

Wage Interdependence and Competitiveness

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Introduction

The growing literature on wage bargaining has mainly been concerned with closed economies. By contrast, the majority⁽¹⁾ of open economy macroeconomic models considers the labour market as competitive. The best-known exception is the open economy branch of the quantity rationing school.⁽²⁾ Unfortunately, the latter does not provide foundations accounting for wage rigidity.⁽³⁾ Consequently, the analysis of the links between union-firm bargaining and the competitiveness of an economy needs to be deepened. This is especially true if we consider a disaggregated economy with decentralized wage bargaining: in that case, the presence of externalities between unions leads to a kind of Nash equilibrium between sectors which introduces a loss of efficiency because each union does not internalize the effect of its claim on the other sectors.⁽⁴⁾ This loss of efficiency has been used to analyse inflation and unemployment but the implications for an open economy in terms of competitiveness have not been examined thoroughly.

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⁽¹⁾ Some exceptions are Rama [1990], Kaskarelis [1989] and Andersen [1991].

⁽²⁾ See Neary [1990] for a survey.

⁽³⁾ An exception is Ellis and Fender [1987] who develop an efficient bargaining framework with quantity constrained equilibrium. However, goods prices are exogenous.

⁽⁴⁾ See Gylfason and Lindbeck [1984b] for a simple example of wage rivalry. This literature can be seen from a new angle using the game theory concepts of strategic complementarities and coordination failures proposed by Cooper and John [1988].

We first provide a multi-sector model for an open economy. We apply a simple decentralized bargaining framework to a world where firms set their prices in a monopolistic competition environment. The idea is to introduce externalities among sectors through wage formation and to analyse their effect on competitiveness. In order to obtain a precise “anatomy” of competitiveness, we combine structural factors such as demand-supply mismatch and capacity constraints (which have been stressed by quantity rationing models as in Lambert [1988] and Sneessens [1987]) with market imperfections such as union power, firm market power and externalities (as in McDonald and Solow [1981], Blanchard and Kiyotaki [1987] and Cooper and John [1988]).

Secondly, we try to answer two questions:

- How is the inefficiency resulting from the non-cooperative behaviour of unions affected by union power and quantity constraints, and how does this inefficiency affect the competitiveness of the economy?
- How are the specific conditions of one sector (such as productivity gains) passed on to the wages of the other sectors and how can they modify their competitiveness?

Finally, we estimate price and wage equations for six Belgian manufacturing sectors to see which implications can be drawn from the theoretical model. We try to evaluate the importance of the loss of competitiveness due to non-cooperation by simulating external shocks with and without externalities in wage formation.

At this stage, two remarks on the scope of the paper are worth noting: First, the development of the theoretical model is made very detailed to ground the model in optimising behaviour in a general equilibrium setting. This allows us to see the role of *structural* parameters on price and wage formation and therefore on competitiveness. However, because of the lack of appropriate sectoral data to estimate the full model, the general equilibrium perspective will be put aside in the late sections; the empirical part will not fully exploit the general equilibrium structure. Note nevertheless that full advantage of the general equilibrium set-up is exploited in two companion papers: Arnsperger and de la Croix [1993] analyse in much more detail the interaction between monopolistic competition, quantity constraints and union power and their impact on unemployment; de la Croix [1993] examines the implications of externalities in wage formation on unemployment.

Second, this paper will focus on one specific aspect of competitiveness, i.e. the effect of wage interdependence through decentralized

bargaining on price formation, and will neglect the potential effect of other elements, like the gap arising in open economies between consumption prices and value-added prices.

1 The Model

1.1 Households

The economy is divided into K sectors. Each sector k is composed of a large number n^k of firms i , each producing a single consumption good. The goods are imperfectly substitutable. The utility function of the representative household j is defined over the domestically produced consumption goods c_{ij}^k . The elasticity of substitution between the different goods of the same sector is a constant $-\epsilon^k$, with $\epsilon^k > 1$. The utility function is also defined over H baskets of goods produced abroad c_{ij}^k , $k = K + 1..H$; the elasticity of substitution between any two baskets (foreign and domestic) equals -1 . Therefore, the utility function is a Cobb-Douglas of different baskets of goods, each basket being a CES of different goods. The households are *risk neutral*.⁽⁵⁾

The utility function is separable in consumption and leisure. The marginal disutility of work, which is equal to the real reservation wage, is r/p . Moreover, as in Sneessens [1987], we assume that labour supply is firm-specific: if the offered wage is greater than the reservation wage, ls_i^k workers supply one unit of labour to firm i of sector k . This assumption is the simplest way to allow for the coexistence of vacancies and unemployment.

The budget constraint of household j includes income I_j . The first order conditions for utility maximization yield notional goods demand functions and demand for money as a function of wealth and of the vector of prices. Details are provided in appendix; the goods demand is:

$$c_{ij}^k = \left(\frac{p_i^k}{p^k} \right)^{-\epsilon^k} \frac{\alpha^k}{n^k} \left[\frac{I_j}{p^k} \right] u_i^k \quad (1)$$

with

$$p^k = \frac{1}{n^k} \left(\sum_{i=1}^{n^k} u_i^k p_i^{k(1-\epsilon^k)} \right)^{1/(1-\epsilon)}$$

where α^k is the average propensity to consume the goods of sector k . Note the presence of u_i^k . These good-specific weights, which are due

⁽⁵⁾The risk neutrality assumption does not imply any change in demand functions. It implies that the indirect utility is a linear function of income.

to Licandro [1991], make the utility function more general than the one presented in Dixit and Stiglitz [1977] or Blanchard and Kiyotaki [1987] and will be used to model firm-level uncertainty in the spirit of Lambert [1988] and Sneessens [1987]. The distribution function of the u_i^k is the same for all households and determines the allocation of a given sectoral demand across the various firms of *this sector*. We assume that this distribution is of mean 1 and that $\sum_k u_i^k = 1 \quad \forall k$.

1.2 Unions

The utility of the firm-specific union V_i^k is obtained by computing the sum of the indirect utilities of the members. The indirect utility of each member (obtained by replacing (1) in the utility function) is equal to its real income I_j/p since households are risk neutral.⁽⁶⁾ If every worker supplying its work to the firm is a union member, the total membership is $l s_i^k$. The utility of the union is the sum of labour income net of the reservation wage, $(w_i^k - r) l_i^k$ and capital income. The fall-back utility \tilde{V}_i^k , which is the status quo point in the bargaining process, is the income attainable in case of breakdown in the negotiation. In this situation, there is no production, no labour income and no employment; fall-back income is simply equal to the sum of distributed profits of all other firms.⁽⁷⁾ The net utility of the union is therefore equal to employment times the difference between the wage and the disutility of work:

$$V_i^k - \tilde{V}_i^k = l_i^k \frac{w_i^k - r}{p} .$$

Let us assume that the reservation wage is a function of the mean wage in the economy, \tilde{w} , which can also be called the reference wage: $r = \phi \tilde{w}$ with $\phi < 1$. This simply says that, when households evaluate their gain from working, they compare the wage they would earn with a reference wage which is the average labour earning in the economy⁽⁸⁾. Consequently, the net union utility is defined over employment

⁽⁶⁾ Where p is the aggregate price level consistent with household utility:

$$p = \prod_{k=1}^{K+H} p^k (\alpha^k / \sum_{z=1}^K \alpha^z)$$

⁽⁷⁾ Total profit of other firms is assumed to be the same in the case of no bargain. Since the households' share of profit in the i th firm of the k th sector is infinitely small compared with that of the rest of the economy, dividend income is not significantly affected by the outcome of the bargaining.

