Trend inflation as a disciplining device in a general equilibrium model*

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Abstract

We investigate the strategic interaction between "large" wage setters and the central bank, potentially resulting in trend inflation. The combination of predetermined wages and central bank discretion disciplines wage claims, because wage setters anticipate the inflationary central bank response to distortions and the ensuing reduction of real money balances. We also consider commitment to a positive inflation target, showing that this may help to discipline non-atomistic wage setters. Finally, we show that the model is consistent with a number of stylized facts concerning real wage and unemployment in Europe and, perhaps surprisingly, in the US.

1 Introduction

New Keynesian dynamic stochastic general equilibrium models provide a new perspective on the linkages among monetary policy, inflation and the business cycle, based on monopolistic distortions in the goods and labour markets. This literature, however, has little to say about long term inflation - typically assumed to be zero despite overwhelming empirical evidence. Furthermore, analysis of the labour market is confined to the special case of atomistic wage setters, with the notable exception of Gnocchi (2005, 2006). In the paper we allow for the possibility of "large" wage setters, and investigate the resulting strategic interaction between such "large" wage setters and the central bank, potentially resulting in trend inflation.

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In doing so, we resurrect and substantially extend some developments of the Barro and Gordon model (1983) where it is shown that equilibrium real variables are not invariant to the monetary policy rule when wage setters are non-atomistic. The empirical relevance of strategic wage setters and labor market institutions in European countries is stressed by many studies (e.g. Cukierman and Lippi, 1999; Nickell et al., 2005). Labor unions, however, are found important also for the United States (see, e.g., Mulligan 2002).

Intuitively, Barro-Gordon’s causal link between real distortions and inflation should survive in the imperfect competition framework of New Keynesian models. As a matter of fact, replicating the inflation bias in a micro-founded model may require some form of cash-in-advance constraint and the inclusion of money in the utility function, as in Neiss (1999) and Albanesi and Chari (2003). These important contributions, however, play a relatively marginal role in the new macroeconomic literature, where it is often assumed that monetary policy follows a timeless perspective (Woodford, 2003) and is bound to zero steady state inflation. This is clearly at odds with post-war evidence (Ascari, 2000).

In the paper we reconsider the non neutrality result emerged in ad hoc Barro-Gordon models, exploiting Neiss’ (1999) framework to model a game between a policymaker and the wage setters. The innovation here is twofold. On the one hand, unlike standard microfounded models, it is assumed that wage setters are "large", allowing for the possibility of policy-endogenous markups. On the other hand, unlike traditional macromodels of unionized labor markets, wage setters are assumed to maximize a representative household’s utility.

We can outline our main results as follows. The combination of predetermined wages and central bank discretion disciplines wage claims, because wage setters anticipate the inflationary central bank response to distortions and the ensuing reduction of real money balances. Note that this result holds for any non-zero value of real money balances in the utility function. Thus, the widely popular practice of neglecting money when considering policy analysis is misleading when wage setters are non-atomistic. We also consider commitment to a positive inflation target, showing that this may help to discipline non-atomistic wage setters. The intuition for this result is as follows. Under flexible wages, the trade union optimization problem is solved by choosing a real wage above the competitive rate, implying that output and consumption fall below the perfectly competitive rate. When wages are predetermined, the union will anticipate the negative effect of lower consumption on real money balances. Such an effect is stronger the higher the level of expected inflation. Thus choosing a positive inflation target raises the trade union cost from raising the real wage. Comparing monetary discretion and commitment to "trend inflation" we find that the former is more effective the greater the level of wage centralization, whereas the opposite holds true for relatively decentralized labour markets.

Finally, we show that the model is consistent with a number of stylized facts concerning real wage and unemployment dynamics. First, the model implies that the wage markup is countercyclical, as documented in Gali et al. (2007), just because inflation is procyclical and inflation expectations discipline wage setters. Second, calibrations show that monetary discretion may have non-negligible effects on unemployment even when the number of wage setters is

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1See, among others, Bratsiotis and Martin, (1999); Soskice and Iversen (1998, 2000); Cukierman and Lippi (1999, 2001); Acocella et al. (2003); Lippi (2003); Coricelli et al. (2006).
relatively high. Thus the model may be relevant beyond the boundaries of Euroland, and perhaps contribute to explain unemployment and inflation even in the 20th century US economy, where labour market distortions played a significant role (Mulligan, 2002). Third, the differential role of monetary policy non-neutrality may explain the different unemployment dynamics in Europe and in the US, following the 1980 disinflationary episode.

The rest of the paper is structured as follows. Section 2 describes the model. Section 3 considers the case of flexible wages. Section 4 computes the model solution with pre-determined wages under alternative monetary regimes (discretionary and inflation targeting). Section 5 simulates our model. Section 6 re-interprets some facts on the basis of our model. Section 7 concludes.

2 The economic structure

We build on Neiss (1999) model, where a staggered timing structure in the acquisition of nominal money balances within a money-in-the-utility function framework generates a discretionary inflation equilibrium when the economy is plagued by monopolistic distortions. To simplify the analysis we assume full price flexibility in the goods market, whereas wages are predetermined.

