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Awareness of General Equilibrium Effects and Unemployment

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ABSTRACT

Awareness of General Equilibrium Effects and Unemployment*

We examine wage-bargaining in a two-sector economy when employers and labor unions in each sector are not always aware of all general equilibrium feedback effects. We show analytically that if agents only consider labor demand effects, low real wages and low unemployment result. With an intermediate view, i.e. when partial equilibrium effects within a sector are taken into account, high real wages and unemployment result. If all general equilibrium effects are considered at once, low real wages and low unemployment again result. The assumption that unions and employers' federations are not able to incorporate all feedback effects from other sectors may explain the persistence of high unemployment in Europe.

JEL Classification: D58, E24, J60, L13

Keywords: Sectoral wage-bargaining, awareness of general equilibrium effects, unemployment

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1 Introduction

In this paper we argue that insufficient recognition of general equilibrium effects by unions and employers' associations may provide an explanation for high unemployment rates. We consider wage-bargaining between labor unions and employers' associations embedded in a two-sector economy. We analyze the outcomes of three different perspectives taken by agents bargaining over wages. First, we assume that labor unions and employers' associations take *all* general equilibrium effects into account when maximizing their objectives. Second, we investigate the case in which only the employment effects of wage setting are considered while all other variables are assumed to stay constant. Third, we analyze the intermediate case where agents take account of partial equilibrium effects happening in their sector, whereas feedback effects from other sectors are ignored.

Our main finding is that unemployment is highest under the intermediate view. The significant differences to the other two views hold if there is collective wage agreement in one sector of the economy or in both sectors simultaneously.

The paper is a response to the extensive literature on the European unemployment problem, which is reviewed briefly in the next section. Since unemployment is substantially structural in nature and could, in principle, be eliminated, it has been difficult to explain why high unemployment persists. Our paper suggests that agents' insufficient recognition of general equilibrium effects in countries with collective bargaining arrangements or minimum wage laws can provide a complementary explanation of why unemployment persists. If unions and employers' associations are not able to incorporate all feedback effects from other sectors or from the government's budget constraint when negotiating wages, they end up with high wages and unemployment and fail to recognize an alternative outcome with low unemployment.

The paper is organized as follows. In the next section, we relate our paper to the literature. In section 3 we introduce the model. We examine a general equilibrium model with two industry sectors and labor as input into production. The model is closed by a system of unemployment insurance financed by income taxes, i.e. the government's budget constraint. We first elucidate a bargaining process called General Equilibrium Bargaining (GEB). GEB means that all general equilibrium effects are taken into account when wages are negotiated. Next, we analyze a bargaining process called Myopic Bargaining (MB). Under MB, bargaining parties are assumed to be highly myopic, taking only the direct employment effects of wage settings into account without recognizing changes in product prices, etc. Finally we investigate Partial Equilibrium Bargaining (PEB). For PEB we assume that the bargaining parties recognize, and therefore take into account, the *direct* effects on their sector that result from wage setting without considering anything else.

In section 4 we compare the outcomes of these three different types of bargaining. We show that wages and unemployment are always higher under PEB than under GEB or MB. This means that an intermediate recognition level of general equilibrium effects is worse than considering all general equilibrium effects or limiting consideration to the employment effect of the negotiated wage. We then compare our results to a well-known phenomenon in labor economics, namely, the observation of a hump-shaped relationship between the degree of wage-bargaining centralization and real wages or unemployment (Calmfors and Driffill (1988)). We argue that our analysis represents a new way of thinking about possible outcomes of collective wage agreements. In section 5, we extend our model to take into account simultaneous wage-bargaining in both sectors, which reinforces our conclusions and allows us to derive the magnitude of unemployment differences for the different perspectives. Section 6 presents our conclusions.

2 Relation to the Literature

There is a vast literature discussing the impact of labor market institutions on unemployment and we will not try to summarize here.[1] In general, unemployment has been associated in the literature with labor market factors affecting supply and demand for labor, including unemployment benefits systems, institutional settings for wage determination and minimum wages.[2]

The main point we make in our paper is that insufficient recognition of general equilibrium effects can considerably reinforce the negative impact of particular labor market institutions on unemployment. We show that collective wage agreements yield high un-

1 Surveys and detailed accounts of labor market factors as root causes of the unemployment problem in Europe can be found in Blanchard and Summers (1986), Burda and Wyplosz (1994), Layard, Jackman, and Nickell (1991), Snower (1993), Bean (1994), Krugman (1994), Franz (1995), Minford (1995), OECD (1995), Alogoskoufis, Bean, Bertola, Cohen, Dolado and Saint-Paul (1996), Giersch (1996), Gersbach and Sheldon (1996), Lindbeck (1996), Oswald (1996), Siebert (1997), Nickell (1997).

2 For a recent paper on how these factors lead to a cut of fixed labor costs by firms, see Boone (2000).

employment under PEB, while they would only create moderate unemployment under GEB (and MB).

Our paper is related to political implementation and reform design issues. First, Saint-Paul (1994, 1995, 1997) has shown that the redistributive goals that motivate labor market institutions in Europe can be achieved at a much lower cost by using more traditional tax and transfer instruments. However, the current level of regulation can be explained by a political equilibrium, since there is a bias towards maintaining the status quo. Second, as suggested in Coe and Snower (1997) for the labor market and in Gersbach and Sheldon (1996) for the combination of product and labor market reforms, many policies appear to be complementary. The employment effect of each policy is greater when it is implemented in conjunction with the other policies than when it is implemented in isolation. Broad packages of labor market reforms can internalize complementarities across reform steps. Third, Piketty (1998) has suggested that unemployment remains high because a necessary decline in low-skilled people's wages would be associated with a low social status or human value, which may not be widely accepted in the public. The results in our paper suggest that high unemployment may also be the result of insufficient recognition of general equilibrium effects.