⁽⁸⁾ This has something to do with the usual 'rivalry' or 'jealousy' effect: the workers look at the other workers to evaluate their gain of reaching an agreement during the bargaining. This interpretation is often used in the literature, from Keynes [1936] to Bhaskar [1990]. An important source of

and over the difference between the negotiated wage and a portion of the average wage in the economy:

$$V_i^k - \tilde{V}_i^k = l_i^k \frac{w_i^k - \phi \tilde{w}}{p}.$$

The parameter ϕ measures the intensity of the externality between unions.⁽⁹⁾ It will allow us to study the impact of the intensity of the externality on the equilibrium, including the special case where $\phi = 0$ (no externalities).

1.3 External Sector

The rest of the world buys goods from the domestic sectors, sells goods to the domestic households and sells energy as an intermediate input to the domestic sectors. The demand from the rest of the world is defined as resulting from the utility maximisation of \hat{J} foreign consumers. This utility function is the same as for domestic households. Denoting \hat{I} the nominal income of the rest of the world, notional demand to domestic firm i is:

$$c_{ij}^k = \left(\frac{p_i^k}{p^k}\right)^{-\epsilon^k} \frac{\alpha^k}{n^k} \left[\frac{\hat{I}}{p^k}\right] w_i^k \quad j = J + 1 \dots J + \hat{J}. \quad (2)$$

1.4 Firms

The firm's supply is determined as in Sneessens [1987]. Its production function includes three inputs: labour, capital and energy. In a given sector k , the only difference between the firms is that they are affected by a different realization of the demand shock w_i^k . The production function uses labour with constant returns with α^k as the mean productivity of labour (subscript i is omitted since the firms in

wage interdependence in Belgium is of course the indexation mechanism on the consumption price index. This indexation can be seen as an institutional factor that implements partly the requirements of wage rivalry by reducing the gap between the wages in the different sectors.

⁽⁹⁾ There is another attractive way of modelling externalities in this context: If the disutility of work were evaluated as a function of the value of domestic work, the reservation wage would be indexed on the general price level p . Since this price will turn out to be a function of the wages in the economy, we would retrieve the same qualitative relation in a different way. An unemployment insurance scheme could also provide some kind of interdependence.

sector k have the same labour productivity):

$$y_i^k = a^k l_i^k. \tag{3}$$

The production function uses also capital in a fixed proportion. Since the total capital stock is fixed, the firm is limited in its production by the availability of capital. Let us denote the maximum possible output, or potential output, as \bar{y}^k , with $y_i^k \leq \bar{y}^k$.

Finally the technology needs also some input of imported energy in a fixed proportion; let z^k be the mean productivity of energy. We assume that the firm can not be constrained on this market. The total input of energy is y_i^k/z^k . The firm's profit Π_i^k is equal to output y_i^k times the difference between the output price p_i^k and the average production cost, where p^E is the price of energy (the exchange rate is supposed fixed):

$$\Pi_i^k = y_i^k \left(p_i^k - \frac{w_i^k}{a^k} - \frac{p^E}{z^k} \right).$$

The notional demand yd_i^k addressed to the firm is obtained by aggregating (summing) over households the consumption functions (1) and (2):

$$yd_i^k = \sum_{j=1}^{J+\hat{J}} c_{ij}^k = \left(\frac{p_i^k}{p^k} \right)^{-\epsilon^k} \frac{1}{n^k} \left[\frac{\alpha^k \left(\sum_{x=1}^K (p^x - p^E/z^x) y^x + \hat{I} \right)}{p^k} \right] u_i^k. \tag{4}$$

According to equation (4), the demand addressed to firm i is a share of total income depending on the relative price of the firm with respect to the price of its sector and on the weight u_i^k of good i in the utility function. The role of these weights is to introduce demand uncertainty in the model: firms and unions know only the probability distribution of these weights at the time of their decision about prices and wages.

The timing of the decisions is the following: 1) Unions and firms bargain at the firm level over prices and wages, knowing the distribution of the u_i^k . 2) Firm-specific shocks u_i^k become known. 3) Firms determine output and employment. Since output is determined after the realization of the shock, it is equal to the minimum of the two constraints:

$$y_i^k = \min(\bar{y}^k, yd_i^k). \tag{5}$$

Let us assume that the shock u_i^k is lognormally distributed among firms. We then apply Lambert's [1988] theorem and approximate expected output as a CES function of the two expected constraints:

$$E(y_i^k) = \left[(\bar{y}^k)^{-\rho^k} + E(yd_i^k)^{-\rho^k} \right]^{-1/\rho^k}. \tag{6}$$

The parameter ρ^k is a function of the variance of the shock u_i^k . In particular, if this variance goes to zero, ρ^k goes to infinity, it can be shown that the CES would tend to the minimum function (5).⁽¹⁰⁾

A crucial variable at the firm level is the probability of facing a demand constraint. This probability is also equal to the elasticity of firm output with respect to demand. It is defined by Lambert [1988] as:

$$\Pr[y_i^k \leq yd_i^k] \equiv \pi_{Di}^k = \left(\frac{E(y_i^k)}{E(yd_i^k)} \right)^{\rho^k} \tag{7}$$

2 The Equilibrium

Since we are mainly interested in (a) the effect of wage interdependence on competitiveness and in (b) the nature of the contagion of shocks between sectors, we focus here on price and wage formation.

2.1 The Firm Level Equilibrium

In each firm of the K sectors, the union and the firm negotiate an efficient outcome (Mc Donald and Solow [1981]), bargaining jointly to determine the nominal wage and the output price. Given the exogenous timing of the decision imposed above, bargaining over prices and wages is the best solution for the players, the decision about prices being equivalent to a decision about the expected level of employment.⁽¹¹⁾ Using the asymmetric Nash bargaining solution, and assuming a zero fall-back profit, the maximization problem is:⁽¹²⁾

$$\max_{w_i^k, p_i^k} \left[\frac{E(y_i^k)}{a^k} \frac{w_i^k - \phi \tilde{w}}{p} \right]^{\beta^k} \left[\frac{E(y_i^k) p_i^k - w_i^k / \alpha^k - p^E / z^k}{p} \right]^{(1-\beta^k)}$$

s.t. (3), (4) and (6)

⁽¹⁰⁾ In this case, there would be no more uncertainty and the model would be equivalent to a regime-switching (unemployment or not) framework where all firms are in the same situation. We would then always have to distinguish the two cases (as in Malinvaud [1977] or, more recently, in Jacobsen and Schultz [1990]).

⁽¹¹⁾ We have chosen a cooperative solution at the firm level in order to limit the loss of efficiency to the aggregate level at which a non-cooperative framework between firm-union pairs will be introduced.

⁽¹²⁾ Note that p is the aggregate price level, which is exogenous at the firm level.

FOC:

$$\begin{cases} p_i^k &= \left[1 - \frac{1 - \beta^k}{\epsilon^k \pi_{Di}^k} \right]^{-1} \left(\frac{w_i^k}{a^k} + \frac{p^E}{z^k} \right) \\ w_i^k &= (1 - \beta^k) \phi \tilde{w} + \beta^k a^k \left(p_i^k - \frac{p^E}{z^k} \right). \end{cases} \tag{8}$$

The first order conditions determine price and wage equations (which are the variables that are decided before the realization of the shock). Concerning the price equation, we see that the firm’s price is a markup on marginal variable cost, with the markup rate depending on union power and on the probability of a demand constraint. The second order condition requires $\pi_{Di}^k \geq (1 - \beta^k) / \epsilon^k$. As stated before, the union refuse to work if $w_i^k > \phi \tilde{w}$ is not verified.

