government to workers are given by $\tau(h)$.

At the beginning of a new contract period worker h maximizes her utility function

$$\max_{w_{t,t}(h)} E_t \sum_{i=0}^{N-1} \beta^i \left[U\big(c_{t+i}(h)\big) - V\big(n_{t+i}(h)\big) - Z\big(\mathcal{I}_{t+i}(h)\big)\right] \tag{5}$$

subject to her budget constraint (4) and her individual labor demand curve (2). The optimal wage is set as a markup $\mu = \frac{\theta\zeta}{\theta-1}$over the marginal rate of substitution between the present value of the disutility of labor (the numerator) and the sum of the present values of the marginal utility of consumption and income (the denominator).

$$w_{t,t}(h) = \mu\frac{E_t\sum_{i=0}^{N-1}\beta^i n_{t+i}(h)^{1+\eta}}{E_t\sum_{i=0}^{N-1}\beta^i\frac{n_{t+i}(h)}{(1+\pi)^i} + E_t\sum_{i=0}^{N-1}\beta^i\frac{1}{(\theta-1)}\frac{\partial\mathcal{I}_{t+i}(h,k)}{\partial w_{t,t}(h)}}, \tag{6}$$

Next, we elaborate on the choice of the reference point k. The reference point $k \in \{\bar{j}, j\}$ can take two forms: either group comparison from BO or bilateral comparison from FS. In group comparison the reference point is given by the average income over all other workers in the economy, which we denote $k = \bar{j}$. In bilateral comparison workers from cohort h compare bilaterally with all workers from other cohorts $j \neq h$. We denote this situation with $k = j$.

2.2.1 BO Inequality Aversion

Inequality aversion in group comparison is captured by

$$\mathcal{I}_{t+i}(h,\bar{j}) = \frac{\psi_{t+i}^{h,\bar{j}}}{2}\left(w_{t,t+i}(h)n_{t+i}(h) - \frac{1}{N-1}\sum_{j\neq h} w_{t+i}(j)n_{t+i}(j)\right)^2, \tag{7}$$

where $w_{t+i}(j)$ is the real value of worker j's current wage. Equation (7) implies that worker h compares her real income to the average real income of all other workers $j \neq h$ in the economy. The parameter ψ_{t+i} is an indicator function

$$\psi_{t+i}^{h,\bar{j}} = \begin{cases} \varepsilon & \text{for} \quad \Delta_{t+i}(h,\bar{j}) < 0 \\ \gamma & \text{for} \quad \Delta_{t+i}(h,\bar{j}) > 0 \end{cases}, \tag{8}$$

where $\Delta_{t+i}(h,\bar{j})$ represents the deviation of worker h's income from the average income of all other workers, i.e. the term in parantheses in equation (7). The parameter ε represents envy and the parameter γ represents guilt. The following parameter restrictions apply: $\varepsilon > 0$, $0 < \gamma < 1$, and $\varepsilon = \kappa\gamma$, with $\kappa > 1$. The latter restriction is known as egocentric bias[5], i.e. envy is stronger than guilt. Applying the above definition of inequality aversion (7) to the optimal reset wage (6) and re-arranging, yields the labor supply relation in an BO setting

$$\begin{aligned} & \mu E_t \sum_{i=0}^{N-1} \beta^i n_{t+i}(h)^{1+\eta} \qquad (9) \\ = \quad & E_t \sum_{i=0}^{N-1} \beta^i w_{t,t+i}(h) n_{t+i}(h) - E_t \sum_{i=0}^{N-1} \beta^i \psi_{t+i}^{h,\bar{j}} \Delta_{t+i}(h,\bar{j}) w_{t,t+i}(h) n_{t+i}(h). \end{aligned}$$

2.2.2 FS Inequality Aversion

Inequality aversion in bilateral comparison is captured by

$$\mathcal{I}_{t+i}(h,j) = \frac{1}{N-1} \sum_{j \neq h} \frac{\psi_t^{h,j}}{2} \left(w_{t,t+i}(h) n_{t+i}(h) - w_{t+i}(j) n_{t+i}(j) \right)^2. \tag{10}$$

Equation (10) implies that worker h bilaterally compares her real income to the real income of each other worker $j \neq h$ in the economy. Note that for the special case $N = 2$ both BO and FS inequality aversion coincide. With bilateral comparison, the indicator function $\psi_{t+i}^{h,j}$ becomes

$$\psi_{t+i}^{h,j} = \begin{cases} \varepsilon & \text{for} \quad \Delta_{t+i}(h,j) < 0 \\ \gamma & \text{for} \quad \Delta_{t+i}(h,j) > 0 \end{cases}, \tag{11}$$

where $\Delta_{t+i}(h,j)$ represents the bilateral deviation of worker h's income from worker j's income, i.e. the term in parantheses in equation (10). Applying the definition of inequality aversion and re-arranging yields the labor supply relation

[5] Messik and Sentis (1979).

