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Lars Calmfors
Anna Larsson

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## Abstract

Pattern bargaining with the tradables (manufacturing) sector as wage leader is a common form of wage bargaining in Europe. We question the conventional wisdom that such bargaining produces wage restraint. In our model all forms of pattern bargaining give the same outcomes as uncoordinated bargaining under inflation targeting. Under monetary union wage leadership for the non-tradables sector is conducive to wage restraint, whereas wage leadership for the tradables sector is not. Comparison thinking may lead the follower to set the same wage as the leader. Such equilibria can arise when the leader sector is the smaller sector and promote high employment.

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Keywords: pattern bargaining, wage setting, inflation targeting, monetary regimes.

*Lars Calmfors*
*Institute for International Economic Studies*
*Stockholm University*
*10691 Stockholm*
*Sweden*
*Lars.Calmfors@iies.su.se*

*Anna Larsson*
*Department of Economics*
*Stockholm University*
*10691 Stockholm*
*Sweden*
*Anna.Larsson@ne.su.se*

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# 1 Introduction

The wage-setting arrangements of many Western European countries are characterised by pattern bargaining. This means that a key sector, usually the engineering sector, concludes the first agreement in a wage bargaining round and that this agreement sets a norm for subsequent wage contracts in other sectors. Pattern bargaining thus works as a coordination device. Typical examples are Austria, Denmark, Germany, Norway and Sweden (EEAG 2004).

It is usually believed that wage moderation is promoted by choosing a tradables sector, heavily exposed to international competition, as wage leader. The gradual decline in the relative importance of the manufacturing (tradables) sector and the associated rise of the services (non-tradables) sector has, however, put the earlier system under strain in many countries.

Sweden provides a good example of both earlier thinking and the current problems for pattern bargaining. Since the conclusion in 1997 of a framework agreement on how wage bargaining should be conducted (the Industry Agreement), it has been generally accepted that the manufacturing sector should act as a wage leader, setting the norm for wage increases in all industry-level wage contracts.[1] This principle has also been written into the instruction of the National Mediation Office. The thinking goes back to the normative "Scandinavian model of wage formation" from the early 1970s, according to which wage increases should follow the room given by price and productivity increases in the tradables sector.[2] In the fixed exchange-rate system of the time, this norm was supposed to discipline wage setting, as firms in the tradables sector would have to adjust their prices to those of foreign competitors if they were to maintain their market shares. Hence, wage setters would realise that higher wage increases than according to the norm would reduce the profit share in the tradables sector and cause unemployment. The belief was that the incentives for wage moderation would be much weaker under uncoordinated bargaining or if the non-tradables sector instead would set the norm, as the possibilities to shift wage increases on to prices are much greater there.

Recently, the wage leadership role of the manufacturing sector has been questioned in Sweden.

[1] See, for example, Lönebildning för full sysselsättning (1999), God sed vid lönebildning (2006) or Medlingsinstitutet (2006).

[2] The Scandinavian model of wage formation was originally formulated as a basis for wage bargaining in Norway; see Aukrust (1972). The Swedish version was termed the EFO model; see Edgren, Faxén and Odhner (1973). An early analysis of the model was provided by Calmfors (1977).

There has been widespread discontent on the part of both service sector employers and unions with the wage leadership role of the manufacturing sector: they argue that it forces them to adjust to an inappropriate wage norm that does not duly take their interests into account. Similar discussions have taken place in other European countries, too, particularly Germany.

There is little previous academic research on the consequences of different choices of wage leader. Our aim is to fill this gap. A key issue is how the effects are influenced by the monetary regime: a flexible exchange rate with inflation targeting or membership in a monetary union (an irrevocably fixed exchange rate). Another aim is to explain why negotiated wage increases in subsequent bargaining tend to follow the key sector wage agreement very closely. We also examine the assertion sometimes made that the key sector agreement provides a "floor" for subsequent agreements. A final issue is how the effects of choosing a sector as wage leader are affected by its size. Our analysis is a follow-up to Calmfors (2008), who discussed pattern bargaining in Sweden in an informal way.

We present a two-sector model of a small open economy. Pattern bargaining is modelled as a Stackelberg game where either the tradables or the non-tradables sector is wage leader. Uncoordinated bargaining is modelled as a Nash equilibrium. We consider first a case with standard trade union utility functions. This analysis gives a few unexpected results. It turns out that the monetary regime is crucial for the effects of wage leadership. Under inflation targeting, the two Stackelberg equilibria coincide with the Nash equilibrium. Pattern bargaining thus provides identical outcomes to uncoordinated bargaining and it does not matter which sector is wage leader. In monetary union, the real wage in the follower sector is the same under pattern bargaining as under uncoordinated bargaining. If the tradables sector is leader in a Stackelberg game, it sets a higher wage than in the Nash equilibrium. In contrast, the non-tradables sector sets a lower wage when it is wage leader in a Stackelberg game than in the Nash game. As a consequence, with pattern bargaining aggregate employment is higher with the non-tradables sector than with the tradables sector as wage leader. This result goes against the conventional wisdom, according to which wage leadership for the tradables sector is conducive to wage restraint and high employment.

We also analyse a case where trade union utility in the follower sector depends on a reference wage, which is taken to be the leader's wage. The idea is to capture the tendency to use the bargained wage in the key sector as the comparison norm in subsequent bargaining in other sectors. This analysis provides an explanation of the strong tendency for pattern bargaining to result in more or less identical wage outcomes in different sectors. Using the Kahneman-Tversky (1979) concept of loss aversion, we show the possibility of corner solutions where it is optimal for the follower to set the same wage as the leader. Such corner solutions can arise under both monetary regimes when the smaller sector is wage leader. The leader may then have an incentive to act strategically to induce the follower to choose such an equilibrium. We show that "comparison thinking" in combination with loss aversion may promote wage restraint and high employment.

The paper is organised as follows. Section 2 briefly reviews related literature. The model assumptions regarding output, employment, prices and monetary policy are presented in Section 3. Section 4 analyses wage setting assuming standard trade union utility functions. Section 5 considers the case where the leader determines a wage norm that influences union utility in the follower sector. Section 6 provides numerical results. Section 7 concludes.

## 2 Related literature

A recent literature has suggested that the conventional result of the neutrality of money does not necessarily obtain in the presence of large wage setters. The reason is that when trade unions are large enough to internalise the impact of their wage decisions on aggregate variables, the potential response of the central bank will affect wage and employment outcomes.

The literature on wage setting and monetary regimes can be divided into two strands. In the first strand, inflation-averse trade unions have an incentive to set low wages to avoid that a time-inconsistent liberal central bank will inflate as in Cukierman and Lippi (1999) and Coricelli et al. (2006). In the second strand, a conservative central bank provides a deterrent to wage increases by threatening to pursue contractionary policy in response to wage hikes (Soskice and Iversen, 2000, Corricelli et al., 2006).[3]

Although most of the literature considers closed economies, exceptions include Vartiainen (2002) and Holden (2003), who compare inflation targeting under a flexible exchange rate with a fixed exchange-rate regime in a two-sector model of a small open economy. These papers show that in

[3] See also Calmfors (2004) for a review of this literature.

the tradables sector, the real wage is higher under inflation targeting than under a fixed exchange rate, while the reverse applies in the non-tradables sector. Under rather general assumptions, employment and welfare are higher under inflation targeting than under a fixed exchange rate.[4]

The models discussed assume that wages in different parts of the economy are set simultaneously and thus independently of each other (Nash equilibrium). Our contribution is to analyse also Stackelberg games where one sector acts as wage leader and the other as wage follower and to compare these equilibria to the Nash equilibrium. The closest counterpart to our paper is Vartiainen (2010), who analyses how Stackelberg leadership in general may be beneficial for employment, but not the consequences of different choices of wage leader.

## 3 The model

Consider a small open economy consisting of a tradables ($T$) and a non-tradables ($N$) sector, where subscript $i = N, T$ indicates sector. Each sector is made up of a continuum of identical perfectly competitive firms. The firms in each sector are indexed on the interval [0,1]. The economy is inhabited by a large number of households with identical utility functions and which consume the two goods. Households consist of two groups: one group provides labour to firms, the other group is made up of "capitalists" owning the firms. The nominal wage in each sector is set through bargaining between one large union and one employers' federation.

The monetary target is given and credible. The timing of events is as follows: In stage one, wages are set. In stage two, the central bank determines monetary policy. In stage three, production, employment, consumption and prices are determined. The model is solved by backward induction and the equilibrium is subgame perfect.

### 3.1 Production, consumption and employment

In the last stage, profit-maximising firms decide how much to produce and utility-maximising households how much to consume. Both firms and households take prices and wages as given.

[4] Larsson (2007) shows that when perfect labour mobility is introduced in a similar setting, worker migration offsets the effects of the monetary regime and the neutrality of money is restored. However, in reality, labour mobility is limited and the prediction that the monetary regime matters is likely to be empirically relevant.

### 3.1.1 Firms

Firms in each sector produce a homogeneous good with labour as the only input. A representative firm in sector $i$ maximises real profits $\Pi_i$ by choosing employment $N_i$ so as to:

$$\max_{N_i} \Pi_i = \left(P_i Y_i - W_i N_i\right)/P, \tag{1}$$

where $P_i$ is the product price in the sector, $W_i$ is the nominal wage in the sector, $Y_i$ is the output of the firm and $P$ is the aggregate price index, subject to the production function:

$$Y_i = \frac{1}{\theta_i} N_i^{\theta_i},$$

where $\theta_i \in (0,1)$. The first-order condition for profit maximisation gives employment in a representative firm in sector $i$:

$$N_i = \left(\frac{W_i}{P_i}\right)^{-\eta_i}, \tag{2}$$

where $\eta_i = (1-\theta_i)^{-1} > 1$ is the labour demand elasticity with respect to the real product wage, $W_i/P_i$. The corresponding supply function is:

$$Y_i = \frac{1}{\theta_i}\left(\frac{W_i}{P_i}\right)^{-\sigma_i}, \tag{3}$$

where $\sigma_i = \theta_i/\left(1-\theta_i\right)$ is the output elasticity with respect to the real product wage. Substituting the profit-maximising levels of output and employment into the profit function, it can be written:

$$\Pi_i = \frac{1}{\eta_i - 1}\frac{W_i}{P}\left(\frac{W_i}{P_i}\right)^{-\eta_i}. \tag{4}$$

Real profits thus depend positively on the real consumption wage, $W_i/P$, and negatively on the real product wage, $W_i/P_i$. The explanation for the former effect is that a rise in the consumption wage at a constant product wage is equivalent to a rise in the real product price, $P_i/P$, which raises profits.

