WAGE INTERDEPENDENCE THROUGH DECENTRALIZED BARGAINING
- A SURVEY -

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Abstract

The idea that sector-specific unions are influenced by the wages obtained by other unions has mainly been used to support the empirical observation that wages are highly correlated among industries. The sources of wage interdependence can mainly be found in unions' preferences, in the nature of technology and in price and demand determination. The presence of externalities and of strategic complementarity among unions leads to sub-optimal equilibria, which generates non-desired inflation, unemployment and possibly also trade balance deficit. This enforces the idea that part of current unemployment can be eliminated by improving the coordination between social actors.

Introduction

The observation that wages which are negotiated at the sectorial or firm level depend on the wage of other firms or sectors has long been treated in both empirical studies and theoretical analysis. This observation has led to the concepts of "wage imitation effect" (Mitchell, 1980), "envy effect" (Gylfason and Lindbeck, 1984a, b), "wage rivalry" (Oswald, 1979), "jealousy effect" (Calmfors and Driffill, 1988), "spillovers in wage determination" (Mehra, 1976), or, more simply, "wage-wage" spirals. We think that it is time to clarify the links between the various branches of this literature which are generally unknown to each other. In this survey, we try to make some links between wage rivalry, coordination failures, Scandinavian models and empirical studies of wage formation.[1] Their common point is that they deal with bargaining between unions and firms[2] at the sectoral or firm level.[3] The general aim of this survey is to synthetise the results about the implications of "wage-wage" spirals on economic activity.

In a first section, we investigate the sources of wage interdependence (or the way of modeling wage interdependence). These can mainly be found in unions' preferences, in the nature of technology and in price and demand determination. The analysis of the sources of wage interdependence allows us to make the link with some recent investigations dealing with the role of externalities (or spillovers) among players and their consequences on the allocation of resources (Cf. Cooper and John, 1988). In this first section, we also distinguish between two main frameworks of interdependence: (a) The multi-causal framework where the sectors are equally treated with causality links in all directions, and (b) the one-way causal framework where some leading sectors give the pace for the wages of the following sectors.

Secondly, we analyse the effect of the "wage-wage" spirals on economic performance, looking at the sub-optimality of decentralized wage setting. The sub-optimality can be analysed in terms of non-desired inflation, unemployment or trade deficit. As illustrated by Mitchell (1980) for the case of unwanted inflation, changes in wage structure, sparked by some initial cause, could continue to produce wage inflation long after the spark had gone out. This leads to the idea of *wage explosion* that can be at the root of the explanation of the important wage increases that have occured in Europe around 1975. The question can also be treated in an open economy perspective, considering the Scandinavian model as a special branch of the sectorial wage setting theory. We use this framework to analyse the implications on the trade balance surplus or deficit. We will ask how wage interdependence can affect the profitability of the tradeables sector and the competitiveness of the economy.

Finally, some aspects of empirical analysis about wage spillovers are studied.

[1] These models are generally static. We treat briefly the question of desynchronisation of wage negotiation in the analysis of the inflation process as a consequence of decentralized bargaining.

[2] We do not investigate the relation between union and nonunion sectors, since it has been surveyed by Oswald (1985).

[3] The two-sector models with centralised bargaining will not be treated here.

1 Modeling wage interdependence

The dependence between the negotiated wages of different sectors is generally expressed by the concept of wage reaction function. This says simply that the wage of a sector i is a (positive or negative) function of the wage in the other sector(s) j:

$$w_i = w_i(w_j, ...) \qquad i \neq j$$

The shape of this reaction function depends on the source of wage interdependence. The reaction function is derived by maximising the bargaining function which is generally approximated by the Nash product of the objective functions of the union and of the firm. In the case of a non-cooperative set-up, which is dominant in the literature about wage interdependence, the Nash product can be seen as an approximation of the outcome of a sequential bargaining if the reaction speed of both players to other player's proposals tends to infinity (cf. Binmore et al. (1986)). A general maximisation problem for the agents of sector i can be written as:

$$\max_{w_i} \quad \left[U_i\left(\frac{w_i}{p}, n_i, \frac{w_j}{p}, t\right) - \bar{U}_i\left(\frac{w_j}{p}\right)\right]^{\beta} \left[\Pi_i\left(E\left(\frac{w_i}{w_j}\right), \frac{w_i}{p}, n_i\right) - \bar{\Pi}_i\right]^{(1-\beta)}$$

$$s.t. \qquad n_i = n_i\left(\frac{w_i}{p}, E\left(\frac{w_i}{w_j}\right)\right)$$

where U_i is the utility of the union and $\bar{U}_i$ is its fall-back utility level, which is the utility in case of disagreement. p is the price level, t is taxes, β is union power,[4] Π_i is the profit of firm i, E is workers' effort, $\bar{\Pi}_i$ is fall-back profit, and n_i is labour demand.

This maximisation programme allows to determine an optimal wage for a given labour demand schedule (Right-to-manage model). If $\beta = 1$, the union determines alone the optimal wage (Monopoly union model). The various arguments of utility, profit and labour demand will be explained in the following sections. The above maximisation programme puts together all the channels that will be discussed later on.

Using partial equilibrium analysis (1.1), the sources of wage interdependence can be found directly in the utility of the union $U_i(w_i/p, n_i, w_j/p, t)$ (1.1.1), in the production function of the firm $n_i = n_i(w_i/p, E(w_i/w_j))$ (1.1.2), in the effort function of workers $E(w_i/w_j)$ (1.1.3) or in the specification of fall-back utility levels of unions $U_i(w_j)$ (1.1.4). Indirect links between sectors are also found in general equilibrium frameworks (1.2), mainly through demand structure and aggregate price level p (1.2.1) and through an endogenous tax system t (1.2.2). Finally, a last subsection is devoted to the specific (uni-directional) interdependence between leading and following sectors (1.3).

1.1 Partial equilibrium analysis

In this subsection, we analyse the models dealing with wage interaction across different sectors, considering only the maximisation programme of unions and firms. The channel

[4]The parameter β is to be interpreted as the relative reaction speed of the firm compared to the union.

of interdependence passes through wages and employment. Demand and prices are kept exogenous.

1.1.1 Unions utility function and relative wage

Let us consider an economy with a number of different labour groups. These groups may correspond to economic sectors (Gylfason and Lindbeck, 1984a,b) or to different types of labour (Oswald, 1979). In each group, there is one trade union which determines the wage, constrained by the firm's labour demand curve. The utility of each union is defined over the real wage of the representative member and over the employment level in its sector or group. It could also be defined over the *relative* wage level, formalising the original idea of Keynes that unions care about some fairness between the workers:

> "In other words, the struggle about money wages primarily affects the distribution of the aggregate real wage among labour groups and not its average amount per unit of employment, which depends, as we shall see, on a different set of forces. The effect of combination on the part of a group of workers is to protect their relative wage. The general level of real wages depends on the real forces of the economic system". Keynes (1936, p14).