3 Model

In this section, we develop a model to analyze different wage-bargaining processes associated with different degrees of sophistication in the knowledge of agents about feedback effects.

There are two sectors producing good 1 and good 2. The only input into production is labor.[3] The production functions are given by:

$$q_1 = L_1^{\beta} \tag{1}$$

$$q_2 = L_2^{\beta} \tag{2}$$

3 In the long run, there is no loss of generality associated with neglecting capital, provided that capacity constraints are not binding and that the long-run capital stock is determined by equating the marginal product of capital with the real world interest.

Subscripts 1 and 2 denote the first and second sector, respectively. We assume that workers are immobile across industries, i.e. they can only work in one sector. Total labor input is $L_1 + L_2$. Labor supply is assumed to be inelastic and is given by $\overline{L_1}$ in sector 1 and $\overline{L_2}$ in sector 2.

Profits accrue to some firm-owners (henceforth "capitalists"), denoted by L_k, who do not work. The strict separation of working class and capital owners is made for unambiguous objectives pursued by unions and employers' federations. We assume that all types of workers and all capitalists have the same symmetric Cobb Douglas utility function[4]:

$$u = c_1^{\frac{1}{2}} \cdot c_2^{\frac{1}{2}} \tag{3}$$

c_1 and c_2 denote the consumption levels for good 1 and good 2. We assume that workers own no shares so that labor unions are only concerned about the wage bill. The concrete distribution of shares among capitalists is irrelevant, since all individuals have the same preferences and the demand functions are unit-elastic to income. Thus any distribution of shares yields the same aggregate demand. One could imagine that shares of firms are traded in a way that each shareholder holds the market portfolio.

In the labor market of sector 2, we proceed in two steps. First we assume an exogenously given real wage, denoted by $\overline{rw}_2$. Second, in section 5 the wage is also determined by collective wage-bargaining. $\overline{rw}_2$ is assumed to exceed the market clearing real wage, so that it becomes binding and unemployment occurs in the second sector. The nominal wage w_2 is then $p \cdot \overline{rw}_2$. A variety of regulations can cause a real wage floor. Later we will explain $\overline{rw}_2$ by centralized wage setting in sector 2.

Wages for labor in the first sector are determined by the wage-bargaining process that will be the focus of our examination. Occurring unemployment is financed by a flat tax on total income, denoted by τ. We assume that the unemployed obtain a fixed real benefit, denoted by $\overline{ri}$, that is lower than the real wage in sector 2.

At this stage a remark about our working assumption is necessary. Our description of labor markets mirrors a situation with non-competitive wages in several industries. We first focus on wage determination in one industry given real wages in other industries; then we endogenize wage setting in other industries as well.

4 The symmetry assumption is made solely for ease of presentation.

3.1 Markets and the Government's Budget Constraint

In the first step we derive demand and supply for goods and labor. Throughout the paper we normalize the price of the second good to 1, i.e.

$$p_2 = 1 \tag{4}$$

By utility maximization for an individual worker or capitalist, we obtain the following demand equations for consumption:

$$c_1 = \frac{1}{2} \cdot \frac{b}{p_1} \tag{5}$$

$$c_2 = \frac{1}{2} \cdot b \tag{6}$$

b denotes the budget of the individual. It consists of wages for workers in sector 1 and 2, and of profits if the individual is a capitalist. In the case of unemployment b denotes unemployment benefits.

Profit functions of the firms are sales minus costs. Therefore:

$$\pi_1 = p_1 q_1 - w_1 L_1 \tag{7}$$

$$\pi_2 = q_2 - w_2 L_2 \tag{8}$$

Firms are price-takers in both sectors. We obtain the standard first-order conditions for profit maximization in sector 1 and 2 as:

$$w_1 = p_1 \beta L_1^{\beta-1} \tag{9}$$

$$w_2 = \beta L_2^{\beta-1} \tag{10}$$

Since the income elasticity of the demand functions for goods across all types of individuals is 1, we can aggregate the demand by aggregating the budgets of all agents using (5) or (6). Let C_1 and B denote aggregated demand for good 1 and aggregated budget, respectively. Market clearing for good 1 is then given by

$$C_1 = \frac{1}{2} \cdot \frac{B}{p_1} = q_1 \tag{11}$$

Using the identity that aggregate budgets equal GDP, which is $p_1 q_1 + q_2$, we obtain

$$\frac{1}{2} \cdot \frac{p_1 q_1 + q_2}{p_1} = q_1 \tag{12}$$

This equation can be simplified to our final market clearing equation

$$p_1 = \frac{q_2}{q_1} \tag{13}$$

The appropriate consumer price index is

$$p = p_1^{\frac{1}{2}} \cdot p_2^{\frac{1}{2}} = p_1^{\frac{1}{2}} \tag{14}$$

This price index guarantees that changes in prices do not affect a household's utility as long as real income remains constant.

We will assume that the exogenous real wage $\overline{rw}_2$ will be binding in sector 2, so that the labor market for low-skilled workers will not clear. Nominal gross wages for low-skilled workers in sector 2 are given by:

$$w_2 = \overline{rw}_2 \cdot p \tag{15}$$

Gross unemployment benefits ub are similarly defined as

$$ub = \overline{ri} \cdot p \tag{16}$$

with an exogenously given $\overline{ri} \leq \overline{rw}_2$. Unemployment, denoted by Δ, is given by

$$\Delta = \overline{L}_1 - L_1 + \overline{L}_2 - L_2 \tag{17}$$

To finance the unemployment benefits, the government is assumed to use a flat tax, denoted by τ, on the total income of all individuals. The tax is determined by the government's budget constraint:

$$(p_1 q_1 + q_2) \cdot \tau = ub(1 - \tau) \cdot \Delta \tag{18}$$

3.2 Market Equilibria

The above system of equations can be solved analytically as a function of the wage w_1 in the first sector for all the relevant variables . Wage negotiations in sector 1 are the main focus in the first part of our paper and are discussed later. The solution for the equilibrium as a function of w_1 is derived in the appendix and is summarized in the following table:

Table 1: Solution of the Equation System

$p_1(w_1)$	$\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}}$
$p_2(w_1)$	1
$p(w_1)$	$\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{\beta}{2+\beta}}$
$L_1(w_1)$	$\left(\frac{\beta}{w_1}\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}}\right)^{\frac{1}{1-\beta}}$
$L_2(w_1)$	$\left(\frac{\beta}{\overline{rw}_2}\left(\frac{\overline{rw}_2}{w_1}\right)^{\frac{\beta}{2+\beta}}\right)^{\frac{1}{1-\beta}}$
$\Delta(w_1)$	$\overline{L_1} - L_1 + \overline{L_2} - L_2$
$ub(w_1)$	$\overline{ri} \cdot p$
$\tau(w_1)$	$\frac{ub \cdot \Delta}{p_1 L_1^{\beta} + L_2^{\beta} + ub \cdot \Delta}$
$q_1(w_1)$	$\left(\frac{\beta}{w_1}\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}}\right)^{\frac{\beta}{1-\beta}}$
$q_2(w_2)$	$\left(\frac{\beta}{\overline{rw}_2}\left(\frac{\overline{rw}_2}{w_1}\right)^{\frac{\beta}{2+\beta}}\right)^{\frac{\beta}{1-\beta}}$

The previous solutions for p_1, p, L_1, L_2 as a function of w_1 from the table must be inserted in Δ, ub and τ . In the following, we will denote the equilibrium that still depends on w by $E(w_1)$ which is given by:

$$E\Big(p_1(w_1), p(w_1), L_1(w_1), L_2(w_1), \Delta(w_1), ub(w_1), \tau(w_1), q_1(w_1), q_1(w_1), w_1\Big) \tag{19}$$

In the next section we discuss how w_1 is determined within a wage-bargaining process in sector 1.

3.3 The Wage-Bargaining Process in Sector 1

We assume that wages in sector 1 are determined by collective bargaining between a union and an employers' association.[5] The union has the following objective function:

$$\Gamma_u = \frac{w_1(1-\tau) - ub(1-\tau)}{p} \cdot L_1 \tag{20}$$

Γ_u results from utility maximization of the labor union for its members (see Manzini (1998)). It is the excess of the union members' utility in case of agreement over the utility in case of disagreement in the negotiation.

Profits accrue to the group of capital owners L_k represented by an employers' federation whose objective is to maximize real net profits:

$$\Gamma_e = \frac{\pi_1(1-\tau)}{p} \tag{21}$$

We assume that wages are determined by the Nash-bargaining solution with equal bargaining power. The outcome is the wage maximizing the Nash-bargaining product, i.e. the general objective function

$$\Gamma = \Gamma_u \cdot \Gamma_e = \frac{w_1 - ub}{p} \cdot L_1 \cdot \frac{\pi_1}{p} \cdot (1-\tau)^2 \tag{22}$$

Since τ is set by the state, we assume in the following that both bargaining parties take τ as given; thus τ can be neglected in the objective function. The case in which changes in τ are considered by the bargaining parties is discussed below.

5 Manzini (1998) provides a recent survey of collective bargaining processes.

We consider a labor market where firms and employees are not wage-takers but negotiate wages. Then, all other variables of the system (employment, prices, output, etc.) depend on the negotiated wage. The question arises which dependencies are taken into account by the wage-bargaining parties. Do they only consider employment effects when wages are determined or do they also consider changes in prices, unemployment benefits etc.? And do such different levels of sophistication in the consideration of general equilibrium effects change the outcome, i.e. the negotiated wage, and hence all prices and allocations? In this paper we investigate three different levels of sophistication.

3.3.1 General Equilibrium Bargaining

Let us start with the general objective function, written explicitly as:

$$\Gamma = \frac{w_1 - ub}{p(p1, p2)} \cdot L_1 \cdot \frac{p_1 L_1^{\beta} - w_1 L_1}{p(p1, p2)} \tag{23}$$

We first consider the possibility of *all* general equilibrium effects being taken into account by the bargaining parties. Hence, changes in output, prices in all sectors, and changes in unemployment benefits etc. are calculated for various wages w_1 and enter the common objective. This implies that we must insert the solutions for the variables ub, p, L_1 and p_1 from table (1) into the objective function (23), then take the derivative with respect to w_1, and solve the first-order condition for w_1. By taking the derivative of Γ in this way, all dependencies on w_1 are taken into account (except τ). The Nash-bargaining solution is determined as the wage that maximizes Γ. We call this bargaining process, in which agents take account of all general equilibrium effects that occur when a wage is negotiated, General Equilibrium Bargaining (GEB).

3.3.2 Myopic Bargaining

We next examine the case where agents do not or cannot take account of all feedback effects operating at the general equilibrium level. At the one extreme, one might imagine a situation where unions and industry associations only take into account the employment effect $L_1(w_1)$, i.e. only considering the change in employment associated with a change in wages, while assuming all other variables to stay constant. Firms derive the employment effect of a given wage by solving the first-order condition of profit maximization for labor demand L_1 dependent on the negotiated wage w_1. When we only insert labor demand $L_1(w_1)$ from profit maximization into the objective function (23) while treating all other variables (like p_1, ub etc.) as constants, we are assuming that agents only consider the direct employment effect of a wage agreement while ignoring all other interactions in the economy. The wage-bargaining process based on this myopic assessment of the economy is called Myopic Bargaining (MB).

3.3.3 Partial Equilibrium Bargaining

Probably the most plausible scenario is that agents will only take account of the most direct changes occurring in response to a variation in w_1, i.e. the effects that occur *directly* in their sector. In doing so, the bargaining parties consider not only the employment effect L_1 of the negotiated wage w_1, but also the price effect $p_1(w_1)$ (and hence p). Both the unemployment benefits $ub(w_1)$ and all other variables in the economy - notably output and price in sector 2 - are assumed (by the bargaining agents) to stay constant. We call the bargaining process based on this method of assessing the feedback from wage setting Partial Equilibrium Bargaining (PEB).