### 3.1.2 Households

Households do not save but instead spend all their incomes. Preferences are Cobb-Douglas. A household thus solves the following optimisation problem:

$$\max_{C_N, C_T} C_N^{\gamma} C_T^{1-\gamma},$$

where $C_i$ is consumption of good $i$, subject to

$$I/P = (P_N C_N + P_T C_T)/P,$$

where $I$ is the nominal income of the household. Real income is given by

$$I/P = \begin{cases} w_i \text{ for a worker employed in sector } i \\ \pi_i \text{ for a capitalist in sector } i \\ 0 \text{ if unemployed,} \end{cases}$$

where $w_i = W_i/P$ is the real consumption wage and $\pi_i$ is the real income from profits of a capitalist in sector $i$. Solving the problem yields the household demand functions $C_N = \gamma I/P_N$ and $C_T = (1-\gamma)I/P_T$. Denoting aggregate income $\tilde{I}$, aggregate demand for non-tradables $\tilde{C}_N$ and aggregate demand for tradables $\tilde{C}_T$ , we obtain:

$$\begin{aligned} \tilde{C}_N &= \gamma \frac{\tilde{I}}{P_N} \\ \tilde{C}_T &= (1-\gamma) \frac{\tilde{I}}{P_T}. \end{aligned} \tag{5}$$

The consumer price level (CPI) is given by:

$$P = P_N^{\gamma} P_T^{1-\gamma}. \tag{6}$$

The budget share, $\gamma$, of non-traded goods is a measure of the economy's openness, so that when $\gamma = 0$ the economy is completely open with production of only tradables and when $\gamma = 1$ the economy is completely closed with production of only non-tradables.

Tradables produced in different countries are perfect substitutes and there exists a common world market for them. This market determines a foreign-currency price of tradables, which by way of the small-country assumption is exogenous to domestic producers. Aggregate output of non-tradables is $\int_0^1 Y_N di = Y_N$. Aggregate output of tradables is $\int_0^1 Y_T di = Y_T$. Clearing of the domestic market for non-tradables implies $Y_N = \tilde{C}_N$. It then follows that $Y_T = \tilde{C}_T$. To see this, use the fact that the zero-savings assumption implies that nominal aggregate expenditure must equal nominal aggregate income, i.e. $P_N Y_N + P_T Y_T = P_N \tilde{C}_N + P_T \tilde{C}_T$.

The production technology is the same in the two sectors, i.e. $\theta_N = \theta_T \equiv \theta$. Using the equality between domestic supply and demand in both sectors, the demand functions (5) and the supply functions (3), we obtain the following "relative market-clearing" condition:

$$\frac{P_N}{P_T} = \left(\frac{\gamma}{1-\gamma}\right)^{1-\theta} \left(\frac{W_N}{W_T}\right)^{\theta}. \tag{7}$$

The equation states that the relative price between non-tradables and tradables, $P_N/P_T$, is uniquely determined by the relative wage between the sectors, $W_N/W_T$. Since the elasticity between the relative price and the relative wage is $\theta < 1$, an increase in the relative wage causes a less than proportional increase in the relative price.

### 3.1.3 Employment

It is convenient to rewrite the labour demand equations in terms of real consumption wages. By using the definition of the aggregate price level (6) and the equation for the equilibrium relative price (7) we obtain:

$$N_N = w_N^{-\eta} \left(\frac{w_N}{w_T}\right)^{(1-\gamma)\sigma} \left(\frac{\gamma}{1-\gamma}\right)^{(1-\gamma)} \tag{8}$$

$$N_T = w_T^{-\eta} \left(\frac{w_T}{w_N}\right)^{\gamma\sigma} \left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}. \tag{9}$$

Equations (8) and (9) imply that employment in a sector depends negatively on the real consumption wages in both sectors.[5] Aggregate employment is obtained by summing (8) and (9):

$$N = \left(\frac{w_N}{w_T}\right)^{(1-\gamma)\sigma} \left(\frac{\gamma}{1-\gamma}\right)^{(1-\gamma)} w_N^{-\eta} + \left(\frac{w_T}{w_N}\right)^{\gamma\sigma} \left(\frac{\gamma}{1-\gamma}\right)^{-\gamma} w_T^{-\eta} \tag{10}$$

## 3.2 Monetary policy

Let $E$ denote the nominal exchange rate in domestic currency per unit of foreign currency and let $P_T^*$ denote the exogenously given foreign-currency price of tradables.[6] Since the law of one price applies for tradables, we have $P_T = EP_T^* = E$ if we normalise the foreign-currency price to unity.

[5] Note that $(1-\gamma)\sigma - \eta = [(1-\gamma)\theta - 1] / [1-\theta] < 0$ and $\gamma\sigma - \eta = [\gamma\theta - 1] / [1-\theta] < 0$.

[6] One can think of the exchange rate as being *endogenously* determined by an interest rate parity condition: $R = R^* + (E^e - E)/E$, where $R$ is the domestic interest rate, $R^*$ is the foreign interest rate and $E^e$ is the expected exchange rate. By setting $R$, the central bank then determines $E$ given $R^*$ and $E^e$. We do not implicitly model monetary policy, but the implicit assumption is thus that the central bank uses an interest rate instrument to influence the exchange rate.

Table 1: Perceived producer and consumer price elasticities under the two regimes

| Regime | (1) $I$ | (2) $M$ |
|---|---|---|
| $\frac{d\ln P_N}{d\ln W_N}$ | $(1-\gamma)\,\theta\left[1-\frac{d\ln W_T}{d\ln W_N}\right]$ | $\theta\left[1-\frac{d\ln W_T}{d\ln W_N}\right]$ |
| $\frac{d\ln P_T}{d\ln W_N}$ | $-\gamma\theta\left[1-\frac{d\ln W_T}{d\ln W_N}\right]$ | 0 |
| $\frac{d\ln P}{d\ln W_N}$ | 0 | $\gamma\theta\left[1-\frac{d\ln W_T}{d\ln W_N}\right]$ |
| $\frac{d\ln P_T}{d\ln W_T}$ | $\gamma\theta\left[1-\frac{d\ln W_N}{d\ln W_T}\right]$ | 0 |
| $\frac{d\ln P_N}{d\ln W_T}$ | $-\left(1-\gamma\right)\theta\left[1-\frac{d\ln W_N}{d\ln W_T}\right]$ | $-\theta\left[1-\frac{d\ln W_N}{d\ln W_T}\right]$ |
| $\frac{d\ln P}{d\ln W_T}$ | 0 | $-\gamma\theta\left[1-\frac{d\ln W_N}{d\ln W_T}\right]$ |

Taking logs and differentiating, (6) implies

$$d\ln P = \gamma d\ln P_N + (1-\gamma)d\ln P_T. \tag{11}$$

Under inflation targeting, the central bank pursues monetary policy in such a way that $d\ln P = 0$ always. Policy must thus induce such exchange rate changes that price changes for tradables exactly offset the effects on the CPI of price changes for non-tradables. More precisely, (11) implies that $d\ln P_T = -\gamma/(1-\gamma)d\ln P_N$. In monetary union (with a fixed exchange rate) it simply holds that $d\ln P_T = 0$.

Taking logs of the relative goods market equilibrium condition (7) and differentiating gives:

$$d\ln P_N - d\ln P_T = \theta\left(d\ln W_N - d\ln W_T\right). \tag{12}$$

Together with (11), (12) determines the effects on prices that wage setters in the two sectors *perceive* their wage decisions to have. These perceived effects will differ depending on the monetary regime and the bargaining arrangements. In Table 1, column (1) shows the perceived price elasticities under inflation targeting ($I$) and column (2) the elasticities under monetary union ($M$). The elasticities are *total* elasticities, taking into account the possibility that a wage change in one sector may affect the wage in the other sector.

## 4 Wage setting

In the first stage of the game, wages are set through bargaining between one union and one employers' federation in each sector. The employers' federation seeks to maximise the profit of a representative firm in the sector. The union tries to maximise the rents from unionisation, i.e. the excess of the utility of union members over the utility that would prevail in the absence of a union. Jobs are randomly assigned among the workers in each sector. $L_i$ is the number of union members per firm in sector $i$. Workers are risk neutral so that the utility of an employed worker in sector $i$ is equal to the real consumption wage $w_i$. The utility of an unemployed worker is $b$, which is taken as exogenous. $b$ can be thought of as the value of home production. Union utility in sector $i$ is thus:

$$V_i = N_i w_i + (L_i - N_i)b - L_i b = N_i(w_i - b). \tag{13}$$

The nominal wage $W_i$ in sector $i$ is set so as to maximise a weighted (geometric) average of the utilities of the two parties, i.e. the optimisation problem is:

$$\max_{W_i} \Omega_i = [N_i (w_i - b)]^{\lambda i} \Pi_i^{1-\lambda_i},$$

where $\lambda_i$ is the relative bargaining power of the union in sector $i$. The maximisation is subject to a set of constraints that differ depending on the monetary regime and the bargaining set-up. Wage setters realise that their wage decisions has a potential effect not only on the own product price but also on the other sector's product price and the aggregate price level. The constraints are:

$$\begin{aligned} N_i &= \left(\frac{W_i}{P_i}\right)^{-\eta} \\ \Pi_i &= \frac{1}{\eta_i - 1} \frac{W_i}{P} \left(\frac{W_i}{P_i}\right)^{-\eta_i} \\ P &= P(W_i, W_j) \\ P_i &= P_i(W_i, W_j) \\ W_j &= f\left(W_i\right), \end{aligned}$$

where index $j$ denotes the other sector. Let $\varphi_i = 1 - d \ln P_i / d \ln W_i$ denote the elasticity of the real product wage, $W_i/P_i$, with respect to the nominal wage $W_i$ and $\epsilon_i = 1 - d \ln P / d \ln W_i$ the elasticity of the real consumption wage, $W_i/P$, with respect to the nominal wage.