The concept of "social transference" proposed by Dunlop (1944) is similar: "Wage increases originating in one sector may be diffused because wage earners are determined to fare just as well as their associates. (...) The community of housewives, with the inevitable "you are as good as the next fellow," is not to be underestimated." This story about the existence of a wage norm could also be applied to individual behaviour without implying unionisation (as in Kolm, 1988).

Accordingly, unions base their claim partly on the wages received by other groups of workers. This framework allows to analyse a series of topics which is impossible to treat in a centralised bargaining framework. Gylfason and Lindbeck (1984a, b) and Dixon (1988) use a two-sector model and include the wage of the other sector as a third argument in the utility function of each union. Let us call this assumption the *rivalry* assumption:

$$U_i = U_i\left(\frac{w_i}{p}, n_i, \frac{w_j}{p}\right) \qquad i \neq j$$

w_i is the wage paid in sector i, p is the expected price and n_i is employment of sector i.

The fact that the wage of the other sector is included in the utility of the union can be seen as an externality (or spillover) among players. This is defined as the interaction between agents at the level of payoffs or objective functions (Cf. Cooper and John, 1988). In the model of Gylfason and Lindbeck, the externality is negative since a rise in the alternative wage w_j decreases the utility of union i.

There is no negotiation. The sector-specific union is assumed to maximise its utility function subject to the labour demand constraint (monopoly union model):

$$\max_{w_i} U_i \qquad s.t. \qquad n_i = n_i\left(\frac{w_i}{p}\right)$$

Consequently, the wage of one sector is dependent on the wage of the other sector, leading to the notion of wage reaction function. Using strongly simplifying assumptions about the form of the utility and production functions, the model of Gylfason and Lindbeck implies that the wage of one sector is a loglinear homogeneous function in wages and prices, showing that rational behaviour does not force union i to require full compensation for expected inflation ($\eta_{w_i.p} = 1 - a < 1$ for a given w_j) unless it assumes union j to be fully compensated ($\eta_{w_i.p} + \eta_{w_i.w_j} = 1$).

$$ln(w_i) = aln(w_j) + (1-a)ln(p) + c \tag{1}$$

$$ln(w_j) = bln(w_i) + (1-b)ln(p) + d \tag{2}$$

This introduces some *nominal rigidity* in wage formation. This two-union model using Cournot-type reaction functions leads to a Cournot-Nash equilibrium whose macroeconomic implications are discussed in the next section. This framework can be easily extended to the n-union case (Cf. Oswald, 1979).

The fact that the wage of one sector is a positive function of the wage in the other sector introduces a strategic complementarity among unions. This is defined as the interaction between agents at the level of strategies. Cooper and John (1988) show that the presence of both externalities and strategic complementarities among unions generates coordination failures which make the equilibrium sub-optimal. This sub-optimality is the subject of the next section.

A recent version of the model of Gylfason and Lindbeck is presented by Bhaksar (1990), who makes an additional assumption on the derivative of the unions' utility functions. These utility functions are defined over employment, the real wage and the wage relative to the expected aggregate wage w^e:

$$U_i = U_i\left(\frac{w_i}{p}, n_i, \frac{w_i}{w^e}\right)$$

Following the argument of Keynes, assuming that workers are concerned with fair treatment, Bhaksar supposes that the dissatisfaction of being paid less than the workers of the other sector is greater than the benefit from being paid more. He thus assumes a discontinuity of the derivative at the point $w_i = w^e$: The left-hand side derivative of the utility function with respect to relative wage at the point $w_i = w^e$ is greater than the right- hand side derivative. This discontinuity results from the existence of a minimum acceptable social norm in the mind of each worker.[5] Consequently, the wage setting rule

[5]We find a similar argument in Hahn (1982): The social norms are such that offering to work for less than the reference wage is so repugnant that the gain must be discrete to overcome the negative "social norm" effect.

(which results from union's utility maximisation) defines, at a given employment level, an *interval* for the real wage, instead of a unique level.[6]

1.1.2 Interdependence in the production function

Another modified version of the model of Gylfason and Lindbeck is presented in Risager (1990). He applies the wage rivalry framework to the competing wage claims of skilled and unskilled workers groups. The idea is to test the wage interdependence across skills in Denmark.[7] According to this set-up, the production function of each firm includes in its arguments the two types of labour. When the firm maximises its profit, it determines labour demands as functions of the wages of both labour groups:

$$n_i = n_i\left(\frac{w_i}{p}, \frac{w_j}{p}\right) \qquad i = 1,2 \qquad i \neq j \tag{3}$$

The sign of the derivative of labour demands with respect to the wage of the other group depends on the nature of the technology: If the two labour types are substitutes (complements), this derivative is positive (negative).[8]

Contrary to the previous model, each wage is *negotiated* between the firm and each union given the labour demand functions (3) and (4) (right-to-manage model). The outcome of the non-cooperative bargaining game is approached by the maximisation of the following Nash product:

$$\max_{w_i} \quad U_i\left(\frac{w_i}{p}, n_i, \frac{w_j}{p}\right)^{\beta} \; \Pi\left(\frac{w_i}{p}, n_i, \frac{w_j}{p}\right)^{(1-\beta)}$$

$$s.t.\; n_i = n_i\left(\frac{w_i}{p}, \frac{w_j}{p}\right)$$

The wage reaction function is derived from the first-order condition of the Nash product. The influence of a change in w_j on w_i is determined as the combination of three effects:

- Income effect: The rise in the other wage increases the wage bill paid by the firm and reduces its profit, forcing the firm to be more agressive in the negotiation over w_i (negative effect on w_i).
- Substitution effect: If the two types of labour are substitutes, the rise in w_j increases the input of labour n_i, increasing the benefit to the firm of a fall in w_i (negative

[6]Combining this with the firm pricing rule leads to the determination of a range for the natural rate of unemployment instead of a unique level.

[7]This corresponds to the Danish bargaining structure in which workers are organised along craft lines.

[8]The properties of the production function are also quite important in explaining the optimal pattern of unionisation. In this section, the pattern is considered as given. However, in a model where the type of unionisation is a choice variable, Horn and Wolinsky (1988) (see also Elster (1989), chap. 4) have shown that, when the two types of labour are substitutable enough, the optimal pattern is an encompassing union. When the two types of labour are complementary enough, the optimal pattern is two separate unions.

effect on w_i). If the factors are complements, the effect on w_i is positive. A time dimension is present in this effect: In the short run, we may assume that the two labour groups are complements while they could be substitutes in the long run.