Table (2) summarizes the different views of the bargaining processes.

Table 2: Bargaining Processes

Bargaining Type	Variables Changes considered	Variables Changes not considered
MB	$L_1(w_1)$	p_1, p, ub, variables of sector 2
PEB	$L_1(w_1)$, $p_1(w_1)$, $p(w_1)$	ub, variables of sector 2
GEB	all variables	

3.4 Overall Equilibria

For each bargaining type we need to calculate the overall equilibrium, denoted by E^{MB}, E^{PEB}, and E^{GEB}, respectively. In order to derive the overall equilibria, we first have to calculate the wages w_1 that result in the different bargaining processes. Accordingly, we have to insert the variables corresponding to the different views under which bargaining takes place in the Nash-bargaining function of unions and employers' associations (see eq. (23)).

3.4.1 GEB Equilibrium

To derive the wage resulting under GEB, we insert all the variables $p_1(w_1), p(w_1), L_1(w_1)$, $ub(w_1)$ from table (1) into Γ. The resulting objective function, denoted by Γ^{GEB}, amounts to

$$\Gamma^{GEB} = \left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta(1+\beta)}{(2+\beta)(1-\beta)}} \left[\overline{ri}\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{\beta}{2+\beta}} - w_1\right] \left[w_1\left(\frac{\beta}{w_1}\right)^{\frac{2}{1-\beta}} - \left(\frac{\beta}{w_1}\right)^{\frac{1+\beta}{1-\beta}}\right] \tag{24}$$

The first-order condition with respect to w_1 is given by

$$\frac{d\Gamma^{GEB}}{dw_1} = \frac{2\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta(1+\beta)}{(2+\beta)(1-\beta)}} \left[w_1\beta - \overline{ri}\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{\beta}{2+\beta}}\right] \left[w_1\left(\frac{\beta}{w_1}\right)^{\frac{2}{1-\beta}} - \left(\frac{\beta}{w_1}\right)^{\frac{1+\beta}{1-\beta}}\right]}{(2+\beta)(1-\beta)w_1} = 0 \tag{25}$$

Solving for w_1 yields the wage in GEB equilibrium, w_1^{GEB}. After some elementary algebra and rearrangement of terms, we obtain

$$w_1^{GEB} = \frac{\overline{ri}^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} \tag{26}$$

Note that w_1^{GEB} depends positively on $\overline{ri}$ and negatively on $\overline{rw}_2$. The higher the unemployment benefits, the higher the wage requirements, as the threat point of the union is higher. On the other hand, high real wages in the other sector lead to cautious nominal wage setting in the agents' own sector. How agents' *real* wages are affected by real wages in the other sector will be discussed later. Inserting w_1^{GEB} into the variables of table (1), we obtain the overall equilibrium under GEB, $E^{GEB} = E(w_1^{GEB})$.

3.4.2 MB Equilibrium

In the MB case, we assume that agents only recognize the dependence of L_1 on w_1, which is derived from profit maximization (9) as:

$$L_1 = \left(\frac{p_1\beta}{w_1}\right)^{\frac{1}{1-\beta}} \tag{27}$$

In the objective function (23) we now only insert $L_1(w_1)$ from (27). All other variables are assumed not to change when w_1 varies. The objective function under MB amounts to

$$\Gamma^{MB} = \frac{w_1 - ub}{p^2}\left(\frac{p_1\beta}{w_1}\right)^{\frac{1}{1-\beta}}\left[p_1\left(\frac{p_1\beta}{w_1}\right)^{\frac{\beta}{1-\beta}} - w_1\left(\frac{p_1\beta}{w_1}\right)^{\frac{1}{1-\beta}}\right] \tag{28}$$

In the MB case, we *first* take the derivative of Γ^{MB} with respect to w_1 and *then* insert all the relevant variables for $p_1(w_1), p(w_1), ub(w_1)$ etc. from table (1) into the first-order condition. The resulting first-order condition for the MB wage then becomes

$$\frac{d\Gamma^{MB}}{dw_1} = \frac{\left[w_1\left(\frac{\beta}{w_1}\right)^{\frac{2}{1-\beta}} - \left(\frac{\beta}{w_1}\right)^{\frac{1+\beta}{1-\beta}}\right]\left[\overline{ri}\left(\frac{w_1}{r\overline{w}_2}\right)^{\frac{\beta}{2+\beta}}(1+\beta) - 2w_1\beta\right]}{(\beta-1)w_1\left(\frac{w_1}{r\overline{w}_2}\right)^{\frac{2\beta(1+\beta)}{(2+\beta)(\beta-1)}}} = 0 \tag{29}$$

This can be solved for the wage under MB, denoted by w_1^{MB}:

$$w_1^{MB} = \frac{(\overline{ri}(1+\beta)/2)^{\frac{2+\beta}{2}}}{\beta(\beta r\overline{w}_2)^{\frac{\beta}{2}}} \tag{30}$$

Inserting this into $E(w_1)$ yields the corresponding equilibrium $E^{MB} = E(w_1^{MB})$.