The first-order condition for maximisation is:

$$\Omega_{W_i} = \lambda_i \left[ \frac{w_i \epsilon_i}{(w_i - b)} - \eta \varphi_i \right] + (1 - \lambda_i) \left[ \epsilon_i - \eta \varphi_i \right] = 0, \tag{14}$$

where $\Omega_{W_i} = \partial \ln \Omega_i / \partial \ln W_i$ throughout the paper. The condition states that the marginal gain for the union from a wage increase must balance the marginal loss for the employers' federation. The marginal gain for the union is the difference between the utility gain from a higher real consumption wage and the utility loss from lower employment. Solving for the real consumption wage we obtain:

$$w_i = \frac{W_i}{P} = \left[1 + \lambda_i M_i\right] b, \tag{15}$$

where $M_i = \epsilon_i / (\eta \varphi_i - \epsilon_i)$. The real consumption wage in a sector is thus a positive mark-up on the value of unemployment. The parameters $\varphi_i$ and $\epsilon_i$ depend on the monetary regime and the wage-setting arrangement and will therefore determine how the equilibria differ. Below we analyse both a Nash equilibrium (uncoordinated bargaining) and the two possible Stackelberg equilibria (pattern bargaining) with one of the sectors as leader and the other as follower.

## 4.1 The wage follower

It is instructive to first analyse wage behaviour of the follower in a Stackelberg game. The follower takes the leader's nominal wage as given. It thus acts in the same way as in a Nash game, when each sector takes the nominal wage of the other sector as given. The assumption of a given money wage in the other sector means that $f' = 0$. Hence:

$$\varphi_i = 1 - d \ln P_i / d \ln W_i = 1 - \partial \ln P_i / \partial \ln W_i \tag{16}$$

and

$$\epsilon_i = 1 - d \ln P / d \ln W_i = 1 - \partial \ln P / \partial \ln W_i \tag{17}$$

in (15) when it applies to the follower in a Stackelberg game and to each sector in a Nash game.

## 4.2 The wage leader

Bargaining in the leader sector in a Stackelberg game also takes into account the response of the follower, i.e. the leader internalises the impact of its wage decision on the wage of the follower.

Table 2: Producer and consumer price effects under different institutional settings

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Regime | $I$ | $I$ | $I$ | $M$ | $M$ | $M$ |
| Leader | $Nash$ | $N$ | $T$ | $Nash$ | $N$ | $T$ |
| Restrictions | $\frac{d\ln W_i}{d\ln W_j}=0,\forall i$ | $\frac{d\ln W_N}{d\ln W_T}=0$ | $\frac{d\ln W_T}{d\ln W_N}=0$ | $\frac{d\ln W_i}{d\ln W_j}=0,\forall i$ | $\frac{d\ln W_N}{d\ln W_T}=0$ | $\frac{d\ln W_T}{d\ln W_N}=0$ |
| $\frac{d\ln P_N}{d\ln W_N}$ | $(1-\gamma)\,\theta$ | $(1-\gamma)\,\theta$ | $(1-\gamma)\,\theta$ | $\theta$ | $\frac{\theta}{1+\gamma\theta}$ | $\theta$ |
| $\frac{d\ln P_T}{d\ln W_N}$ | $-\gamma\theta$ | $-\gamma\theta$ | $-\gamma\theta$ | $0$ | $0$ | $0$ |
| $\frac{d\ln P}{d\ln W_N}$ | $0$ | $0$ | $0$ | $\gamma\theta$ | $\frac{\gamma\theta}{1+\gamma\theta}$ | $\gamma\theta$ |
| $\frac{d\ln P_T}{d\ln W_T}$ | $\gamma\theta$ | $\gamma\theta$ | $\gamma\theta$ | $0$ | $0$ | $0$ |
| $\frac{d\ln P_N}{d\ln W_T}$ | $-(1-\gamma)\,\theta$ | $-(1-\gamma)\,\theta$ | $-(1-\gamma)\,\theta$ | $-\theta$ | $-\theta$ | $-\frac{\theta}{(1-\gamma\theta)}$ |
| $\frac{d\ln P}{d\ln W_T}$ | $0$ | $0$ | $0$ | $-\gamma\theta$ | $-\gamma\theta$ | $-\frac{\gamma\theta}{(1-\gamma\theta)}$ |

Letting index $i$ denote the leader and index $j$ the follower, applying (15) to the leader gives:

$$\begin{aligned}\varphi_i &= 1-\frac{d\ln P_i}{d\ln W_i}=1-\frac{\partial\ln P_i}{\partial\ln W_i}-\frac{\partial\ln P_i}{\partial\ln W_j}\frac{d\ln W_j}{d\ln W_i}\\ \epsilon_i &= 1-\frac{d\ln P}{d\ln W_i}=1-\frac{\partial\ln P}{\partial\ln W_i}-\frac{\partial\ln P}{\partial\ln W_j}\frac{d\ln W_j}{d\ln W_i}.\end{aligned}$$

When evaluating the price effects of an own wage increase, the leader thus takes into account that prices are not only influenced by the direct effect of the wage increase but also by an indirect effect from the induced change in the wage of the follower. It follows from (15) applied to the follower sector that

$$\frac{d\ln W_j}{d\ln W_i}=\frac{d\ln P}{d\ln W_i}, \tag{18}$$

i.e. the elasticity of the follower's nominal wage with respect to the leader's nominal wage equals the elasticity of the CPI with respect to the leader's nominal wage. This is the consequence of the fact that for a given value of unemployment, $b$, (15) determines a unique real consumption wage, $W_i/P$, for the follower in each regime.

## 4.3 Price elasticities under different institutional conditions

To compare different equilibria we develop the expressions in Table 1 for the perceived total price elasticities under different monetary regimes and bargaining arrangements. We do so by inserting the proper values of $d \ln W_N / d \ln W_T$ and $d \ln W_T / d \ln W_N$. In a Nash equilibrium we set both derivatives to zero. If sector $i$ is wage leader, it internalises the impact it has on the follower sector $j$ according to (18) and we thus impose $d \ln W_j / d \ln W_i = d \ln P / d \ln W_i$. The follower sector $j$, on the other hand, takes $W_i$ as given and we therefore impose the restriction $d \ln W_i / d \ln W_j = 0$ for it.

In Table 2, columns (1)-(3) show the perceived price elasticities under inflation targeting for different wage-setting assumptions. Column 1 applies to the Nash equilibrium, column 2 to the Stackelberg equilibrium with the non-tradables sector as wage leader and column 3 to the Stackelberg equilibrium with the tradables sector as wage leader. Columns (4)-(6) show the corresponding elasticities in monetary union.

It is useful to first give the intuition in the Nash equilibrium. Consider first inflation targeting. Then by definition there are no consumer price effects, which implies that both $d \ln P / d \ln W_N$ and $d \ln P / d \ln W_T$ are zero. The mechanisms are as follows. A wage increase in the tradables sector causes a reduction in output in that sector, leading to lower aggregate income and lower demand for non-tradables. The fall in demand puts downward pressure on the price of non-tradables. To offset the effect on the CPI, the central bank engineers an exchange rate depreciation, raising the price of tradables.

A wage increase in the non-tradables sector generates upward pressure on the CPI. Hence, under inflation targeting the central bank engineers an exchange rate appreciation to counter this effect. A wage increase in the non-tradables sector raises the price of non-tradables, whereas the price of tradables falls.

In monetary union, the nominal exchange rate does not change. If the wage increases in the tradables sector, the price of tradables is not affected, but output falls. This in turn leads to a fall in aggregate income, which reduces the demand for non-tradables. As a result, both the price of non-tradables and the CPI fall. A wage increase in the non-tradables sector causes a negative supply shift in the sector, with the consequence that both the price of non-tradables and the CPI rise.

How does pattern bargaining change the perceived elasticities? The consumer price effects under inflation targeting are still zero. But the table also shows that the perceived producer price elasticities under inflation targeting are the same as in the Nash game. This is self-evident for a wage change by the follower, who takes the money wage of the leader as given. The reason why the perceived price elasticity is the same for the leader as well is that the effect of the leader's wage on the follower's wage according to (18) goes via the CPI. Since the wage leader internalises the fact that the central bank will prevent an own wage increase from raising the CPI, it realises that the nominal wage of the follower will remain unchanged just as in the Nash game.

Under a fixed exchange rate, the bargaining arrangement *does* matter for the size of the price elasticities. Consider first the case where the non-tradables sector is leader. An increase in the $N$-sector wage raises the price of non-tradables and thus also the CPI. But the wage setters in the non-tradables sector realise that this consumer price increase will cause the wage in the tradables sector to increase by as much. As the tradables sector increases its wage, output in the sector falls and thus also aggregate income. The associated fall in demand counteracts the rises in both the price of non-tradables and the CPI. Hence, both the own producer price and the consumer price effects of a wage rise in the non-tradables sector are perceived to be smaller when the sector is wage leader than when wages are set simultaneously.

If the tradables sector is wage leader the mechanisms are as follows. A rise in $W_T$ causes a fall in the output of tradables and thus in aggregate income. This reduces the demand for non-tradables and causes their price to drop. The associated fall in the CPI leads to a *decrease* in the nominal wage in the non-tradables sector, holding the real consumption wage there, $W_N/P$, unchanged. The nominal wage reduction in the $N$-sector amplifies the decreases in the price of non-tradables and the CPI. Wage setters in the tradables sector will thus perceive larger falls in the price of non-tradables and the CPI when they are wage leaders than when wages are set simultaneously.

