UNIVERSITA' DEGLI STUDI DI ROMA "LA SAPIENZA"
DIPARTIMENTO DI STUDI GEOECONOMICI, LINGUISTICI, STATISTICI, STORICI PER L'ANALISI REGIONALE

Via del Castro Laurenziano, 9 – 00161 - ROMA
Tel. Amm.ne 064976433 – Tel. Biblioteca 064976220 – Tel. Segr.Didattica e Studenti 0649766240 – Fax 064957606

TREND INFLATION AS A WORKERS DISCIPLINING DEVICE IN A GENERAL EQUILIBRIUM MODEL

Giovanni Di Bartolomeo
Tirelli Patrizio
Nicola Acocella

Working Paper n°47
Settembre 2008

TREND INFLATION AS A WORKERS DISCIPLINING DEVICE IN A GENERAL EQUILIBRIUM MODEL

Giovanni Di Bartolomeo
Patrizio Tirelli
Nicola Acocella

Abstract. In New Keynesian models nominal rigidities determine socially inefficient outcomes. Our paper reverses this view: properly designed monetary policies may take advantage of predetermined nominal wages to discipline monopolistic wage setters. This, in turn, requires accepting a non-zero inflation rate. Discretionary monetary policy is effective when wage setters are non atomistic. Inflation targeting has real effects irrespective of the degree of labor market centralization.

JEL Classification: E52, E58, J51; E24
Keywords: Inflation bias, discretionary monetary policy, non-zero inflation targeting, unemployment, strategic wage setters.

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

Giovanni Di Bartolomeo
University of Teramo (gdibartolomeo@unite.it)

Patrizio Tirelli
University of Milan Bicocca (patrizio.tirelli@unimib.it)

Nicola Acocella
University of Rome La Sapienza (nicola.acocella@uniroma1.it)

September, 2008

Abstract

In New Keynesian models nominal rigidities determine socially inefficient outcomes. Our paper reverses this view: properly designed monetary policies may take advantage of predetermined nominal wages to discipline monopolistic wage setters. This, in turn, requires accepting a non-zero inflation rate. Discretionary monetary policy is effective when wage setters are non atomistic. Inflation targeting has real effects irrespective of the degree of labor market centralization.

Jel codes: E52, E58, J51; E24.

Keywords: inflation bias, discretionary monetary policy, non-zero inflation targeting, unemployment, strategic wage setters.

1 Introduction

New Keynesian models provide a new perspective on monetary policy, inflation and the business cycle, based on exogenous monopolistic distortions in the goods and labor markets. This literature, however, has little to say about long term inflation – typically assumed to be zero despite overwhelming empirical evidence of the contrary.

In this paper we derive inflation and labor market distortions as joint equilibrium outcomes of a game between the wage setters and the central bank. We do that by investigating the employment/output performance of alternative monetary policy regimes at different degrees of labor market decentralization. Thus

*The authors are grateful to P. Benigno, A. Cukierman, A. Dalmazzo, F. Giuli, S. Gnocchi, L. Lambertini, D. Soskice and participants at the EEA 2008 Congress of Milan (Bocconi), workshops on "Central Banks, fiscal policies and unionized labor markets: the role of different institutions" (University of Rome La Sapienza, February 2008) and on "Monetary policy and the business cycle" (University of Milano-Bicocca, September 2007) for useful comments on earlier drafts. We acknowledge financial support by MIUR (PRIN 2005). This research project has also been supported by a Marie Curie Transfer of Knowledge Fellowship of the European Community's Sixth Framework Programme under contract number MTKD-CT-014288.

our model accounts for both the relatively "large" trade unions typically associated to European labor markets in continental Europe and for the atomistic wage setters popularized in New Keynesian models.

Previous studies outside the New Keynesian literature[1] show that the monetary policy regime, typically characterized by the central bank degree of conservativeness (Cukierman, 2004), affects real variables when the labor market is relatively centralized. Policy non-neutrality is obtained imposing *ad hoc* objective functions for either the trade unions or the central bank, or both. Our contribution is based on the assumption that both the wage setters and the policymaker maximize a representative household's utility. Inflation costs therefore reflect preferences, technology and institutions, i.e. the features of the labor market. The new results presented in the paper are linked to the size of such costs.

A central tenet of the New Keynesian literature is that nominal rigidities determine socially inefficient outcomes. Our paper reverses this view: properly designed monetary policies may take advantage of predetermined nominal wages to discipline wage setters. This, in turn, requires accepting a non-zero inflation rate. Furthermore, the relative employment performance of a specific monetary policy regime is conditional to the degree of competition in the labor market.

Consider discretionary monetary policy. With respect to the case of flexible wages, the combination of predetermined wages and discretion leads to an inflationary equilibrium that partly disciplines "large" wage setters who anticipate the inflationary central bank response to distortions and the ensuing reduction of real money balances. Note that the strength of the disciplining effect is the same for any non-zero value of real money balances in the utility function. Thus, the widely popular practice of neglecting money balances when considering policy analysis is misleading if wage setters are non atomistic.

The analysis of inflation targeting is a key contribution of the paper. The adoption of non-zero inflation targets is increasingly popular among central bankers, but the justification for this policy is hardly found in standard DSGE models (Schmitt-Grohé and Uribe, 2004). In our framework, due to predetermined nominal wages and to the money-in-the-utility-function hypothesis, the cost to the wage setters from imposing monopolistic distortions is increasing in the target level. In fact they anticipate the negative impact of the wage markup on consumption and, in turn, on real money balances. Such an effect increases with the level of expected inflation, and unambiguously disciplines wage claims. The key difference with standard New Keynesian models is that the wage setters internalize the consequences of their choice for their own future money holdings. For this reason inflation targeting has real effects irrespective of the degree of labor market centralization.

We are also able to show that the model is consistent with a number of stylized facts concerning wage setting behavior, unemployment dynamics and central bank policies. First, the implied wage markup in our model is countercyclical (as documented in Galì *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 relatively high. Thus our analysis of

[1] See e.g. Cukierman and Lippi (1999), Soskice and Iversen (1998, 2000), Bratsiotis and Martin (1999), Guzzo and Velasco (1999), Lippi (2003), Coricelli *et al.* (2006).

discretionary inflation equilibria may be relevant beyond the boundaries of continental Europe. Third, the differential role of monetary policy non neutrality may explain the different unemployment dynamics in Europe and in the United States, 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 discretionary monetary policy. Section 5 considers inflation targeting. Section 6 concludes.