- Rivalry effect: The rise in w_j reduces the utility of the union and forces it to claim an increase in w_i.

The net effect is uncertain.

With respect to the model of Gylfason and Lindbeck, the two first effects are new, but they are dependent on the particular bargaining structure which assumes that the negotiation is specific to the labour types. Moreover, it should be interesting to treat the same problem in an efficient bargaining framework[9] rather than in a right-to-manage framework, since the aptitude of the union to bargain also over employment should be crucial in this type of model.

1.1.3 The role of the effort function

In addition to the introduction of the wages of the other sector(s) in the utility of the union and of the substitution possibilities between different types of labour, the alternative wages may play a role through the efficiency wage phenomenon.[10] The combination of the bargaining framework with efficiency wages and the discussion of the role of the alternative wage (mainly in determining the employment level) are found in Nickell and Wadhwani(1988) and Urga (1990). The main idea is the following: Workers' productivity depends on workers' effort, which is linked to the ratio between the wage and the alternative wage; this ratio measures the cost to be paid by the worker if being laid off in case of shirking.[11] In that case, the profit of the firm is a function of workers' effort, $E\left(\frac{w_i}{w^e}\right)$. The Nash product becomes:

$$\max_{w_i} \quad U\left(\frac{w_i}{p}, n_i, \frac{w^e}{p}\right)^{\beta} \quad \Pi\left(E\left(\frac{w_i}{w^e}\right), \frac{w_i}{p}, n_i\right)^{(1-\beta)}$$

$$s.t.\ n_i = n_i\left(\frac{w_i}{p}, E\left(\frac{w_i}{w^e}\right)\right)$$

The influence of a change in w^e on w_i is determined as the combination of three effects:

- The direct negative externality of w^e on U_i which is the usual rivalry effect (positive effect on w_i).
- The direct effect on profit: On the one hand, the reduction in workers' effort increases the unit cost for the firm, decreases profit and forces the firm to be more aggressive in the bargaining process (negative effect on w_i). On the other hand,

[9] In efficient bargaining, the players negotiate both wages and employment level; the outcome is located on the contract curve and is Pareto-efficient for the players. Cf. Mc Donald and Solow (1981).

[10] For a survey, see Yellen (1984).

[11] We use here a particular version of the efficiency wages model,i.e.,the shirking version.

reducing w_i during the bargaining process will reduce $\frac{w_i}{w^e}$ still more: The firm could have advantage to increase its wage in order to boost the effort of the workers. Therefore, the net effect through profit is uncertain.

- The indirect effect through the demand for labour: As emphasised by Nickell and Wadhwani, a rise in the alternative wage has two effects on employment. It implies a fall in labour productivity since the cost of the punishment of being laid off if shirking is reduced. The same output is produced with more workers, employment rises, increasing the utility of the union, allowing for a reduction in the current wage. However, since the unit costs are increased, a lower level of output is produced so that employment could be reduced, having a negative impact on the union's utility.

The inclusion of efficiency wage theory (using the shirking approach) in rivalry models considerably complicates the story by enriching the nature of externalities. It increases the role played by the firm in the treatment of wage externalities. This approach seems promising and has not yet been fully treated in the theoretical literature.

1.1.4 Alternative wages and the outside option

As we have seen, the bargaining set-up used to model wage interdependence is generally the simple monopoly union model which assumes that the union maximises its utility to determine the wage, being constrained by the firm's labour demand.[12] This framework is useful to derive easily interpretable wage equations; however, the framework where the union bargains *with the firms' representative organisation* to determine the wage and possibly also the employment level is closer to the practice of social negotiations in many countries. If we specify the model as a 'true' bargaining process between two agents, we have to introduce fall-back positions (or minimum acceptable levels for union utility and firm profit) corresponding to the income stream obtained by the players during the delay of agreement.

If we assume that there exists a point in time at which it is credible for the workers to leave and look for a job in other firms or sectors, the *outside option* must be included in the fall-back position of the firm.[13] This outside option includes two elements through which the wages of the other sectors intervene:

- the probability with which leaving workers can find employment in other firms or sectors.[14]
- the income paid in other firms or sectors.

In that case, following Barth's (1989) argument, the wage equation is (to be compared

[12]Two exceptions are Risager (1990) and Nickell and Wadhwani (1988).

[13]This point may correspond to the time when strike-payments are exhausted, so that quitting becomes a credible threat.

[14]This probability depends on the ratio $\frac{employment}{labour\ supply}$ in other firms and sectors which depend on wages.

with equation (1)):

$$w_i = (1-\beta)\left[\phi s + (1-\phi)\left(\lambda w^e + (1-\lambda)w^u\right)\right] + \beta\frac{R-\pi^0}{n_i} \tag{4}$$

The parameters β and ϕ are functions of the size of strike funds, of the number of proposals made by the firm during the period in which strike payments are positive and of the length of the total bargaining period. s is the strike allowance, λ is the probability of finding a job elsewhere, w^e is the expected wage in the other sectors, w^u is the unemployment allowance and $\frac{R-\pi^0}{n_i}$ is the net profit per worker. We see that wage interdependence arises directly through the expected wage w^e. The derivative of w_i with respect to w^e is a function of the probability of finding a job.[15] Equation (4) is derived by Barth using a sequential bargaining set-up, but can also be generated by the maximisation of the asymmetric Nash product

$$\left[w_i - \left(\phi s + (1-\phi)\left(\lambda w^e + (1-\lambda)w^u\right)\right)\right]^{\beta} \left[R - w_i n_i - \pi^0\right]^{(1-\beta)}.$$

1.2 General equilibrium analysis

As emphasised by Cahuc (1990), the main problem of rivalry models is that the union's utility function is postulated: The inclusion of the alternative wage is ad hoc. We may add that it is not derived from the utility of the households; for instance, Dixon (1988) postulates a Stone-Geary utility function defined over employment and relative wages, while the households have a Cobb-Douglas utility function.[16]

The inclusion of the relative wage as an externality in the objective of the union is not necessary to have "wage-wage" spirals and to define wage reaction function. In the absence of direct externalities between unions, the interdependence may pass through the aggregate price level and the composition of demand (1.2.1) or through the modeling of governement behaviour with endogenous taxes (1.2.2).

1.2.1 Demand and prices

The externalities between two different labour groups due to aggregate demand are treated in Jacobs and Janssen (1990): They assume two types of households, the firm owners and the wage earners, with different utility functions. The economy is divided into two

[15]This would be more complex if the unemployment allowance w^u were a function of the mean wage paid in the economy.