### 4.4 Comparison of equilibria

We use (15) to compare the wage outcomes under different bargaining set-ups and monetary regimes. We focus on within-sector comparisons between monetary regimes and bargaining set-ups, which implies that differences in the mark-up $\lambda_i M_i$ only depend on differences in $M_i$.[7] So a ranking of $M_i$ (which will subsequently be referred to as the "mark-up factor") across regimes and

[7] The rankings of real wages and employment across sectors in a given regime have been addressed by Vartiainen (2002) and Holden (2003).

Table 3: Wage mark-up factors under different institutional settings

| | (1) | (2) | (3) |
|---|---|---|---|
| Leader | $Nash$ | $N$ | $T$ |
| $M_{NI}$ | $\frac{1-\theta}{\gamma\theta}$ | $\frac{1-\theta}{\gamma\theta}$ | $\frac{1-\theta}{\gamma\theta}$ |
| $M_{TI}$ | $\frac{1-\theta}{(1-\gamma)\theta}$ | $\frac{1-\theta}{(1-\gamma)\theta}$ | $\frac{1-\theta}{(1-\gamma)\theta}$ |
| $M_{NM}$ | $\frac{1-\gamma\theta}{\gamma\theta}$ | $\frac{1-\theta}{\gamma\theta}$ | $\frac{1-\gamma\theta}{\gamma\theta}$ |
| $M_{TM}$ | $\frac{(1+\gamma\theta)(1-\theta)}{\theta(1-\gamma+\gamma\theta)}$ | $\frac{(1+\gamma\theta)(1-\theta)}{\theta(1-\gamma+\gamma\theta)}$ | $\frac{1-\theta}{(1-\gamma)\theta}$ |

bargaining arrangements is also a ranking of the corresponding real wages. By using the perceived total price elasticities under different conditions in Table 2, the mark-up factors in Table 3 are obtained. Let superindex $k = N, T, Nash$ indicate the Stackelberg equilibrium with sector $N$ as leader, the Stackelberg equilibrium with sector $T$ as leader and the Nash equilibrium, respectively. Multiple superindices indicate that the mark-up factor assumes the same value for the indicated institutional settings. As before, subindex $i = N, T$ indicates for which sector the mark-up factor applies. Subindex $m = I, M$ denotes the monetary regime.

**Proposition 1** *Under inflation targeting, the Nash equilibrium coincides with the two Stackelberg equilibria, since $M_{iI}^{Nash} = M_{iI}^{N} = M_{iI}^{T}$ for $i = N, T$. So, it does not matter what sector is leader under pattern bargaining and this form of bargaining gives the same outcome as uncoordinated bargaining.*

This is an important conclusion as it implies - contrary to the presumption in the general debate - that the bargaining set-up is irrelevant under inflation targeting.[8] The result is easy to understand. The difference between a Nash and a Stackelberg game is that the leader in the latter case takes the effect of its wage decision on the follower's wage into account. But this effect goes via the CPI: the follower's nominal wage rises equiproportionally to the CPI increase so that the real consumption wage is held constant. Under inflation targeting this channel is cut off, as the

[8] This result hinges on the assumption of Cobb-Douglas preferences since this implies reaction functions according to which the wage in a sector is independent of the wage in the other sector. This does not hold with CES preferences which have been analysed by Vartiainen (2010).

central bank prevents the CPI from changing. Hence, the central bank response implies that the leader takes the follower's nominal wage as constant also in the Stackelberg game. Each sector thus faces the same optimisation problem when the game is Nash, when the sector is wage leader in a Stackelberg game and when the sector is follower in a Stackelberg game. Hence the real consumption wage in each sector is the same in all three cases. This implies that employment and profits are also the same across alternative bargaining set-ups.

**Proposition 2** *In monetary union, the real consumption wage in a sector is the same when the sector is wage follower in a Stackelberg game as in a Nash game, since* $M_{iM}^{j} = M_{iM}^{Nash}$ *for* $i, j = N, T$*,* $i \neq j$*.*

The intuition is obvious, since the follower in the Stackelberg game solves the same optimisation problem as the sector does in the Nash game. The equality of real consumption wages between the two games does not, however, imply equality between nominal wages, as these will differ to the extent that the CPI levels differ.[9]

**Proposition 3** *In monetary union, the real consumption wage in the non-tradables sector is lower in the Stackelberg game when the sector is wage leader than in the Nash game as* $M_{NM}^{Nash} > M_{NM}^{N}$*. The Stackelberg game with the non-tradables sector as wage leader gives higher employment in both sectors, and thus also higher aggregate employment, than the Nash game.*

**Proof.** It is straightforward to show that $M_{NM}^{Nash} > M_{NM}^{N}$ is equivalent to $(1-\gamma\theta)/\gamma\theta > (1-\theta)/\gamma\theta$, which must hold as $\gamma < 1$. ■

When being wage leader, bargainers in the non-tradables sector know that if they raise the wage, the resulting increase in the price of non-tradables dampens the rise in the real product wage and thus the reductions in employment and profits in the sector. But they also realise that the rise in the price of non-tradables, by pushing up the CPI, triggers a wage increase in the tradables sector. As a consequence, output of tradables and aggregate income fall. This lowers the demand for non-tradables and counteracts the rise in the price of non-tradables. This additional negative producer price effect compared to the Nash equilibrium implies a larger rise in the real product

[9] See footnote 10.

wage and hence a larger moderating influence on wages. The negative producer price effect also triggers a fall in consumer prices that benefits both employers and employees, but this effect is smaller in magnitude than the disciplining producer price effect.[10]

The employment consequences follow from equations (8)-(9). As the real consumption wage is lower in the (leader) non-tradables sector than in the Nash equilibrium (Proposition 3) and the same in the (follower) tradables sector (Proposition 2), employment in both sectors must be higher in the Stackelberg equilibrium with the non-tradables sector as wage leader than in the Nash equilibrium.

**Proposition 4** *In monetary union, the real consumption wage in the tradables sector is higher in the Stackelberg game when the sector is leader than in the Nash game as* $M_{TM}^{T} > M_{TM}^{Nash}$. *The Stackelberg game with the tradables sector as leader results in lower employment in both sectors than in the Nash game.*

**Proof.** It can be shown that $M_{TM}^{T} > M_{TM}^{Nash}$ if, and only if, $(1-\theta)/(1-\gamma)\theta > (1+\gamma\theta)(1-\theta)/\theta(1-\gamma+\gamma\theta)$. This is equivalent to $\gamma\theta > \gamma\theta(1-\gamma)$, which must hold since $\gamma < 1$. ■

In monetary union, there are no producer price effects that affect the wage decision in the tradables sector, as the price of tradables is fixed. But there is a negative CPI effect from a wage rise in the tradables sector that comes from the fall in output of tradables, and hence in aggregate income, which causes a reduction in the demand for non-tradables. This negative CPI effect strengthens the incentives for a high wage in the tradables sector in both the Nash and the Stackelberg equilibrium, since it raises the purchasing power of the wage. But the incentive effect is stronger in the latter case. The reason is that the reduction in the CPI causes a fall in the wage in the non-tradables sector. This reduces consumer prices even more than in the Nash game. Hence, since the negative CPI effect is amplified by the fall in non-tradables wages, the incentive for high wages in the tradables sector is even stronger when the sector is leader under pattern bargaining than in the Nash equilibrium.

[10] As $W_N/P$ is lower in this case than in the Nash equilibrium and $W_T/P$ the same, it follows from the relative market clearing equation that $P_N/P_T$ is lower. With a given $P_T$, $P_N$ and thus also $P$ must be lower. It follows that the nominal wage in the (follower) tradables sector $W_T$ is lower in the Stackelberg equilibrium with the non-tradables sector as wage leader than in the Nash equilibrium. A similar reasoning shows that the nominal wage in the (follower) non-tradables sector $W_N$ is higher in the Stackelberg equilibrium with the tradables sector as wage leader than in the Nash equilibrium.

Because the real consumption wage is higher in the (leader) tradables sector than in the Nash equilibrium and the same in the (follower) non-tradables sector, it follows from (8) and (9) that employment in both sectors is lower in the Stackelberg equilibrium with the tradables sector as leader than in the Nash equilibrium.

The above results go against the conventional wisdom that under a fixed exchange rate (monetary union) pattern bargaining with the tradables sector as leader promotes wage restraint and high employment.[11] Our conclusion is the reverse one: it is pattern bargaining with the non-tradables sector as leader that is conducive to wage restraint and high employment in a fixed exchange-rate regime.

The problem with the conventional wisdom is that it assumes that the *direct* wage-restraining effect from foreign competition in the tradables sector dominates. Our model highlights instead the importance of *general-equilibrium interaction* between the two sectors. The results can be understood in terms of the relation between perceived changes in the real product wage and in the real consumption wage. Optimisation by wage setters strikes a balance between the two. A nominal wage hike is positive to the extent that it raises the real consumption wage (as both union welfare and profits increase at a given real product wage), but it is negative to the extent that the real product wage rises (as both employment and profits fall at a given real consumption wage).[12]

With a fixed exchange rate, a one percent increase of the wage in the tradables sector implies also a one percent increase in the real product wage in the sector. Table 2 shows that the real consumption wage in the sector rises by $1 - d\ln P/d\ln W_T = 1 + \gamma\theta$ percent in the Nash case and by $1 - d\ln P/d\ln W_T = 1 + \gamma\theta/(1-\gamma\theta)$ percent in the Stackelberg case with the tradables sector as leader. As $\gamma\theta/(1-\gamma\theta) > \gamma\theta$, it is clear that there is a more favourable trade-off between consumption and product wage increases in the Stackelberg than in the Nash case. This is what creates the stronger incentive for wage rises when the tradables sector is leader. In a similar vein, it can be shown that the balance between perceived consumption and product wage increases is less favourable in the Stackelberg case with the non-tradables sector as leader than in the Nash case.

[11] See, e.g., Calmfors (2008).