2 The model

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.[2] 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

$$U = \sum_{t=0}^{\infty} \beta^t \left(\ln C_{t,i} - \frac{\eta}{1+\phi} l_{t,i}^{1+\phi} + \frac{\gamma}{1-\varepsilon} \left(\frac{M_{t,i}}{P_t} \right)^{1-\varepsilon} \right) \tag{1}$$

where $\beta_t \in (0,1)$ is the intertemporal discount rate, $C_{t,i}$ is a consumption bundle, $l_{t,i}$ 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:

$$C_{t,i} + \frac{M_{t+1,i}}{P_{t,i}} + \frac{B_{t+1,i}}{P_t} = \frac{w_{t,i}}{P_t} l_{t,i} + \frac{M_{t,i}}{P_t} + \frac{\tau_t}{P_t} + \theta_t + R_t \frac{B_{t,i}}{P_t} \tag{2}$$

where $B_{t,i}$ denotes holdings of one-period bonds; $w_{t,i}$ is the nominal wage; τ_t is a lump-sum transfer from central bank profits, θ_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:

$$C_t = \left(\int_0^1 c_t(j)^{\rho} dj \right)^{\frac{1}{\rho}} \tag{3}$$

$$P_t = \left(\int_0^1 p_t(j)^{\frac{\rho}{\rho-1}} dj \right)^{\frac{\rho-1}{\rho}} \tag{4}$$

[2] Albanesi *et al.* (2003) obtain similar results.

[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:[4]

$$c_t(j) = C_t \left(\frac{p_t(j)}{P_t} \right)^{\frac{1}{\rho-1}} \tag{5}$$

$$C_t = \frac{1}{\beta} \frac{1}{R_{t+1}} \frac{P_{t+1}}{P_t} C_{t+1} \tag{6}$$

The money demand equation is

$$\frac{M_{t+1}}{P_t} = \left(\frac{P_t}{P_{t+1}} \right)^{\frac{1-\varepsilon}{\varepsilon}} \left(\frac{\gamma \beta C_t}{1 - R_{t+1}^{-1}} \right)^{\frac{1}{\varepsilon}} \tag{7}$$

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 ε denotes the inverse 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:[5]

$$y_t(j) = l_t(j)^{\alpha} \tag{8}$$

where

$$l_{t,j} = \left[\int_0^1 l_{t,j}(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}} \tag{9}$$

denotes a labour bundle and σ is the intra-temporal elasticity of substitution across different labor inputs.

The price is set as a markup, $\frac{1}{\rho}$, 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, subject to aggregation technology (9). Firm (j) demand for labor type (i) is

$$l_{t,j}(i) = \left(\frac{w_t(i)}{w_t} \right)^{-\sigma} l_{t,j} \tag{10}$$

where

$$w_t = \left[\int_0^1 w_t(i)^{1-\sigma} di \right]^{\frac{1}{1-\sigma}} \tag{11}$$

is the wage index.

Aggregating across firms we obtain

[4] Index i is dropped for simplicity.

[5] Capital is assumed fixed and normalized to unity.

$$Y_t = C_t = l_t^{\alpha} \tag{12}$$

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

$$l_t = \left(\frac{1}{\alpha\rho}\frac{w_t}{p_t}\right)^{-\frac{1}{1-\alpha}} \tag{14}$$

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 labour demand effect, due to the increase in the aggregate real wage. In fact, in the decentralized equilibrium each union (z) anticipates that[6]

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

2.4 Monetary policy

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

$$M_{t+1} - M_t = \tau_t \tag{16}$$

In the following we consider two policy regimes.

In the first regime the central bank maximizes

$$U_B = \sum_{t=0}^{\infty} \beta^t \left(\ln C_{t,i} - \frac{\eta}{1+\phi} l_{t,i}^{1+\phi} + \frac{\gamma_B}{1-\varepsilon}\left(\frac{M_{t,i}}{P_t}\right)^{1-\varepsilon}\right) \tag{17}$$

taking wages as given.

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 we differentiate between: *a)* $\gamma_B = \gamma$, which denotes the

[6] In the literature it is sometimes assumed that unions bargain over the *nominal* wage. In that case the union takes as given the *nominal* wage set by the other unions. Our 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 discussed in Lippi (2003), Coricelli *et al.* (2006) or Acocella *et al.* (2008).

standard case of *discretion*, where the central bank shares the representative household's preferences; *b)* $\gamma_B \neq \gamma$, the case of *distorted preferences,* which allows to replicate both Rogoff's (1985) *inflation-conservative* central banker ($\gamma_B > \gamma$) and Guzzo and Velasco's (1999) *populist* central banker ($\gamma_B < \gamma$).

The second regime we consider is commitment to a fixed money growth rate, m, i.e. commitment to an exogenous *inflation target* (Svensson, 1997).

3 Equilibrium employment under flexible wages

The flexible wages provide a benchmark case for our analysis of the game with pre-determined wages under the two monetary regimes above described.

In the case of flexible wages the central bank sets money supply and the unions choose wages simultaneously. As a result, monetary policy is neutral and there is a Barro-Gordon inflation bias.[7]

Regarding the employment determination, 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

$$0 = \frac{l_t\left[-(\sigma-1)(n-1)-\frac{\alpha}{1-\alpha}\right]}{C_t} + \eta\frac{l_t^{1+\phi}\left[\sigma(n-1)+\frac{1}{1-\alpha}\right]}{\bar{w}_t} \tag{18}$$

where subscripts z have been dropped since the symmetric equilibrium has been imposed.

This implies that

$$\bar{w}_t = \eta\mu l_t^{\phi} C_t \tag{19}$$

where:

$$\mu = \frac{\sigma(n-1)+(1-\alpha)^{-1}}{(\sigma-1)(n-1)+\alpha(1-\alpha)^{-1}} \tag{20}$$

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:

$$l_\mu = \left(\frac{\alpha\rho}{\eta\mu}\right)^{\frac{1}{1+\phi}} \tag{21}$$

Observe that $\mu\rho^{-1}$ denotes the labor and goods market wedge. The competitive (Pareto optimal) level of employment obtains if $\mu\rho^{-1} = 1$.

4 Pre-determined wages and discretionary monetary policy

When wages are pre-determined, the timing of the game is as follows. 1) Before the price level is known, trade unions must choose the nominal wage rate,

[7] If the central bank sets money supply before the unions choose wages, the monetary authorities anticipate that they cannot affect output and thus set the inflation bias equal to zero by following the Friedman rule (see Friedman, 1969).