3.4.3 PEB Equilibrium

In our intermediate PEB approach, agents take account of the change in employment L_1 and the price p_1 (and hence p) when the wage is negotiated. Agents calculate the variable changes from profit maximization, goods market clearing and the price index definition (equations 9, 13, and 14). Solving these three equations simultaneously for L_1, p_1, and p, we obtain

$$L_1 = \frac{\beta}{w_1} L_2^{\beta} \tag{31}$$

$$p_1 = \Big(\frac{L_2^{1-\beta} w_1}{\beta}\Big)^{\beta} \tag{32}$$

$$p = \Big(\frac{L_2^{1-\beta} w_1}{\beta}\Big)^{\frac{\beta}{2}} \tag{33}$$

Note that in the above equations L_2 is perceived to be constant by the agents under PEB when the wage changes. Next, we again insert the above expressions for L_1, p_1, and p into the objective function (23), simplify and obtain

$$\Gamma^{PEB} = (w_1 - ub)(1-\beta)\Big(\frac{\beta}{w_1}\Big)^{1+\beta} L_2^{\beta(1+\beta)} \tag{34}$$

Again we set the partial derivative of Γ^{PEB} with respect to w_1 equal to zero. Treating L_2 and ub as constants captures the partial equilibrium perspective of agents who are not aware of all general equilibrium interactions which do indeed generally cause a change of L_2 and ub (and hence Γ) when w_1 changes. To obtain the overall equilibrium, we insert the requisite variables (L_2 and ub) from table (1) into $\frac{d\Gamma^{PEB}}{dw_1} = 0$, yielding

$$\begin{aligned} \frac{d\Gamma^{PEB}}{dw_1} &= \frac{(\beta-1)\beta}{w_1^2}\Big(\frac{\beta}{w_1}\Big)^{\beta}\Big(\frac{\beta}{\overline{rw}_2}\Big)^{\frac{\beta(1+\beta)}{1-\beta}}\Big(\frac{w_1}{\overline{rw}_2}\Big)^{\frac{\beta^2(1+\beta)}{(2+\beta)(\beta-1)}}\Big[w_1\beta - \overline{ri}\Big(\frac{w_1}{\overline{rw}_2}\Big)^{\frac{\beta}{2+\beta}}(1+\beta)\Big] \\ &= 0 \end{aligned} \tag{35}$$

Solving the first-order condition for w_1^{PEB} yields

$$w_1^{PEB} = \frac{(\overline{ri}(1+\beta))^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} \tag{36}$$

Again, we insert this solution into the variables of table (1) to obtain the equilibrium $E^{PEB} = E(w_1^{PEB})$. In the following section we compare the results under GEB, MB, and PEB conditions.

4 Results

We now compare the different equilibria associated with the different levels of sophistication in the information on which wage negotiations are based. To this end, we first establish

Proposition 1

(i) For $\beta, \overline{rw}_2$ and $\overline{ri} > 0$, we have $w_1^{PEB} > w_1^{GEB}$.

(ii) For $\beta, \overline{rw}_2$ and $\overline{ri} > 0$, we have $w_1^{PEB} > w_1^{MB}$.

Proof:

For the first step we compare equations (36) and (26): $w_1^{PEB} > w_1^{GEB}$ is true if and only if

$$\frac{(\overline{ri}(1+\beta))^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} > \frac{\overline{ri}^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} \tag{37}$$

which is true since the expression can be reduced to $\beta > 0$.

For the second step we compare the equilibrium wages w_1^{PEB} and w_1^{MB} in equations (36) and (30): $w_1^{PEB} > w_1^{MB}$ is true if and only if

$$\frac{(\overline{ri}(1+\beta))^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} > \frac{(\overline{ri}(1+\beta)/2)^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} \tag{38}$$

which reduces to $2 > 1$, completing the proof.

$\square$

We now analyze the consequences for unemployment. In every equilibrium, labor demands in sector 1 and sector 2 are given by (see table (1))

$$L_1(w_1) = \Big(\frac{\beta}{w_1}\Big(\frac{w_1}{\overline{rw}_2}\Big)^{\frac{2\beta}{2+\beta}}\Big)^{\frac{1}{1-\beta}} \tag{39}$$

$$L_2(w_1) = \Big(\frac{\beta}{\overline{rw}_2}\Big(\frac{\overline{rw}_2}{w_1}\Big)^{\frac{\beta}{2+\beta}}\Big)^{\frac{1}{1-\beta}} \tag{40}$$

For $0 < \beta < 1$ we thus have $\frac{dL_1}{dw_1} < 0$ and $\frac{dL_2}{dw_1} < 0$. This implies that aggregate employment decreases when the wage w_1 rises. If $L = L_1 + L_2$ denotes aggregate employment in the economy, we thus obtain

Corollary 1

(i) $L(w_1^{GEB}) > L(w_1^{PEB})$

(ii) $L(w_1^{MB}) > L(w_1^{PEB})$

Corollary 1 stipulates a hump-shaped relationship between the far-sightedness of wage negotiating agents and unemployment. In the case of a very myopic view (MB), negotiated wages are quite low and so is unemployment. With an intermediate view (PEB), wages and unemployment are high. Under the most far-sighted view, where all general equilibrium consequences of a negotiated wage are taken into account, wages and unemployment are again low.

4.1 Interpretation of the Results

We first explain why w_1^{PEB} is higher than w_1^{GEB}. Within the PEB view, agents recognize that a higher wage implies less employment. The agents are aware that a lower level of employment implies less output and thus a rise in the price p_1 and accordingly in p. Everything else is assumed to stay constant; under this view the wage is chosen to maximize the Nash-bargaining objective function.

What unions and employers in the first sector do not perceive within PEB is the consequence of a higher price level p. In sector 2, where nominal wages w_2 are kept such that real wages w_2/p stay constant, the rise in the price index must lead to a rise in the nominal wage. In turn, higher nominal wages in sector 2 lead to a decline of labor demand in sector 2, so that employment and output in sector 2 decrease as well. This causes a rise in p_2 relative to p_1, i.e. a fall of p_1. A decline in p_1 of course leads to lower profits in sector 1 (which interferes with the employers' objective) and lower employment (counter to the union's objective). Less employment in the first sector then leads to less output and a higher price p_1, leading in turn to a higher price index, which causes higher wages in sector 2, again leading to less labor demand in sector 2, and so on.