[12] The importance of the relationship between the real product wage and the real consumption wage can be illustrated by re-writing the first-order condition (14) as $\epsilon_i \left[\frac{w_i \epsilon_i}{(w_i - b)} + 1 - \lambda_i\right] - \eta\varphi_i = 0$. The first term is the positive effect on the weighted utility of the union and the employers' federation of a one percent increase in the nominal wage via the real consumption wage and the second term the negative effect via the real product wage.

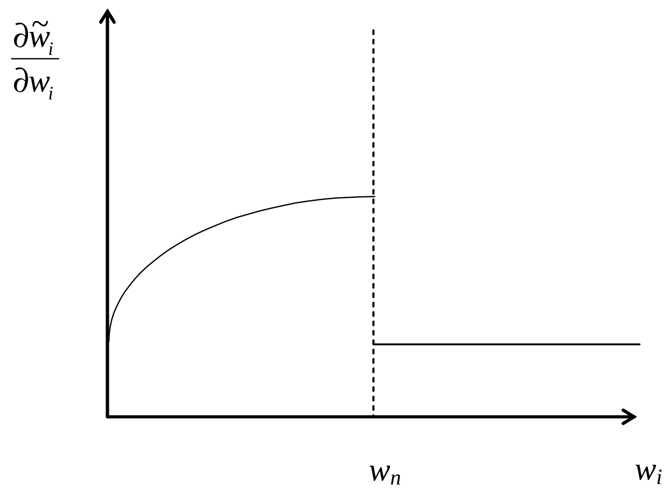


Figure 1: Union-perceived marginal utility of the real wage for an employed worker, $\alpha_1 \in (0, 1)$.

# 5 Wage setting with wage norms

A well-known feature of collective bargaining is the important role played by wage comparisons. Under pattern bargaining the wage increases in the key sector often become a reference norm for subsequent agreements. There is a strong tendency for wage increases in other sectors to follow this norm closely. This section extends our analysis to account for this. It is done by incorporating the Kahneman-Tversky (1979) concept of loss aversion in the way proposed by Bhaskar (1990), according to which a larger weight is attached to losses relative to a reference norm than to gains.

## 5.1 Trade union utility

We now assume that the utility of an employed worker in sector $i$, as perceived by the union, depends on both the real wage received and on a wage comparison norm, denoted $w_n$.[13] Following Holden and Wulfsberg (2007), the assumption is that the perceived utility of an employed worker in sector $i$ is $\widetilde{w}_i = w_i^{1+\alpha_k}/w_n^{\alpha_k}$, where $\alpha_k$ measures the importance of wage comparisons. In accordance

[13] Our assumption is thus that comparison thinking influences the union utility function, which matters for wage setting, but not the utility function of consumers, which determines the demand functions for goods.

with the Kahneman-Tversky hypothesis of loss aversion, $\alpha_k$ takes on different values depending on whether or not the wage exceeds the norm. More specifically, we assume that wage comparisons matter for union-perceived utility only when the wage is below the comparison norm, i.e.

$$\alpha_k = \begin{cases} \alpha_1 > 0 \text{ when } w_i \leq w_n, \\ 0 \text{ when } w_i > w_n. \end{cases}$$

The union-perceived marginal utility of the real wage for an employed worker is thus a non-differentiable function at $w_i = w_n$. It takes on a larger value for a wage immediately below than for a wage immediately above the norm, as shown in Figure 1, since

$$\frac{\partial \widetilde{w}_i}{\partial w_i} = (1 + \alpha_k) \left( \frac{w_i}{w_n} \right)^{\alpha_k}.$$

We continue to assume that the union-perceived utility of an unemployed worker is the value of home production $b$. For the union, wage comparisons play no role with regard to the unemployed. Hence, the utility function for the union in sector $i$ is now:

$$V_i = N_i \left( \widetilde{w}_i - b \right) = N_i \left[ \frac{w_i^{1+\alpha_k}}{w_n^{\alpha_k}} - b \right]. \tag{19}$$

(19) is substituted for (13) in the weighted utility function to be maximised when the wage is set.

## 5.2 The wage follower

We assume that the real consumption wage in the leader sector serves as the reference norm for the follower. As before we denote the leader by subindex $i$ and the follower by subindex $j$. Hence, the assumption is that $w_n = w_i$. The optimisation problem of the follower then is:

$$\max_{W_j} \Omega_j = \left[ N_j \left( \frac{w_j^{1+\alpha_k}}{w_i^{\alpha_k}} - b \right) \right]^{\lambda_j} [\Pi_j]^{1-\lambda_j}.$$

subject to

$$\begin{aligned} N_j &= \left( \frac{W_j}{P_j} \right)^{-\eta} \\ \Pi_j &= \frac{1}{(\eta - 1)} \frac{W_j}{P} \left( \frac{W_j}{P_j} \right)^{-\eta} \\ P &= P(W_j, W_i) \\ P_j &= P_j(W_j, W_i), \end{aligned}$$

and taking $W_i$ as given. Let $\varphi_j = (1 - d\ln P_j/d\ln W_j)$ and $\epsilon_j = (1 - d\ln P/d\ln W_j)$ as before. Note that:

$$\frac{\partial}{\partial \ln W_j} \ln\left(\frac{W_j^{1+\alpha_k}}{W_i^{\alpha_k} P} - b\right) = \frac{\frac{W_j^{1+\alpha_k}}{W_i^{\alpha_k} P}\left(1 + \alpha_k - \left(\frac{\partial \ln P}{\partial \ln W_j}\right)\right)}{\left(\frac{W_j^{1+\alpha_k}}{W_i^{\alpha_k} P} - b\right)} = \frac{\widetilde{w}_j\left(\alpha_k + \epsilon_j\right)}{\left(\widetilde{w}_j - b\right)},$$

where

$$\widetilde{w}_j \equiv \frac{W_j^{1+\alpha_k}}{W_i^{\alpha_k} P} = \frac{w_j^{1+\alpha_k}}{w_i^{\alpha_k}} = w_j\left(\frac{w_j}{w_i}\right)^{\alpha_k}.$$

The discontinuity of the union utility function means there could be both an interior and a corner solution. The interior solution is given by:

$$\frac{\partial \ln \Omega_j}{\partial W_j} = \Omega_{W_j} = \lambda_j\left[-\eta\varphi_j + \frac{\widetilde{w}_j\left(\alpha_k + \epsilon_j\right)}{\left(\widetilde{w}_j - b\right)}\right] + (1 - \lambda_j)\left[\epsilon_j - \eta\varphi_j\right] = 0 \tag{20}$$

Solving (20) for $\widetilde{w}_j$, we obtain:

$$\widetilde{w}_j = \left[1 + \lambda_j \widetilde{M}_j\right] b, \tag{21}$$

where $\widetilde{M}_j = \left(\alpha_k + \epsilon_j\right) / \left(\eta\varphi_j - \epsilon_j - \lambda_j\alpha_k\right)$. Equation (21) states that the union-perceived utility of an employed worker is again a mark-up over the value of unemployment. Equivalently, equation (21) can be written as an equation for the real consumption wage in sector $j$, which is homogenous of degree one in the value of unemployment and the wage in the leader sector:

$$w_j = \left[1 + \lambda_j \widetilde{M}_j\right]^{\frac{1}{1+\alpha_k}} b^{\frac{1}{1+\alpha_k}} w_i^{\frac{\alpha_k}{1+\alpha_k}}, \tag{22}$$

With an interior solution, the real wage in the follower sector is thus a mark-up on a weighted geometric average of the value of unemployment and the wage norm set by the leader sector.

A corner solution with $w_j = w_i$ is obtained when

$$\lim_{w_j \to w_i^-} \Omega_{W_j}^- \equiv \lim_{w_j \to w_i^-} \frac{\partial \ln \Omega_j}{\partial \ln W_j} = \lambda_j\left[-\eta\varphi_j + \frac{\widetilde{w}_j(\alpha_1 + \epsilon_j)}{(\widetilde{w}_j - b)}\right] + (1 - \lambda_j)\left[\epsilon_j - \eta\varphi_j\right] > 0$$

$$\lim_{w_j \to w_i^+} \Omega_{W_j}^+ \equiv \lim_{w_j \to w_i^+} \frac{\partial \ln \Omega_j}{\partial \ln W_j} = \lambda_j\left[-\eta\varphi_j + \frac{\epsilon_j \widetilde{w}_j}{(\widetilde{w}_j - b)}\right] + (1 - \lambda_j)\left[\epsilon_j - \eta\varphi_j\right] < 0,$$

where $\Omega_{W_j}^- \equiv \Omega_{W_j}$ for $w_j \leq w_i$ and $\Omega_{W_j}^+ = \Omega_{W_j}$ for $w_j > w_i$. This means that when the weighted gain to the bargaining parties of a wage increase is positive immediately below the wage $w_i$ set by the leader, but negative immediately above this wage, it is optimal for the follower to choose the same wage as the leader. This is a consequence of our loss aversion assumption.

Table 4: Wage mark-ups under different assumptions about sector setting the wage norm

| Leader | $N$ | $T$ |
|---|---|---|
| $M_{NI}$ | $\frac{(1-\theta)(1+\alpha_1)}{\theta(\alpha_1+\gamma)}$ | |
| $\widetilde{M}_{TI}$ | $\frac{(1+\alpha_1)(1-\theta)}{(1-\gamma\theta)-(1+\lambda_T\alpha_1)(1-\theta)}$ | |
| $M_{TI}$ | | $\frac{(1-\theta)(1+\alpha_1)}{\theta(\alpha_1+1-\gamma)}$ |
| $\widetilde{M}_{NI}$ | | $\frac{(1+\alpha_1)(1-\theta)}{(1-(1-\gamma)\theta)-(1+\lambda_N\alpha_1)(1-\theta)}$ |
| $M_{NM}$ | $\frac{(1-\theta)(1+\alpha_1)}{\theta(\alpha_1+\gamma)}$ | |
| $\widetilde{M}_{TM}$ | $\frac{(1+\alpha_1+\gamma\theta)(1-\theta)}{\theta(1-\gamma+\gamma\theta)-\lambda_T\alpha_1(1-\theta)}$ | |
| $M_{TM}$ | | $\frac{(1-\theta)(1+\alpha_1)}{\theta(\alpha_1+1-\gamma)}$ |
| $\widetilde{M}_{NM}$ | | $\frac{1+\alpha_1-\gamma\theta}{\gamma\theta-\lambda_N\alpha_1}$ |

### 5.3 The wage leader

Since the wage comparison norm is the wage of the leader, the union-perceived utility of an employed worker in the leader sector is the same as in Section 4.1, i.e. $\widetilde{w}_i = w_i^{1+\alpha_k}/w_i^{\alpha_k} = w_i$. It follows that the trade union utility function is the same, as is the weighted utility function to be maximised in the wage-setting process. The employment and price equations are also identical.