$w_t = \bar{w}_t^e P_t^e$, where P_t^e is the rational expectation of the price level and $\bar{w}_t^e$ is the desired real wage rate. 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.[8] This is equivalent to assuming that inflation is the control variable. For expositional purposes we define the ex post real wage, employment and consumption as functions of inflation surprises

$$\frac{w_t}{P_t} = \frac{\bar{w}_t^e P_t^e}{P_t} = \bar{w}_t^e \frac{(1+\pi_t^e)}{(1+\pi_t)} \tag{22}$$

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

$$C_t = Y_t = \left(\frac{1}{\alpha\rho} \bar{w}_t^e \frac{1+\pi_t^e}{1+\pi_t} \right)^{-\frac{\alpha}{1-\alpha}} \tag{24}$$

where π_t, π_t^e denote inflation and its rational expectation, respectively.

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

$$\frac{\alpha}{1-\alpha} - \frac{\eta}{1-\alpha} l_t^{1+\phi} - \gamma \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} = 0 \tag{25}$$

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 choosing $\bar{w}_t^e$, i.e. the real wage that maximizes the expected value of (1) subject to (15), (22), (23), (24), (25).

Under rational expectations and imposing the symmetrical equilibrium, the first order condition is

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

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.

[8] In this model there is no state variable to link periods and the policy problem is time invariant; see Neiss (1999) for a discussion.

Equation (26) implies that

$$\bar{w}_t = \eta \mu_\delta l_t^\phi C_t \tag{27}$$

where

$$\mu_\delta = \frac{\sigma (n-1) + \frac{1}{1-\alpha} - \delta}{(\sigma - 1)(n-1) + \frac{\alpha}{1-\alpha}} = \mu - \frac{\delta}{(\sigma - 1)(n-1) + \frac{\alpha}{1-\alpha}} \tag{28}$$

Monetary policy is non-neutral because the 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 can discipline the wage setters. 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.

Indeed, the moderating effects of discretionary monetary policy are inversely related to the number of wage setters. In fact, the wage markup (28) grows monotonically with n and for $n \to \infty$ the atomistic markup $\frac{\sigma}{\sigma - 1}$ is obtained, but non-negligible effects can be detected also for large values of n, as shown in figure 1.[9]

About here Figure 1

We can now characterize equilibrium employment and inflation. The solution for equilibrium employment is:

$$l_\delta = \left(\frac{\alpha \rho}{\eta \mu_\delta} \right)^{\frac{1}{1+\phi}} > l_\mu \tag{29}$$

Substituting (7), (12), (29) into the central bank's first order condition (25) we get:

$$\pi = \beta - 1 + \underbrace{\left(\frac{1}{\gamma} \right)^{\frac{1}{\varepsilon - 1}} \left[\frac{\alpha}{1-\alpha} \left(1 - \frac{\rho}{\mu_\delta} \right) \right]^{\frac{\varepsilon}{\varepsilon - 1}} \beta l_\delta^\alpha}_{Bias} \tag{30}$$

4.1 A quantitative assessment

It is often argued that money matters theoretically but its impact is empirically negligible (McCallum, 2002; Ireland, 2004). Thus to gauge the potential relevance of our findings, namely the disciplining role of discretion *vis-à-vis* the flexible wage regime, we consider a numerical exercise referred to two economies where a different number of "large" unions operates.[10] For the sake of exposition we refer to the United States and Europe over the period 1960-2000. Over this period both countries scored a 6% unemployment rate and the inflation

[9] In the figure we plot the markup for some of the different values of σ normally used in the literature. α is set at 0.6. Observe that, for the parameterisation used in Figure 1 the flexible wage markup, μ, falls with the number of unions. When wages are predetermined, this effect is entirely reversed under monetary policy discretion.

[10] Ireland (1999) shows that the U.S. inflation-unemployment pattern is consistent with Barro and Gordon (1983) theory of time-consistent monetary policy.

rate amounted to 4% in the United States and to 5% in Europe. We proceed in two steps (see the appendix for details of calibrations). First we set the almost identical markups and the money scale parameter, γ, necessary to meet the observed long run values of inflation and unemployment in the two economies.[11] Then we identify the different combinations in the degree of wage centralization and in the labor elasticity of substitution, parameters n and σ respectively, consistent with the markups and with the assumed differences in the two regional labor markets. In our exercise "Europe" should identify the "average" European country ("EU" henceforth) characterized by sovereign monetary policy and country-specific labor market institutions.[12]

In Table 1 we present the gains from discretion, relative to the employment loss (EL)[13] and inflation rates (INF) that would obtain under the markup rule (20).

Table 1 – Flexible vs. pre-determined wages

	US		"EU"	
	INF	EL	INF	EL
Flexible wages	4.9	6.5	14.2	9.8
Pre-determined wages	4.0	6.0	5.0	6.0

It is striking that substantial gains accrue even in the case of the United States. We test the robustness of the result by assuming alternative labor market calibrations (see Table 2).

Table 2 – Alternative (labour market) calibrations for the United States

	Flexible wages		Gains of discretion	
Size of the representative union	INF	EL	INF	EL
0.6% (n=150)	4.6	6.3	0.6	0.3
0.5% (n=200)	4.4	6.2	0.4	0.2
0.25% (n=400)	4.2	6.1	0.2	0.1
0.16% (n=600)	4.1	6.0	0.1	0.0

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

4.2 The effects of distorted central bank preferences

We now consider the case of *distorted* central bank's preferences. Straightforward manipulations show that equilibrium employment amounts to

$$l_\gamma = \left(\frac{\alpha\rho}{\eta\mu_\gamma} \right)^{\frac{1}{\phi+1}} \tag{31}$$

where

$$\mu_\gamma = \frac{\sigma\,(n-1) + \frac{1}{1-\alpha} - \delta\frac{\gamma}{\gamma^B}}{(\sigma-1)\,(n-1) + \frac{\alpha}{1-\alpha}} \tag{32}$$

[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 Galì and Gertler (2007) for a discussion.

[12] Despite obvious differences, we believe that European institutions share some features that strongly differentiate them from their US counterpart.

[13] The employment loss is defined as the deviation from the Pareto optimal equilibrium.

Thus by setting

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

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 γ_B is low.

Our simulations, however, sound a note of caution. In Figure 2 we describe the effects of central bank's conservatism (defined as $\gamma_B - \gamma$) on inflation and employment loss.