[16]The Cobb-Douglas household utility function is used to derive the goods demand functions while the Stone-Geary union utility function is used to derive the wage reaction function. It is probably more coherent to derive both equations from the same set-up as in Jacobsen and Shultz (1990) or in Arnsperger and de la Croix (1990). However, Jackman (1985), who mixes also a CES utility function for households and a Stone-Geary utility function for unions, argues that the decision-making process of unions does not seem sufficiently well understood to impose any specific requirement on the relationship between unions' decisions and the welfare of their individual members.

productive sectors, each producing one good. If the wage is modified in one sector, the income allocation between the two types of household changes and the demand addressed to each sector is modified.[17] This is the *demand composition* effect. A second effect passes through the aggregate price: A rise in the wage of one sector reduces the real wage of the other sector through its influence on the output price and therefore on the aggregate consumption price index. Two cases may arise:

1. In case I, a rise in the wage of sector 1 decreases the demand for sector 2 through the demand composition argument, and hence lower employment in sector 2. This reduces the utility level of union 2 and modifies the outcome of the bargaining process. This is called a *negative externality* of the alternative wage on the union utility.
2. In case II, a rise in the wage of sector 1 increases the employment of sector 2 through the demand composition effect, but increases also the consumption price index, leading to an undetermined effect (the externality may be positive or negative) on union's utility.

In both cases, the authors show that there is *strategic complementarity*, in the sense that the optimal wage level of a union depends positively on the wage set by the other union.

Calmfors and Driffill (1988) suggest an extension which does not neglect inter-industry sales of intermediate inputs. In a model with many sectors and intermediate goods, a nominal wage increase in one sector affects other sectors via input prices (if we assume price-making behaviour). This creates an effect on labour demand, whose sign depends upon the characteristics of the production function, i.e., if the intermediate inputs are substitutes or complements with respect to labour. However, it is unlikely that this extension could qualitatively change the results. It adds an additional uncertainty on the nature of the externality.

The major interest of the above general equilibrium approach is to make a link we would like to emphasise in this survey: The old story of wage rivalry gets a new dimension in a more general model since we may fully exploit the concepts of externalities and strategic complementarities which came from the game-theory literature (Cooper and John, 1988). This should allow future research to treat topics such as multiple equilibria and sub- optimality resulting from union behaviour in a more rigorous context. On the other hand, it is interesting to note that the seminal paper of Cooper and John uses as examples (for externalities) technological interaction, demand externalities and price linkages in monopolistic competition environments, but they do not treat the interaction among unions.

[17]For example, if the wage of sector 1 rises, the income of firm owners is reduced and the demand for the good preferred by firm owners is lowered. The sector that produces this good is penalised. The situation of the sector that produces the good prefered by wage earners is improved. The outcome of the bargaining in sector 2 will be different.

1.2.2 Endogenous governement behaviour

If we introduce the government in a general equilibrium model with unions and wage bargaining specific to the public sector, two new types of externalities may arise (Holmlund, 1991):

- The *tax externality* arises when the public-sector union which negotiates the wage ignores that a wage increase in its sector involves a tax increase (in order to maintain a balanced budget) for workers in the other sectors.
- The *public-good externality* arises when the increasing wages in the public sector induces a lower level of public employment and therefore a lower level of public good production for all workers.

In both cases, there is a negative externality from the public sector to the private sector. Any change in the public-sector bargaining outcome affects union utility in the private sector, inducing changes to private wages. This illustrates that, when we complicate the basic model (here with endogenous governemnet behaviour), new sources of externalities arise leading to a more complex pattern of wage interdependence.

1.3 Leaders and Followers

In the previous subsections, we have assumed that the wages of the different sectors interact mutually, with causality links in all directions. A second approach involves one-way causal flows only. In this approach, there are "key" wage determination units that set patterns for other units: There are "leading" sectors and "following" sectors. The "key" units are comparable to the "wage contour" as described by Dunlop (1957), which consisted of stable group of firms linked together by their wage determination set-ups. These firms generally have similar product markets and similar sources of labour.

This view is supported by many empirical studies: Eckstein and Wilson (1962)[18] found that the wage of some industries is determined mainly by the specific variables of the sector under consideration, while in other industries, the wage is simply determined by the wage of the leading sectors. Jacobson and Lindbeck (1971) found that manufacturing and construction are leading sectors in Sweden. Holmlund and Ohlsson (1990) show that wage changes in the public sector are Granger caused by private sector wage changes.

Flanagan (1976) mentions that small firms may find it cheaper to maintain a given wage differential by imitating the wage changes in reference firms in their sector; empirically, this could explain why many small firms participate in wage surveys of their industry. This is simply a way of economising on personnel management costs.

The approach concerned with leaders and followers has not yet received strong theoretical foundations. The main factors that determine a sector as leader or follower have not been analysed. It is however sure that historical and institutional elements play an important role.

[18]This empirical study is detailed in section 3.

Despite the lack of theoretical models explaining unidirectional wage interdependence, we show in the next section that this pattern has strong implications, in particular on the trade balance and on income policies.

2 Sub-optimality of decentralized bargaining

The outcome of the sectorial-level bargaining is a kind of Nash equilibrium if unions do not cooperate. The equilibrium wages are sub-optimal, because each union is not able to internalise the effect of its claims on the other sectors and on the aggregate variables. The following example shows how this inefficiency depends on the importance of the externality between unions (which is modeled here as a simple rivalry effect). Let us assume the following maximisation programme for the union i of a two-sector economy:

$$U_i = n_i\,(w_i - \beta w_j - (1-\beta)p) \qquad \beta < 1$$

$$s.t. \qquad n_i = \delta - \gamma(w_i - p)$$

The union of sector i maximises a utility function defined over employment n_i and the difference between the wage w_i and an average of the wage of the other sector w_j and of the price level p (the variables are taken in logs). The maximisation is subject to the labour demand constraint of the firm. In the absence of any externality, $\beta = 0$. The Nash non-cooperative equilibrium real wage is:

$$w_i - p = \frac{\delta}{\gamma(2-\beta)}$$

The cooperative solution, obtained by maximising the sum of the utilities $U_i + U_j$ gives:

$$w_i - p = \frac{\delta}{2\gamma}$$

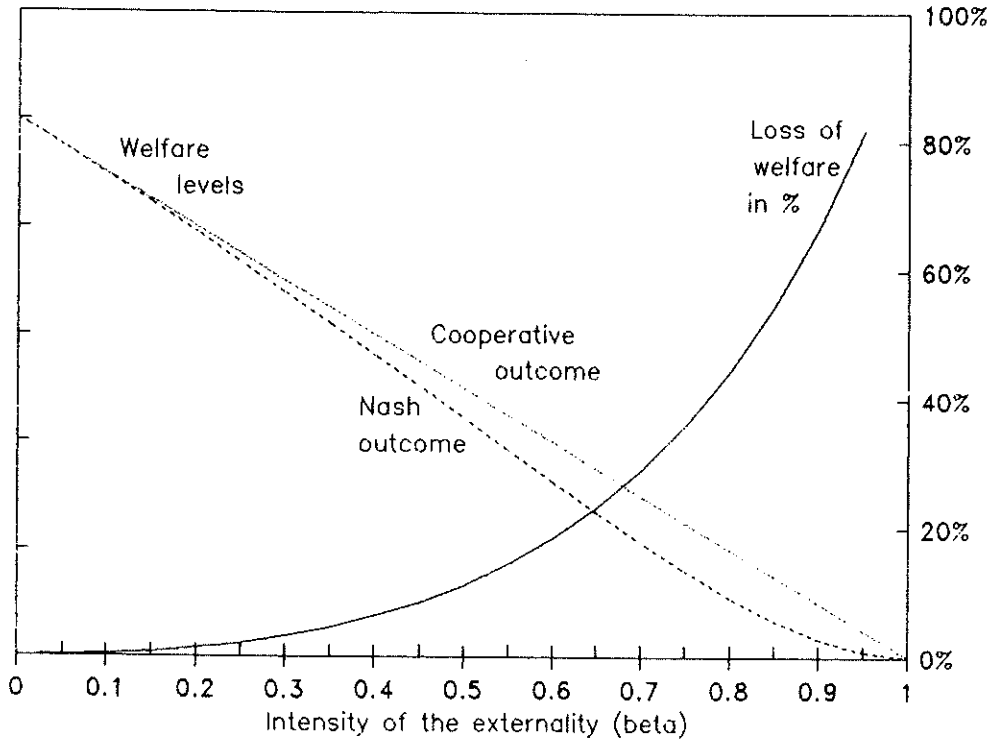
The corresponding utilities are:

$$U_i^{Nash} = \frac{\delta^2(1-\beta)^2}{\gamma(2-\beta)^2} \qquad U_i^{Coop} = \frac{\delta^2(1-\beta)}{4\gamma}$$

The utility is higher in the cooperative solution. The gap between the two solutions is a function of the intensity of the externality which is measured by β; in the absence of externalities, the two solutions are the same (see Figure 1).

The recent literature about coordination failures allows to give more precise conditions to get this sub-optimality: If there is an interdependence at the level of objective functions (externality) and if there is a positive relation between the strategies of the players (strategic complementarity, a rise in w_j implies a rise in w_i), then the equilibrium which is chosen by the agents is sub-optimal; if these agents coordinate their activities, they could achieve a better equilibrium. Moreover, if the externalities are strong enough, we may have multiple Pareto- ranked equilibria.

Figure 1: Sub-optimality of decentralized bargaining



The consequences of the sub-optimality in terms of macroeconomic variables can be seen from different points of view:

- The literature about relative wages and inflation (2.1) may be seen as analysing the consequences of decentralized (and often desynchronised) wage setting on inflation. This non-desired inflation is the consequence of the loss of efficiency.
- The explanation of unemployment as a coordination failure (2.2) is based on this argument of inefficiency.
- In (2.3), the question is put in the open economy perspective. We analyse the implications of wage interdependence on the trade balance, using the results of the Scandinavian model (tradeables/non-tradeables).

2.1 Relative wages and inflation

The basic model is in Akerlof (1969). He builds a two-sector model with desynchronised wage setting in order to explain price inflation in terms of relative wages. The oligopolistic interdependence and the temporary fixity of wage contracts are used to explain how a Phillips curve does exist and why neutrality of money is false.[19]

[19]Cf. Blanchard (1990) for a survey that comments on the place of Akerlof's paper in the discussion about money neutrality.

The economy is composed of two firms. Each firm faces a simple linear production function. Goods' prices are free to adjust in each period. These prices are a linear homogeneous function of all other prices and wages:

$$p_i = p_i(w_i, w_j, p_j, ...) \tag{5}$$

$$p_j = p_i(w_i, w_j, p_i, ...) \tag{6}$$

There are two unions; each union deals with one firm. Bargaining takes place in each sector at two different points in time (let us say at $2t$ and $2t+1$ for sector 1 and 2 respectively). Each union maximises the expected utility of its representative member.[20] When each union determines the wage, it is constrained by the fixity of the wage of the other sector (non- synchronisation assumption):

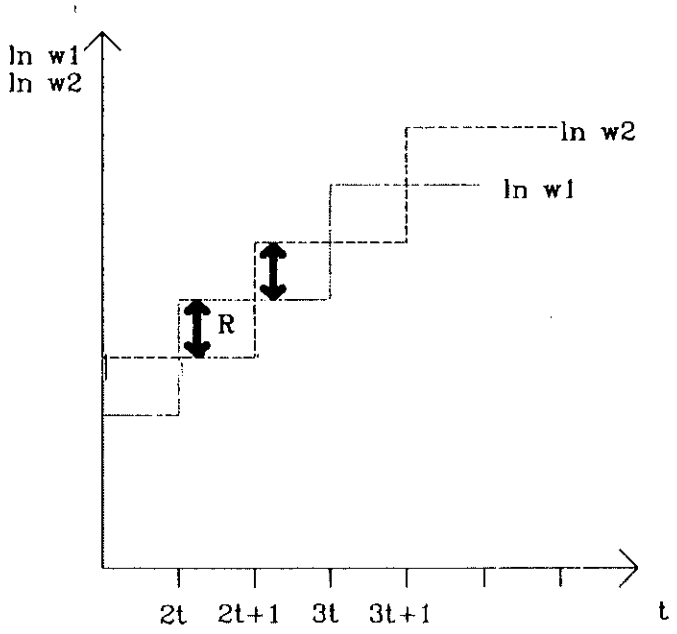
$$w_i = w_i(p_i, p_j, w_j) \tag{7}$$

Union one's view of the world at even times corresponds exactly to union two's view of the world at odd time (symmetry assumption). Consequently, the relative wage chosen by union one at even times is the same as the relative wage chosen by union two at odd times:

$$\frac{w_{i,2t}}{w_{j,2t}} = \frac{w_{j,2t+1}}{w_{i,2t+1}} \tag{8}$$

This argument is illustrated by Figure 2: At time $2t$, union 1 chooses a relative wage R. At time $2t+1$, union 2 chooses the same relative wage. Combining the assumptions of symmetry among firms and of non-synchronisation, he shows that the relative wages of the two sectors determine the rate of inflation.