The introduction of firm-specific uncertainty allows to express the mark-up rate as a function of the probability of a demand constraint and endogenized the mark-up rate. Note that the Lerner index is not the same as in standard theory: the markup rate depends on demand conditions, but also on union power.⁽¹³⁾

In system (8), the wage is a weighted sum of the reference wage and marginal labour productivity in value. The inclusion of the reference wage reflects what has been called the “rivalry effect”: The presence of the reference wage in the bargaining function introduces a negative externality between unions;⁽¹⁴⁾ This formulation shows why the rational behaviour of unions derived from household preferences does not force the union to require full compensation for inflation unless it assumes other unions to be fully compensated. Stated in real terms, the wage equation can be rewritten

$$\frac{w_i^k}{p} = \frac{(1 - \beta^k) \phi \tilde{w} + \beta^k a^k \left(p_i^k - \frac{p^E}{z^k} \right)}{p}$$

⁽¹³⁾ The intuition behind this is relatively straightforward: the efficient contract between the firm and the union contains an implicit clause about employment which forces the firm to reduce its output price in order to increase the demand for its good. The Lerner index is negatively affected by union power: A “powerful” union extracts some part of the pure monopoly profits, which amounts to lowering the firm’s effective monopoly power.

⁽¹⁴⁾ Since the resulting wage is a positive function of the reference wage, we also have strategic complementarity between unions. The presence of both externalities and strategic complementarities leads to sub-optimal equilibria which are treated in the next section.

which shows that workers will ask for full compensation of aggregate inflation as long as \tilde{w}/p and p_i^k/p remains constant. What is important here, comparing our rivalry model with the one of Gylfason and Lindbeck [1984b], is that the weights of the two elements in the wage equation are a function of union power: If union power is high, the workers capture a higher part of firms added-value. If it is low, the wage is determined to a larger extend by the wages of the other sectors.

2.2 Sectoral Equilibrium

As is usually supposed in quantity rationing models, we assume that sectoral demand is randomly distributed among a large number of firms. When they take their decision about prices and wages, firms do not know their position in the distribution of demand. However, total sectoral demand yd^k is known and is proportional to the expected demand perceived by the firm: $E(yd_i^k) = yd^k/n^k$. For this reason, we say that uncertainty is only *firm-specific*. At the sectoral level, the model becomes deterministic.

To derive (9), we use the properties of a symmetric equilibrium. All firms of each sector are the same ex-ante (when they decide about prices and wages) but differ after the realization of the shock (when they set output and employment). In each sector, all agents set the same price and wage:

$$\begin{cases} p^k &= \left[1 - \frac{1 - \beta^k}{\epsilon^k \pi_D^k}\right]^{-1} \left(\frac{w^k}{a^k} + \frac{p^E}{z^k}\right) \\ w^k &= (1 - \beta^k)\phi\tilde{w} + \beta^k a^k \left(p^k - \frac{p^E}{z^k}\right). \end{cases} \quad (9)$$

After the realization of the shocks, aggregate demand is distributed among firms following the same distribution as the probability distribution of the shock. For this reason, we can equalize the ex-ante probability distribution of the shocks with the ex-post distribution of demand across firms in each sector. Consequently, the sectoral economy is similar to the firm-level one, where the expected variables are replaced by aggregate variables. What was before the ex-ante probability of being constrained by demand now becomes the ex-post proportion of firms actually constrained by demand. If we define the degree of utilisation of capital, for which we have data, as

$$duc^k = \frac{y^k}{n^k \bar{y}^k} \quad (10)$$

the proportion of firms actually constrained by demand can be expressed as a function of duc^k :

$$\pi_D^k = 1 - (duc^k)^{\rho^k}. \tag{11}$$

2.3 Macroeconomic Equilibrium

A macroeconomic equilibrium is characterized by K sectoral equilibria and by a scalar \tilde{w} which satisfies (13).

$$\tilde{w} = \sum_k \lambda^k w^k \tag{13}$$

where $\lambda^k = l^k / \sum_z l^z$ is the size of sector k in percentage of total labour market.⁽¹⁵⁾

Some important characteristics of the model are the following:

- The relation between prices and wages passes through the mark-up of prices on the marginal cost. This mark-up is a function of union power (as in Arnsperger and de la Croix [1993]), of the elasticity of substitution between goods (cf. Dixit and Stiglitz [1977]), of the degree of capacity utilisation and of the parameter measuring firm-level uncertainty (see Sneessens [1987]). Using (11) we have:

$$p^k = \left[1 - \frac{1 - \beta^k}{\epsilon^k (1 - (duc^k)^{\rho^k})} \right]^{-1} \left(\frac{w^k}{a^k} + \frac{p^E}{z^k} \right). \tag{14}$$

- The relation between wages and the state of the labour market is determined by the share λ^k of each sector in total labour supply. An important variable is the aggregate unemployment rate $\lambda^u = 1 - \sum_k \lambda^k$. If it increases, the share of the unemployed workers in the reference wage increases, provoking a general decrease in each sectoral wage.
- The relation between world market conditions and output prices comes through duc only. If the price of the rest of the world increases, the demand addressed to domestic firms rises, implying a rise in domestic duc and therefore in domestic output prices.

⁽¹⁵⁾ This amounts to assuming zero unemployment compensation. If unemployment allowances w^u were non-zero, the average wage would have been $\tilde{w} = \sum \lambda^k w^k + (1 - \sum \lambda^k) w^u$.

- The relation between wages of different sectors is mainly determined by union power and by the intensity of externalities. If union power increases, the elasticity of wages to productivity (in value) rises and the elasticity of wages to the reference wage falls. From the point of view of one firm alone, the wage equation in (9) shows that high union power links the wage to the specific conditions of the firm, allowing to share the increase in production between wage-earners and share-holders. If the union becomes less powerful, the wage is lowered and depends increasingly on the wage paid elsewhere, reinforcing wage interdependence. From an empirical point of view, we can distinguish the *leading sectors* where union power is high, and where the wage incorporates productivity gains to a substantial extent, and the *following sectors* where union power is low and where the wage is mainly determined by the reference wage.⁽¹⁶⁾

3 Inefficiency and Competitiveness

We measure the competitiveness of sector k through the relative price p^k/p . The size of sector k is small compared to the one of the world implying that p is not significantly affected by sectoral or even country-specific changes. Following (9), we compute each sectoral price resulting from bargaining by replacing in the price equation the value of w^k given by the wage equation. This shows that the firm and the union plan this price to be a mark-up μ^k over the reference wage and the unit price of energy:

$$p^k = \mu^k \left(\frac{\phi \tilde{w}}{a^k} + \frac{p^E}{z^k} \right) \quad (15)$$

with

$$\mu^k = \left[1 - \frac{1}{\epsilon^k \left(1 - (du^k)^{\rho^k} \right)} \right]^1.$$

The inefficiency comes from the fact that the agents are not able to internalize the effect of their decision on the reference wage. An increase in their wage pushes up the wages in every other firm and sector, therefore improving their own reference wage. If, on the contrary, we take into account all these interactions, we can compute

⁽¹⁶⁾ Our conception of “leading sectors” has here nothing to do with temporal aspects of staggering.

the resulting output price incorporating the value of \tilde{w} by solving (9) with (13):

$$p^k = \mu^k \left[1 + \phi \left(\frac{\sum_q \lambda^q \beta^q (\mu^q - 1) \frac{a^q z^k}{a^k z^q}}{1 - \phi \sum_q \lambda^q (1 + (\mu^q - 1) \beta^q)} \right) \right] \frac{p^E}{z^k}. \quad (16)$$

Comparing (15), the desired price at any given \tilde{w} , and (16), the actual price resulting from the “fully adjusted” \tilde{w} , we have some elements to answer our questions.

3.1 The Magnitude of the Loss of Competitiveness

Result 1. *Competitiveness is decreasing in union power, in the magnitude of externalities, in the degree of uncertainty and in duc . It is increasing in the elasticity of substitution between goods and in the unemployment rate.*

Proof:

from (16), $\frac{dp^k}{d\beta^q} > 0$, $\frac{dp^k}{d\phi} > 0$, $\frac{dp^k}{dduc^q} > 0$, $\frac{dp^k}{de^q} < 0$, $\frac{dp^k}{d\rho^q} < 0$, $\frac{dp^k}{d\lambda^q} < 0$ $q \neq k$.

