ON WAGE FORMATION, WAGE DEVELOPMENT AND UNEMPLOYMENT: A COMPARISON BETWEEN EUROPEAN COUNTRIES AND THE UNITED STATES*

H.M.M. Peeters and A.H.J. den Reijer**

* This paper is a follow up of the WO&E Research Memorandum On wage formation, wage development and unemployment no. 677 by the same authors that appeared in 2001. Extensions and improvements in this paper concern (1) the application of the econometric model to Germany, France and the United States in addition to -what was done in the previous version- Spain and the Netherlands (2) one additional degree of freedom in the theoretical model by allowing for a non-unity elasticity of the labour productivity in the wage equation and (3) the estimation strategy, being a system 3-Stage-Least-Squares procedure instead of univariate Ordinary Least Squares.

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Views expressed in this research memorandum are those of the individual authors and do not necessarily reflect official positions of De Nederlandsche Bank.
ABSTRACT

On wage formation, wage development and unemployment: A comparison between European countries and the United States
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For Germany, Spain, France, the Netherlands and the US an Error Correction Model with a long-term non-linear wage equation is estimated by 3-SLS to obtain consistent estimates, accounting for endogeneity and common shocks. On the basis of the estimated parameter elasticities of labour productivity, value added and consumer prices, taxes, unemployment and replacement rates are computed along with the wage contributions. The results indicate that the dominant role of prices in the formation of wages in the seventies and eighties was taken over by labour productivity in the US and unemployment in Spain and –almost– in the Netherlands at the end of the nineties. Evidence for a stronger real wage flexibility of the US in comparison with the four European countries is not found.

Key words: wage flexibility, labour market
JEL codes: C22, E24, J30

SAMENVATTING

Over loonvorming, loonontwikkeling en flexibiliteit:
Een vergelijking tussen Europese landen en de Verenigde Staten
H.M.M. Peeters en A.H.J. den Reijer

Voor Duitsland, Spanje, Frankrijk, Nederland en de Verenigde Staten een foutencorrectiemodel met een niet-lineaire lange termijn loonvergelijking is geschat met 3-Staps-Kleinste-Kwadraten om consistente schattingen te verkrijgen, rekening houdend met endogeniteit en gemeenschappelijke schokken. Op basis van de geschatte parameters worden loonelasticiteiten van arbeidsproductiviteit, toegevoegde waarde en consumptieprijzen, belastingvoeten, werkloosheid en terugvalvoet berekend tezamen met de loongroeibijdragen. De resultaten tonen aan dat de dominante rol van prijzen in de loonvorming in de zeventiger en tachtiger jaren in de negentiger jaren werd overgenomen door de arbeidsproductiviteit in de VS en werkloosheid in Spanje en (bijna) in Nederland. Bewijs voor een sterkere reële loonflexibiliteit in de VS in vergelijking met de vier Europese landen is niet gevonden.

Trefwoorden: loonflexibiliteit, arbeidsmarkt
JEL codes: C22, E24, J30
1 INTRODUCTION

This study goes into the complexity of wage formation. The aim is to study wage development, wage formation and wage flexibility for a number of European countries in comparison with the US. Considering the labour market changes that took place in the nineties in Spain and the Netherlands\textsuperscript{1} and also in the US, the expectations are that wage formation may have changed also considerably during the last decade in these countries in comparison with other European countries where these changes did not take place or to a smaller extent.

We adopt a theoretical model where a non-linear wage equation can be derived, as developed by Graafland and Huizinga (1999) and also used in Peeters and Den Reijer (2001). An important extension is made to the model in order to impose no longer a unity labour productivity wage elasticity. This model is estimated for Germany, Spain, France, the Netherlands and the United States and the accompanying elasticities are calculated. Special attention is paid to the estimation strategy in order to have a solid framework for the deduction of (policy) conclusions. The non-linear nature of the wage equation has the advantage that the wage elasticities need not necessarily be constant. So, instead of the constant elasticities presented in other studies like Layard et al. (1991), this framework enables us to compute elasticities that may differ in time. Moreover, we are able to quantify the partial contributions to the wage increase of the different determinants. These calculations are performed over a sample of almost thirty years. The determinants that turn out to be dominant during the different decades will be investigated. Not only flexibility in the long term, but also wage flexibility in the short term, real as well as nominal, gains furthermore a prominent place in this study.

