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Labor Market Institutions and the Effects of Monetary Policy

Consider two Labor Market Institutional Regimes; in each regime labor unions have “monoply” wage setting power:

1. “**Rigid**”: Unions contract nominal wages in advance for at least one period (long-term contracting). They internalize the central bank’s known reaction to their wage policies.
2. “**Flexible**”: Unions do not sign binding contracts, and are able to adjust wages in every period. Both unions and the monetary authority interact simultaneously, taking realizations of m (money) and w_i (nominal wages), respectively, as given.

Under both flexible and rigid wage settings, firms are ‘super leaders’ whose price setting behavior incorporates realizations of wages and the money supply, perceived by backward induction of solutions to the (deterministic) optimal programs of unions and the central bank.

Graphically, the sequences of moves is:

Unions → Central Bank (“Stackelberg”) → Firms

Unions & Central Bank (“Nash”) → Firms

A Boiler Plate Economy

(lower case letters denote logs of corresponding upper case letters)

- There are n unions of equal size, and a continuum of monopolistic firms of mass one, each producing a differentiated good or service.
- Wages are set by unions which are indexed by i . All firms associated with union in wage bargaining are indexed by ij .

Output Technology:

$$Y_{ij} = L_{ij}^{\alpha} \quad \alpha \in (0,1)$$

Profit function:

$$\Pi_{ij} = \frac{P_{ij}}{P} Y_{ij}^d - \frac{W_i}{P} L_{ij}$$

Firm level demand:

$$Y_{ij}^d = \left(\frac{P_{ij}}{P} \right)^{-\eta} \frac{M}{P}, \quad \eta > 1, \quad \frac{M}{P} = \text{Aggregate Demand}$$

Under **monopolistic competition** firms set price by equating marginal revenue to marginal cost, giving **firm price** and **labor demand** as

$$p_{ij} - p = \theta [(1 - \alpha)(m - p) + \alpha(w_i - p)]$$

$$l_{ij}^d = \theta [m - p - \eta(w_i - p)],$$

$$\theta = \frac{1}{\alpha + \eta(1 - \alpha)} > 0$$

It follows that **union-level unemployment** is proportional to:

$$U_i = \theta [\eta(w_i - p) - (m - p)].$$

The foregoing imply (setting some inessential constants to zero) that the **macroeconomic price** level and **unemployment** rate are:

$$p = \alpha w + (1 - \alpha)m$$

$$U = w - m$$

Using the solution for **p**, firm/union-level unemployment is:

$$U_i = \theta [\eta w_i - \alpha(\eta - 1)w] - m$$

The **economy-wide log nominal wage** level is

$$w = \sigma w_i + (1 - \sigma) w_{-i}$$

$\sigma = \frac{1}{n}$ is the relative size of union i 's membership (which is equivalent to the degree of union centralization), and w_{-i} is the average log nominal wage set by other unions.

It follows that U_i can be expressed:

$$U_i = \theta \left\{ (\eta - \alpha \sigma (\eta - 1)) w_i - \alpha (1 - \sigma) (\eta - 1) w_{-i} \right\} - m.$$

When setting the nominal wage, union i faces two opposite effects:

1. By raising its wage, it decreases the demand for labor and, thus, employment due to the higher labor costs imposed on the firm.
2. By raising its wage, the union increases the economy-wide wage, which by itself makes firm ij more competitive.

The former effect naturally dominates the latter.

Optimal Policies

The central bank's problem:

Set m to Maximize

$$CB = -\frac{\beta}{2} \pi^2 - \frac{U^2}{2}, \quad \beta \in (0, \infty), \quad \pi = (p - p_{-1}) = p$$

The resulting optimal wage-contingent monetary policy rule is:

$$m = -\phi w, \quad \phi = \frac{\alpha(1-\alpha)\beta - 1}{(1-\alpha)^2 \beta + 1}.$$

The reaction parameter ϕ defines the central bank's degree of "conservativeness", with lower bound -1 and upper bound $\alpha/(1-\alpha)$:

- When $\phi < 0$, wage increases are at least partly accommodated; the central bank is liberal or "populist". As β goes to its lower bound of zero, ϕ approaches the lower

bound, -1. The central bank is ultra-liberal. Its objective function is only minimization of unemployment, and monetary policy full accommodates wage increases.