in the FS setting[6]

$$\mu E_t \sum_{i=0}^{N-1} \beta^i n_{t+i}(h)^{1+\eta} = E_t \sum_{i=0}^{N-1} \beta^i w_{t,t+i}(h) n_{t+i}(h) - E_t \sum_{i=0}^{N-1} \beta^i w_{t,t+i}(h) n_{t+i}(h) \frac{1}{N-1} \sum_{j \neq h} \psi_t^{h,j} \Delta_{t+i}(h,j) \tag{12}$$

2.3 The General Equilibrium

The government prints money m, issues bonds b and gives direct transfers τ to the workers. Hence, the government's budget constraint is

$$b_{t+i+1} + m_{t+i+1} = R_{t+i} b_{t+i} + m_{t+i} + \tau_{t+i}. \tag{13}$$

The market clearing condition is given by

$$c_t = y_t. \tag{14}$$

Aggregate labor is the sum of indiviual labor of all cohorts

$$n_t = \sum_{h=0}^{N-1} n_t(h). \tag{15}$$

Finally, the aggregate wage index in terms of efficiency labor is

$$w_t = \left[\frac{1}{N} \sum_{h=0}^{N-1} w_{t-h,t}(h)^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{16}$$

We focus on the long-run relationship between inflation and real variables. Thus, we consider the behavior of workers, firms and the government in a symmetric steady state.[7] From equation (16) in the steady state, we can derive the optimal reset wage[8]

$$w^* = \left[\frac{1}{N} \frac{1 - \pi^{N(\theta-1)}}{1 - \pi^{\theta-1}} \right]^{\frac{1}{\theta-1}}. \tag{17}$$

The model is fully described by two distinct systems each of three equations and three unknowns. Both systems comprise the reset wage (17) and the labor

[6] Note that in the absence of envy and guilt, equations (9) and (12) break down to the standard New Keynsian labor supply relation as for instance in Graham and Snower (2004). This is brought about either if we assume $\psi_{t+i}(h) = 0$, i.e. envy and guilt simply do not matter to workers or at zero inflation, where there is no wage dispersion and consequently, all incomes are equal.

[7] A symmetric steady state implies that the intertemporal real wage distribution of a worker across her contract period is equivalent to the intratemporal distribution of real wages across all workers. Refer to Graham and Snower (2008) for a visual representation.

[8] Equation (17) expresses the optimal reset wage for a finite number of cohorts $N < \infty$.

Symbol	Value	Source
R	4%	Graham and Snower (2004)
N	52	Graham and Snower (2004)
θ	5	Galí et al. (2011)
η	0.25	Imai and Keane (2004)
ε	0.85	Fehr and Schmidt (1999)
γ	0.32	Fehr and Schmidt (1999)
$\overline{n}$	0.33	Ascari and Merkl (2009)

Table 1: Calibration

demand relation (2), while the BO system also includes the BO labor supply relation (9) and the FS system also includes the FS labor supply relation (12). The unknown variables are the steady state reset wage, aggregate employment, and aggregate output $\{w^*, n, y\}$. The reset wage (17) follows directly from the calibration. The labor supply equations (9) and (12) determine the worker's steady state labor supply, while the labor demand equation (2) together with the reset wage solve aggregate output. We calibrate the model according to standard values in the literature.[9] Table 1 summarizes our base calibration.

3 Results

Figure 1 shows the Phillips Curves for the BO and the FS setting, given the base calibration from Table 1. The vertical axis measures the percentage deviations of aggregate output and aggregate employment from their respective levels at the zero-inflation steady state. The horizontal axis measures the steady state inflation rate.[10] Figure 1 shows that monetary policy has significant long-run effects on real aggregates such as employment and output. The circled and crossed lines display the schedules for aggregate employment and output for the FS setting and the BO setting, respectively. Interestingly, while the qualitative result is independent of the choice between bilateral and group comparison, the quantitative result is not. Figure 1 clearly indicates that the effectiveness of monetary policy is larger, if the underlying workers evaluate income inequality on a bilateral basis. So is expansionary monetary policy, for instance given by an increase in money growth from 0% to 2%, associated with a 0.92% increase in aggregate employment under group comparison, whereas this figure elevates to 0.69% under bilateral comparison. A second general result is that as the inflation rate rises the effectiveness of expansionary monetary policy ceases. This effect, however, is stronger if workers apply group comparison compared to

[9] For a detailed description of the calibration refer to Ahrens and Snower (2012).

[10] We restrict ourselves to inflation rates below 5% for two reasons: first, inflation rates above 5% are of little relevance for industrialized and emerging countries (Roger and Stone (2005)). The second reason is to remain comparability to the Calvo version of Ahrens and Snower (2012). Ascari (2004) and Bakshi et al. (2007) show that the Calvo framework is not viable for inflation rates above 5%.