The first main element of the difference between (15) and (16) is the presence of the mark-up rates of all sectors $q \neq k$ in p^k . If these are close to one, competitiveness is improved through the moderation of the wage-price spiral. In order to have a low mark-up rate, we need a high elasticity of substitution between goods, a low degree of capacity utilization and a low degree of uncertainty at given duc . We see here the role of the quantity constraints: the stronger the capacity constraint in the economy, the lower the probability of being constrained by demand and the higher the elasticity of prices to wages. As a result, the “price-wage” spiral is stronger and competitiveness is lower. A higher degree of capacity utilization therefore decreases competitiveness.

Let us stress here also the importance of the role of the quantity rationing framework through the parameter ρ . Policies which aims at reducing the variance of the shocks will normally improve the competitiveness.

The second main element of the difference between (15) and (16) is the fact that rising union power improves competitiveness in (15) and worsens it in (16). Therefore, low union power contributes to reducing the spiral: We have seen in the second equation of (9) that increased union power reduces the “wage-wage” spiral. However, increased union power intensifies the wage-price spiral, since the elasticity of wage to productivity is higher. Since the mark-up rate of price over marginal cost is larger than one, the second effect dominates. Consequently,

contrary to a usual result in the efficient bargaining literature, we have the following:

Corollary 1.1. *In monopolistic competition, when the bargaining is efficient, a rise in union power decreases the employment level when the sectoral inter-relations are taken into account.*

An increase in union power in one sector increases that sector's output price and therefore decreases demand, output and employment. This negative relationship between union power and employment is not usual in efficient bargaining models since the union negotiates the employment level: A rise in β should decrease the price and therefore boost demand and employment. The perverse effect of Corollary 1.1 is due to the underestimation of "wage-wage" spiral by the agents.

3.2 Contagion of Productivity Shocks

We now turn our attention to a second question: How are the specific conditions of one sector passed on to the wages of the other sectors and how can they modify their competitiveness? We analyse (1) the effect of an increase in the productivity of energy and (2) the effect of an increase in the productivity of labour.

An increase in the productivity of energy in sector q has two effects on the output price of sector k : the first passes through the wage-price block (let us call it the rivalry effect) at given demand; the second occurs via an increase in household income through profit redistribution.

- **Rivalry effect:** From equation (16) the output price of one sector is a function of some characteristics of the other sectors (a^q/z^q). If the productivity of energy increases in sector q (e.g. through energy-saving technical progress), the firm and the union reach a new agreement more favourable to employment: the nominal wage and the output price in this sector decrease as shown by (8). The reference wage for the union of sector k is less advantageous so that it accepts a lower nominal wage. This decreases the output price of sector k and increases its competitiveness. From (16), this effect is increasing in $\phi\lambda^q\beta^q(\mu^q - 1)$, and in particular, in the union power of sector q .
- **Income effect:** The increase in the productivity of energy increases profits and household income. Consumption rises, leading to an increase in the degree of capacity utilization. This tends to increase the output prices in all sectors so that competitiveness is worsened.

The total effect is undetermined.⁽¹⁷⁾

If labour productivity increases in sector q , the wage in this sector increases (through the distribution of value added between labour and capital) and the wages in the other sectors are pushed up through the rivalry effect. The price of these sectors therefore increases, worsening competitiveness.⁽¹⁸⁾ This effect is more important if union power in sector q is high so that the wage of this sector incorporates the productivity gain in a substantial way. A second channel through which labour productivity affects competitiveness is by increasing the unemployment rate and therefore decreasing the reference wage. This goes in the opposite direction compared to the first effect, so that the total effect is again undetermined.

The following Result sums up the main conclusion:

Result 2. *At given duc , the effect of productivity conditions in sector q on the competitiveness of sector k is increasing in $\phi\lambda^q\beta^q(\mu^q - 1)$. In particular, if union power in q is high enough, energy-saving technical progress in q affects the competitiveness of k positively and labour-saving technical progress in q affects the competitiveness of k negatively.*

Proof: from (16),

$$\frac{dp^k}{d(\alpha^q/z^q)} = \frac{\mu^k \phi \lambda^q \beta^q (\mu^q - 1) \frac{p^E}{\alpha^k}}{1 - \phi \sum_z \lambda^z (1 + (\mu^z - 1)\beta^z)}$$

3.3 Demand Shocks

Facing a shock on world demand, the reaction of the price of a sector is mainly determined by the elasticity of substitution between the various goods of this sector. The elasticity of the mark-up with respect to π_D^k is:

$$\eta_{\mu^k, \pi_D^k} = \frac{\beta^k - 1}{\epsilon^k \pi_D^k + \beta^k - 1} < 0.$$

⁽¹⁷⁾ The effect of union power on the multipliers of a small open economy has also been treated by Fehr and Hof [1990]; they conclude that "the degree of bargaining power is indeed an important determinant of how shocks affect small open economies. It affects not only the magnitude of the corresponding multipliers but also their qualitative nature, i.e. their sign." We retrieve this result here where the total effect depends on the value of the parameters and in particular on union power in each sector.

⁽¹⁸⁾ This is the standard mechanism of the Scandinavian model. See Aukrust [1977].

The mark-up response of a given sector to a demand shock is a function of union power, firm market power and duc . A sector where union power is relatively low and firm market power and initial duc are relatively high will tend to put more pressure on its markup facing a demand shock, in order to preserve its market share.

Finally, when a specific sector benefits from a demand shock, it increases its price which leads to wage increases in the other sectors. Consequently, the other sectors will increase their own price, implying a loss in competitiveness. In this case, an increasing demand in one sector implies falling demand in other sectors. The magnitude of this effect will of course depend on the various parameters, and in particular on firm market power and union power.

4 Empirical Investigation

In this section, we try to evaluate the relevance of our price and wage equations and to analyse the importance of wage interdependence in the main branches of Belgian manufacturing. In a first step, we look for a long-term relationship using cointegration techniques. In a second step, we simulate various shocks to evaluate the effect of wage interdependence in the long run.

4.1 The Data Set

The data are based on a disaggregation of the Belgian manufacturing sector into branches provided by IRES (Louvain-la-Neuve). These branches are: 1: Food, 2: Metal products, 3: Steel, 4: Chemicals, 5: Building Materials, 6: Textiles. The data set includes indices for wholesale prices, labour costs, output and worked hours for the period 1963-1990 on a quarterly basis; the size of the sample allows to limit the small sample bias of unit root tests and also to limit the multicollinearity problem between the different wage series. Proxies for duc are also available; they come from business surveys carried out by the Belgian National Bank. (They are only available since 1973 for the food industry and since 1969 for the chemical industry).

These data have two important drawbacks. First, the data are available for manufacturing sectors only. Generally, it is thought that manufacturing sectors are leaders and services sectors are followers in wage formation (see e.g. Aukrust [1977]) but a recent study by Nymoen [1991] shows that the contrary is true for Norway. In the present case, we are not able to check these assumptions. Second, prices are wholesale prices which are not always good proxies for output prices.