The organisation of this paper is as follows. Section 2 presents the theoretical model and the derivation of the non-linear wage equation. Section 3 discusses the main wage determinants according to this model. Section 4 to 7 report the estimation results. In section 4 the estimated wage equations for the countries are presented. Section 5 presents the elasticities, section 6 the contributions of the determinants to the wage formation and Section 7 pays attention to real and nominal wage flexibility. Section 8 summarises and concludes.

\textsuperscript{1} See Peeters and Den Reijer (2001).
2 ON THE THEORETICAL WAGE BARGAINING PROCESS

This section describes the wage negotiation process as a Nash bargaining model. A non-linear wage equation results as the optimal solution.

The model distinguishes on the one hand employers (organisations) and on the other hand employees (organisations) or labour unions, wishing to reach an agreement on the employees’ wage. The model deals thus with two ‘players’, being ‘the’ employer and ‘the’ employee, who negotiate on equal terms about an ‘average’ wage. During the negotiation process the gross wage is at stake. The players bargain and have a strict conflict of interests. The employer’s aim is profit maximisation, while the employee aims at obtaining a net wage that is as high as possible. The employee maximises the ‘utility’ that depends proportionally on this net wage. A higher wage for the employee necessarily implies a lower profit for the employer and, *vice versa*, a higher profit can only be achieved by paying the employee a lower wage.

The ‘optimal’ gross wage is the wage that maximises the combined objectives of the employer and the employee, i.e.

\[ O \equiv \frac{\alpha}{1-a} \]  

where \( \alpha \) is the profit function of the employer, \( \gamma \) the utility function of the employee and \( a \) a parameter representing the bargaining power. In case \( a = 1 \) the employer has all the profits and the employee no utility. The other extreme is the case where \( a = 0 \), i.e. the employee reaches full utility and the employer no profits. So, the closer \( a \) is to 1 the more power the employer has in comparison with the employee during the negotiation process, and the closer \( a \) is to 0 the higher the relative power of the employee.

The profits, exclusive sunk costs, is defined as the turnover per employee after deduction of the gross wage of the employee. This can be written as

\[ \gamma \equiv P q^\rho - W \quad \text{where} \quad \rho \leq 1 \]  

where \( P \) is the value added price of production, \( q^\rho \) the labour productivity and \( W \) the gross wage. In case \( \rho = 1 \) each unit produced per employee is profitable. In case \( \rho < 1 \) the marginal profit from each unit produced per employee is lower than 1.
The utility of the employee equals a net wage, so a gross wage after deduction of the taxes and social contributions, $t$, paid by the employer as well as by the employee in deviation of the reservation wage $W$.

$$ ? \equiv W (1-t) - W. \quad (3) $$

The reservation wage is the wage or benefit the employee would receive in case he would not fulfill the job under consideration. This is a so called opportunity wage. The employee’s utility increases in case the net wage $W(1-t)$ increases or in case the reservation wage $W$ decreases. The reservation wage is however not directly observable. It can be calculated as a kind of average earnings the employee would receive in case of being employed elsewhere or in case of being without a job. Otherwise stated, these cases concern having another paid job and being (in-)voluntarily unemployed. The reservation wage is therefore a weighted average of the wage income in the official and the informal sector,

$$ W \equiv \beta W_{\text{official}} + (1-\beta) W_{\text{informal}} \quad (4) $$

The parameter $\beta$ represents the fraction of the official wage in the reservation wage. Searching for a job - in the official sector- may take some time, in particular in case of a loose labour market. During this search period the unemployed person receives no wage, but an unemployment or a social benefit. A tight labour market, on the contrary, raises the probability of finding a job. This probability can be assumed to equal the fraction of unemployed persons in the labour force, say $u$. The unemployment rate $u$ and the so called replacement ratio $R$ play a role in determining the wage in the official sector $W_{\text{official}}$, that is

$$ W_{\text{official}} \equiv u R \bar{W} (1-t) + (1-u)\bar{W} (1-t) \quad (5) $$