All these interactions with the other sector exacerbate the consequences of high wages in sector 1 but are not taken into account by agents under a PEB view. Furthermore, a higher price index implied by a higher wage does not only lead to a rise in w_2, but also to a rise in ub. Although this also depreciates the value of the union's objective function, it is not perceived by the agents with a PEB perspective. In summary, we may say that agents are prepared to agree on high wages because they are not aware of all the interactions and thus underestimate the detrimental effects of high wages.

Second, we explore the question why the negotiated wage under MB is lower than under PEB. If ignoring general equilibrium effects leads to bad outcomes, why does the MB outcome, where even fewer effects are considered, not lead to even higher unemployment than PEB? Under MB, agents are very myopic. While under PEB both employment and price reactions are considered, agents with a MB view consider only employment reactions. So when unions and employers consider high wages, they think of a reduction of labor. This is bad both for the union's and the employers' objectives because a reduction of labor means a reduction of both the wage bill *and* the profits from lower output. The latter occurs because although overall income declines, income shares for capital and labor remain the same. The rise in the price (due to less employment and therefore less output) is not considered by agents under MB. A high price p_1 increases both profits and employment, thus boosting both the union's and the employers' objective. This positive impact is not perceived and attention is restricted to the negative employment effect of high wages. Hence, unions and employers are very cautious and negotiate lower wages under MB than under PEB.

The results in proposition 1 and corollary 1 have some similarities to a well-known observation from labor economics: in an economy with highly decentralized wage negotiations, wages and unemployment are quite low, whereas in an economy with more centralized wage-bargaining wages and unemployment are high; in economies with totally centralized wage settings wages and unemployment are again quite low (Calmfors and Driffill (1988)). Taking demand as exogenously given, Calmfors and Driffill do not need to take account of feedback effects from the demand side. They vary the number and size of sectors and with them the degree of bargaining centralization; by contrast, we vary the degree of far-sightedness, also obtaining a hump-shaped curve for wages and unemployment, respectively.

In PEB, as opposed to GEB, the underestimation of these negative employment and benefits effects, plus the overestimation of the positive price effect that follow from high wages, lead to a shift in the maximum of the objective functions to the right and thereby to a higher wage agreement, which in turn involves higher unemployment. Table (3) summarizes estimations of variables under PEB relative to GEB, as well as consequences for employment, etc.

Table 3: Estimations and Impacts under PEB/ GEB

Variable	Estimation under PEB relative to GEB	Impact on employment and output under PEB relative to GEB
p_1, p	overestimated	negative
L_1	overestimated	negative
ub	underestimated	negative

At this point, two remarks need to be made on our analysis so far. First, if the tax effect were taken into account by the agents under a general equilibrium view, they would be even more cautious: high wages lead to high unemployment and therefore high taxes to finance unemployment benefits. These taxes further reduce the net wage and profit income, i.e. the objective function.

Second, the equilibrium under MB and PEB can also be interpreted as the steady state of a learning process. If the agents started at *any* equilibrium $E(w_1)$ and then negotiated wages, the PEB and MB bargaining processes would generally produce errors due to the fact that the outcomes under MB or PEB are different from what agents expect. Approaching the PEB or MB equilibrium can then be interpreted as the convergence of a learning process.[6]

5 Extensions

In this section, we discuss some possible extensions of our model. We first investigate the case where wage negotiations take place in both sectors. Next, we analyze the case of competitive wages in the second sector. Finally we discuss possible variations of the different perspectives from which wage-bargaining takes place.

6 See Gersbach and Schniewind (2000) for a simulation of this learning process in a more complex setting.

5.1 Wage Negotiations in Both Sectors

So far, we have assumed fixed real wages in sector 2, i.e. in the rest of the economy. In the next step, we analyze what happens when agents in sector 2 bargain over wages as well. In section 3 we calculated nominal wage-bargaining outcomes in sector 1 under different levels of information sophistication. These wages were a reaction to a given real wage in sector 2. To justify the given real wage in the second industry, one might imagine an agreement between employers' associations and unions whereby the purchasing power of negotiated wages is maintained by adjusting nominal wages to changes in the price level. When this nominal wage agreement, plus one-to-one adjustments to changes in the price level, occur in both sectors, then employers and employees are in fact choosing a particular real wage when they choose a particular nominal wage.

Given the two real-wage reaction functions, we can thus calculate Nash Equilibria for the wage-setting games between the two sectors. We first analyze the Nash Equilibrium for GEB, then for MB and PEB.

Maximization of the Nash bargaining objective function of unions and employers yields the optimal wages w_1, dependent on β, $\overline{ri}$, and $\overline{rw}_2$. For fixed parameters β and $\overline{ri}$, the resulting wages can be interpreted as a reaction to a given $\overline{rw}_2$ in the other sector. Under GEB, the reaction function was

$$w_1^{GEB} = \frac{\overline{ri}^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}} \tag{41}$$

Dividing through the price level (see table (1)) in the GEB equilibrium yields the corresponding real-wage reaction function:

$$\frac{w_1}{p}^{GEB} = \frac{\frac{\overline{ri}^{\frac{2+\beta}{2}}}{\beta(\beta\overline{rw}_2)^{\frac{\beta}{2}}}}{\left(\frac{w_1^{GEB}}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}}} \tag{42}$$

Inserting w_1^{GEB} and simplifying yields

$$\frac{w_1}{p}^{GEB} = \frac{1}{\beta}\cdot\overline{ri} \tag{43}$$

Note that this expression can also be obtained by assuming a symmetrical equilibrium with $p = 1$. For that, set $\overline{rw}_2 = w_1^{GEB}$ in (41) and solve for w_1^{GEB}. We observe that the chosen real wage in sector 1 does not depend on the real wage $\overline{rw}_2$ in sector 2. This surprising fact is a result of the following reasoning: a higher real wage in sector 2 leads to less employment and output and thus to a rise in the price p_2. The increasing price index then induces the parties to agree on higher wages because their goal is to maximize real income (see 23). The rises in w_1 and p cancel each other out. As we are dealing with a symmetric economy, a reaction function in sector 2 to real wages in sector 1 would be exactly the same. In the symmetric equilibrium, both prices p_1 and p_2 are equal to 1, as is the price index p.