About here Figure 2

The Pareto optimum is achieved for $\gamma_B = \gamma_B^*$, but small deviations from this value[14] lead to catastrophic losses because of the non linearity of inflation.[15]

5 Pre-determined wages and inflation targeting

5.1 Derivation of the wage markup

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 precommits to a constant growth rate of nominal money balances, m. In our framework, this is equivalent to setting an inflation target. The union now maximizes (1) subject to (7). Imposing rational expectations ($\pi^e = m$ and $P_t^e = P_t$), the latter becomes[16]

$$\frac{M_{t,i}}{P_t^e} = \left(\frac{\gamma\beta C_{t,i}^e}{1+m-\beta}\right)^{\frac{1}{\varepsilon}} \tag{34}$$

Unions anticipate that real money balances will fall due to the adverse effect of the wage choice on consumption. Formally, the union's first order condition in the symmetric equilibrium is:

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

where the adverse effect is measured by:

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

which is increasing in m.[17]

[14] These could occur because of shocks or imperfect information about the model parameters. Both features can be easily included in our framework.

[15] For more details on the figure see the Appendix.

[16] Equation (34) has been obtained using the Euler equation (6) under the expectation that $C_t = C_{t+1}$.

[17] Recall that $\varepsilon > 1$ for the marginal cost of inflation to be positive.

Straightforward manipulations show that

$$\bar{w}_t = \eta \mu_m l_t^{\phi} C_t \tag{36}$$

where:

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

The effects of the target are clearly summarized by δ_m.

5.2 The rationale for effectiveness of monetary policy

By comparing μ_m to μ, i.e. inflation targeting and the flexible-wage cases, the moderation effect of the former is clear. Even though the benefit of monetary discretion is now lost, the inflation target still disciplines wage claims.

The rationale is as follows. 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 and the central bank adopts an inflation targeting strategy, real money balances fall due to the adverse effect of the wage choice on consumption. Unions anticipate this effect and reduce real wages inducing agents to work more, thus increasing real money balances and consumption. As the inflation target increases, the moderation effect is stronger.

The size of moderation clearly depends on δ_m. A striking result is that the target has a disciplining effect even in the limiting case of monopolistic competition, due to the anticipated impact of wage claims on money holdings (see equation (35)).

To support intuition, it is worth emphasizing the key difference relative to standard New Keynesian models incorporating nominal rigidities. In our framework the wage choice is antecedent to consumption, employment and money demand realizations, whereas under Calvo's wage setting rule all these variables obtain simultaneously to the optimizing wage setter's decision.

In the following figure we describe the effects of changes in γ and n on the employment loss associated to a 2% inflation target.

About here Figure 3

Unlike the case of discretion, now the employment loss is highly sensitive to changes in γ, whereas changes in the number of wage setters do not significantly affect the results.

5.3 Inflation targeting vs. discretion

Both discretionary policy and inflation targeting tend to discipline wage setters (see equations (28) and (36)). However wage moderation is driven by different forces in the two regimes. The former works through the inflation threat in response to wage claims. The latter acts on the benefit of holding money and depends on the commitment to a higher rate of inflation, which in turn will be implemented by the credible central bank.

In other words, discretion disciplines unions by the fear that the central bank will inflate after real wage expansions. By contrast, in the inflation targeting regime, the central bank credibly promises to hold inflation at the target. This disciplines the unions because the target affects the marginal utility of real money balances. As a result wage setters increase consumption by working more.

Under discretion, the wage markup is moderated by unions' anticipation of the central bank's reaction and thus is inversely related to the number of unions, fading away when this becomes very large. The effect is independent of the real money balance weight (γ), even if distorted preferences can affect the outcomes. The contrary is true for inflation targeting, which instead holds also in the case of perfectly monopolistic unions.

Table 3 reports calibrations of the employment loss differentials associated to inflation targeting, relative to discretion, that arise as a consequence of the target, starting from the standard zero-inflation target, typically adopted in the literature.[18]

Table 3 – Differences in employment loss

	Non-atomistic wage setters						
Inflation target	20	25	50	75	100	200	300
0%	-5.1	-1.9	0.8	1.2	1.4	1.7	1.9
2%	-4.5	-1.3	1.4	1.9	2.1	2.4	2.5
4%	-4.0	-0.8	1.9	2.4	2.6	2.8	2.9
6%	-3.6	-0.4	2.3	2.8	3.0	3.3	3.4

For a small number of wage setters inflation targeting implies a worse performance than discretion, and *vice versa*.[19] Employment gains increase in the level of the target.

The employment gain in setting a higher inflation target is also sensitive to the value of ε. As depicted in Table 4, for each target the gains (with respect to zero inflation target) increase with ε.[20]

Table 4 – Employment gains (%) with respect to zero targeting

Inflation target	Inverse money elasticity (ε)								
	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2
2%	0.87	0.82	0.76	0.70	0.64	0.59	0.55	0.51	0.47
4%	1.53	1.45	1.36	1.26	1.16	1.08	1.01	0.94	0.88
6%	2.06	1.99	1.87	1.75	1.63	1.52	1.42	1.33	1.25

5.4 Post-1980 disinflation and the labour market wedge

In this section we show that our emphasis on the role of "large" wage setters may offer a re-interpretation of the post 1980 different unemployment performance between Europe and the United States (Figure 4).

[18] In order to isolate the effects of the unionization from those arising from the inflation targeting, the table is built by calibrating the model to obtain in the discretionary equilibrium an unemployment rate equal to 6% and an inflation rate equal to 4% independent of the number of unions. See the Appendix for details.

[19] An increase in the number of wage setters: an increase in the number of unions has a very small effect on the employment loss of the targeting regime, but it strongly reduces the moderation effect under discretion.

[20] In our benchmark we have assumed $\varepsilon = 2.3$.

About here Figure 4

To explain these facts, Blanchard and Wolfers (2000) argued that European institutions performed relatively well in the 60s, when unemployment was in fact lower than in the United States, but proved unsuitable for the new, more turbulent macroeconomic environment following the oil shocks. This view was challenged in Nickell *et al.* (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 United States 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. 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 in both countries an inflation rate of 2% by changing the value of γ_B. To obtain an inflation rate of 2% we fix γ_B equal to 0.7 in the United States and 0.76 in "EU" (case 1).

As a robustness check, we also consider two alternative policies: a 50% increase in γ_B (case 2) and $\gamma_B = 0.75$ in both countries (case 3).

In Table 5 we document the different unemployment consequences of an increase in central bank "conservatism" in the two regions. All cases imply a similar result: European disinflation has a higher cost in terms of unemployment.

Table 5 – Deflationary policy shift

	US		EU	
	INF	EL	INF	EL
Case 1	2.0	6.2	2.0	7.5
Case 2	1.0	6.4	2.4	7.3
Case 3	1.6	6.3	2.1	7.5

In our view this is line with the Nickell *et al.* (2005) results. In fact, our model indirectly suggests that in a disinflation period large wage setters should become more "militant," i.e. union activism should increase.[21] Furthermore, the adverse changes in employment protection and unemployment benefits that contributed to raise unemployment could also be seen as the consequence of trade unions pressure.