- When $\phi > 0$, and the central bank is conservative, with policy designed to offset at least partly wage-induced increases to inflation. As β goes to its upper limit ∞ , ϕ approaches its upper bound, $\alpha/(1-\alpha)$, and we observe the ultra-conservative central bank that aims only to minimize inflation (or deflation).
- At $\beta = \frac{1}{\alpha(1-\alpha)}$, the reaction coefficient $\phi = 0$. The central bank is “passive,” and monetary policy is neither accommodating nor non-accommodating.

The unions' problem

Set W_i to Maximize

$$TU_i = \gamma(w_i - p) - \frac{U_i^2}{2}, \quad \gamma > 0$$

The first order condition for union i is:

$$FOC \Rightarrow \gamma \left(1 - \frac{\partial p}{\partial w_i} \right) - U_i \frac{\partial U_i}{\partial w_i} = 0,$$

After substitution for the endogenous variables π and U_i we shall obtain the corresponding optimality conditions in terms of parameters and given variables.

Macroeconomic Outcomes

Flexible labor markets

Each union finds the nominal wage that maximizes its objectives by differentiating p and U_i with respect to its control variable w_i , taking both m , and the wages of other unions, w_{-i} , as *given*, and substituting these derivatives into the first-order optimality condition.

The wage policy reaction functions obtained are:

$$w_i = \frac{\eta - \alpha(\eta - 1)}{\eta - \alpha\sigma(\eta - 1)} m + \frac{\alpha(1 - \sigma)(\eta - 1)}{\eta - \alpha\sigma(\eta - 1)} w_{-i} \\ + \gamma(1 - \alpha\sigma) \left(\frac{\eta - \alpha(\eta - 1)}{\eta - \alpha\sigma(\eta - 1)} \right)^2 > 0$$

The Nash equilibrium is found by imposing the symmetry condition $w = w_i = w_{-i}$, giving the **macroeconomic nominal wage**:

$$w = \left(\frac{1}{1+\phi} \right) \left(\frac{\eta - \alpha(\eta-1)}{\eta - \alpha\sigma(\eta-1)} \right) (1 - \alpha\sigma)\gamma > 0$$

After substitution of w into m , $p(\pi)$ and U :

$$\pi = \frac{(1 - \alpha\sigma)(\eta - \alpha(\eta-1))(\alpha - \phi + \alpha\phi)}{(\eta - \alpha\sigma(\eta-1))(1 + \phi)} \gamma \geq 0$$

"inflation bias"

$$U = \frac{(1 - \alpha\sigma)(\eta - \alpha(\eta-1))}{\eta - \alpha\sigma(\eta-1)} \gamma > 0 \quad \text{"excess U"}$$

Note:

- Since the conservativeness parameter, ϕ , is the only term dependent on the central bank's preferences, monetary authority cannot affect the real economy, (U). Therefore, monetary policy is neutral.
- Unemployment goes to the competitive equilibrium $U = 0$, and the inflation bias goes to zero, only when unions with monopoly wage power place no weight on achieving a real wage above that warranted by productivity, that is, only when $\gamma = 0$.
- See Table 1 for additional, important comparative statics

Rigid labor markets

Each union solves its problem by internalizing the central bank's reaction function and the *given* wage claims of other unions. After substitution of the appropriate wage derivatives into the first-order optimality condition, we obtain:

$$w_i = \frac{\kappa_2}{\kappa_1} w_{-i} + \frac{\gamma}{\kappa_1} \frac{\partial(w_i - p)/\partial w_i}{\partial U_i/\partial w_i}$$

with $\kappa_1 = (\eta - \alpha\sigma(\eta - 1))\theta + \sigma\phi$, $\kappa_2 = (\alpha(1 - \sigma)(\eta - 1))\theta - (1 - \sigma)\phi$.