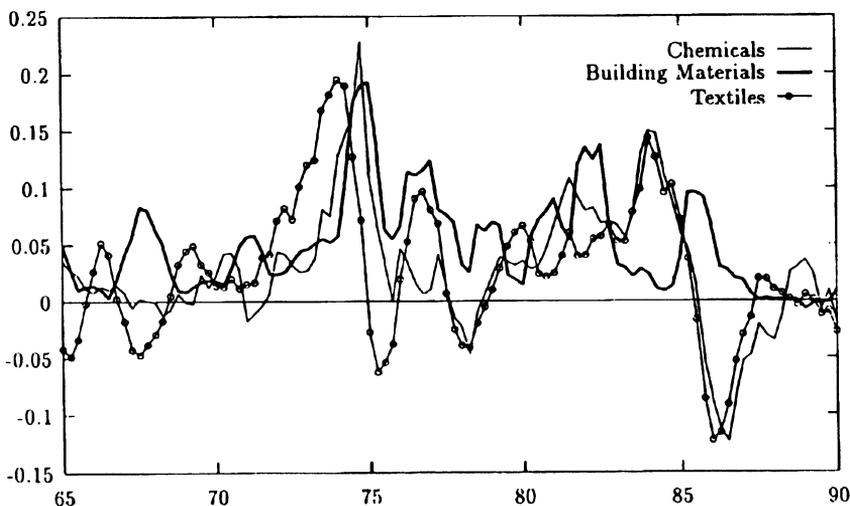
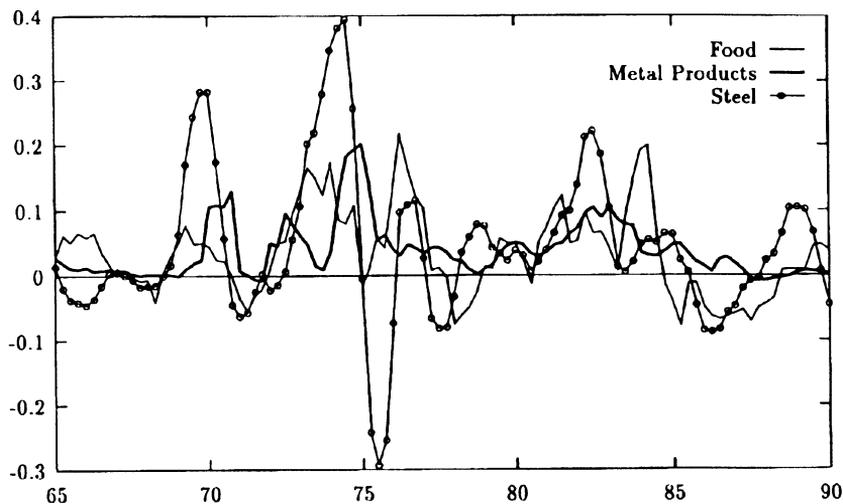


Figure 1: Sectoral Wholesale Prices

Figures 1 and 2 show the annual growth rate of prices and wages for the six sectors over 27 years. Prices are quite a lot more volatile and differ significantly across sectors while wages follow essentially the same pattern in the various sectors.

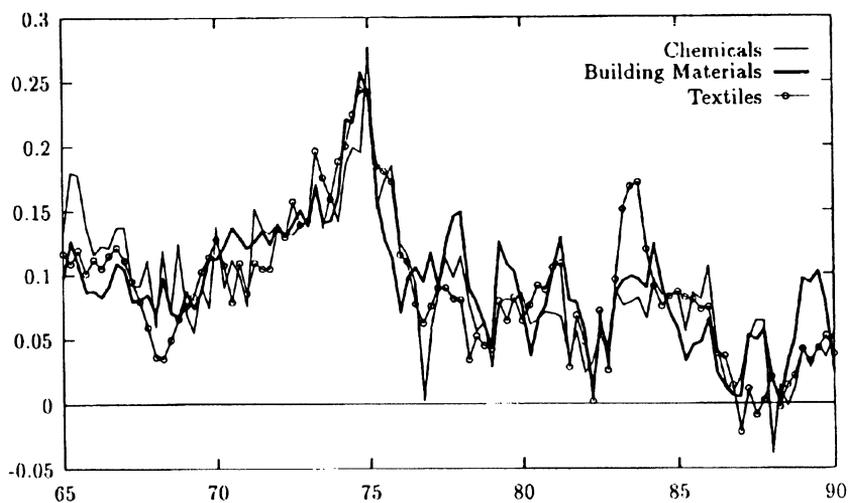
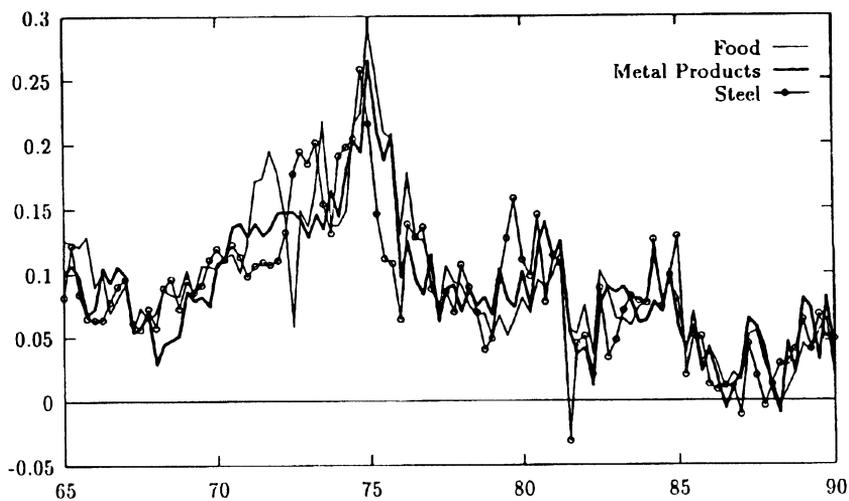


Figure 2: Sectoral Wages

4.2 Methodology

The wage-price block of our model imposes, in each sector, two deterministic long-run relationships between some variables. If these variables are $I(1)$, we have to find two cointegration relationships per

sector. In that case, the variable involved in each relation should not diverge from a linear combination of the others by too great an extent. If these variables begin to be far apart in the long-run, the outcome of the bargaining will bring them together again. To test the presence of these relations, we choose the Engle and Granger [1987] method and estimate separately⁽¹⁹⁾ each of our 12 relations. This choice is motivated by three reasons: 1) The number of variables is quite too large to apply Johansen's method to the full system. 2) We are interested in the long-run structural model which is generally difficult to obtain from Johansen's reduced form. 3) We have quarterly observations over a relatively long period; this limits the small sample bias of Engle and Granger [1987].

4.3 Estimation

The presence of one unit root in duc^k , $\ln(w^k/p^k)$, $\ln(p^e/p^k)$ and a^k is tested using a classical ADF approach.⁽²⁰⁾ All the variables can be seen as $I(1)$ variables.⁽²¹⁾ An exception is labour productivity for which the trend stationary model is not rejected in sector 1. For duc^k , the two variables corresponding to the sectors with a shorter sample period (1 and 5) are stationary, the other being a random walk without drift. The fact that duc^k is non-stationary implies that the variance of

⁽¹⁹⁾ To test the presence of these relations we roughly have two competing methods. Engle and Granger's [1987] method amounts to estimating each long-run relation with ordinary least squares and to detect the presence of a unit root in the residuals. If these estimated residuals are stationary, they represent the deviation from the long-run equilibrium. The main drawback of the method is that the estimate is subject to small sample bias (due to autocorrelation of the residuals and to simultaneity between the variables); however, it is asymptotically consistent. Moreover, the method does not pay attention to the potential presence of several cointegration vectors among the same set of variables. Johansen's [1991] multivariate method has good small sample properties and allows to estimate the whole set of cointegration vectors. It amounts to estimating in one step a VAR model which includes the set of cointegration vectors. However, this set of long-run relations is a kind of reduced form of the long-run model; it does not produce an estimation of the structural relationships. It only provides a generating system for the cointegration space. Another drawback of Johansen's method is that, like any multi-equation estimation technique, it is not feasible for systems including a large number of variables.

⁽²⁰⁾ Due to lack of space, these results are not presented here. They are available from the author upon request.