However, the maximisation problem of the leader is now more complex than in Section 4.1 because of the possibility of various types of equilibria for the follower. It is not enough for the leader to maximise subject to the response function of the follower given the type of equilibrium for the latter. The leader can also set its wage strategically to achieve the type of equilibrium (corner solution or interior solutions for the follower) that gives it the highest utility.

We proceed as follows. First, we analyse potential equilibria with interior solutions for the follower. Second, we analyse potential equilibria with corner solutions for the follower. Third, we derive the actual equilibria that are realised.

Table 5: Critical values for $\alpha$, below which there is a potential equilibrium such that $w_j < w_i$

| Leader | $N$ | $T$ |
|---|---|---|
| Inflation targeting | $\frac{1-2\gamma}{1+\lambda(1-\theta)/\theta}$ | $\frac{1-2(1-\gamma)}{1+\lambda(1-\theta)/\theta}$ |
| Monetary union | $-\frac{\left[2\gamma+\frac{\lambda}{\theta}(1-\theta)\right]}{2\left[1+\frac{\lambda}{\theta}(1-\theta)\right]} \pm \left(\frac{\left[2\gamma+\frac{\lambda}{\theta}(1-\theta)\right]^2}{4\left[1+\frac{\lambda}{\theta}(1-\theta)\right]^2}+\frac{\left[1-2\gamma+\gamma(1-\gamma)\theta\right]}{\left[1+\frac{\lambda}{\theta}(1-\theta)\right]}\right)^{1/2}$ | $-\frac{\left[2(1-\gamma)+\frac{\lambda}{\theta}(1-\theta)\right]}{2\left[1+\frac{\lambda}{\theta}(1-\theta)\right]} \pm \left(\frac{\left[2(1-\gamma)+\frac{\lambda}{\theta}(1-\theta)\right]^2}{4\left[1+\frac{\lambda}{\theta}(1-\theta)\right]^2}+\frac{\left[2\gamma-1-\gamma^2\theta\right]}{\left[1+\frac{\lambda}{\theta}(1-\theta)\right]}\right)^{1/2}$ |

### 5.4 Potential equilibria with interior solutions for the follower

With an interior solution for the follower, (22) implies that the follower's response function is:

$$\frac{d\ln W_j}{d\ln W_i} = \frac{\alpha_k}{1+\alpha_k} + \frac{1}{1+\alpha_k}\frac{d\ln P}{d\ln W_i},$$

where $\alpha_k = \alpha_1 > 0$ applies for $w_j < w_i$ and $\alpha_k = \alpha_2 = 0$ for $w_j > w_i$.

#### 5.4.1 Interior solutions with a lower wage for the follower than for the leader

We first examine potential equilibria with interior solutions for the follower where $w_j < w_i$. The real wage of the leader is still given by an equation of the same form as (15). The real wage of the follower is given by equation (22). Dividing the two equations by each other gives:

$$\frac{w_j}{w_i} = \left(\frac{1+\lambda_j\widetilde{M_j}}{1+\lambda_i M_i}\right)^{\frac{1}{1+\alpha_1}}.$$

Assuming that $\lambda_i = \lambda_j = \lambda$, it is obvious that an equilibrium with $w_j < w_i$ requires that $\widetilde{M_j} < M_i$. The mark-up factors under various institutional assumptions are given in Table 4. The condition for a potential equilibrium with a lower wage for the follower than for the leader is that the $\alpha$-term, measuring the importance of wage comparisons, is below a critical value $\overline{\alpha}$, the magnitude of which depends on the monetary regime and what sector is leader. Table 5 displays these critical values. Under inflation targeting, an equilibrium with a lower wage for the follower than the leader can never come about if the leader sector is the larger one. If, for example, under inflation targeting the $N$-sector is leader and $\gamma > \frac{1}{2}$, so that this sector is the larger one, the critical value is negative

Table 6: Conditions for $w_j > w_i$ in the case of an interior solution for the follower

| Leader | $N$ | $T$ |
|---|---|---|
| Inflation targeting | $\gamma > \frac{1}{2}$ | $1-\gamma > \frac{1}{2}$ |
| Monetary union | $\gamma > \frac{1}{2}$ | $1-\gamma > \frac{1}{2} + \gamma^2\theta/2$ |

(first row, first column in the table). But since $\alpha$ is always positive by assumption, it can never be below this critical value.[14]

#### 5.4.2 Interior solutions with a higher wage for the follower than for the leader

In the case of an interior solution with a higher wage for the leader than for the follower, (15) gives the wages for both the leader and the follower. The mark-up factors are the same as in Table 3, as $\alpha_2 = 0$ when $w_j > w_i$ implies that we are back to the case without comparison norms.

From Table 3, it is straightforward to derive under what conditions interior solutions with a higher wage for the follower than the leader could occur. Table 6 shows that in three out of four possible cases an equilibrium with a higher wage for the follower than for the leader can occur only when the leader is the larger sector: the two inflation-targeting cases and the monetary-union case with the non-tradables sector as leader. In the monetary-union case with the tradables sector as leader, it is not enough that this sector is the larger one for the follower (non-tradables) sector to set the higher wage: the size of the leader (tradables) sector must be above a critical limit: $\frac{1}{2} + \gamma^2\theta/2$. The intuition for the effect of size on the relative wage is that a larger leader sector has a stronger incentive for wage moderation, as its wage rises induce larger effects on the rest of the economy, which causes negative feedback effects on the own sector's utility.

### 5.5 Possible equilibria with corner solutions for the follower

Next, we examine the possibility of an equilibrium with a corner solution for the follower where it sets the same wage as the leader. Vartiainen (2010) has shown that a bargaining system where the

[14] Similarily, if the tradables sector is wage leader and this sector is the larger, i.e. $1-\gamma > \frac{1}{2}$, then the critical value is again negative (first row, second column in Table 5).

follower's wage mimics the leader's wage is conducive to high employment and high welfare under the assumption of monopoly unions. The explanation is that the leader's wage choice is disciplined by the "irresponsibility" of the follower: because the leader knows that its wage will also be the follower's wage, it has a strong incentive for wage restraint. A natural question is whether such a beneficial equilibrium can arise in our model.

To examine this, we solve the leader's optimisation problem under the assumption that the follower's wage equals the leader's wage, i.e. $W_j = W_i$. If we again assume that $\lambda_i = \lambda_j = \lambda$, we can compare the mark-up factors $M_i$ after having inserted the proper total price elasticities $d\ln P_i/d\ln W_i$ and $d\ln P/d\ln W_i$ in the expressions for $\epsilon_i$ and $\varphi_i$. It turns out that under this assumption, the wage outcome for the leader is the same independent of monetary regime and which sector is wage leader, as $M^N_{NI} = M^N_{NM} = M^T_{TI} = M^T_{TM} = (1-\theta)/\theta$.[15]

The described behaviour of the leader is an equilibrium behaviour only if the follower does choose the corner solution perceived by the leader. This requires that $\Omega^-_{W_j} > 0$ and $\Omega^+_{W_j} < 0$.[16] We show in the Appendix that at the wage chosen by the leader under the corner solution assumption, $w_i = (1+\lambda(1-\theta)/\theta)b$, the second inequality never holds. Instead, it is always the case that $\Omega^+_{W_j} > 0$. This implies that the follower always chooses a higher wage than the leader in this case. Hence, in our model there does not exist an equilibrium of the Vartiainen type where the leader sets its wage by optimising against a response function for the follower according to which the latter mimics the leader's wage.

However, this does not rule out the existence of corner solutions. Indeed, such solutions may exist. To find them, the following procedure is adopted. Consider, for example, a potential equilibrium with an interior solution for the follower resulting in $w_j < w_i$, as analysed in Section 5.4.1.

[15] The intuition for this result is simple. The leader would choose different wages in the different cases only if the perceived total price elasticities $d\ln P_i/d\ln W_i$ and $d\ln P/d\ln W_i$ differ. If the relative wage between the two sectors $W_N/W_T$ is always unity, such differences can never arise. Instead, all total price elasticities are then zero. This follows from the definition of the CPI and the condition for relative market clearing in goods markets, i.e. from (6) and (7). A constant relative wage between the two sectors holds the relative goods price $P_N/P_T$ constant. With a fixed exchange rate (monetary union), $P_T$ is fixed. Hence also $P_N$ and therefore also the consumer price index $P$ are fixed. With inflation targeting, $P$ is held fixed by the central bank. This can be consistent with a fixed relative price $P_N/P_T$ only if $P_N$ and $P_T$ also remain fixed. Hence, a wage leader, believing that the wage follower will set the same wage, will always perceive that there will be no price consequences of a wage change. This means that the wage leader solves the same optimisation problem regardless of whether it is the tradables or the non-tradables sector that is wage leader and regardless of the monetary regime.

[16] See Section 5.2.