The implied economy-wide equilibrium log nominal wage is:

$$w = \frac{(1 - (\alpha - \phi + \alpha\phi)\sigma)(\alpha + (1 - \alpha)\eta)}{(\eta(1 - \sigma(\alpha - \phi + \alpha\phi)) + \alpha\sigma(1 + \phi))(1 + \phi)} \gamma > 0.$$

Inflation and unemployment in the macroeconomy implied by \mathcal{W} are:

$$\pi = \frac{(1 - (\alpha - \phi + \alpha\phi)\sigma)(\alpha - \phi + \alpha\phi)(\alpha + (1 - \alpha)\eta)}{\{\eta(1 - \sigma(\alpha - \phi + \alpha\phi)) + \alpha\sigma(1 + \phi)\}(1 + \phi)} \gamma \geq 0 \text{ "inflation bias"}$$

$$U = \frac{(1 - (\alpha - \phi + \alpha\phi)\sigma)(\alpha + (1 - \alpha)\eta)}{\eta(1 - (\alpha - \phi + \alpha\phi)\sigma) + \alpha\sigma(1 + \phi)} \gamma > 0$$

“excess U ”

Note: (See Table 1 ahead)

- Monetary policy now affects the real economy, (U); monetary policy is non-neutral. Conservative monetary policy is able to achieve both lower inflation and lower unemployment when wages are pre-committed vis-à-vis monetary policy.
- As before unemployment goes to the competitive equilibrium $U = 0$, and the inflation bias goes to zero, only when unions with monopoly wage power place no weight on achieving a real wage above that warranted by productivity, that is, only when $\gamma = 0$.

Comparative Statics: Summary of Effects

Table 1. Parameter effects on inflation and unemployment in various settings*

| | (a) <i>Flexible wage regime (Nash)</i> | | (b) <i>Rigid wage regime (Stackelberg)</i> | | (c) <i>Single union ($\sigma = 1$)</i> | | (d) <i>Perfect competition ($\eta = \infty$)</i> | |
|--------------------------------------|---|-----|---|-----|--|-----|--|-----|
| | π | U | π | U | π | U | π | U |
| <i>Parameter effects</i> | | | | | | | | |
| Central Bank conservativeness ϕ | - | N | - | - | - | N | - | N |
| Product market competition η | - | - | - | - | N | N | | |
| Union centralization σ | - | - | - | - | | | N | N |
| Union real wage weight γ | + | + | + | + | + | + | + | + |

*The table reports the sign of the effect of increases in the parameters in the first column on inflation (π) and unemployment (U). N indicates no effects. The outcomes associated with cases (c) and (d) are independent of the wage regimes.

The comparative statics yield standard results, with a couple of wrinkles:

- Row 1: the degree of central bank conservativeness always affects inflation, but has capacity to affect unemployment (the real economy) only if a multiplicity of uncoordinated unions pre-commit wages in an economy with less than perfectly competitive product markets.
- Rows 2 and 3: Increasing either product market competition or union centralization reduces both inflation and unemployment in the both flexible and rigid wage regimes.
- The degree of union centralization of wage setting affects macroeconomic outcomes only if firms exert market power over product prices, $\eta < \infty$.
- The degree of market competition affects outcomes only if there is a multiplicity of unions, $\sigma < 1$.
- Absent either a multiplicity of unions or imperfect product competition, monetary policy is neutral.

- Row 4: The greater the weight placed on the (net of productivity) real wage relative to unemployment, the higher are both unemployment and inflation under any combination of labor and product markets.
- The overall pattern of results is therefore quite standard: A low unemployment and low inflation macroeconomy are promoted by conservative, anti-inflation central bankers, highly competitive product markets, and highly centralized unions that place relatively small weight on real wage premiums as compared to unemployment.

Model Calibration and Quantitative Effects

Parameter Settings:

$$\alpha = 2/3$$

η : baseline setting of 1.3; values spanning 1.1 to 2.0.