Figure 2: Relative wages and inflation



[20]For two periods, without long term considerations.

Although very different, the models of Akerlof (1969) and of Gylfason and Lindbeck (1984a) rely on the same intuition (which is the same as Keynes'): Each union sees the wage of the other groups as given; it chooses or bargains its wage, as a function of the other wages; the other union(s) bargain(s) symetrically; when we put the claims together, the interaction leads to *non-desired overbidding*:

- in a static world, the Nash equilibrium implies a loss of efficiency which corresponds to higher prices in levels and lower employment (Cf. 2.2);
- in a dynamic world, this leads to a rate of inflation which is a function of the relative wages among the two groups.

The link between the static and the dynamic framework becomes clear when we model a decision process with bargaining over three elements: Wage level, contract length and bargaining period. This is presented in Fethke and Policano (1984) and (1986). They show mainly that synchronisation will dominate if there is a large number of sectors, or when the aggregate shocks dominate the sectorial shocks.[21]

A problem with Akerlof's model is that the process seems infinite: Each year, both unions repeat the same process leading to the same inflation without ever adapting their expectations. The inclusion of expectations in Akerlof's model is made by Taylor (1979). Each period, half of the labour force determines a nominal wage for two periods. The optimal wage is a linear homogenous function of the current price level and of the expected price level for the next period, since the wage is pre-set for this period. Because the price is a mark-up over current wage and past wage, we can express the optimal wage as a function of past wage and expected wage for the next period. This is interpreted by Taylor in the way of Keynes: Workers care about relative wages, which are the wages paid to the other half of the labour force this period and the next period. This framework allows for real effects of unanticipated increases in money which will disappear after some periods.[22]

The interest of treating the models of Akerlof (1969) and Taylor (1979) as wage interdependence models (this is the second link we want to emphasise in the survey) is to show that a dynamic approach, even very sketchy, allows to analyse dynamic wage interdependence, output persistence and inflation. Unfortunately, nothing has been done to reformulate an explicit decentralized bargaining model in an intertemporal framework, probably because of the difficulties linked with formalising intertemporal bargaining procedures.

[21]Explaining the results in detail is beyond the scope of this survey. See also Kempf (1990a) for a discussion of the implications.

[22]The staggered wage structure, even weakened by allowing reactions of the predetermined wage to excess demand variable, seems to be able to generate output persistence. In that case, output persistence is seen as the outcome of the coordination failures. See Kempf (1990b) for a recent research in this direction.

2.2 Unemployment as a coordination failure

The presence of unemployment[23] as resulting from coordination failure is due to the combination of two elements: The existence of externalities or spillovers (if union 1 obtains a higher wage, union 2 is worse off) and the existence of strategic complementarity (if union 1 obtains a higher wage, unions 2 claims a wage increase). As it as been illustrated by the example in the beginning of this section, when unions' utility contains the alternative wage, the two conditions are met and cooperation between unions increase total welfare. This cooperation reduces the level of wages since each union incorporates in its computation the negative externality of its wage on employment in the other sector. Employment is increased. In Figure 3a, coordination allows to go from the Nash equilibrium N, which is at the intersection of the reaction functions (dashed lines) to the cooperative equilibrium C, where wages and therefore unemployment are lower.[24] This is always true as long as the externality remains negative, i.e. as long as the demand composition effect or the substitution effect between labour types do not dominate the rivalry effect. If the externality is positive, the indifference curves have another shape and the cooperative equilibrium C implies higher wages than the Nash equilibrium N (figure 3b).

Figure 3a: Negative externality

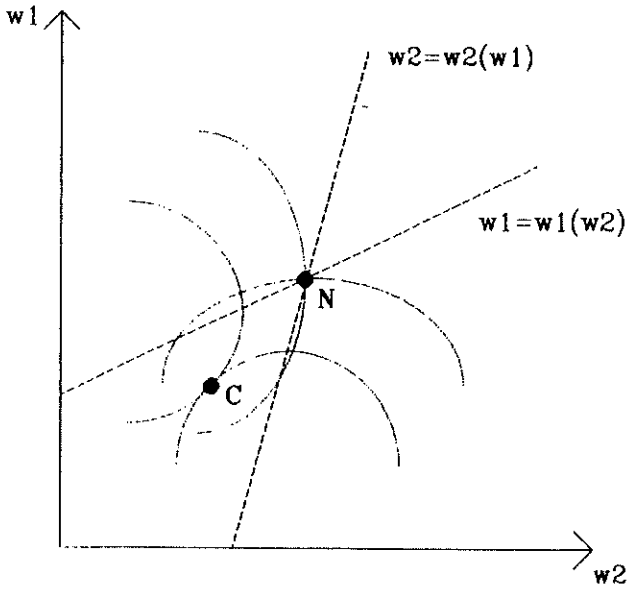
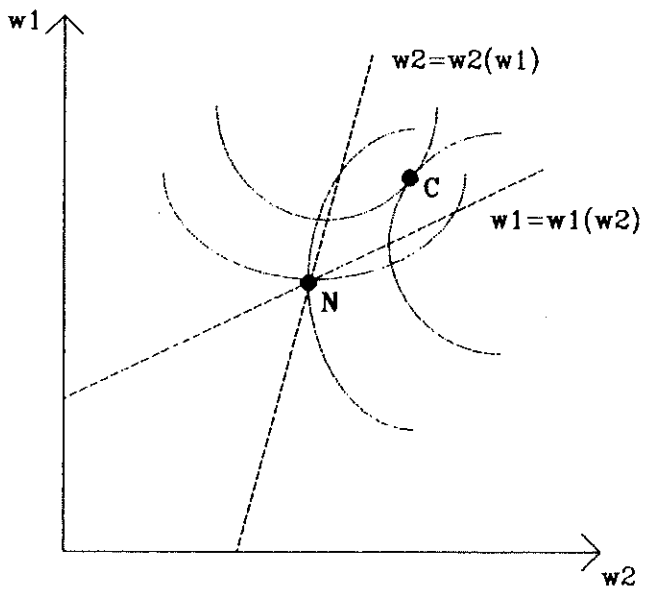


Figure 3b: Positive externality



The way suggested by Figure 3a of considering part of unemployment as a coordination failure is true even if we abandon the ad hoc assumption about unions' utility which allow to include the alternative wage in the objective function of the union. In general equilibrium (cf. section 1.2), when unions coordinate, they take into account the effect

[23] We make a shortcut when we call unemployment what is in fact a lower level of output and labour demand. Implicitly, we assume a large fixed labour supply.