2.1 Households

The representative household \((i)\) maximizes the following utility function

\[
U = \sum_{t=0}^{\infty} \beta_t \left( \frac{C_{t,i}^{1-\Delta}}{1-\Delta} - \frac{\eta}{1+\phi} t_{t,i}^{1+\phi} + \frac{\gamma}{1-\varepsilon} \left( \frac{M_{t,i}}{P_t} \right)^{1-\varepsilon} \right)
\]

where \(\beta_t \in (0,1)\) is the intertemporal discount rate, \(C_{t,i}\) is a consumption bundle\(^2\), \(t_{t,i}\) is a differentiated labor type that is supplied to all firms, \(\frac{M_{t,i}}{P_t}\) denotes real money holdings.\(^3\)

The flow budget constraint is:

\[
C_{t,i} + \frac{M_{t+1,i}}{P_{t+1}} + \frac{B_{t+1,i}}{P_{t+1}} = \frac{w_{t,i} t_{t,i}}{P_t} + \frac{M_{t,i}}{P_t} + \frac{\tau_t}{P_t} + \theta_t + \frac{R_t B_{t,i}}{P_{t+1}}
\]

where \(B_{t,i}\) is the period \(t\) holdings of one-period bonds; \(w_{t,i}\) is the nominal wage; \(\tau_t\) is a lump-sum transfer from Central Bank profits, \(\theta_t\) denotes firms profits, \(R_t\) is the nominal interest rate. Note that \(M_{t+1,i}\) is chosen at \(t\).

Consumption basket and price index are defined as follows:

\[
C_t = \left( \int_0^1 c_t(j)^\rho di \right)^{\frac{1}{\rho}}
\]

\[
P_t = \left( \int_0^1 p_t(i)^{\frac{\rho}{\rho-1}} di \right)^{\frac{\rho-1}{\rho}}
\]

\(^2\Delta \geq 1\) denotes the CRRA coefficient in the consumption function

\(^3\)New Keynesian models typically assume logarithmic preferences over real money balances (Corsetti and Pesenti, 2001). Here we assume \(\varepsilon > 1\), which is sufficient to ensure that the marginal cost to inflating is positive in discretionary inflation and that the solution to the monetary authority problem in the game with the wage setters is always a global maximum (see Neiss, 1999: 361, 368).
The standard first order conditions for consumption are:

\[ c_t(j) = C_t \left( \frac{p_t(j)}{P_t} \right)^{\frac{1}{\rho}} \]  

(5)

\[ C_t^\Delta = \frac{1}{\beta R_t + 1} \frac{P_{t+1}}{P_t} c_t^\Delta \]  

(6)

The money demand equation is

\[ \frac{M_{t+1}}{P_t} = \left( \frac{P_t}{P_{t+1}} \right)^{\frac{1-\epsilon}{\epsilon}} \left( \frac{\gamma \beta C_t^\Delta}{1 - R_{t+1}} \right)^{\frac{1}{\epsilon}} \]  

(7)

As in Neiss (1999) the agent faces a trade-off between \( t \) period consumption and \( t + 1 \) period holdings of nominal money balances. Observe that (7) can also be interpreted as a demand function: when the central bank increases next period nominal money balances, \( coeteris paribus \) current consumption increases. Straightforward manipulations would show that \( \frac{1}{\epsilon} \) denotes the income elasticity of money demand.

The condition about the optimal labor supply will be introduced at a later stage, when we consider different wage-setting regimes.

### 2.2 Firms

There is a continuum of monopolistically competitive firms uniformly distributed over the interval \([0, 1]\). Each firm \((j)\) produces a differentiated good using a Cobb-Douglas production function:

\[ y_t(j) = l_t(j)^\alpha \]  

(8)

where

\[ l_{t,j} = \left[ \int_0^1 l_{t,j}(i)^{\frac{\sigma+1}{\sigma-1}} di \right]^{\frac{\sigma-1}{\sigma}} \]  

(9)

denotes a labour bundle and \( \sigma \) is the intra-temporal elasticity of substitution across different labor inputs.

The price is set as a mark-up, \( \frac{1}{\rho} \), over real marginal costs. For any given level of its labor demand, \( l_{t,j} \), the firm must decide the optimal allocation across labor inputs, i.e. the allocation which minimizes the labor cost \( \int_0^1 w(i) l_{t,j}(i) di \) subject to aggregation technology (9). Firm \((j)\) demand for labor type \((i)\) is

\[ l_{t,j}(i) = \left( \frac{w_t(i)}{w_t} \right)^{-\sigma} l_{t,j} \]  

(10)

where

\[ w_t = \left[ \int_0^1 w_t(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}} \]  

(11)

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4 Index \( i \) is dropped for simplicity.

5 Capital is assumed fixed and normalized to unity.
is a wage index representing the minimum cost of acquiring a unit of the labor bundle \((9)\).