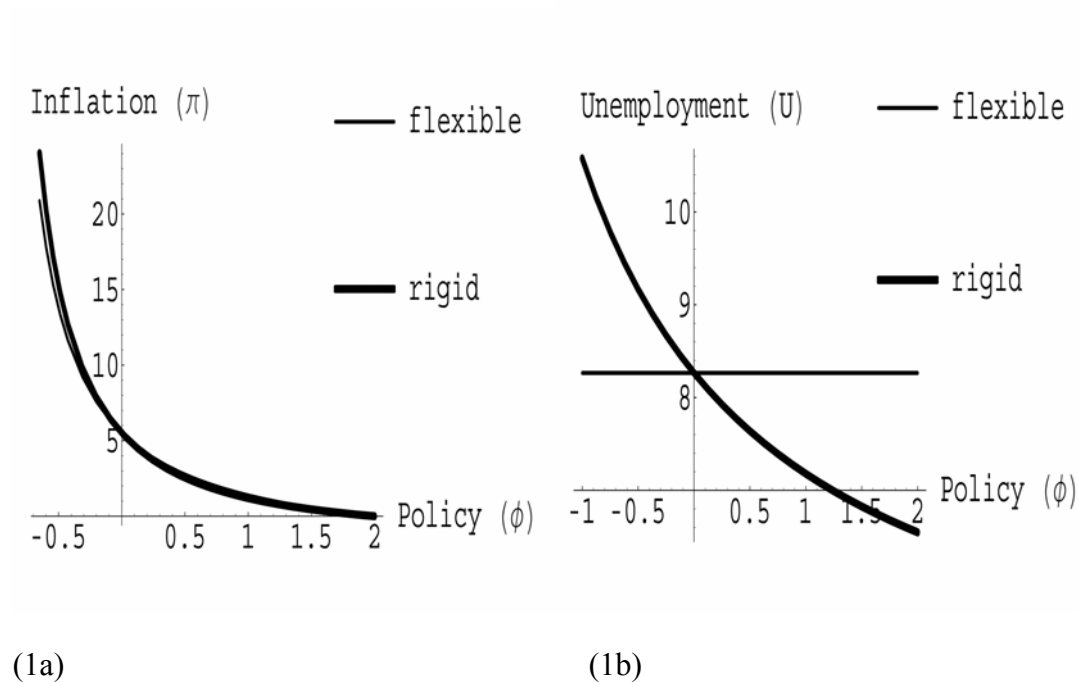
σ : baseline setting 0.4; values spanning 0.20 to 0.8.

γ : baseline setting 0.125; values spanning 0.075-0.175

ϕ : full theoretical range, ≈ -1 , $\alpha/(1-\alpha) = 2$

Simulation Graphs

Figure 1. Inflation and Unemployment in Rigid- and Flexible-Wage Regimes as Monetary Policy Conservativeness Increases*



*Data are expressed as log approximations to percentage inflation rates and percentage points of unemployment. Inflation and unemployment were generated by parameter settings $\alpha = 2/3$, $\gamma = 0.125$, $\sigma = 0.4$ and $\eta = 1.3$ as ϕ goes from its lower bound, -1 , to its upper limit, $\alpha/(1-\alpha) = 2$. The ultra-liberal lower bound of conservativeness is truncated in 1(a) because $\pi \rightarrow \infty$ as $\phi \rightarrow -1$.

Figure 1:

- In both rigid and flexible wage regimes inflation declines with central bank conservativeness. However, when monetary policy is liberal or “populist”, $\phi < 0$, a flexible wage regime generates lower inflation than a rigid wage regime, and conversely, if policy is conservative.
- But that the differences are small to vanishing for plausible parameter settings.
- When policy is “passive” and does not respond to nominal wage developments, $\phi = 0$, inflation converges across wage formation regimes.