6 Concluding remarks

In contrast with popular wisdom, we suggest a reconsideration of inflationary equilibria. Instead of being the unpleasant by-product of imperfections, inflation

[21] An emblematic cases of unions' activism in the 80s are the Netherlands and Ireland (see Ebbinghaus and Visser, 1997, Freeman, 2007).

plays a positive role in disciplining wage claims. Properly designed monetary policies may take advantage of predetermined nominal wages to discipline monopolistic wage setters. This, in turn, requires accepting a non-zero inflation rate. Discretionary monetary policy is effective when wage setters are non atomistic, but inflation targeting has real effects irrespective of the degree of labor market centralization.

Our results strongly support the European Central Bank choice of a positive inflation target. In fact, with "relatively small" wage setters an inflation targeting regime is preferable to a discretionary monetary policy. Since there is little doubt that EMU has diluted the impact of wage choices of individual trade unions on central bank policy, this may explain why the ECB has repeatedly insisted on her commitment to 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.

Appendix

In this section we calibrate the model and investigate the quantitative relevance of our theoretical results. We begin by modelling two hypothetical economies characterized by a similar macroeconomic performance but substantially different with regard to wage-setting behavior. We set baseline parameters consistent with the long run macroeconomic performance of the United States and Europe, in terms of inflation and unemployment averages over the period 1960-2000. Considering the former as a case of a country with a low union density and the latter as a case of a more unionized area.[22] In our exercise "Europe" should then be identified as an "average" European country ("EU" henceforth). Both regions scored a 6% unemployment rate; the inflation rate amounted to 5% in the United States and to 4% in Europe.

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, γ, 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 σ respectively, consistent with the markups and with the assumed differences in the two regional labor markets.[23]

We set the labor coefficient α at 0.6, the discount rate (β) at 0.97, corresponding to a yearly long-term real interest rate of 3%, the labor supply elasticity ($1/\phi$) at 0.47;[24] and determine the scale parameter of labor disutility

[22] In the US the number of unions affiliated to the *AFL-CIO* in the United States is about 50-60. In major countries of continental Europe the number of industy unions ranges from about 15 in Germany to about 40 in Italy. In Europe, however, industry unions are heterogeneously affiliated to different confederations and thus their action is partially coordinated. See Rhodes (2001), Visser (2002, 2007).

[23] As said in the main text, in this model employment losses are defined as a gap in hours per worker.

[24] 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

(η) to obtain a Pareto optimal level of employment equal to 1/3. We assume the money demand elasticity ($1/\varepsilon$) to be 0.43.[25] Given these assumptions, the total markup (μ_δ/ρ) 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 United States ($\gamma = 0.56$).[26]

Turning to our calibration of the two regional labor markets, we set n at 25 for the "EU" and 100 for the United States. Correspondingly, the values for σ are 5 and 9.6 respectively.

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

Table 5 – Parameters of our benchmark scenario

Common parameters					
Labor coefficient	0.6		Discount rate	0.97	
Labor supply elasticity	0.47		Money demand elasticity	0.43	
Non distorted employment	1/3		Price markup	1.10	
Specific country parameters	US	"EU"		US	"EU"
Money scale parameter	0.56	0.47	Strategic wage setters	100	25

In our baseline calibration the wage markup is equal to 1.10.[27] In Figure 2, we have also considered the intermediate case of $n = 50$ (with σ equal to 8).

In Table 3 we isolate the effects of the unionization from those arising from the inflation targeting; given the degree of unionization (n), σ and γ are thus chosen to obtain 4% inflation and 6% unemployment; then in each column the effect of the targeting is compared. The table is calibrated for the case of $n = 100$, i.e. the "US".

Technical appendix

We have also checked the robustness of our results (by computing the flexible wage, discretionary and inflation targeting equilibrium) with respect to other standard functional forms for the agents' preferences. In particular, we solve our model by considering a more general functional form for agents' utility function by assuming that the representative household (i) maximizes the following utility function

$$U = \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{t,i}^{1-\Delta}}{1-\Delta} - \frac{\eta}{1+\phi} l_{t,i}^{1+\phi} + \frac{\gamma}{1-\varepsilon} \left(\frac{M_{t,i}}{P_t} \right)^{1-\varepsilon} \right) \tag{38}$$

range of 0.05-0.6. See Card (1994) for a survey. and Mulligan (1998, 2002) for a discussion.

[25] See e.g. Choi and Oh (2003), Dib (2004), Knell and Stix (2005) and references therein.

[26] Note that the money scale parameters, which are endogenously determined, are close to those used by Christiano *et al.* (2005).

[27] We also test the robustness of our results by considering two alternative scenarios where the parameters are the same as those reported in table 5, but the labor market elasticity of substitution (σ) 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 tha latter to that of Gali *et al.* (2007).

The standard first order conditions for consumption are:[28]

$$c_t(j) = C_t \left(\frac{p_t(j)}{P_t} \right)^{\frac{1}{\rho-1}} \tag{39}$$

$$C_t^{\Delta} = \frac{1}{\beta} \frac{1}{R_{t+1}} \frac{P_{t+1}}{P_t} C_{t+1}^{\Delta} \tag{40}$$

The money demand equation is

$$\frac{M_{t+1}}{P_t} = \left(\frac{P_t}{P_{t+1}} \right)^{\frac{1-\varepsilon}{\varepsilon}} \left(\frac{\gamma \beta C_t^{\Delta}}{1 - R_{t+1}^{-1}} \right)^{\frac{1}{\varepsilon}} \tag{41}$$

Agent faces a trade-off between t period consumption and $t+1$ period holdings of nominal money balances.

The firms optimization problem is unaffected by considering (38). Instead, the same it is not true for the unions and the central bank, as each union maximizes members' lifetime utility (38) subject to the budget constraint (2) and to labor demand for all union's members.

Under flexible wages each union chooses the real wage, $\bar{w}_t(z)$, that maximizes (38), taking real money balances as given and subject to the budget constraint (2). In addition, each union (z) anticipates that $\frac{\partial w_t}{\partial w_t(z)} = n^{-1} \left(\frac{w_t(z)}{w_t} \right)^{-\sigma}$. The trade union first order condition is

$$0 = \frac{l_t \left[-(\sigma - 1)(n-1) - \frac{\alpha}{1-\alpha} \right]}{C_t^{\Delta}} + \eta \frac{l_t^{1+\phi} \left[\sigma (n-1) + \frac{1}{1-\alpha} \right]}{\bar{w}_t} \tag{42}$$

where subscripts z have been dropped since the symmetric equilibrium has been imposed.