Applying the same procedure to the MB and PEB cases also yields flat real-wage reaction functions. Obviously the flat reaction functions are also the Nash equilibria of the wage-setting game between the two symmetrical sectors. We now summarize the resulting Nash equilibrium wages:

$$w_{NE}^{GEB} = \frac{1}{\beta} \cdot \overline{ri} \tag{44}$$

$$w_{NE}^{MB} = \frac{(1+\beta)/2}{\beta} \cdot \overline{ri} \tag{45}$$

$$w_{NE}^{PEB} = \frac{(1+\beta)}{\beta} \cdot \overline{ri} \tag{46}$$

where the lower index stands for **N**ash **E**quilibrium. Accordingly, we obtain

Proposition 2

(i) For $0 < \beta < 1$ and $\overline{ri} > 0$ we have $w_{NE}^{PEB} > w_{NE}^{GEB}$.

(ii) For $0 < \beta < 1$ and $\overline{ri} > 0$ we have $w_{NE}^{PEB} > w_{NE}^{MB}$.

Proof:

The two statements follow directly from the assumptions $0 < \beta < 1$ and $\overline{ri} > 0$ and by comparing equations (44) (45) (46).

$\square$

As was to be expected, we again obtain the result that w_{NE}^{PEB} is bigger than w_{NE}^{GEB} and w_{NE}^{MB} for the Nash equilibria. That means that the PEB view, where feedback effects from other sectors or from the state are ignored by agents, leads to higher wages in equilibrium than both the GEB view, where all general equilibrium effects are considered, and the MB view, where only the employment effect of wage-setting is taken into account. Correspondingly, unemployment is higher than in the GEB or MB cases in the PEB Nash equilibrium. We further observe that all equilibrium wages depend positively on the real income for the unemployed $\overline{ri}$. Since the utility loss of losing one's job is alleviated when real incomes for the unemployed increase, unions require higher wages in this case. We can conclude that our results will also hold when wage negotiations take place in all sectors.[7]

In the next step we assess the magnitude of the (un)employment differences among the different levels of sophistication in the information considered in wage negotiations. We denote total employment in the Nash equilibrium by L_{NE}^{GEB}, L_{NE}^{PEB}, and L_{NE}^{MB}. Using the expression for $L_1(w_1)$ or $L_2(w_1)$ in table (1), and bearing in mind that $p = 1$ and thus $\overline{rw}_2 = w_1$ in the symmetric equilibrium, we obtain

Corollary 2

The relationship of employment levels across different types of bargaining is given by:

(i) $\frac{L_{NE}^{PEB}}{L_{NE}^{GEB}} = (1+\beta)^{\frac{1}{\beta-1}}$

(ii) $\frac{L_{NE}^{PEB}}{L_{NE}^{MB}} = 2^{\frac{1}{\beta-1}}$

As Corollary 2 indicates, employment differences depend solely on production elasticity β. The magnitude of the differences can be very large. For instance, suppose $\beta = \frac{1}{2}$, then $\frac{L_{NE}^{PEB}}{L_{NE}^{GEB}} = \frac{4}{9}$ and $\frac{L_{NE}^{PEB}}{L_{NE}^{MB}} = \frac{1}{4}$.

5.2 Competitive Wages in Sector 2

How do the results change when wages in the second industry are flexible? In the following we will argue that the "rankings" between PEB, GEB, and MB do not change. To this end, we compare first GEB and PEB then PEB and MB.

7 One could also think of a game where unions and employers do not choose wages simultaneously but one after another. Due to the flat reaction functions, however, such Stackelberg equilibria would not differ from the symmetrical Nash equilibria.

Within PEB people see the partial equilibrium effects of wage-setting (in their sector), but they ignore feedback effects from other sectors or from the state. Feedback effects from sector 2 originate from the fact that wage-setting in sector 1 affects output in sector 2: high wages in sector 1 imply low employment and therefore low output and a high price for good 1, since goods are complements in our model. A rise in p_1 leads to a rise in the price level, causing a nominal wage adjustment in sector 2 if real wages are to be kept constant. Higher nominal wages lead to less employment in sector 2 (see equation 10) and hence to less output and a rise in price p_2 (relative to p_1). This in turn causes negative feedback effects: a rise in p_2 actually means a fall in p_1 ($p_2 \equiv 1$). For a negotiated wage, this implies less employment in sector 1, less output, and so on.

When wages are competitive in the second industry, this effect does not occur. Wages always adjust to full employment and hence to full output in sector 2, so that p_2 does not increase relative to p_1. Therefore, there is no feedback effect causing a decline in employment and output in sector 1. It is therefore correct to ignore feedback effects from other sectors.

What feedback effects emanate from the state? Higher wages in sector 1 imply lower employment and output, hence a rise in p_1 and price index p. In order to keep real unemployment benefits constant, the state must increase nominal unemployment benefits ub. This causes a decline of the objective function Γ (see eq. (23)) that is not foreseen by the agents. Thus even with flexible wages in other sectors, people agree upon higher wages under PEB than under GEB because they do not consider the negative feedback effects from the state.

Under MB, feedback effects from the state are also ignored. But while agents with a PEB view see the positive price effect that follows from high wages (through less employment, i.e. less output in sector 1), people engaging in MB fail to consider this fact. Ignoring the positive effect of high wages, "myopic bargainers" are more cautious and therefore end up with lower wage agreements.

Summarizing, we can say that flexible wages in sector 2 alleviate the detrimental consequences from a PEB view, but the fact remains that wages and unemployment are higher under PEB than under GEB or MB.