Aggregating across firms we obtain

\[ Y_t = C_t = l_t^\alpha \]  
\[(12)\]

\[ l_t (i) = \left( \frac{w_t (i)}{w_t} \right)^{-\sigma} l_t \]  
\[(13)\]

\[ l_t = \left( \frac{1}{\alpha \rho \pi_t} \right)^{-1} \]  
\[(14)\]

### 2.3 Labor market

The economy is populated by \(n\) unions. Workers equally split across unions (each union has mass \(n^{-1}\)). The mass can be interpreted as the degree of wage setting centralization as well as unions’ ability to internalize the consequences of their actions (unions’ coordination).

We assume that each union maximizes members’ lifetime utility \((1)\) subject to the budget constraint \((2)\) and to labor demand for all union’s members. We also assume that each union bargains over the real wage taking other unions’ decisions as given. From equations \((13)\) and \((14)\) each union understands that a real wage increase will trigger two adverse effects: a substitution effect, due to the relative wage change, and an aggregate labor demand effect, due to the increase in the aggregate real wage. In fact, in the decentralized equilibrium each union \((z)\) anticipates that\(^6\)

\[ \frac{\partial w_t}{\partial w_t (z)} = n^{-1} \left( \frac{w_t (z)}{w_t} \right)^{-\sigma} \]  
\[(15)\]

### 2.4 Monetary Policy

At time \(t\) the central bank sets next period money supply \((M_{t+1})\), facing the following budget constraint:

\[ M_{t+1} - M_t = \tau_t \]  
\[(16)\]

In the following we consider three policy regimes.

The first is full discretion, when the central bank maximizes \((1)\) taking wages as given.

\(^6\)In the literature it is sometimes assumed that unions bargain over the nominal wage. In this case the union takes as given the nominal wage set by the other unions. Therefore, the union anticipates a stronger substitution effect to the extent that her decision to raise the wage triggers an inflation response. In fact this inflation effect is perceived to reduce the real wage of the other unions. For the same reason the anticipated aggregate labor demand effect becomes weaker. Due to its algebraic complexity we leave the analysis of nominal wage bargaining for further research. This choice is justified here because the focus of the paper is on the strategic interaction between unions and the monetary authority, via the real money balances effect. The effects of monetary policy on nominal wage externalities and unions’ interactions are also discussed in Acocella et al. (2003), Lippi (2003) or Coricelli et al. (2006).
The second is the case of distorted preferences, when the central bank maximizes
\[ UB = \sum_{t=0}^{\infty} \beta^t \left( \frac{C^1_{t+\lambda}}{1-\Delta} - \frac{\eta}{1+\phi} l_{t,i}^{1+\phi} + \frac{\gamma_B}{1-\varepsilon} \left( \frac{M_{t,i}}{P_t} \right)^{1-\varepsilon} \right) \]  
(17)
where \( \gamma_B \neq \gamma \). In traditional time-inconsistency models, the central bank’s aversion to inflation crucially affects the outcome of monetary policy games. In our framework equilibrium inflation impacts on welfare through its negative effect on real money balances. Thus setting \( \gamma_B > \gamma \) would mimic Rogoff’s (1985) inflation-conservative central banker, whereas \( \gamma_B < \gamma \) would resemble Guzzo and Velasco’s (1999) populist central banker.

The third regime we consider is commitment to a fixed money growth rate, i.e. commitment to an exogenous inflation target.

3 The case of flexible wages

Equilibrium employment under flexible wages provides a benchmark case for our analysis of the game between the central bank and the trade unions under pre-determined wages. Each union chooses the real wage, \( \bar{w}_t(z) \), that maximizes (1), taking real money balances as given and subject to the budget constraint (2).

The trade union first order condition is
\[ 0 = \frac{l_t}{C_t^\Delta} \left( (1-\sigma)(n-1) - \frac{\alpha}{1-\sigma} \right) + \eta \frac{l_{t,i}^{1+\phi}}{\bar{w}_t} \left[ \sigma (n-1) + \frac{1}{1-\sigma} \right] \]
(18)
where subscripts \( z \) have been dropped since the symmetric equilibrium has been imposed.

This implies that
\[ \bar{w}_t = \eta \mu l_t^\phi C_t^\Delta \]
(19)
where:
\[ \mu = \frac{\sigma (n-1) + (1-\alpha)^{-1}}{(\sigma-1)(n-1) + \alpha (1-\alpha)^{-1}} \]
(20)
denotes the wage mark-up under flexible wages. Observe that (20) is consistent with alternative labor market regimes, ranging from perfect competition \((n, \sigma \to \infty, \mu = 1)\), to monopolistic competition \((n \to \infty, 1 < \sigma < \infty, \mu = \sigma (\sigma-1)^{-1})\), to strategic wage setting \((1 \leq n < \infty, 1 < \sigma < \infty)\).