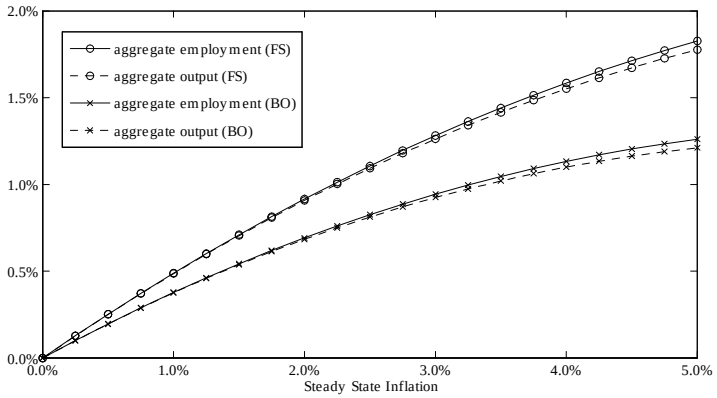

Figure 1: Relation of In‡ation to Real Variables for FS versus BO

workers applying bilateral comparison. An expansionary monetary policy, which increases steady state inflation from $\pi = 2\%$ to $\pi = 3\%$ increases aggregate employment by 0.25% in an BO setting. In a FS setting, the same expansionary monetary policy increases employment by 0.36%.

3.1 Intuition

In this model, the long-run tradeoff between steady state inflation and real variables is brought about by four effects: the employment cycling effect, the labor smoothing effect, the discounting effect, and the envy-guilt effect. Since for inflation rates covered in this paper, the envy-guilt effect is highly dominant and since we focus on the disctinction between group and bilateral comparison, in the following, we restrict ourselves to the analysis of the envy-guilt effect.[11]

In general, with positive inflation rates, real wages fall over the contract period, because nominal wages are constant over the contract period while the price level rises. Under Taylor wage staggering, different wage-setting cohorts write nominal wage contracts with the same duration at different times in a uniformly staggered way. Cohorts which have recently reset their nominal wages have a relatively high real wage, while cohorts which have not done so for a while have relatively low real wages. Therefore, positive inflation rates are accompanied by fluctuations of relative real wages. Workers experience relatively low incomes early in the contract period and relatively high incomes later.[12] Thus

[11] Refer to Ahrens and Snower (2012) and Graham and Snower (2008) for a thorough discussion of the employment cycling-, the labor smoothing-, and the discounting effect. For the distinction between inequality aversion under bilateral and group comparison, these effects are of no interest.

[12] Since workers are monopolistic competitors in the labor market, the elasticity of labor demand is greater than unity at the utility-maximizing employment level. Thus the relatively high real wages early in the contract period are associated with relatively low wage incomes.

they experience envy early on. To reduce their disutility from envy, they reduce their average wage so as to increase their average employment. Conversely, they experience guilt later in the contract period, leading them to reduce average employment. But since envy is stronger than guilt, average employment rises. The greater is the inflation rate, the greater is the associated employment and output. Thereby the envy-guilt effect generates a positive relation between inflation and macroeconomic activity. Consequently, monetary policy if effective in the long-run.

While generally the envy-guilt effect holds for both notations of inequality aversion, the strength of this effect varies with the choice for bilateral or group comparison. This result is not suprising. Intuitively, while the middle-income worker has disutility neither from envy nor from guilt in the BO setting, the same worker has substantial disutility from both, envy and guilt in the FS setting. Note that for the latter, advantageous deviations of income are exactly matched by disadvantageous one.[13] Since envy is greater than guilt, however, the ramifications of the former outperform the ramifications of the latter and therefore, the net effect is an increase in employment. For non-middle-income workers it holds true that - due to the asymmetry of envy and guilt - in group comparison, workers overweight the role of positive deviations in disadvantageous situations and underweigh the role of negative deviations in advantageous situations. This weighing-effect mitigates the dominance of the envy effect over the guilt effect and therefore induces a weakened net reaction of employment to income inequality. Summarizing, at any point in time FS agents suffer stronger from envy and guilt relative to BO agents and therefore engender stronger reactions in employment.[14]

4 Conclusion

We have shown that the positive long-run tradeoff between inflation and macroeconomic activity imduced by inequality aversion is qualitatively independent from the choice of FS or BO preferences. Quantitatively, however, it is not.

In our analysis, the positive long-run trade-off is present. However, it is more significant if workers compare themselves to each other individually, i.e. on a bilateral basis relative to a situation, where workers compare themselves with the average of all other workers. Thus, the definition of the reference group is of importance for the long-run effectiveness of monetary policy in quantitative terms. The reason for this result is straighforward. Due to the fact that envy and guilt are asymmetric, workers overweight positive deviations and underweight negative deviations when applying BO preferences. This mitigates the influence of envy relative to the influence of guilt and therefore results in a weaker reaction of aggregate employment to income inequality.

[13] This follows from the asymmetry assumption.

[14] This does not hold for contract periods $i = 0$ and $i = N - 1$. In these two cases BO and FS coincide.

From the macroeconomic perspective, the BO scenario seems more appropriate than the FS scenario. This is due to the availability of income information. While it seems impossible to gather detailed information on the complete income distribution of an economy, average income data is publicly available.[15] Furthermore, such data is provided for a variety of aggregation levels, which serve as different reference groups.

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