⁽²¹⁾ An interesting extension should be to test the real wage series for a structural break in the trend around 1982 to take into account government intervention in wage formation since 1982. See Perron [1989].

equilibrium duc^k is increasing over the sample period.⁽²²⁾ Even if we do not believe the results of the ADF tests on the basis that a bounded variable should be I(0), the estimates of the first order autoregressive coefficient of duc are so much near unity, that, following the advise of, a.o., Campbell and Perron [1991], it is preferable to assimilate near- I(1) series to I(1) ones as their asymptotic behaviour is more adequately described by that of unit root processes than by that of stationary processes.

To limit the multicollinearity problems in the wage series (see in Figure 2), we do not estimate the structural wage equation directly. We estimate two log-linearized versions of the price equation, one with the wage of the sector (equation (14)) and one with the reference wage (equation (15)); the difference between the two is that the mark-up rate is a function of union power only in the first case. The combination of the two gives the wage equation:

$$1 - \frac{1 - \beta^k}{\epsilon^k (1 - (duc^k)^{\rho^k})} = \left(\frac{w^k}{p^k a^k} + \frac{p^E}{p^k z^k} \right) \tag{14}$$

$$1 - \frac{1}{\epsilon^k (1 - (duc^k)^{\rho^k})} = \left(\frac{\phi \tilde{w}}{p^k a^k} + \frac{p^E}{p^k z^k} \right) \tag{15}$$

The log-linearization of (14) and (15) yields:

$$\ln duc^k = \gamma_{k0} - \gamma_{k1} \ln \frac{w^k}{p^k} - \gamma_{k2} \ln \frac{p^E}{p^k} + \gamma_{k3} \ln a^k + \gamma_{k4} T$$

$$\ln duc^k = \gamma_{k5} - \gamma_{k6} \ln \frac{\tilde{w}}{p^k} - \gamma_{k7} \ln \frac{p^E}{p^k} + \gamma_{k8} \ln a^k + \gamma_{k9} T$$

where z^k is modelled by a deterministic trend T . The coefficient of labour productivity is left free in a first step. If we can impose $\gamma_{k3} = \gamma_{k1}$ or $\gamma_{k8} = \gamma_{k6}$ without deteriorating the cointegration, we keep the restriction. For the first three sectors, labour productivity will turn out to be non-significant in the sense that its coefficient displays very low value and dropping it does not deteriorate cointegration. It is likely that its influence is better captured by the linear trend. The reference wage is computed as the average of the sectoral wages for manufacturing times $(1 - \lambda^u)$ where λ^u is the aggregate unemployment rate in the wider sense (including government special programmes).

⁽²²⁾Note that this result is not inconsistent with the quantity rationing result that there is an equilibrium value for duc^k which is lower than one (see Licandro [1992]) and which may vary over time.

Table 1: Cointegration Regressions

Equation	R^2	Durbin	ADF
<u>Sample 73:1-90:1</u>			
$\ln duc^1 = -0.35 - 0.191 \ln \frac{w^1}{p^1} - 0.009 \ln \frac{p^e}{p^1} + 0.001T$	0.55		
$\Delta u = -0.68u_{-1}$		0.9	5.78
$\ln duc^1 = -0.30 - 0.127 \ln \frac{\bar{w}}{p^1} - 0.047 \ln \frac{p^e}{p^1} + 0.0002T$	0.49		
$\Delta u = -0.62u_{-1}$		0.6	5.28
<u>Sample 65:1-90:1</u>			
$\ln duc^2 = -0.46 - 0.165 \ln \frac{w^2}{p^2} - 0.178 \ln \frac{p^e}{p^2} + 0.002T$	0.60		
$\Delta u = -0.25u_{-1} + 0.17\Delta u_{-1} + 0.24\Delta u_{-2} + 0.25\Delta u_{-3}$		0.2	4.47
$\ln duc^2 = -0.43 - 0.13 \ln \frac{\bar{w}}{p^2} - 0.205 \ln \frac{p^e}{p^2} + 0.001T$	0.58		
$\Delta u = -0.24u_{-1} + 0.16\Delta u_{-1} + 0.26\Delta u_{-2} + 0.24\Delta u_{-3}$		0.3	4.37
<u>Sample 65:1-90:1</u>			
$\ln duc^3 = -0.61 - 0.536 \ln \frac{w^3}{p^3} - 0.114 \ln \frac{p^e}{p^3} + 0.003T$	0.68		
$\Delta u = -0.27u_{-1} - 0.22\Delta u_{-1}$		1.0	3.23
$\ln duc^3 = -0.60 - 0.498 \ln \frac{\bar{w}}{p^3} - 0.158 \ln \frac{p^e}{p^3} + 0.002T$	0.69		
$\Delta u = -0.27u_{-1} - 0.22\Delta u_{-1}$		1.0	3.15
<u>Sample 69:3-90:1</u>			
$\ln duc^4 = -0.25 - 0.314 \ln \frac{w^4}{a^4 p^4} - 0.115 \ln \frac{p^e}{p^4} + 0.0007T$	0.41		
$\Delta u = -0.54u_{-1} + 0.14\Delta u_{-2}$		0.9	5.50
$\ln duc^4 = -0.11 - 0.311 \ln \frac{\bar{w}}{p^4} - 0.107 \ln \frac{p^e}{p^4} + 0.51 \ln a^4 - 0.002T$	0.46		
$\Delta u = -0.52u_{-1} + 0.09\Delta u_{-2}$		0.6	5.48
<u>Sample 65:1-90:1</u>			
$\ln duc^5 = -0.27 - 0.196 \ln \frac{w^5}{a^5 p^5} - 0.392 \ln \frac{p^e}{p^5}$	0.57		
$\Delta u = -0.46u_{-1} + 0.25\Delta u_{-4}$		0.0	5.86
$\ln duc^5 = -0.29 - 0.1128 \ln \frac{\bar{w}}{a^5 p^5} - 0.406 \ln \frac{p^e}{p^5}$	0.58		
$\Delta u = -0.46u_{-1} + 0.25\Delta u_{-4}$		0.2	5.79
<u>Sample 65:1-90:1</u>			
$\ln duc^6 = -0.29 - 0.547 \ln \frac{w^6}{a^6 p^6} - 0.075 \ln \frac{p^e}{p^6} + 0.0008T$	0.61		
$\Delta u = -0.26u_{-1}$		0.9	4.15
$\ln duc^6 = 0.11 - 0.385 \ln \frac{\bar{w}}{p^6} - 0.126 \ln \frac{p^e}{p^6} + 0.66 \ln a^6 - 0.003T$	0.55		
$\Delta u = -0.19u_{-1}$		0.6	3.30

The cointegration regressions are shown in Table 1. We present the long-run equations together with the auto-regressive process for their corresponding residuals. We have chosen a parcimonious representation of this error term, performing a Durbin- t test to be sure that there is no remaining autocorrelation in the residuals. Using the critical values computed by McKinnon [1990], non-cointegration is rejected at 5% for all sectors except for the steel industry and for the second equation of the textiles industry. The bad performance of the equation for steel is not surprising since the prices in this sector are highly administrated by the EEC.

From the first equations of each sector, we conclude that in sectors 1, 2, 4, 5, and 6 the demand constraint (or the degree of capacity utilization) plays a significant role in the long run: We find cointegration relations between duc , the real wage (or labour share) and the real price of energy. This implies that a disaggregation of the economy allows for significant effects of demand pressure on prices even though, as emphasized by Drèze and Bean [1991], macro-level analysis does not. This stresses the important role of quantity constraints on sectoral price formation. To illustrate, we compute the elasticity of price to duc for our sectors and compare these values with existing macroeconomic estimates for Belgium. Table 2 presents the partial elasticity at given wages (which is equal to $1/(\gamma_{k1} + \gamma_{k2})$) and the total elasticity incorporating the effect of duc on wages (which is equal to $1/(\gamma_{k6} + \gamma_{k7})$).⁽²³⁾

Table 2: Elasticity of prices with respect to duc

Model	Sector	Partial η	Total η
This paper	1	5.0	5.7
	2	2.9	3.0
	3	(1.5)	(1.5)
	4	2.3	2.4
	5	1.7	1.9
	6	1.6	2.0
Mehta and Sneessens [1991]		0.0	0.0
Bogaert et al. [1989]		0.6	n.a.