[24] At point C, the indifference curves (dotted lines) of the two unions are tangent.

of their decision on the aggregate price level so that the tradeoff between wages and employment is reinforced, leading to a higher level of employment (Cf. Jackman, 1985). Moreover, it can be shown that the gain of coordinating unions' activity is increasing with the firms' monopoly power on the goods market (Cf. Cahuc, 1988, p330).

This story can also be put in terms of tradeoff between unemployment and inflation: "The more intensely the unions compete with one another, the more costly in terms of increased inflation it is for the government to attempt to reduce unemployment at a given rate through monetary or fiscal expansion." (Gylfason and Lindbeck, 1984b). The problem is that the intensity of the competition is not really explained; the solution for the government is simply to reduce this competition and to encourage coordination between social actors.

An additional topic that may arise in the story of unemployment as a coordination failure is the one of multiple equilibria. If the reaction functions depicted in Figure 2a are not linear, we may have more than one intersection between the reaction functions, leading to the existence of several equilibria. In general, these equilibria can be Pareto-ranked. This means that, in addition to the inefficiency resulting from the non-cooperative solution, the actors could choose an equilibrium which is not the best among the set of non-cooperative equilibria. Unfortunately, this topic has not yet been applied to decentralized wage formation, except in an empirical paper of Risager (1990) which is overviewed in the next section.

2.3 Wage interdependence and the trade balance

The idea that manufacturing sectors (tradeables sectors) are leading in wage formation is at the root of the Scandinavian model, such as described by Aukrust (1977), Lindbeck (1979) and Calmfors (1979). We make here a third link between separate branches of the literature: It consists precisely to show that the Scandinavian model of inflation can be seen as a special case of the decentralized bargaining set-up which is not explicitly formalised, where we have one-way causality only. This is due to two of their assumptions:

- Wage inflation in the tradeables sector is defined by the growth rate in the value of labour's product $(\dot{p}_1 + \dot{q}_1)$. This is equivalent to making a constant labour share assumption.

  $$\dot{w}_1 = \dot{p}_1 + \dot{q}_1$$

  This is not based on an explicit wage bargaining model, but reflects a kind of implicit agreement which defines a trend in wage inflation, such that the labour share in value-added is constant.
- A wage transmission mechanism is postulated such that wage inflation in the non-tradeables sector is equal to the wage inflation in the tradeables sector:

  $$\dot{w}_2 = \dot{w}_1$$

  This is equivalent to the leading and following sectors assumption.

When we add the price-taking assumption for the tradeables sector, $\dot{p}_1 = \dot{p}^w + \dot{e}$,[25] and the price-making assumption for the non- tradeables sector, $\dot{p}_2 = \dot{w}_2 - \dot{q}_2$, we find the crucial result that the non- tradeables price inflation exceeds world inflation by the same amount as the tradeables sector productivity increase exceeds productivity growth in the non-tradeables sector:

$$\dot{p}_2 - \dot{p}^w = \dot{q}_1 - \dot{q}_2$$

If the productivity growth differential is important, which is generally the case, the Scandinavian model predicts a steady fall in the relative price p_1/p_2. This leads to a steady shift from internal demand to the tradeables goods and consequently to a chronic trade balance deficit.

This result is important since it shows that wage interdependence can have strong implications on the trade balance. Unfortunately, little has been done in order to combine the coordination failure models of wage rivalry with open economy features.

3 Empirical analysis

The inefficiency caused by decentralized bargaining can be used as an argument for state intervention through incomes policy. Moreover, it suggests that a direct intervention into the labour market should take full account of the differing characteristics of wage formation in different markets (Cf. Flanagan, 1976) and of possible interactions between sectors. This stresses the importance of empirically evaluating the interdependence and analysing its consequences on labour market behaviour.

Empirical studies and descriptive analyses dealing with wage interdependence are particulary numerous. They are generally devoted to proving the existence of spillovers in wage formation but also to determining the leading sectors. The one-way causality paradigm seems dominant in this literature. In (3.1) we present some investigations around the determination of the leading sectors. In (3.2), we briefly treat the problem of multiple equilibria. In (3.3), we sketch some policy implications of the empirical studies.

3.1 Determination of the leading sectors

The first econometric attempt to determine the importance of wage spillovers is Eckstein and Wilson (1962). Their theoretical model is based on five assumptions: (1) wage rates are set by a bargaining process, (2) both product and labour market conditions influence wage determination, (3) profit (product market) and unemployment rate (labour market) are sufficient to explain most of the variation in the wage rate, (4) wage determination in a group of heavy industries is interdependent, (5) wages are determined in wage round. Assumptions (1)-(2)-(3) are more or less equivalent to computing the Nash product between profit and utility in determining the wage rate. Assumption (4) determines the

[25] Where $\dot{p}^w$ is the rate of growth of world price and $\dot{e}$ the rate of growth of the exchange rate.

key group, the leading sector, the "wage contour". Assumption (5) says that once the pattern for a round in set in early key bargains, the movements of wages in the remaining years are largely determined until the next round is settled. These last two assumptions are similar to the basic assumption about wage determination in Scandinavian models as described in the previous section.

The first main result is that both profit and unemployment rate are highly significant in the key group wages equation.[26] Concerning wage determination outside the key group, explicit allowance must be made for spillover from the key industries in order to get reasonable results. The inclusion of the key group wages in the non-key group wage equations significantly improves the fit. The existence of the key group is supported by the superiority of individual industry regressions with group variables over those with industry variables.

The main problem of this study is that the definition of the key group rests on a priori information only: This group is built by looking at the similarities among a large number of heavy industries, and after discussion with labour economists. For this reason we have to consider more sophisticated methodologies.

A response to the Eckstein and Wilson article is Mehra (1976), who tries to test more rigorously the existence of leading sectors. He decomposes the wage into two components: A deterministic one that can be explained in terms of exogenous market forces and a residual one. He then tests the correlation between the residual components to infer the interdependence of wages between sectors. The conclusion is that there is a large interdependence between the wages of a key group of industries; the composition of this group is enlarged with respect to the one of Eckstein and Wilson: It includes the majority of manufacturing sectors. The second conclusion is that there is no evidence of large spillovers from key to non-key industries. This view is shared by Flanagan (1976). Franz and Smolny (1991) do not find clearcut results concerning wage spillovers for Germany: Relative wages contribute to the explanation of nominal wage growth in two sectors among eight.

Unfortunately, the implications for the loss of efficiency of this large wage interdependence among the key group has not been quantified.

3.2 Non-linear reaction functions

In the previous empirical studies, the wage reaction functions are assumed linear. This allows a well-defined and easily computable vector of equilibrium wages. The question of multiple equilibria can be treated in a simple way by testing for some non- linearities.