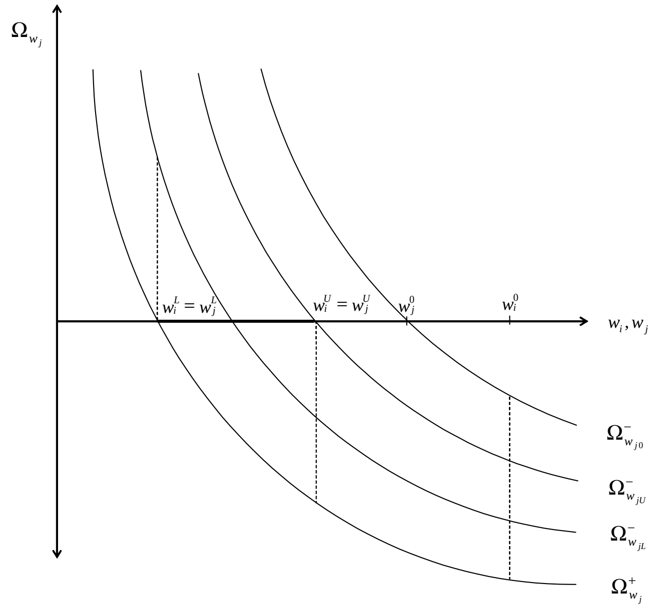


Figure 2: The set of possible corner solutions

The leader could set its wage strategically so as to avoid ending up in such an equilibrium and instead force the follower to choose a corner solution. This will be done if an equilibrium with a corner solution for the follower gives the leader higher welfare than the equilibrium with the interior solution.

To analyse the possibility of a corner solution, Figure 2 is helpful. Assume there is a potential equilibrium with an interior solution for the follower where the leader sets the wage $w_i^0$ and the follower sets the lower wage $w_j^0$. The curve denoted $\Omega^-_{W_{j0}}$ shows how $\Omega_{W_j}$ depends on $w_j$ when $\alpha_k = \alpha_1 > 0$ and applies for $w_j < w_i^0$ and $w_i = w_i^0$. The curve denoted $\Omega^+_{W_j}$ shows how $\Omega_{W_j}$ depends on $w_j$ when $\alpha_k = \alpha_2 = 0$ and applies for $w_j > w_i$. The assumption $\alpha_1 > \alpha_2 = 0$ ensures that the $\Omega^-_{W_{j0}}$-curve lies above the $\Omega^+_{W_j}$-curve. $w_i = w_i^0$ and $w_j = w_j^0$ is a possible equilibrium, since $w_j = w_j^0$ gives $\Omega^-_{W_j} = 0$.

Assume now that the leader lowers is wage from $w_0^i$. This shifts the $\Omega^-_{W_j}$-curve downwards as

$\Omega^-_{W_j}$ depends positively on $w_i$.[17] $w_i$ could be lowered to $w_i^U$ at which point $\Omega^-_{W_j} = 0$ (depicted by the $\Omega^-_{W_{jU}}$-curve) at the same time as $\Omega^+_{W_j} < 0$ (depicted by the $\Omega^+_{W_j}$-curve). This represents an upper bound for a corner solution with $w_i = w_j$. A lower bound is found for the wage $w_i^L = w_j^L$, which gives $\Omega^+_{W_j} = 0$ and $\Omega^-_{W_{jL}} > 0$. So, $w_i^L = w_j^L < w_i = w_j < w_i^U = w_j^U$ all represent possible equilibria with a corner solution for the follower.

To find out whether the realised equilibrium is one with an interior or a corner solution for the follower, one has to calculate the (weighted) utility for the wage setters in the leader sector in the various possible equilibria. The leader sets its wage strategically to reach the equilibrium which provides it with the highest welfare. It is not possible to derive analytical solutions, so to explore what equilibria will result we resort to numerical simulation.

# 6 Numerical solutions

The objective of our numerical analysis is to evaluate the effects of the choice of wage leader for employment and welfare in the two monetary regimes when there is loss aversion. We are particularly interested in the impact of relative sector size. To study the impact of wage norms we compare equilibrium outcomes and welfare in the case with wage norms as described in Section 5 to the benchmark setting without wage norms as described in Section 4. We set $\theta = .8$ to capture decreasing returns to scale. We normalise $b$ to one and make sure that the results yield reasonable mark-ups on the value of unemployment.

## 6.1 Equilibrium without wage norms

Table 7 describes numerically the equilibria in the case without wage norms under different assumptions. Since the objective functions are continuous and differentiable under this assumption, each regime-specific equilibrium is unique. The uniqueness of equilibria made it possible to provide an analytical ranking of real wages and employment as stated in Propositions 1-4. However, to assess the importance of wage norms, quantitative measures of wage and employment outcomes in

[17] As $\Omega^-_{W_j} = \lambda\left[-\eta\varphi_j + \{(\alpha_1 + \varepsilon_j)/(1 - b/\widetilde{w}_j)\} + (1-\lambda)(\varepsilon_j - \eta\varphi_j)\right]$ and $\widetilde{w}_j = w_j^{1+\alpha_1}/w_i^{\alpha_1}$, it follows that $\partial\Omega^-_{W_j}/\partial\widetilde{w}_j < 0$ and $\partial\widetilde{w}_j \,/\, \partial w_i < 0$. Hence $\partial\Omega^-_{W_j}/\partial w_i > 0$.

Table 7: Equilibrium outcomes without wage norms, $\lambda_N = \lambda_T = .5$

| Regime | Inflation targeting | | | | | | Monetary union | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Leader | $Nash$ | $Nash$ | $N$ | $N$ | $T$ | $T$ | $Nash$ | $Nash$ | $N$ | $N$ | $T$ | $T$ |
| $\gamma$ | .25 | .75 | .25 | .75 | .25 | .75 | .25 | .75 | .25 | .75 | .25 | .75 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| $w_N$ | 1.500 | 1.167 | 1.500 | 1.167 | 1.500 | 1.167 | 3.000 | 1.333 | 1.500 | 1.167 | 3.000 | 1.333 |
| $w_T$ | 1.167 | 1.500 | 1.667 | 1.500 | 1.167 | 1.500 | 1.158 | 1.235 | 1.158 | 1.235 | 1.167 | 1.500 |
| $N_N$ | .123 | .474 | .123 | .474 | .123 | .474 | .031 | .337 | .126 | .575 | .031 | .278 |
| $N_T$ | .474 | .123 | .474 | .123 | .474 | .123 | .244 | .121 | .488 | .181 | .237 | .082 |
| $N$ | .596 | .596 | .596 | .596 | .596 | .596 | .276 | .458 | .614 | .756 | .268 | .360 |

the case without norms are computed for the sake of comparison. In all cases $\lambda_N = \lambda_T = \lambda = .5$ is assumed. Columns (1) to (6) display the results under inflation targeting and columns (7) to (12) the results under monetary union. For each regime, the first two columns show the Nash equilibrium for $\gamma = .25$ and $\gamma = .75$, respectively, and the last four columns the corresponding outcomes when one of the sectors is wage leader. Since the results illustrated in Table 7 are have already been analysed qualitatively in Section 4 we do not comment on them further here.

## 6.2 Equilibrium with wage norms

Next, consider the case when the wage norm is set by the leader and the follower is loss averse. Table 8 displays the equilibrium outcomes for $\alpha_1 = .3$. With this parameterisation, two of the three different types of equilibria may arise. We obtain either corner solution equilibria or interior solution equilibria with a higher wage for the follower than for the leader. Regardless of regime, corner solutions arise when the $N$-sector is wage leader and $\gamma = .25$ or when the $T$-sector is wage leader and $\gamma = .75$. This suggests that corner solutions are more likely when the smaller sector is wage leader. The corner-solution equilibria give higher aggregate employment than the interior-solution equilibria. In these numerical examples, wage leadership for the smaller sector thus promotes employment.

Table 8: Equilibrium outcomes with wage norms, $\lambda_N = \lambda_T = .5$ and $\alpha_1 = .3$.

| Regime | Inflation targeting | | | | Monetary union | | | |
|---|---|---|---|---|---|---|---|---|
| Leader | $N$ | $N$ | $T$ | $T$ | $N$ | $N$ | $T$ | $T$ |
| $\gamma$ | .25 | .75 | .25 | .75 | .25 | .75 | .25 | .75 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $w_N$ | 1.167 | 1.167 | 1.500 | 1.167 | 1.158 | 1.167 | 3.000 | 1.333 |
| $w_T$ | 1.167 | 1.500 | 1.167 | 1.167 | 1.158 | 1.235 | 1.167 | 1.333 |
| $N_N$ | .203 | .474 | .123 | .609 | .211 | .575 | .031 | .312 |
| $N_T$ | .609 | .123 | .474 | .203 | .632 | .181 | .237 | .104 |
| $N$ | .812 | .596 | .596 | .812 | .843 | .756 | .268 | .416 |
| $\Omega_N$ | .045 | .104 | .053 | .134 | .045 | .127 | .038 | .104 |
| $\Omega_T$ | .134 | .053 | .104 | .045 | .135 | .049 | .052 | .035 |
| Type of equilibrium | Corner | $w_j > w_i$ | $w_j > w_i$ | Corner | Corner | $w_j > w_i$ | $w_j > w_i$ | Corner |

Do wage setters in the two sectors agree on who should be leader? Under inflation targeting the answer is no. While (the larger) follower sector benefits from the corner-solution equilibrium, the smaller leader would prefer to be follower (and thereby achieve an interior solution where the follower sets a higher wage than the leader). Suppose that $\gamma = .25$ so that the non-tradables sector is smaller. When the $N$-sector is leader, as in column (1), it achieves a utility level of .045 and the follower $T$-sector a utility level of .134. If instead the smaller $T$-sector is leader as in column (3), this would give the $N$-sector a slightly higher utility of .053, but reduce the utility of the T-sector to .104. In a monetary union, however, wage setters always agree on who should be wage leader under this parameterisation. Regardless of which sector is larger, it is always optimal to have the non-tradables sector as wage leader.