⁽²³⁾ Elasticities are taken from Table 1 where duc is on the left hand side so that elasticities are inverted; given the relatively low R^2 values, it is possible that the estimates and hence the elasticities change when the ordering of the variables is changed. This is a limitation of the procedure followed here.

In the wage equations, both internal (price and productivity) and external (reference wage) conditions matter. The corresponding elasticities are presented in Table 3 where $\eta_{w^k, \bar{w}} = \gamma_{k6}(\gamma_{k1} + \gamma_{k2}) / (\gamma_{k1}(\gamma_{k6} + \gamma_{k7}))$ and $\eta_{w^k, q^k} = 1 - \eta_{w^k, \bar{w}}$ and where q^k is the nominal value added per worker $q^k = a^k(p^k - p^e/z^k)$. Since high union power is linked with a high capacity of extracting value added, $\beta^k \propto \eta_{w^k, q^k}$. From the Table, sectors 1, 2 and 5 (food, metal and building materials) are leaders and sectors 3 and 4 (steel and chemicals) are followers. This last fact is striking because the chemical industry is often said to be a leader with strong union power; An explanation could be that this sector has experienced very important productivity gains and that the unions have not been able to extract a large part of them, even though they look strong because wages in this sector are relatively high.

Table 3: Wages elasticities

Sector	$\eta_{w^k, \bar{w}}$	η_{w^k, q^k}
1	0.76	0.24
2	0.81	0.19
3	0.92	0.08
4	1.02	-0.02
5	0.72	0.28
6	0.86	0.14

We see that, even though there are substantial differences between wage formation in various sectors, wage interdependence is important. The conditions in some sectors seem to strongly affect the wages of other sectors. This point will be deepened by simulations in the following subsection.

4.4 Simulations

To investigate the magnitude of the contagion effects and the implications of wage interdependence, we simulate the 12 equations of the model, taking wages and prices as the endogenous variables. Three elements, however, will render our results subject to caution: The price series are not necessarily good proxies for the output prices; we have no cointegration in sector 3; a small sample bias in the coefficients is possible although we have superconsistency in the cointegration regressions.

In interpreting the results we have to keep in mind two limitations: the technology (productivities) is exogenous in the model; the fact that we do not take into account the input/output linkages may bias some effects.

In a first simulation, we have computed a 20% rise in the price of energy. If we do not take into account wage interdependence we see that the pattern of price response varies quite a lot across sectors. If wage interdependence is included,⁽²⁴⁾ the intersectoral variance of the price increases is considerably reduced and nominal wages rise everywhere in the same proportion. Moreover, the real wage decreases much less when we take into account the externalities. For instance, in the textile industry (6), the bargaining outcome implies, at given reference wage, a drop of 2.1% in the real wage while with wage interdependence the real wage drops by only 0.5%. Intuitively, the explanation is the following: When p^e increases, sectoral prices increase more than sectoral nominal wages in order to achieve a fall in the real product wage; when we incorporate the intersectoral effects, there is a nominal spiral pushing up prices and wages; at the end of this spiral, the real price of energy p^e/p^k is lower than without interdependence, implying that the corresponding drop in the real wage is lower. The increase in the price of energy is nearly fully compensated by an increase in domestic prices, so that there is virtually no real wage cut but a more important loss in competitiveness and market shares. In the case of a shock on the price of energy, wage interdependence thus contributes to worsening the loss in competitiveness and to reducing both the inter-sectoral differences and the drop in real wages.

Table 4: 20% Increase in p^e

Sector	No externalities			Externalities		
	Δp	Δw	$\Delta(w/p)$	Δp	Δw	$\Delta(w/p)$
1	5.4	4.7	-0.7	15.9	15.7	-0.2
2	12.2	3.9	-8.3	17.8	15.4	-2.4
3	4.8	1.6	-3.2	15.7	14.8	-0.9
4	5.1	-0.3	-5.4	15.8	14.2	-1.6
5	15.2	5.6	-9.6	18.6	15.9	-2.7
6	4.9	2.8	-2.1	15.7	15.2	-0.5

⁽²⁴⁾ We include in the simulation the definition of the reference wage $\tilde{w} = \sum \lambda^k w^k$.

We next look at a shock on unemployment: Let us assume that the labour supply increases exogeneously so that the unemployment rate rises in all labour markets by 20%. The reason for computing this simulation is that in the majority of macromodels, little evidence is found for an important effect of unemployment on wages (i.e., of a Phillips' curve in levels). Table 5 shows a weak effect of unemployment on the sectoral wages considered separately (without externalities). This is especially true in real terms. However, the multiplicative influence of wage interdependence intensifies this effect, leading to an elasticity of nominal wage to unemployment near -1 . The difference across sectors is low in terms of nominal wages but important in terms of product wages: Real wages drop by 8.5% in sector 2 and by only 0.6% in sector 1. Note that, even though real wages do not react strongly to unemployment, competitiveness is improved since the domestic output prices fall.

Table 5: 20% Increase in λ^u

Sector	No externalities			Externalities		
	Δp	Δw	$\Delta(w/p)$	Δp	Δw	$\Delta(w/p)$
1	-3.4	-3.5	-0.1	-14.8	-15.4	-0.6
2	-2.5	-5.2	-2.7	-7.9	-16.4	-8.5
3	-3.3	-4.0	-0.7	-15.5	-18.8	-3.3
4	-3.7	-5.1	-2.4	-15.1	-20.7	-5.8
5	-1.0	-3.1	-2.1	-4.9	-14.6	-9.7
6	-3.4	-3.9	-0.5	-15.3	-17.5	-2.2

Let us next look at the contagion effect. Since the most important leading sector is the metal industry, we simulate labour productivity increases (Table 6a) and energy productivity increases (Table 6b) in this sector.⁽²⁵⁾ If these increases had occurred in a follower sector we would have observed little or no transmission to the other sectors. Note also that we are unfortunately not able to take into account the effects passing through the product and labour markets since we are in a partial equilibrium framework. From Table 6a, we see that an increase in labour productivity has important negative effects on the competitiveness of the other follower sectors. The aggregate effect on competitiveness is all the more negative since an important part of the

⁽²⁵⁾ This simulation is run by multiplying the coefficients of the ratios w^2/p^2 , \bar{w}/p^2 and p^e/p^2 by 0.8.

decrease in the price of sector 2 is lost through the wage-wage spiral (from -7.8 to -4.5). Moreover, the incorporation of productivity gains into real wages is relatively limited without interdependence (elasticity of $(3.9 + 7.8)/20 = 0.59$) and is higher with wage interdependence (elasticity of $(4.5 + 10.8)/20 = 0.77$).⁽²⁶⁾ From Table 6b, the increase in energy productivity has positive effects on the competitiveness of all sectors.