Using (14) and the goods market clearing condition \( C_t = Y_t \) equilibrium employment is:
\[ l_{\mu} = \left( \frac{\alpha \rho}{\eta \mu} \right)^{\frac{1}{1+\phi(\Delta-1)}} \]
(21)
Observe that the competitive (Pareto optimal) level of employment obtains when the gross markup is equal to one, i.e. \( \mu \rho^{-1} = 1 \).
4 Real effects of alternative monetary policy regimes under pre-determined wages

When wages are pre-determined, the timing of the game is as follows. 1) wage setters simultaneously choose \(\bar{w}_t\) and set \(w_t = \bar{w}_t P_t^e\), where \(P_t^e\) is the rational expectation of the price level. 2) The central bank chooses its monetary policy. Then, full price flexibility ensures that markets clear. The model is solved by backward induction. Relative to the case of wage flexibility, unions now anticipate the effects of wage choice on inflation and the equilibrium level of real money balances in consequence of the central bank response.

We closely follow Neiss’ solution method. The central bank maximizes equation (1) with respect to \(M_{t+1}\), taking wages as given.\(^7\) This is equivalent to assuming that inflation is the control variable of the central bank. For expositional purposes we define the real wage, employment and consumption as functions of inflation surprises

\[
\frac{w_t}{P_t} = \frac{\bar{w}_t P_t^e}{P_t} = \bar{w}_t \left(1 + \pi_t^e\right) \left(1 + \pi_t\right) \tag{22}
\]

\[
l_t = \left(\frac{\bar{w}_t^e}{\alpha \rho^e + \pi_t^e}\right)^{1 - \frac{\rho}{\alpha}} \tag{23}
\]

\[
C_t = Y_t = \left(\frac{1}{\alpha \rho^e + \pi_t^e}\right)^{1 - \frac{\rho}{\alpha}} \tag{24}
\]

where \(\pi_t, \pi_t^e\) denote inflation and its rational expectation, respectively.

4.1 Discretionary monetary policy

Bearing in mind that \(p_t = \frac{w_t^e}{\alpha \rho^e + (1 - \alpha)}\), the central bank’s first order condition is:

\[
\frac{\alpha}{1 - \alpha} C_t^{1 - \Delta} - \frac{\eta}{1 - \alpha} l_t^{1 + \rho} - \gamma \left(\frac{M_t}{P_t}\right)^{1 - \varepsilon} = 0 \tag{25}
\]

Condition (25) identifies the marginal costs and benefits of an expansionary monetary policy. By raising next period money supply, \(M_{t+1}\), the central bank aims at an increase in current consumption at the cost of raising the disutility from labor effort and of reducing current real money balances, due to the surge in inflation.

The trade union problem is solved by maximizing (1) subject to (15), (22), (23), (24), (25).

The first order condition is

\[
\frac{l_t \left[\sigma (1 - n - 1) + \frac{\alpha}{1 - \alpha} + \delta \frac{\sigma (\Delta - 1)}{\rho (1 + \rho)}\right]}{C_t^\Delta} = \eta \left[\sigma (n - 1) + \frac{1}{1 - \alpha} - \delta\right] \tag{26}
\]

\(^7\)In this model there is no state variable to link periods and the policy problem is time invariant; see Neiss (1999) for a discussion.
where
\[ \delta = \frac{1 + \phi}{(1 - \alpha)(\varepsilon - 1)} \]
captures the trade unions’ anticipation of the central bank’s reaction to their wage choices. In fact, the higher the real wage, the lower the level of employment, the more the central bank is willing to inflate, reducing equilibrium real money balances.

Equation (26) implies that
\[ \bar{w}_t = \eta \mu \delta \phi t C^\Delta \]
where
\[ \mu \delta = \frac{\sigma (n - 1) + \frac{1}{1 - \alpha} - \delta}{(\sigma - 1)(n - 1) + \frac{1}{1 - \alpha} + \frac{\Delta - 1}{\sigma + 1}} < \mu \]
Equation (28) implies
\[ l_{\mu \delta} = \left( \frac{\alpha \rho}{\eta \mu \delta} \right) \frac{1}{1 + \alpha (1 - \Delta)(1 + \phi)} > l_{\mu} \]

Monetary policy is non-neutral because the non-atomistic wage setters anticipate the inflationary central bank response to their wage choice. The combination of wage stickiness, concern for real money balances and discretionary monetary policy always discipline the wage setters. It is important to note that this result holds for any positive – even small – value of real money balances in the utility function. Thus, the widely popular practice of neglecting real money balances in welfare analysis is misleading when wage setters are non-atomistic.

We can now characterize equilibrium inflation. Substituting (34), (12), (29) into the central bank’s first order condition (25) we get:
\[ \pi = \beta - 1 + \left( \frac{1}{\gamma} \right) \frac{1}{1 \cdot \alpha \rho \left( 1 - \frac{\rho}{\mu \delta} \right)} \frac{\varepsilon - 1}{\beta \mu_{\delta}} \]
When \( \delta > 1 + \alpha (1 - \Delta)(1 + \phi) \), the gross wage mark-up may well fall below one, which would imply that product market distortions are compensated by wage over-moderation. In general terms, to completely remove distortions, including the effects of monopolistic competition in the goods markets, we need \( \frac{\rho}{\mu_{\delta}} = 1 \), that is, from (28) \( \delta = \delta^* = \frac{n + \sigma(n - 1) + (1 - \alpha)^{-1} - n}{1 + \alpha (1 - \Delta)(1 + \phi)} \).