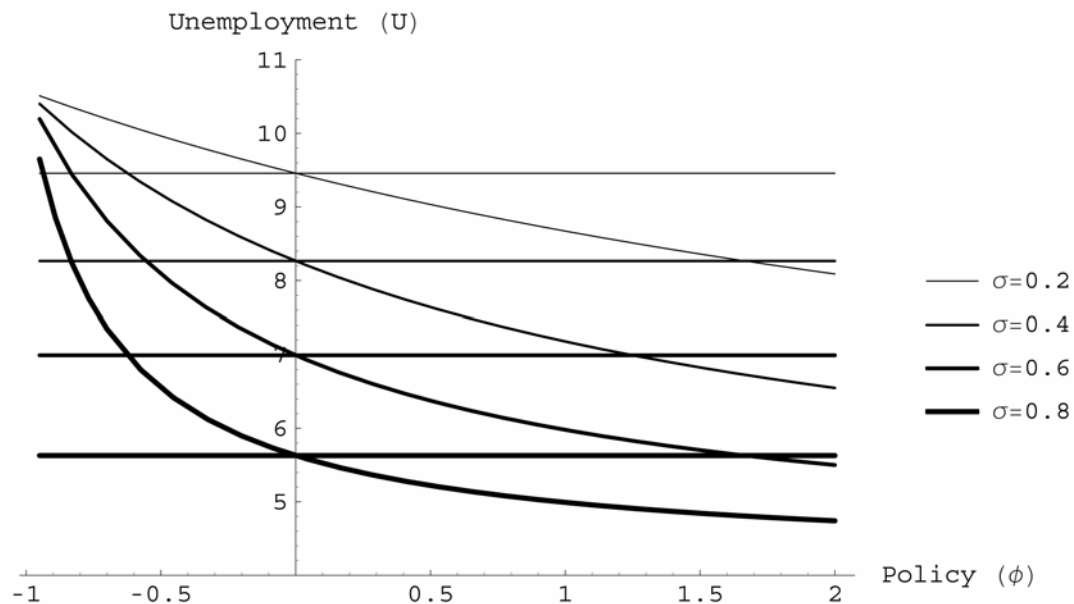
Inflation outcomes also converge to zero when policy approaches the ultra-conservative maximum, $\phi = \alpha/(1 - \alpha)$.

- When monetary policy is liberal, unemployment equilibriums are always higher in Stackelberg, rigid wage environments than in Nash, flexible wage regimes; when monetary is conservative, the reverse is true and rigid wage systems yield superior unemployment (employment) outcomes.

Intuitive Explanations:

- Under monopolistic price competition and a multiplicity of atomistic unions, the contribution of union-specific wages to the general price level is small by comparison to wage effects on product prices. Each uncoordinated union rationally exploits the wedge between log real consumption wage received by its members, $(w_i - p)$, and the log real product wage faced by individual firms, $(w_i - p_{ij})$, by increasing nominal wages in order to achieve higher real wages, discounting the impact of its behavior on the general price level and, therefore, on the real wages of other unions. All unions behave in like fashion; the ensuing increase to the general price level reduces aggregate demand via the negative effect on real money balances, which yields higher economy-wide unemployment .
- In a flexible wage Nash regime, unions interact simultaneously with the central bank, and take the money supply, along with the wages of other unions, as given. Union wage policies are therefore unaffected by the central bank's reactions to wage changes Hence, even a Draconian anti-inflation monetary policy is unable to overcome any of the unemployment costs created by the wage behavior of uncoordinated individual trade unions.
- By contrast, in a rigid wage Stackelberg regime, unions internalize the systematic reaction of the central bank to wage increases, and this affects their strategic calculations. The unemployment effects of union wage policies are aggravated or mitigated, depending on the posture of policy.

Figure 2. The Effects of Monetary Policy Conservativeness on Unemployment by Variation in Centralization of Wage Setting*



*Relative inflation and unemployment are log approximations to percentage point rates and were generated by parameter settings $\alpha = 2/3$, $\gamma = 0.125$ and $\eta = 1.3$ as ϕ goes from its lower bound, -1 , to its upper limit, $\alpha/(1-\alpha) = 2$ for various degrees of union centralization σ . Rigid wage outcomes are depicted by the convex graph lines; flexible wage outcomes by the parallel lines.