This implies that

$$\bar{w}_t = \eta \mu l_t^{\phi} C_t^{\Delta} \tag{43}$$

where:

$$\mu = \frac{\sigma (n-1) + (1-\alpha)^{-1}}{(\sigma - 1)(n-1) + \alpha (1-\alpha)^{-1}} \tag{44}$$

denotes the wage mark-up under flexible wages. Observe that μ is consistent with alternative labor market regimes as mentioned in the main text.

Using (14) and the goods market clearing condition $C_t = Y_t$ equilibrium employment is:

$$l_{\mu} = \left(\frac{\alpha \rho}{\eta \mu} \right)^{\frac{1}{1+\phi+\alpha(\Delta-1)}} \tag{45}$$

Observe that the competitive (Pareto optimal) level of employment obtains when the gross markup is equal to one, i.e. $\mu \rho^{-1} = 1$.

Now assume that wages are pre-determined, The central bank maximizes:

$$U_B = \sum_{t=0}^{\infty} \beta^t \left(\frac{C_{t,i}^{1-\Delta}}{1-\Delta} - \frac{\eta}{1+\phi} l_{t,i}^{1+\phi} + \frac{\gamma_B}{1-\varepsilon} \left(\frac{M_{t,i}}{P_t} \right)^{1-\varepsilon} \right)$$

[28] Index i is dropped for simplicity.

with respect to M_{t+1}, taking wages as given.

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

$$\frac{\alpha}{1-\alpha} C_t^{1-\Delta} - \frac{\eta}{1-\alpha} l_t^{1+\phi} - \gamma \left(\frac{M_t}{P_t} \right)^{1-\varepsilon} = 0 \tag{46}$$

The trade union problem is solved by choosing the expected real wage that maximizes the expected value of (38) subject to (46).

Under rational expectations, the first order condition is

$$\frac{l_t \left[(\sigma - 1)(n-1) + \frac{\alpha}{1-\alpha} + \delta \frac{\alpha(\Delta-1)}{\rho(1+\phi)} \right]}{C_t^{\Delta}} = \eta \frac{l_t^{\phi+1} \left[\sigma(n-1) + \frac{1}{1-\alpha} - \delta \right]}{\bar{w}} \tag{47}$$

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 (47) implies that

$$\bar{w}_t = \eta \mu_\delta l_t^{\phi} C_t^{\Delta} \tag{48}$$

where[29]

$$\mu_\delta = \frac{\sigma(n-1) + \frac{1}{1-\alpha} - \delta}{(\sigma - 1)(n-1) + \frac{\alpha}{1-\alpha} + \delta \frac{\alpha(\Delta-1)}{\rho(1+\phi)}} < \mu \tag{49}$$

The corresponding equilibrium employment is:

$$l_\delta = \left(\frac{\alpha\rho}{\eta\mu_\delta} \right)^{\frac{1}{\phi+1+\alpha(\Delta-1)}} > l_\mu \tag{50}$$

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. This result holds for any positive – even small – value of real money balances in the utility function.

Equilibrium inflation is easily obtained as:

$$\pi = \beta - 1 + \underbrace{\left(\frac{1}{\gamma} \right)^{\frac{1}{\varepsilon-1}} \left[\frac{\alpha}{1-\alpha} \left(1 - \frac{\rho}{\mu_\delta} \right) \right]^{\frac{\varepsilon}{\varepsilon-1}} \beta l_{\mu_\delta}^{\frac{\alpha(\varepsilon-\Delta)}{\varepsilon-1}}}_{Bias} \tag{51}$$

[29] Note that $\mu_\delta < \mu$ because $\Delta \geq 1$. When $\delta > \frac{n}{1+\alpha(\Delta-1)(1+\phi)^{-1}}$ the gross wage markup may well fall below one! To completely remove distortions, including the effects of monopolistic competition in the goods markets, we need $\frac{\rho}{\mu_\delta} = 1$, that is $\delta = \delta^* = \frac{n + [\sigma(n-1) + (1-\alpha)^{-1} - n](1-\rho)}{1+\alpha(1-\Delta)(1+\phi)^{-1}}$

It is easy to verify that optimal delegation implies:

$$\gamma_B = \gamma_B^* = \frac{\gamma\delta\left(1+\alpha\left(\Delta-1\right)\left(1+\phi\right)^{-1}\right)}{n+\left[\sigma\left(n-1\right)+\left(1-\alpha\right)^{-1}-n\right]\left(1-\rho\right)} \tag{52}$$

By considering (52), similar results of those described in the main text hold.

Finally we consider the inflation targeting assuming that the central bank pre-commits to a constant growth rate of nominal money balances, m. The union now maximizes (38) subject to the money demand condition (41). Imposing rational expectations ($\pi^e = m$), the latter becomes

$$\frac{M_{t,i}}{P_t} = \left(\frac{\gamma\beta C_{t,i}^{\Delta}}{1+m-\beta}\right)^{\frac{1}{\varepsilon}} \tag{53}$$

Unions anticipate that real money balances will fall due to the adverse effect of the wage choice on consumption:

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

where:

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

Straightforward manipulations show that

$$\bar{w}_t = \eta\mu_m l_t^{\phi} C_t^{\Delta} \tag{54}$$

where:

$$\mu_m = \frac{\sigma\left(n-1\right)+\frac{1}{1-\alpha}}{\left[\left(\sigma-1\right)\left(n-1\right)+\frac{\alpha}{1-\alpha}\right]\left(1+\delta_m\right)} \tag{55}$$

Similar results of those described in the main text hold.

Further results obtained by using numerical simulations are available upon request.

References

Acocella, N., G. Di Bartolomeo, and D.A. Hibbs (2008), "Labor market regimes and monetary policy," *Journal of Macroeconomics,* 30: 134-156.

Albanesi, S. and V.V. Chari (2003), "Expectation traps and monetary policy," *Review of Economic Studies*, 70: 715-741.

Barro, R.J. and D.B. Gordon (1983), "A positive theory of monetary policy in a natural rate model," *Journal of Political Economy*, 91: 589-610.

Blanchard, O. and J. Wolfers, (2000), "The role of shocks and institutions in the rise of European unemployment: the aggregate evidence," *Economic Journal*. 110: 1-33

Bratsiotis, G. and C. Martin (1999), "Stabilisation, policy targets and unemployment in imperfectly competitive economies," *Scandinavian Journal of Economics*, 101: 241-256.