4.2 Distorted central bank’s preferences

We now consider the case of distorted central bank’s preferences. Straightforward manipulations show that in this case equilibrium employment amounts to
\[ l_{\mu_{\delta} \gamma} = \left( \frac{\alpha \rho}{\eta \mu_{\delta} \gamma} \right) \frac{1}{1 + \alpha (1 - \Delta)(1 + \phi)} \]

\(^\text{8} \text{Note that } \mu_{\delta} < \mu \text{ because } \Delta \geq 1.\)
where

\[ \mu_{\gamma_B} = \frac{\sigma (n - 1) + \frac{1}{1 - \alpha} - \delta \gamma_B}{(\sigma - 1) (n - 1) + \frac{\alpha}{1 - \alpha} + \delta \gamma_B \frac{\alpha (\Delta - 1)}{\beta (1 + \phi)}} \]  (32)

Thus by setting

\[ \gamma_B = \gamma_B^* = \frac{\gamma \delta (1 + \alpha (\Delta - 1) (1 + \phi)^{-1})}{n + \left[ \sigma (n - 1) + (1 - \alpha)^{-1} - n \right] (1 - \rho)} \]  (33)

distortions would be eliminated, and the inflation bias would correspondingly disappear. Choosing \( \gamma_B^* < \gamma \) reinforces the disciplining effects of discretion, because the central bank inflates more in response to a wage increase when \( \gamma_B \) is low. The threat of inflation disciplines the unions. Strategic interactions explains why a central bank with a high propensity to inflation can ensure a good performance, in terms not only of employment, but also of inflation: the inflation threat induces wage setters to moderate their wage claims. Once more, the real effects of the policy regime obtain irrespective of the importance of real money holdings in (1).

### 4.3 Inflation targeting

Over the last decade central banks have shifted to a policy of announcing non-zero inflation targets. As acknowledged in Schmitt-Grohé and Uribe (2004) the justification for this policy is hardly found in micro-founded models. In the following we show that commitment to a positive inflation target may help to discipline wage setters.

Suppose the central bank pre-commits to a constant growth rate of nominal money balances, \( m \). In this case the union maximizes (1) subject to the money demand condition (7). Under rational expectations, i.e. \( \pi = m \), this implies that the union problem is subject to the constraint: \(^9\)

\[ \frac{M_t}{P_t} = \left( \frac{\gamma \beta C_t^\Delta}{1 + m - \beta} \right)^{\frac{1}{\epsilon}} \]  (34)

The union first order condition in the symmetric equilibrium is

\[ \frac{l_t \left[ (\sigma - 1) (n - 1) + \frac{\alpha}{1 - \alpha} \right] (1 + \delta_m)}{C_t^\Delta} = \eta \frac{\delta_m}{\bar{w}} \]  (35)

where:

\[ \delta_m = \frac{\Delta}{\varepsilon} \left[ \gamma \left( \frac{1 + m - \beta}{\beta} \right) \varepsilon^{-1} C_t^{\Delta - \varepsilon} \right] \]

Straightforward manipulations show that

\[ \bar{w}_t = \eta \mu_m \bar{w} \frac{\delta}{\bar{C}_t} \]  (36)

\(^9\)Equation (34) has been obtained using the Euler equation (6) under the expectation that \( C_t = C_{t+1} \)
where:

\[
\mu_m = \frac{\sigma (n - 1) + \frac{1}{1-\alpha}}{\left[(\sigma - 1) (n - 1) + \frac{\alpha}{1-\sigma}\right] (1 + \delta_m)}
\] (37)

> From a comparison between \( \mu_m \) and \( \mu \) in (20) it is easy to see that, even though the beneficial effect of monetary discretion is now lost, the inflation target disciplines wage claims. The rationale for this result can be explained by inspecting equation (34). Unions anticipate that, given the target \( m \), wage moderation increases real money balances. Such an effect is stronger the higher the target. In other words, under flexible wages, the trade union optimization problem is solved by choosing a real wage such that consumption falls below the perfectly competitive rate. This loss of utility is more than compensated for by the corresponding reduction in labour effort. By contrast, when wages are predetermined, unions will anticipate the effect of the target on the correlation between lower consumption and real money balances.

5 Determinants of employment and inflation. A quantitative assessment

In this section we calibrate the model and investigate the empirical relevance of our theoretical results. We begin modelling two hypothetical economies characterized by a similar macroeconomic performance but substantially different with regard to wage setting behaviour. Our aim here is to set baseline parameters consistent with the long run macroeconomic performance of the United States and Europe, that is, inflation and unemployment averages over the period 1960-2000, when both countries scored a 6% unemployment rate and the inflation rate amounted to 5% in the United States and to 4% in Europe.10 We believe that this experiment may be illuminating as, despite a similar macroeconomic performance, the two regions are characterized by substantial differences in their labor market institutions. This should highlight the potential role of large wage setters and contribute to a better understanding of the different reaction to macroeconomic shocks we observed in the two regions.