5.3 Discussion of the Views

In our paper we have dealt with three different views taken by agents on the economic feedback effects from wage-setting. Two of the views are polar cases. One of the polar cases is the general equilibrium view where agents consider *all* feedback effects from the economy. The opposite note is the myopic view, where only the direct employment effect in the corresponding sector is taken into account.

While the two polar cases are canonical, one could imagine different possibilities for the intermediate partial equilibrium view. In our model there are three major sources for feedback effects caused by wage-setting. The first source is the sector in which the wage negotiations take place. We expect this to be a minimum consideration for a partial equilibrium view, as is the case in our model. The other sources are the state (unemployment benefits and taxes) and the other sector. Considering feedback effects from both sources – and thus from the whole economy – leads to the general equilibrium view. Considering feedback effects from the other sector would already quite strongly resemble the general equilibrium view because the major feedback effects in our model stem from this source rather than from the state. Therefore an imaginable extension of our PEB view would be consideration of feedback effects caused by the state when it adjusts the nominal unemployment benefits ub so that real incomes for unemployed remain constant and equal to $\overline{ri}$. If agents with a PEB perspective were to extend consideration to these adjustments in nominal unemployment benefits (henceforth PEB^*), i.e. if they took account of the fact that $ub = \overline{ri} \cdot p$ with $p = p_1^{\frac{1}{2}}$, the results would change slightly. The same calculations as before show that in this case the reaction of sector 1 wages to real wages in sector 2 becomes

$$w_1^{PEB^*} = \frac{(\overline{ri}(2+\beta)/2)^{\frac{2+\beta}{2}}}{\beta(\beta \overline{rw}_2)^{\frac{\beta}{2}}} \tag{47}$$

Accordingly, the Nash equilibrium wage for the case where there is bargaining in both sectors becomes

$$w_{NE}^{PEB^*} = \frac{(2+\beta)/2}{\beta} \cdot \overline{ri} \tag{48}$$

We observe that the wages are lower than the wages that result when state feedback effects are not considered. This is because, under PEB^* more negative feedback effects from high wages are taken into account by agents, and this leads to more cautious wage setting. But we also see that the wages are still higher than the wages under GEB or MB (see equations (26), (44), and (36), (46)). Thus we can conclude that while this extension of PEB alleviates the burden, it is still inferior to the other views.

Our model is symmetric: both sectors are large and thus, in our PEB case agents take price index considerations into account. One could also imagine a case where agents do not consider changes in the price index. The rising price index associated with a higher price p_1 narrows the positive price effect of high wages by decreasing real income. If this dampening effect is ignored by agents, they will push for higher wages. Our calculations lead us to conclude that there is no maximum anymore: agents would try to push wages as high as they can because the perceived increase in real wages and real profits prevails over everything else.

6 Conclusion

We have developed a general equilibrium model to study the way in which different potentials of agents for identifying general equilibrium effects will affect wage negotiations and unemployment. We have shown that a partial equilibrium view of the economy leads to high wages and unemployment. In contrast, if employers' associations and unions take either all or only a very few general equilibrium effects in to account, low wages and low unemployment result.

We consider the case of intermediate awareness of general equilibrium effects to be the most plausible for those countries where wages are negotiated at industry level. Thus our model may explain why unemployment rates are persistently higher in European countries with industry-level bargaining. If we consider taking all general equilibrium effects into consideration to be too demanding in wage negotiations, our results suggest that firm-level wage-bargaining, where general equilibrium effects are usually ignored, would be preferable to industry-level bargaining.

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7 Appendix

We solve the system of equations for any equilibrium that still depends on w_1, i.e. $E(w_1)$. The first order conditions for profit maximization in sector 1 and 2 are

$$w_1 = p_1 \beta L_1^{\beta-1} \tag{49}$$

$$w_2 = \beta L_2^{\beta-1} \tag{50}$$

Dividing (49) by (50), we obtain

$$\frac{w_1}{w_2} = p_1 \left(\frac{L_1}{L_2}\right)^{\beta-1} \tag{51}$$

The goods market clearing condition is given by

$$p_1 = \frac{q_2}{q_1} = \left(\frac{L_2}{L_1}\right)^{\beta} \tag{52}$$

implying

$$\left(\frac{L_1}{L_2}\right)^{\beta-1} = p_1^{\frac{1-\beta}{\beta}} \tag{53}$$

Inserting this into 51 and solving for p_1 yields

$$p_1 = \left(\frac{w_1}{w_2}\right)^{\beta} \tag{54}$$

The price index is defined by

$$p = p_1^{\frac{1}{2}} \tag{55}$$

Inserting $w_2 = \overline{rw}_2 \cdot p$ into (54) and solving for p_1 we obtain

$$p_1 = \left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}} \tag{56}$$

The price index is therefore

$$p = p_1^{\frac{1}{2}} = \left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{\beta}{2+\beta}} \tag{57}$$

Inserting p_1 in (49) and solving for L_1 yields

$$L_1 = \left(\frac{\beta}{w_1}\left(\frac{w_1}{\overline{rw}_2}\right)^{\frac{2\beta}{2+\beta}}\right)^{\frac{1}{1-\beta}} \tag{58}$$

The second first order condition implies

$$L_2 = \left(\frac{\beta}{w_2}\right)^{\frac{1}{1-\beta}} \tag{59}$$

Inserting $w_2 = \overline{rw}_2 \cdot p$ yields the solution for L_2:

$$L_2 = \left(\frac{\beta}{\overline{rw}_2}\left(\frac{\overline{rw}_2}{w_1}\right)^{\frac{\beta}{2+\beta}}\right)^{\frac{1}{1-\beta}} \tag{60}$$

The above solutions for p_1, p, L_1, L_2, i.e. equations (56), (57), (58), (60) must now be inserted into the definitions of Δ, ub, and τ to obtain the complete solution of the system of equations as indicated in table (1).

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