Card, D. (1994), "Intertemporal labor supply: An assessment," in Sims C. (ed.), *Advances in Econometrics*, Vol. II, Cambridge, Cambridge University Press: 40-78.

Choi, W.G. and S. Oh (2003), "A money demand function with output uncertainty, monetary uncertainty, and financial innovations," *Journal of Money, Credit and Banking*, 35: 685-709.

Christiano, L.J., M. Eichenbaum, and C. Evans, (2005), "Nominal rigidities and the dynamic effects of a shock to monetary policy," *Journal of Political Economy*, 113: 1-45.

Clarida R., J. Galì, and M. Gertler (1999), "The science of monetary policy," *Journal of Economic Literature*, 37: 1661-1707.

Coricelli, F., A. Cukierman, and A. Dalmazzo (2006), "Monetary institutions, monopolistic competition, unionized labor markets and economic performance," *Scandinavian Journal of Economics*, 108: 39-63.

Corsetti G. and P. Pesenti (2001), "Welfare and macroeconomic interdependence," *Quarterly Journal of Economics*, 116: 421-446.

Cukierman, A. (2004), "Monetary institutions, monetary union and unionized labor markets – Some recent developments," in Beetsma, R., C. Favero, A. Missale, V.A. Muscatelli, P. Natale, and P. Tirelli (eds.), *Monetary policy, fiscal policies and labour markets: Key aspects of macroeconomic policymaking in EMU*, Cambridge, Cambridge University Press.

Cukierman, A. and F. Lippi (1999), "Central bank interdependence, centralization of wage bargaining, inflation and unemployment – Theory and evidence," *European Economic Review*, 43: 1395-1434.

Dib, A. (2004), "Nominal rigidities and monetary policy in Canada," *Journal of Macroeconomics*, 28: 303–325.

Ebbinghaus, B. and J. Visser (1997), *A Dutch miracle*, Amsterdam, Amsterdam University Press.

Erceg, C., D. Henderson, and A. Levin (2000), "Optimal monetary policy with staggered wage and price contracts," *Journal of Monetary Economics*, 46: 282-313.

Freeman R.B. (2007), "Searching for the EU social dialogue model," in Acocella N., Leoni R. (eds.), *Social pacts, employment and growth: Essay in honor of Ezio Tarantelli*, Berlin, Physica-Verlag.

Friedman, M. (1969), "The optimum quantity of money," in *The optimum quantity of money and other essays*. Chicago, Aldine.

Galì J. and M. Gertler (2007), "Macroeconomic modeling for monetary policy evaluation," NBER Working Paper 13542.

Galì J., M. Gertler, and J.D. Lòpez-Salido (2007), "Markups, gaps, and the welfare costs of business fluctuations," *The Review of Economics and Statistics*, 89: 44-59.

Guzzo, V. and A. Velasco (1999), "The case for a populist central banker," *European Economic Review*, 43: 1317-1344.

Ireland, P.N. (1999), "Does the time-consistency problem explain the behavior of inflation in the United States?," *Journal of Monetary Economics*, 44: 279-292.

Ireland, P.N. (2004), "Money's role in the monetary business cycle," *Journal of Money, Credit and Banking* 36: 969-983.

Knell, M. and H. Stix (2005), "The income elasticity of money demand: A meta-analysis of empirical results," *Journal of Economic Surveys*, 19: 513-533.

Lippi, F. (2003), "Strategic monetary policy with non-atomistic wage setters," *Review of Economic Studies*, 70: 909-919.

McCallum, B. (2002), "Recent developments in monetary policy analysis: The roles of theory and evidence," *FRB Richmond - Economic Review*, 88: 67-96.

Mulligan, C.B. (1998), "Substitution over time: Another look at life-cycle labor supply," in B. Bernanke and J. Rotemberg (eds.), *NBER Macroeconomic Annual*, The MIT Press, Cambridge:

Mulligan, C.B. (2002), "A century of labor-leisure distortions," NBER Working Paper No. 8774.

Neiss, K.S. (1999), "Discretionary inflation in a general equilibrium model," *Journal of Money, Credit, and Banking*, 31: 357-374.

Nickell S., L. Nunziata, and W. Ochel (2005), "Unemployment in the OECD since the 1960s. What do we know?," *The Economic Journal*, 115: 1-27.

Rhodes, M. (2001), "The political economy of social pacts: 'Competitive corporatism' and European welfare reform," in *The new politics of the welfare state*, Oxford, Oxford University Press: 165-194.

Rogoff, K. (1985), "The optimal degree of commitment to an intermediate monetary target," *Quarterly Journal of Economics*, 100: 1169-1190.

Schmitt-Grohé, S. and M. Uribe (2004), "Optimal fiscal and monetary policy under sticky prices," *Journal of Economic Theory*, 114: 198-230.

Soskice, D. and T. Iversen (1998), "Multiple wage-bargaining systems in a single European currency area," *Oxford Review of Economic Policy*, 14: 110-124.

Soskice, D. and T. Iversen (2000), "The nonneutrality of monetary policy with large price or wage setters," *Quarterly Journal of Economics*, 115: 265-284.

Svensson, L.E.O. (1997), "Optimal inflation targets, 'conservative' central banks, and linear inflation contracts," *American Economic Review*, 87: 98-114.

Visser, J. (2002), "Unions, wage bargaining and co-ordination in European labour markets," in Pochet Ph. (ed.), *Wage and policy in the Eurozone*, Bruxelles, P.I.E. Peter Lang.

Visser, J. (2007), "Wage bargaining institutions in Europe. A happy marriage or preparing for divorce?," in Acocella N., Leoni R. (eds.), *Social pacts, employment and growth: Essays in honor of Ezio Tarantelli*, Berlin, Physica-Verlag.