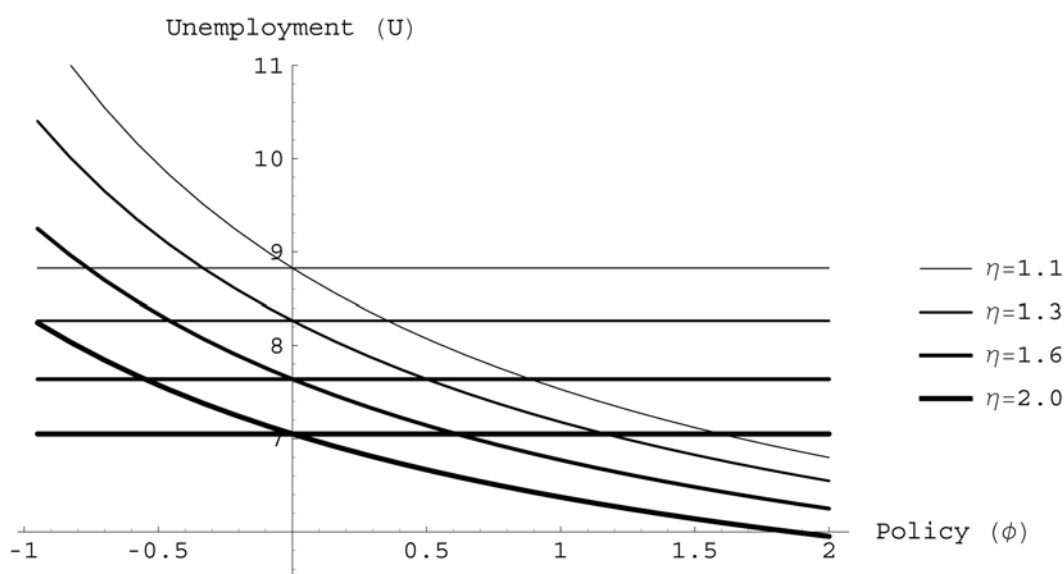
Figure 2:

- When unions are big and therefore set wages for a large fraction of the labor force, they understand that their wage policies have great impact on the general price level and, consequently, that the wedge between product real wages and consumption real wages opened up by nominal wage increases is correspondingly small. Hence, in both flexible and rigid wage environments, large unions correctly perceive that the real wage return to aggressive wage policies is comparatively small, especially relative to the utility cost of wage-induced increases in unemployment among union members. Union size therefore tempers optimal wage aspirations, yielding lower firm-level price rises and lower union-level unemployment as centralization
- In rigid wage systems, however, the effects of union centralization interact with the restrictiveness of monetary policy. At any given degree of centralization, the internalization of liberal policies by unions that must pre-commit nominal wages leads to wage policies that become more aggressive as

monetary policy becomes more accommodating, which yields rates of inflation and unemployment that always exceed the corresponding rates in flexible wage regimes, where the money supply is taken as given. The otherwise beneficial effects of centralization are eroded completely as policy approaches the ultra-liberal limit $\phi = -1$.

- The reverse is true in rigid wage labor markets when policy is conservative, and the central bank contracts the money supply in proportion to nominal wage increases. The bigger are unions, the greater is the internalization of anti-inflation monetary policies, and the lower are rates of unemployment (and inflation) by comparison to outcomes in flexible wage labor markets. At the limit, when all wages are set by one all-encompassing union (i.e as $\sigma \rightarrow 1$), monetary policy no longer affects union wage policies because a single union internalizes fully the macroeconomic consequences of its wage behavior on its own.

Figure 3. The Effects of Monetary Policy Conservativeness on Unemployment by Variation in Product Market Competition*