In calibrating the model we follow a three-step procedure. We first set some common parameters in line with those used in the literature; then we set the almost identical markups and the money scale parameter, \( \gamma \), necessary to meet the observed long run values of inflation and unemployment in the two economies; finally, we identify the different combinations in the degree of wage centralization and in the labor elasticity of substitution, parameters \( n \) and \( \sigma \) respectively, consistent with the markups and with the assumed differences in the two regional labor markets.11

We set the labor coefficient \( \alpha \) equal to 0.6, a discount rate (\( \beta \)) equal to 0.97, corresponding to a yearly long-term real interest rate of 3%; we set the

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10 In our exercise Europe should identify the "average" characterized by sovereign monetary policy and country specific labor market institutions. Despite obvious differences in these regard, we believe that European institutions share some features that strongly differentiate them from their US counterpart.

11 Admittedly, this model shares the widespread shortcoming that employment losses are defined as a gap in hours per worker. Strictly speaking there is no unemployment, per se. See Galí and Gertler (2007) for a discussion.
a labor supply elasticity \( (1/\phi) \) at 0.47,\(^\text{12}\) and determine the scale parameter of labor disutility \((\eta)\) to obtain a Pareto optimal level of employment equal to 1/3. We assume the money demand elasticity \((1/\varepsilon)\) to be 0.43.\(^\text{13}\) The smoothing consumption parameter \(\Delta\) is set equal to 1.\(^\text{14}\) Given these assumptions, the total markup \((\mu_\delta/\rho)\) necessary to obtain the 6% unemployment rate in the two countries amounts to 1.21. Finally, assuming discretionary monetary policy, we set the money parameters consistent with the average inflation rates observed in Europe \((\gamma = 0.47)\) and in the US \((\gamma = 0.56)\).\(^\text{15}\)

We now turn to the characterisation of labour market institutions. Observe that under the assumption of atomistic wage setters the wage markup amounts to \(\sigma\). In the literature, calibrated models typically assign to parameter \(\sigma\) a range of values between 5 and 21. In our framework, for any value of \(\sigma\), the presence of "large" wage setters plays a substantially disciplining role. In fact the wage mark up grows monotonically with \(n\), and we detect non-negligible effects for \(n \leq 100, 50, 40\) as \(\sigma\) takes the values of 5, 12, 21 (see Figure 1).

About here Figure 1

Turning to our calibration of the two regional labor markets, we set \(\frac{1}{n}\) at 4% in Europe, whereas we take half of it for the "United States", i.e. 2%. We thus set \(n\) equal to 25 for Europe and 50 for the United States.\(^\text{16}\) Correspondingly, the values for \(\sigma\) are 5 and 8 respectively.

The common and country-specific parameters of our benchmark are summarized by the following table.

<table>
<thead>
<tr>
<th>Table 1 – Parameters of our benchmark scenario</th>
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</thead>
<tbody>
<tr>
<td>Common parameters</td>
</tr>
<tr>
<td>Labor coefficient 0.6</td>
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<tr>
<td>Labor supply elasticity 0.47</td>
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<td>Non distorted employment 1/3</td>
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<tr>
<td>Money demand elasticity 0.43</td>
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<tr>
<td>Price markup 1.10</td>
</tr>
<tr>
<td>Specific country parameters</td>
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<tr>
<td>US</td>
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<tr>
<td>US</td>
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<tr>
<td>EU</td>
</tr>
<tr>
<td>Money scale parameter 0.56 0.47 Strategic wage setters 50 25</td>
</tr>
</tbody>
</table>

In our baseline calibration the wage markup is equal to 1.10.\(^\text{17}\)

\(^\text{12}\)Our results are robust to different reasonable specifications of labor supply elasticity. Evidence from microdata suggests a labor supply elasticity is mostly concentrated in the range of 0.05-0.6. See Card (1994) for a survey, and Mulligan (1998, 2002) for a discussion.

\(^\text{13}\)See e.g. Choi and Oh (2003), Dib (2004), Knell and Stix (2005) and references therein.

\(^\text{14}\)There is a controversy over the value of this parameter. Direct estimates suggest a value of \(\Delta\) between 2 and 10, but balanced-growth considerations lead the macro literature to a value of 1 (see Cooley and Prescott, 1995). As Gali et al. (2007) we use unity, opting to bias our parameterization against large efficiency costs (which is the less favorable case for obtaining our results, i.e. gains from the discretionary regime). Efficiency costs are, in fact, increasing in the coefficient of relative risk aversion, because this parameter also affects the steepness of the labor supply curve.