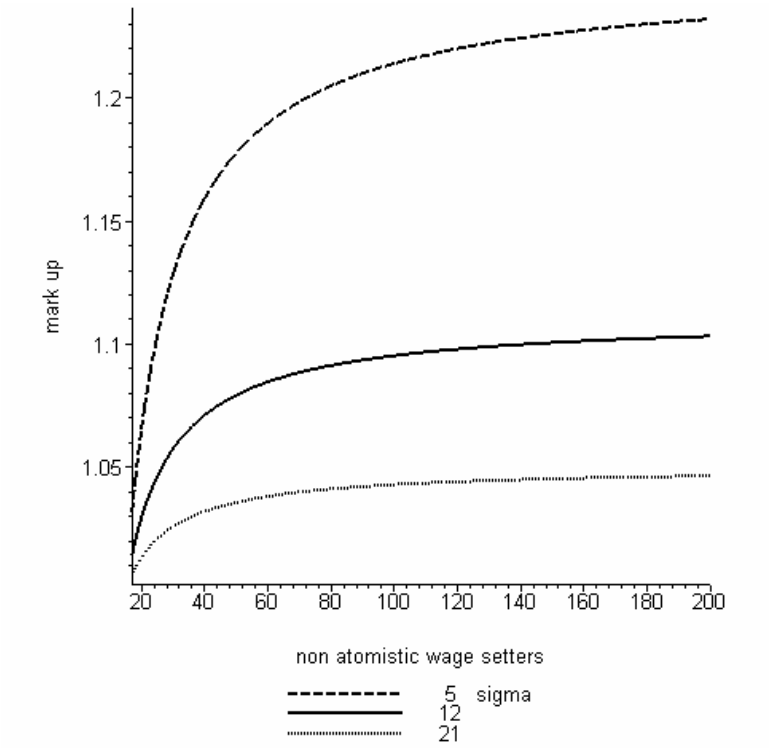

Figure 1 – Markups and non atomistic wage setters.

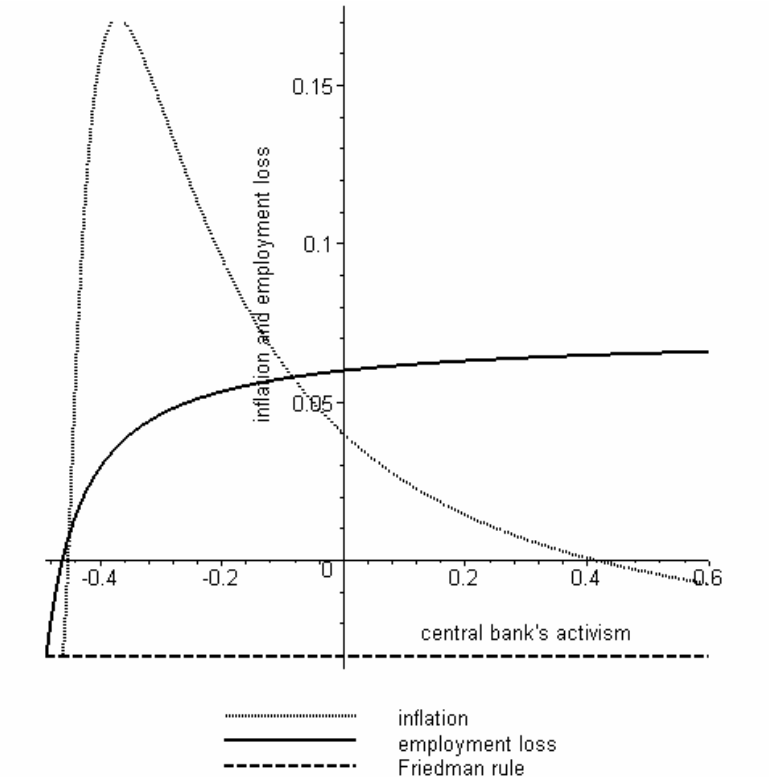

Figure 2 – Distorted preference (n = 50).

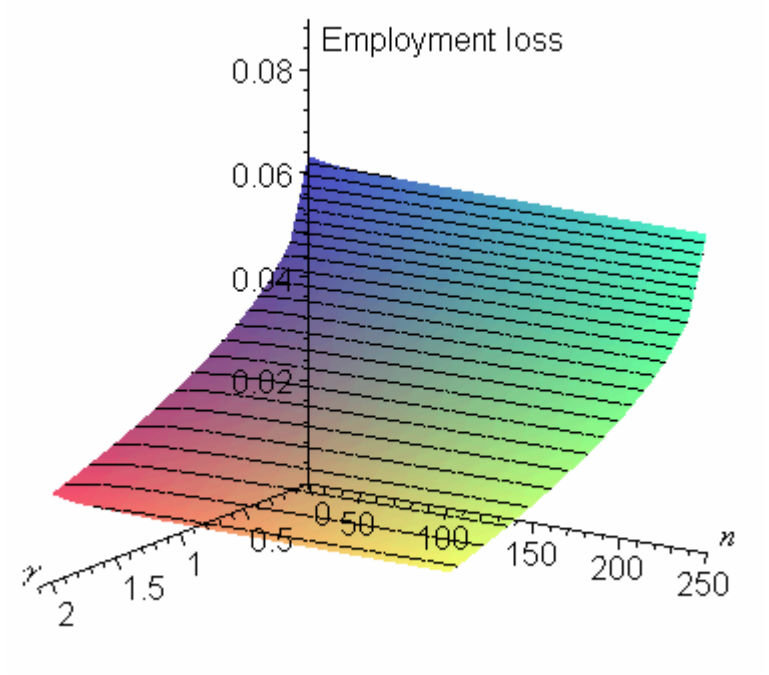

Figure 3 – Inflation targeting and parameters.

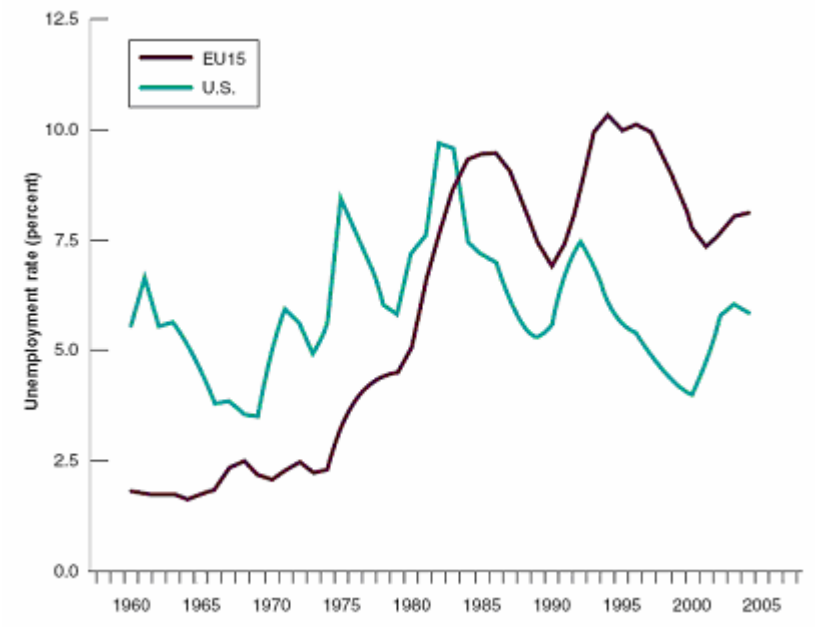

Figure 4 – Unemployment rates in the United States and Europe.