Table 6a: 20% increase in a^2

sector	No external.		Externalities	
	Δp	Δw	Δp	Δw
1	—	—	+6.2	+6.5
2	-7.8	+3.9	-4.5	+10.8
3	—	—	+6.5	+7.9
4	—	—	+6.4	+8.7
5	—	—	+2.0	+6.1
6	—	—	+6.4	+7.3

Table 6b: 20% increase in z^2

Sector	No external.		Externalities	
	Δp	Δw	Δp	Δw
1	—	—	-6.2	-6.5
2	-12.2	-3.9	-15.5	-10.8
3	—	—	-6.5	-7.9
4	—	—	-6.3	-8.7
5	—	—	-2.0	-6.1
6	—	—	-6.4	-7.3

Table 7a: 20% increase in duc^2

sector	No external.		Externalities	
	Δp	Δw	Δp	Δw
1	—	—	+4.9	+5.1
2	+59.7	+3.1	+62.3	+8.5
3	—	—	+5.1	+6.2
4	—	—	+5.0	+6.8
5	—	—	+1.6	+4.8
6	—	—	+5.1	+5.7

Table 7b: 20% increase in duc^5

Sector	No external.		Externalities	
	Δp	Δw	Δp	Δw
1	—	—	+1.7	+1.8
2	—	—	+0.9	+1.9
3	—	—	+1.7	+2.1
4	—	—	+1.7	+2.3
5	+37.5	+10.4	+38.0	+12.0
6	—	—	+1.7	+2.0

Finally, we have simulated positive demand shocks in two sectors (Tables 7a and 7b). The price response in sector 2 is more important because this sector is less competitive (+59.7 compared to +37.5). Without taking into account wage interdependence, the wage response is higher in sector 5 (+10.4 instead of +3.1), but this difference is reduced when we incorporate the outcome of the wage-wage spiral (+12 instead of +8.8). The effect on the other sectors is not negligible in the case of Table 7a because sector 2 is larger than sector 5. Consequently,

⁽²⁶⁾ At the macroeconomic level, the elasticity of real wages to productivity is generally around 1.

competitiveness in the other sectors deteriorates when a *large leading* sector faces a positive demand shock.

4.5 Centralized vs Decentralized Bargaining

Drawing lessons from our analysis of the competitiveness losses in decentralized bargaining, are we sure that we can strongly recommend centralized bargaining?

In general, when we decentralize bargaining, three elements may play a role:

1. The effect of agents' decision on aggregate variables (consumption price, social security financing) is lower, so that, in a Nash equilibrium between agents where no one internalizes the actions of the other agents, the outcome is worse. The agents internalize less and less the macroeconomic consequences of their actions, reducing the tradeoff between wages and employment and increasing the nominal wages.
2. The elasticity of substitution between the firms' or industries' products increases, so that a rise in wages will have more effect on employment. The tradeoff is reinforced, so that the agents will tend to reduce the level of nominal wages.
3. The wage externalities are less and less taken into account, leading to the same effect as in point 1.

In our analysis we focus on 3. while the two first elements are used by Calmfors and Driffill [1988] as the basis of a "hump-shape hypothesis": Their theory says that the more efficient bargaining levels are the fully centralized one (since effect 1 is maximal, all externalities being taken into account) or the fully decentralized one (effect 2 is maximal, and so is the wage-employment tradeoff).⁽²⁷⁾ The inclusion of point 3., supported by our empirical analysis, can be used as an argument for a centralized bargaining set-up.

⁽²⁷⁾ A moderation of this statement is in Bean et al. [1990]. In a *two-country* Calmfors-Driffill model, they show that increasing economic integration reduces the differences between the various levels of bargaining; the hump is less accentuated. This result arises because economic integration increases the wage-employment tradeoff. The price to be paid in terms of job losses for a given wage claim is particularly increased for the agents who bargain at the intermediate level since it is the one who initially perceived the lower tradeoff.

An second implication of our set-up with respect to Calmfors-Driffil model, which is due to the presence of quantity constraints, is that inefficiencies resulting from decentralized bargaining are more important in the highest phase of the business cycle (when the degree of utilisation of capacities is high). The shape of the hump may thus vary along the business cycle. This could have some implications on the empirical tests conducted on its basis.

5 Conclusion

The aim of the paper is to provide some insights into the links between decentralized bargaining and industry competitiveness. The main framework is inspired by previous work on quantity constrained equilibrium, monopolistic competition and wage bargaining. Since we use an efficient bargaining set-up, the union influences the firm's price; it forces the firm to reduce its output price in order to increase demand and employment. The wage is a weighted sum of the workers' reference wage and of the firm's labour productivity in value. The reference wage depends on the wages of the other sectors. In this model, each labour group is restrained by the temporary fixity of the wages of the other labour groups; the interpretation of "leading sectors" in an economy is the one in which primary influence comes from the sector productivity and the bargaining strength and not from the outside reference wage.

Unions and firms are not able to internalize the fact that their reference wage is modified by the decision they take. This introduces a source of inefficiency which deteriorates competitiveness. The loss of competitiveness is increasing in union power and in the degree of capacity utilization, which showing the importance of quantity constraints. It is decreasing in the elasticity of substitution between goods, in the degree of uncertainty and in the unemployment rate. Contrary to the traditional literature, we find a negative relationship between union power and employment even though bargaining is efficient: This is due to the underestimation by the agents of the effect of a wage increase on employment. Wage interdependence also introduces a contagion effect: the conditions of one sector (such as productivity gains) are passed on to the wages of the other sectors. In particular, if union power in one sector is high enough, energy-saving technical progress in this sector affects the competitiveness of the other sectors positively while labour-saving technical progress has a negative impact.

We estimate long-run price and wage equations for six Belgian manufacturing sectors. After performing cointegration tests, we show that quantity constraints play a significant role. This implies that a

disaggregation of the economy allows for significant effects of demand pressure on prices whereas macro-level analysis generally does not. In wage equations, both sectoral productivity and the inter-sectoral reference wage matter. Thus, even though there are substantial differences between wage formation in various sectors, wage interdependence is important. The conditions of some sectors seem to strongly affect the wage of the other sectors, which shows the importance of contagion effects. This estimation shows that the food, metal products and building material industries are leaders. If the agents in a large leading sector substantially increase their nominal wage (because of a positive productivity shock or a positive demand shock), they could trigger generalized wage inflation due to the inter-sectoral “wage-wage” spiral; this kind of spiral forces the wages to converge, implies a loss of competitiveness for the other sectors and substantially reduces the allocative role of wages in the economy.

APPENDIX

The consumer problem

The consumer problem is

$$\max_{c_{ij}^k} U_j = \prod_{k=1}^{K+H} \left[\frac{1}{\alpha^k} \left(\sum_{i=1}^{n^k} \left(\frac{u_i^k}{n^k} \right)^{1/\epsilon^k} c_{ij}^{k(\epsilon^k-1)/\epsilon^k} \right)^{\epsilon^k/(\epsilon^k-1)} \right]^{\alpha^k} - \frac{r}{p} l_{ij}^k$$

$$\text{s.t. } I_j = \sum_{k=1}^{K+H} \sum_{i=1}^{n^k} p_i^k c_{ij}^k$$

with $\sum_k \alpha^k = 1$ and $\sum_k u_i^k = 1$ for all k .

The first order condition is:

$$c_{ij}^k = \left(\frac{p_i^k}{p^k} \right)^{-\epsilon^k} \frac{\alpha^k}{n^k} \left[\frac{m^0 + I_j}{p^k} \right] u_i^k \quad j = 1..J \quad (1)$$

$$\text{with } p^k = \frac{1}{n^k} \left(\sum_{i=1}^{n^k} u_i^k p_i^{k(1-\epsilon^k)} \right)^{1/(1-\epsilon^k)}$$

From this, we compute the indirect utility from which we derive the utility of the union:

$$\sum_{j \in I_s^k} U_j = V_i^k = \frac{1}{p} \left((w_i^k - r)l_i^k + \sum_{j \in I_s^k} \sum_{k=1}^K \sum_{i=1}^{n^k} \theta_{ij}^k \Pi_i^k \right)$$

where θ_{ij}^k are the shares of firm i of sector k being in possession of household j . Π_i^k is the nominal profit of firm i . The fall-back utility \tilde{V}_i^k is

$$\tilde{V}_i^k = \frac{1}{p} \left(\sum_{j \in I_s^k} \sum_{k=1}^K \sum_{i=1}^{n^k} \theta_{ij}^k \Pi_i^k \right).$$

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