\(^\text{15}\)Note that the money scale parameters, which are endogenously determined, are close to those used by Christiano et al. (2005).

\(^\text{16}\)The number of unions affiliated to the AFL-CIO in the United States is about 50. In major countries of continental Europe the number of industry unions ranges from about 15 in Germany to about 40 in Italy. In Europe, however, industry unions are affiliated to different confederations whose action is partially coordinated. For a discussion see Visser (2007).

\(^\text{17}\)We also test the robustness of our results by considering two alternative scenarios where the parameters are the same as those reported in table 1, but the labor market elasticity of substitution \((\sigma)\) is chosen to obtain different wage markups: 1.05 and 1.15. The former is closer to the calibration for the United States of Christiano et al. (2005) whereas the latter to that of Gali et al. (2007).
To highlight the disciplining role of discretion when wage setters act strategically, we then compute (see table 2) the flexible wage solutions for the two regions, that is, unemployment and inflation rates that would obtain in these economies under the markup rule (20).

<table>
<thead>
<tr>
<th></th>
<th>United States</th>
<th>Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INF</td>
<td>UR</td>
</tr>
<tr>
<td>Flexible wages</td>
<td>6.3</td>
<td>7.1</td>
</tr>
<tr>
<td>Pre-determined wages</td>
<td>4.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Table 2 — Flexible vs. pre-determined wages

It is striking that substantial gains accrue even in the case of the US. We test the robustness of the result by assuming alternative labor market calibrations. We compute an alternative scenario for the United States, where the number of unions increases from 75 to 600.

<table>
<thead>
<tr>
<th></th>
<th>Flexible wages</th>
<th>Gains from discretion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of the</td>
<td>INF</td>
<td>UR</td>
</tr>
<tr>
<td>representative union</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3% (n = 75)</td>
<td>5.3</td>
<td>6.7</td>
</tr>
<tr>
<td>1% (n=100)</td>
<td>4.9</td>
<td>6.5</td>
</tr>
<tr>
<td>0.6% (n=150)</td>
<td>4.6</td>
<td>6.3</td>
</tr>
<tr>
<td>0.5% (n=200)</td>
<td>4.4</td>
<td>6.2</td>
</tr>
<tr>
<td>0.25% (n=400)</td>
<td>4.2</td>
<td>6.1</td>
</tr>
<tr>
<td>0.16% (n=600)</td>
<td>4.1</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Gains from discretion fall, but become negligible only for $n > 200$.

5.1 The effects of distorted central bank preferences

We measure the central bank’s activism in responding to the real wages (unemployment) as the difference between $\gamma$ and $\gamma_B$. As the activism of the central bank ($\gamma - \gamma_B$) increases, monetary policy becomes more reactive to wages. By contrast, if wages are pre-determined, an active central banker can discipline the unions by the inflation threat. Our simulations, however, sound a note of caution (figures 3 and 4). In fact the inflation effect of an increase in monetary activism relative to the benevolent case is highly non linear. Especially in the US case, falling short of $\gamma_B^*$ as defined in (33) might generate an excessive increase in inflation.

About here Figure 2 and 3

5.2 Inflation targeting

In this section we consider the effects of setting an inflation target, starting from the standard zero-inflation target typically adopted in the literature, Table 4 reports the unemployment differentials, relative to discretion, that arise as a consequence of the target.
Table 4 — Unemployment and inflation targeting

<table>
<thead>
<tr>
<th>Target</th>
<th>Benchmark calibration</th>
<th>Gains (vis-à-vis discretion)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US</td>
<td>EU</td>
</tr>
<tr>
<td>0%</td>
<td>5.1</td>
<td>7.9</td>
</tr>
<tr>
<td>2%</td>
<td>4.4</td>
<td>7.3</td>
</tr>
<tr>
<td>4%</td>
<td>3.9</td>
<td>6.8</td>
</tr>
<tr>
<td>6%</td>
<td>3.4</td>
<td>6.4</td>
</tr>
</tbody>
</table>

In the United States a 2% target substantially replicates the effects of discretion, whereas in Europe unemployment worsens. This is obviously due to the differential degree of wage centralization. In fact table 5 shows that when unions are sufficiently "small" the adoption of a positive target dominates discretion and implies significant gains.

Table 5 — Unemployment gains (vis-à-vis discretion)

<table>
<thead>
<tr>
<th>Non atomistic wage setters</th>
<th>Inflation target</th>
<th>75</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td>-0.6</td>
<td>-0.4</td>
<td>-0.2</td>
<td>-0.2</td>
<td>-0.1</td>
</tr>
<tr>
<td>2%</td>
<td></td>
<td>0.1</td>
<td>0.3</td>
<td>0.4</td>
<td>0.5</td>
<td>0.6</td>
</tr>
<tr>
<td>4%</td>
<td></td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>6%</td>
<td></td>
<td>1.1</td>
<td>1.3</td>
<td>1.5</td>
<td>1.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

In the United States positive inflation targeting improves on discretion, leading to a better result both in terms of inflation and of unemployment. By contrast, in Europe inflation targeting implies additional cost in terms of unemployment.