To analyse whether comparison thinking could be employment-promoting we compare Tables 7 and 8. We already showed that, for this parameterisation, the case with wage norms gives rise to either corner solution equilibria or interior solution equilibria where the follower sets a higher wage than the follower. But in the interior solution equilibria in Table 8 with a higher wage for

Table 9: Equilibrium outcomes with wage norms, $\lambda_N = .9, \lambda_T = .1$ and $\alpha_1 = .3$.

| Regime | Inflation targeting | | | | Monetary union | | | |
|---|---|---|---|---|---|---|---|---|
| Leader | $N$ | $N$ | $T$ | $T$ | $N$ | $N$ | $T$ | $T$ |
| $\gamma$ | .25 | .75 | .25 | .75 | .25 | .75 | .25 | .75 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $w_N$ | 1.532 | 1.279 | 1.100 | 1.033 | 1.532 | 1.279 | 1.400 | 1.067 |
| $w_T$ | 1.140 | 1.166 | 1.100 | 1.033 | 1.137 | 1.104 | 1.400 | 1.067 |
| $N_N$ | .126 | .422 | .272 | 1.117 | .127 | .446 | .082 | .953 |
| $N_T$ | .508 | .154 | .817 | .372 | .514 | .172 | .245 | .318 |
| $N$ | .634 | .576 | 1.089 | 1.489 | .641 | .618 | .327 | 1.271 |
| Type of equilibrium | $w_j < w_i$ | $w_j < w_i$ | Corner | Corner | $w_j < w_i$ | $w_j < w_i$ | Corner | Corner |

the follower than the leader $\alpha_2 = 0$ by assumption. This implies that the wages set in these interior equilibria coincide with the Stackelberg equilibria without wage norms, i.e. the solutions displayed in Table 7. The only difference is that there may be corner solution equilibria in the norm case if the smaller sector is leader. Since a comparison between Tables 7 and 8 show that these corner solutions always yield better outcomes in terms of employment than the corresponding Stackelberg equilibria without norms, comparison thinking could be employment-promoting. This is an important conclusion, since it goes against the conventional wisdom that comparison thinking leads to union militancy and employment losses.

## 6.3 Differences in bargaining power

Our analysis has questioned the conventional wisdom that wage leadership for the tradables sector promotes wage restraint. A natural question is whether we have missed some important parts of reality. One candidate is the assumption of equal relative bargaining strength in the two sectors ($\lambda_N = \lambda_T$) in the analysis of wage norms.[18] A possible argument is that employers have a stronger

[18] This assumption was not made in the general analysis of wage setting without norms in Section 4.

bargaining position in the tradables than in the non-tradables sector, because they have the option of completely closing down domestic facilities and moving production abroad. To examine such a possibility, we assume that $\lambda_T = .1$ and $\lambda_N = .9$ in Table 9.

We find four cases with corner solutions and four cases with interior solutions for the follower. In three out of four cases (the exception is monetary union and $\gamma = .25$), leadership for the tradables sector gives the highest employment. Strong bargaining power for employers in the tradables sector implies an incentive for wage restraint which is transmitted to the non-tradables sector via norm setting. The upshot is thus that leadership for the tradables sector may be conducive to wage restraint if the difference in relative bargaining strength of the union and the employer side between the two sectors is large enough.

## 7 Discussion

In many European economies one sector, usually a tradables (manufacturing) sector like engineering, acts as wage leader and concludes the first agreement in a wage round, so-called *pattern bargaining*. Recently, the wage leadership role of the tradables sector has been challenged by non-tradables (service) sectors in many countries. Conventional wisdom holds that leadership for the tradables sector is conducive to wage restraint and high employment. The argument is that international competition provides incentives for wage moderation in that sector which is transmitted to the rest of the economy. We examined whether this is indeed the case in a standard model of a small open economy and how outcomes depend on the monetary regime. Our surprising conclusion is that it is hard to corroborate the conventional wisdom when one allows for general-equilibrium interaction between the sectors. The analysis of the effects of various types of pattern bargaining turns out quite complex.

First, assuming standard trade union utility functions, we find that under inflation targeting pattern bargaining gives the same outcome as uncoordinated bargaining. It does not matter which sector is wage leader in this regime. In contrast, the type of bargaining does matter under monetary union (a fixed exchange rate). But contrary to the conventional wisdom, pattern bargaining with the tradables sector as leader gives less wage restraint and lower aggregate employment than uncoordinated bargaining. Pattern bargaining with the non-tradables sector as leader gives more wage restraint and higher employment than uncoordinated bargaining.

Second, letting trade union utility depend on wage comparisons and introducing loss aversion, we show the possibility of equilibria where the follower sets the same wage as the leader. This could help explain the tendency towards uniform wage developments under pattern bargaining. Such equilibria may arise when the *smaller* sector (independently of whether it is the tradables or the non-tradables sector) is wage leader. They are associated with wage restraint and high aggregate employment. So, contrary to what is usually believed, comparison thinking and loss aversion may be beneficial for employment.

Would other assumptions than those in our basic model change the conclusions? One possibility is that the bargaining strength of employers is greater in the tradables than in the non-tradables sector, because production there can be shifted abroad. We show that the likelihood that wage leadership for the tradables sector is conducive to wage restraint and high aggregate employment increases under this assumption. However, it is not obvious that the relative bargaining power of employers is greater in the tradables than in the non-tradables sector: a counterargument is that the rate of unionisation is lower in the non-tradables than in the tradables sector.

Another caveat is that coordination in wage bargaining may be higher in the tradables sector, which tends to be dominated by large corporations, than in the non-tradables sector, which is more fragmented. More internalisation of adverse effects of high wages in the tradables sector might therefore exercise more pressure for wage restraint there, which via wage leadership could spread to the less coordinated non-tradables sector.

One simplification in our analysis is the assumption that the central bank pursues *strict* inflation targeting. An alternative assumption would be that the central bank instead pursues flexible inflation targeting, i.e. acts to minimise a loss function with both inflation and unemployment as arguments. Such an assumption would break the equivalence between uncoordinated bargaining and the two forms of pattern bargaining under inflation targeting in the standard case without norms. When leader, the non-tradables sector would realise that a wage hike causes a rise in both the CPI and unemployment and that a central bank concerned also about employment would not let the currency appreciate by the full amount required to stabilise the CPI. As a consequence, being leader the non-tradables sector would expect a wage hike to result in a smaller increase in the real consumption wage than in our analysis, which provides an incentive for more wage restraint. The analysis would change less with the tradables sector as leader since a wage rise there, by reducing output and thus aggregate demand, tends to reduce both the CPI and employment. It is not clear whether the anticipated monetary policy response would be more or less expansionary than in our analysis.

The assumption that the tradables sector is a perfect price taker in the world market could be relaxed. If domestic and foreign tradables are only imperfect substitutes, a wage hike in the tradables sector would cause the price of domestic tradables to rise in the fixed exchange-rate case. If the price rise were large enough, the CPI might no longer fall in the case without norms. When being wage leader the tradables sector would then no longer expect an own wage rise to have the beneficial effect of pushing down the wage in the non-tradables sector, inducing a further fall in the CPI. This would lead to more wage restraint in the case with a tradables sector as leader under a fixed exchange rate than in our analysis, but wage restraint is still likely to be greater with the non-tradables sector as leader.

Finally, one could argue that we have treated wage comparisons asymmetrically by assuming that the leader's wage becomes the wage norm against which the follower evaluates its wage, whereas the leader does not evaluate its wage against the follower's. Our assumption captures the reality that the first bargain in a wage round tends to become the comparison norm, but one could, of course, conceive of comparisons with the follower being important for the leader, too. Such an assumption would, however, increase the complexity of the model dramatically.

To conclude, a number of considerations could be added to our model. This might change the conclusions. Still, we find it a puzzle that a straightforward analysis of pattern bargaining does not support the conventional wisdom that wage leadership for the tradables (manufacturing) sector is conducive to aggregate wage restraint and high employment.

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# Appendix

**Proof that** $\lim\limits_{w_j \to w_i} \Omega^{+}_{W_j} > 0$ **when** $w_i = (1 + \lambda (1 - \theta)/\theta)\, b$

Since $\alpha_k = 0$ when $w_j > w_i$ we obtain:

$$\lim_{w_j \to w_i} \Omega^{+}_{W_j} = \lambda_j \left[ -\eta \varphi_j + \frac{\widetilde{w}_j \epsilon_{jm}}{(\widetilde{w}_j - b)} \right] + (1 - \lambda_j) \left[ \epsilon_j - \eta \varphi_j \right]$$

In a corner solution

$$\widetilde{w}_j = \frac{w_j^{1+\alpha_k}}{w_i^{\alpha_k}} = w_j = w_i = \left[ 1 + \lambda \frac{1-\theta}{\theta} \right] b.$$

Under inflation targeting and $N$-sector leadership:

$$\begin{aligned} \epsilon_{TI} &= 1 \\ \varphi_{TI} &= 1 - \gamma\theta \end{aligned}$$

This implies:

$$\lim_{w_j \to w_i} \Omega^{+}_{W_j} = \lambda \left[ -\eta (1 - \gamma\theta) + \frac{w_i}{(w_i - b)} \right] + (1 - \lambda) \left[ 1 - \eta (1 - \gamma\theta) \right] = \frac{\gamma\theta}{1 - \theta} > 0.$$

Due to symmetry, the proof for the T-sector is analogous.

In a monetary union, under $N$-sector leadership:

$$\begin{aligned} \epsilon_{TM} &= 1 + \gamma\theta \\ \varphi_{TM} &= 1 \end{aligned}$$

This implies:

$$\lim_{w_j \to w_i} \Omega^{+}_{W_j} = \lambda \left[ -\eta + \frac{w_i (1 + \gamma\theta)}{(w_i - b)} \right] + (1 - \lambda) \left[ 1 + \gamma\theta - \eta \right] = \frac{\gamma\theta}{1 - \theta} > 0.$$

When the T-sector is wage leader in a monetary union:

$$\begin{aligned} \epsilon_{NM} &= 1 - \gamma\theta \\ \varphi_{NM} &= 1 - \theta \end{aligned}$$

This implies:

$$\lim_{w_j \to w_i} \Omega^{+}_{W_j} = \lambda \left[ -\eta (1 - \theta) + \frac{w_i (1 - \gamma\theta)}{(w_i - b)} \right] + (1 - \lambda) \left[ 1 - \gamma\theta - \eta (1 - \theta) \right] = \frac{(1 - \gamma)\,\theta}{(1 - \theta)} > 0$$

and the proposition follows.