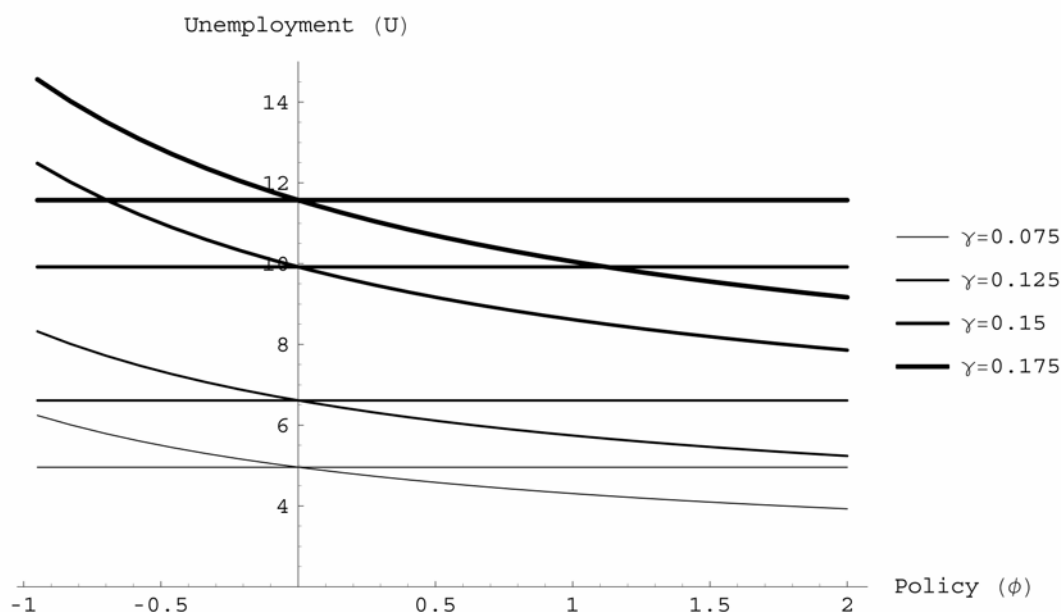


*Relative inflation and unemployment are log approximations to percentage point rates and were generated by parameter settings $\alpha = 2/3$, $\gamma = 0.125$ and $\sigma = 0.4$ as ϕ goes from its lower bound, -1 , to its upper limit, $\alpha/(1-\alpha) = 2$, for various elasticities of price competition, η . Rigid wage outcomes are depicted by the convex graph lines; flexible wage outcomes by the parallel lines.

Figure 3:

- In rigid wage systems monetary policy exerts less potent effects as product markets become more competitive – the convex graph lines get flatter as η increases. The reason is that relatively small values of η (less market competition) yield relatively high monopoly rents to firms and, therefore, higher wages to unionized workers, which in turn raises unemployment. In rigid wage labor markets, where monetary policy has capacity to influence union wage claims, policy activism therefore can worsen unemployment if “populist”, or improve it if conservative.
- Although a price elasticity of product demand of 2.0 is probably a reasonable upper limit, if competition were to become much fiercer, for example, because of government policies that dramatically reduced costs of market entry and barriers to trade, monetary policy would lose most of its relevance to unemployment in rigid wage regimes, where otherwise it exerts great effects. Firms charging non-competitive prices would be driven to bankruptcy, and labor would be reallocated to surviving producers, no matter what the wage inflation posture of the central bank. The ensuing uniformity of product prices would eliminate the wage wedge and, therefore, eliminate the incentive of unions to pursue wage policies exploiting the gap between the real consumption wage and the real product wage.

Figure 4. The Effects of Monetary Policy Conservativeness on Unemployment by Variation in Union Real Wage Weights*



*Relative inflation and unemployment are log approximations to percentage point rates and were generated by parameter settings $\alpha=2/3$, $\sigma=0.4$ and $\eta=1.3$ as ϕ goes from its lower bound, -1 , to its upper limit, $\alpha/(1-\alpha)=2$, for various magnitudes of union real wage utility weights, γ . Rigid wage outcomes are depicted by the convex graph lines; flexible wage outcomes by the parallel lines.

Figure 4:

In principle γ can be interpreted to be a behavioral parameter, rather than a deep, structural parameter such as α . Hence, in principle the weight unions' attach to real wages in the determination of nominal wage policies is subject to planned adjustment.

Unemployment outcomes are very sensitive to union real wage goals. Across plausible settings for γ , unemployment rates shift by as much as 7 percentage points. γ is a parameter that distorts competitive outcomes in labor markets, in that it represents the willingness of unions to impose wage levels exceeding the underlying productivity of the (given) labor force, which in turn drives unemployment above the perfect competition equilibrium $U = 0$.

γ is therefore directly analogous to the status of η in product markets, and it interacts with monetary policy conservativeness in much the same fashion as η . Hence monetary policy exerts greatest effects when union goals are most distorting – that is, at the larger values of γ . As γ gets small union wage behavior corresponds more on its own to competitive behavior, and the conditioning effects of restrictive policy dissipate, just as is the case product price competition, η gets large.