6 Disinflation and the labour market wedge, a re-interpretation of some facts

In this section we show that our theoretical results may offer a re-interpretation of some episodes. Consider for instance the post 1980 different performance in terms of unemployment rates between Europe and the United States (Figure 4).

About here Figure 4

The focus of researchers and policy makers was initially on the interaction between shocks and institutions. Blanchard and Wolfers (2000) argued that European institutions performed relatively well in the 60s, when unemployment was in fact lower than in the US, but proved unsuitable for the new, more turbulent macroeconomic following the oil shocks. This view was challenged in Nickell and Nunziata (2005), who identify a specific role of changing institutions such as employment protection, unemployment benefits, variation in union density changes. According to their estimates, changes in labour market institutions explain around 55% of the rise in European unemployment from the 1960s to the first half of the 1990s.

We offer a complementary interpretation based on the concept of monetary policy non-neutrality. Both in the US and in Europe, the turbulence of the 70s caused an adverse shift in inflation expectations. As documented in Clarida et al.
(1999). The early 80s marked a watershed in monetary policy, as central banks in OECD countries committed to a low inflation regime, regardless of other macroeconomic variables, such as growth and unemployment. Our approach suggests that this induced an adverse effect on the labor market wedge, and that such an effect was stronger in Europe, due to the particular importance of large wage setters.

The post-oil shock inflation averages for Europe and the United States are quite similar. The former experienced an inflation rate of 2.1% between 1982 and 2004 and in the latter inflation in the same period was 1.9%. We thus replicate our calibration experiment to obtain an inflation rate of 2% in both countries by changing the value of $\gamma_B$. To obtain an inflation rate of 2% we fix $\gamma_B$ equal to 0.7 in the United States and 0.76 in Europe (case 1). In order to check the robustness of results, we also consider two alternative policies: a reduction of 50% in the degree of activism degree (case 2)\(^\text{18}\) and $\gamma_B = 0.75$ in both countries (case 3).

In Table 6 we document the different unemployment consequences of an increase in central bank "conservatism" in the two regions according to our policy experiments. All cases imply a similar result: European disinflation has a higher cost in terms of unemployment.

<table>
<thead>
<tr>
<th>Case</th>
<th>INF</th>
<th>UR</th>
<th>INF</th>
<th>UR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1</td>
<td>2.0</td>
<td>6.2</td>
<td>2.0</td>
<td>7.5</td>
</tr>
<tr>
<td>Case 2</td>
<td>1.0</td>
<td>6.4</td>
<td>2.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Case 3</td>
<td>1.6</td>
<td>6.3</td>
<td>2.1</td>
<td>7.5</td>
</tr>
</tbody>
</table>

In our view this is line with the Nickell and Nunziata (2005) results. In fact, our model indirectly suggests that in a disinflation period large wage setters should become more "militant," i.e. union density should increase. Furthermore, the adverse changes in employment protection and unemployment benefits that contributed to raise unemployment could also be seen as the consequence of trade union pressure.

There is widespread consensus that, unlike Europe, trade unions play a limited role in the US. Recent macroeconomic models, however, assign a significant role to labour market imperfections in the the United States. Christiano et al. (2005) calibrate the wage markup at 1.05%, a figure that grows to 1.35% according to Galí et al. (2007). Mulligan (2002) constructs direct measures of labor-leisure distortions for the American economy during the period 1889-1996 and analyses the role of monopoly unionism, finding that it might explain a part of the Great Depression distortions, whereas the decline of unions might contribute to explain the reduced distortions in the 1980’s. In figure 5 we plot his estimates of the average union-non union wage gap for some subperiods, and the corresponding inflation rates.

**About here Figure 5**

We find the evidence quite suggestive and broadly consistent with the view that policy non neutralities might have played some role even in the United States.
States. Particularly striking is the surge in the wage gap during the Depression, when prices fell substantially, and the subsequent reversal during the post 1939 decade.

7 Concluding remarks

In contrast with popular wisdom, we suggest a reconsideration of the role of large wage setters and discretionary monetary policy. Instead of being the unpleasant by-product of imperfections, inflation plays a positive role when labor markets are characterized by large wage setters and product markets are imperfect.

In addition, our model provides a rationale for targeting a positive inflation rate based on a mechanism similar to that operating in the discretionary monetary regime, i.e. unions anticipate the negative effect of lower consumption on real money balances and then moderate wage claims. This effect is stronger the higher the inflation target.

Further research should be devoted to formal welfare analysis of an inflation targeting regime. Intuitively, the optimal inflation target will be between the Friedman deflationary rule and the positive inflation rate ensuring the achievement of the Pareto optimal employment, according to the agents’ preferences.

References


Figure 1 – Markups and non atomistic wage setters.

Figure 2 – Distorted preference in the United States.
Figure 3 – Distorted preference in Europe

Figure 4 – Unemployment rates in the United States and Europe.
Figure 5 – Estimated wage gap and inflation