Risager (1990) uses non-linear reaction functions for the wage of skilled (w_1) and unskilled (w_2) labour group.[27] Its empirical results give the following long term functions:

$$w_1 - c = 1.110(w_2 - c) - 0.290(w_2 - c)^2 + ...$$

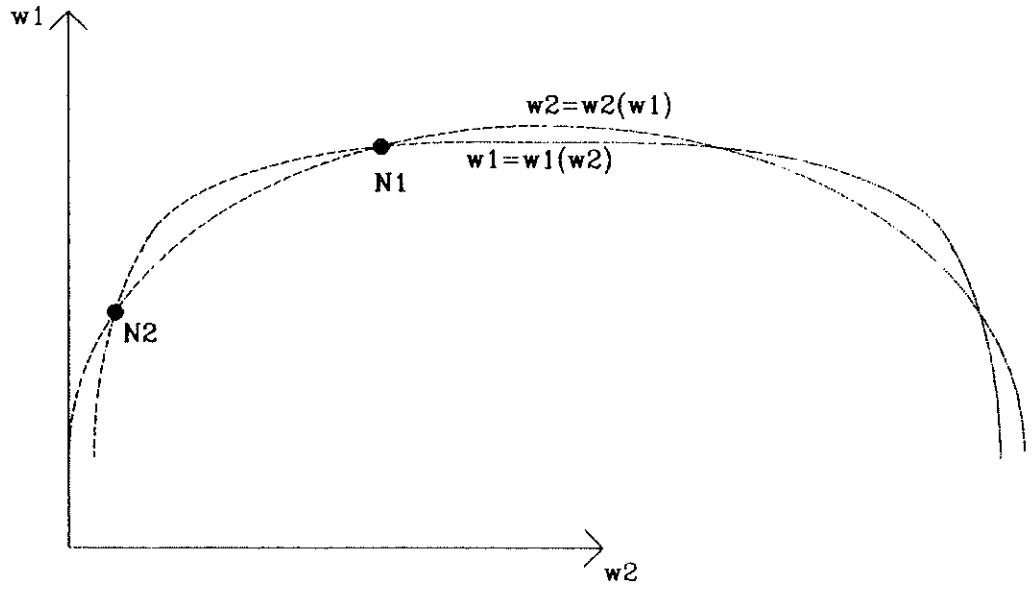
[26] Note that linear relationships are assumed.

[27] Another study concerning skilled and unskilled workers is presented in Bughin (1991).

$$w_2 - c = 0.947(w_1 - c) + 0.135(w_1 - c)^2 + ...$$

where c denotes the consumption price index. Both reaction functions are positively sloped in the observed band of real wages.

Figure 4: Multiple equilibria



The quadratic specification allows for multiple equilibria: Only two of the four possible Nash solutions are feasible in the range of observed real wages. These solutions are represented by point N1 and N2 in Figure 4. Risager shows that the lower wage equilibrium is unstable and that, fortunately, the more plausible equilibrium is stable. Evalutated at this equilibrium, the slope of the reaction function for skilled men is equal to 0.734, which shows that the spillovers are strong enough to cause a significant welfare loss.

3.3 Policy implications

From the above results, we may summarise the main policy implications:

- If there exists identified leading sectors, policy efforts to control cost inflation need to be concentrated on the key industries as these are presumed to set the pace for the rest of the economy. This pleads for the use of *selective policies.*
- If wage spillovers are too important, the wage differentials that are necessary for the allocation of resources may fail to emerge (Cf. Flanagan, 1976), which may call for a interventionist *industrial policy* in order to reduce the distortion and to promote other ways for reaching the best industrial structure.
- The *macroeconomic policy* can also be considerably revised when wage contamination dominates the labour market. Dixon (1986) shows that an increase in gov-

ernment expenditure can lead either to a decrease or an increase in employment, depending on the initial situation of the economy.

- As far as the dynamics of the system is concerned, a policy intented to change labour market conditions may induce a very low response if the wages are mainly determined by past wages in the other sectors, and the lags may be very long.
- With respect to *income policies*, Kolm (1988) shows that a first-best equilibrium can be reached in the presence of externalities in wage formation by implementing fiscal policies in order to correct the overbidding effect. Moreover, from most empirical analyses, it is clear that any intervention should take into account the various degrees of wage flexibility, in particular between the group where wages are highly rigid and interdependent, and the group where market conditions predominate in wage formation.
- Finally, the coordination of separate bargaining processes can be seen itself as a bargaining problem (Elster (1989)). Of course, coordination allows to internalise the externalities so that everbody is better off. However, workers in low-wage industries could argue that, in addition to eliminating externalities, coordination has to achieve a more egalitarian wage structure. This is contrary to the interest of the workers in high-wage industries, so that they may prefer a decentralized bargaining structure. This explains why coordination policies are often difficult to implement.

4 Conclusion

The idea that unions and employers are influenced by the wages perceived by employees in other sectors has been used mainly to support the empirical observation that wages are highly correlated among industries. This very old topic can find a new life in the growing literature about coordination failures: The presence of negative externalities and of strategic complementarity among unions enforces the idea that part of current unemployment can be eliminated by improving the coordination between the social actors who negotiate the wages.

In addition to the link between the literature about wage rivalry and the one about coordination failures, we have emphasised two other connections between different branches of the literature: The simple dynamic model of inflation due to Akerlof (1969) and Taylor (1979) gives an intertemporal perspective to wage interdependence; it stresses the potential importance of expectations and de-synchronisation in decentralized bargaining models. The Scandinavian model provides a first approach to the analysis of the consequences of wage interdependence on the trade balance. However, in both cases, the modeling of interdependence is not derived from explicit bargaining set-ups as it is in rivalry models.

With respect to the present overview of the topic, future research should focus on at least three points.

From the point of view of the foundations of the externalities, the inclusion of the relative wage in the utility of the union is unsatisfactory: A framework where the consumers' demand for goods and the unions' utility function are derived from the same assumptions about households behaviour seems more consistent than the models with specific ad hoc union utility functions. More work is needed in order to assess the externalities on more stable grounds, using the latest developments in bargaining theory and/or efficiency wages.

The implications of wage interdependence for an open economy have not been analysed thoroughly. The old Scandinavian model of inflation seems the only attempt to do so without setting up any explicit bargaining framework. It should be interesting to reconsider the question, by considering a tradeables/non-tradeables model with coordination failures.

Finally, many empirical studies have asserted the existence of wage spillovers, with or without implying the existence of key groups or leading sectors. However, the resulting loss of efficency has not been quantified, neither in terms of additional inflation, neither in terms of unemployment.

The work on wage interdependence should aim at promoting structural changes and structural policies rather than usual Keynesian macroeconomic policy.

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