The wage in the official sector $W_{\text{official}}$ equals $\bar{W}(1-t)$ in case of no unemployment ($u = 0$) and, as another extreme case, $R\bar{W} (1-t)$ if the unemployment rate would be 100% (i.e. $u = 1$). In practice the wage in the official sector will be somewhere in between these two extremes. Wage $\bar{W}$ is the gross average ‘market’ wage. The gross benefit received when unemployed equals $R\bar{W}$ as the replacement rate $R$ equals the ‘average’ unemployment benefit divided by the average market wage. This replacement rate plays an important part in this model. It can be seen as a sort of reduction in income in case a person, in comparison with his wage income when being at work, does not work.
The wage obtained in the unofficial sector can result from work done in the black market or saved expenditures due to homework. Examples of the latter are savings due to child care, cleaning or house (re-) decoration. It is assumed that productivity in the informal sector is linked to that of the official sector because of spillovers of technological progress improving labour productivity in general. A parameter allows for a relatively low labour productivity of the informal vis-à-vis the official sector. Earnings in the informal sector consisting of savings and/or expenses, represented as $W_{\text{informals}}$, is further assumed conditional on the consumer price $P_c$.

$$W_{\text{informal}} = \gamma P_c q^\theta. \quad (6)$$

So the real wage earned in the informal sector, $\frac{W_{\text{informal}}}{P_c}$, is lower than or equal to the productivity in the formal sector in case $\gamma \leq 1$ (see (2)).

Appendix A shows that the wage equation resulting from this bargaining process reads as

$$\log W = \log P + \rho \log q + \log \left[1 + \frac{\alpha (1-\beta) \gamma}{1-\alpha + \alpha (1-\beta) \gamma} \left(\frac{P_c}{P(1-t)} - 1\right)\right]$$

$$- \log \left[1 - \frac{\alpha}{1-\alpha} \left(1 - (1-u(1-R))\right)\right] + \log \left[1 + \frac{\alpha (1-\beta) \gamma}{1-\alpha}\right] \quad (7)$$

In the extreme case where the employer dominates the bargaining process, i.e. $a=1$, the employee is paid just enough to keep him at work. In this case the two last terms in (7) vanish and from the third term follows that the employee receives the after tax reservation wage. In the other extreme where the employee fully dominates the bargain at the cost of the employer, i.e. $a=0$, the employee’s wage equals the total profits of the employer as the three last terms vanish, that is the gross wage $W$ is equal to $Pq^\theta$.

On the basis of (7) it follows that the optimal gross wage ($W$) depends in the long run on six factors: value added price ($P$), consumer price ($P_c$), labour productivity ($q$), average and marginal taxes and social contributions ($\tau$), unemployment rate ($u$) and replacement rate ($R$). These determinants will explain the wage rate provided that the actual bargaining process is specified appropriately by the model.
3 ON THE WAGE DETERMINANTS

According to the wage model an increase in the *labour productivity* of 1% increases the wage rate in the long run by $\rho$. In case $\rho = 1$ each change in labour productivity is fully compensated for in the wages. The econometric analyses in the next section, where $\rho$ is estimated freely, will show whether the hypothesis of full compensation is accepted for the countries under investigation.

The value added price and consumption price exert a positive and strong effect on the wage rate in the long run. A 1% increase in the value added and consumption prices at the same time results eventually in an increase of the wage rate with 1%.

The wage effect of the wedge, that is the difference between the wage that the employer pays and the wage that the employee receives, is not unambiguously positive or negative. As the average and marginal taxes are equalized, see appendix A, no further attention is paid to these determinants.

Important determinants in the wage formation are the *unemployment* and the *replacement rates* that influence the wage rate interactively according to the bargaining model. As explained before, the replacement rate measures the financial distance between working and not working. The definition is as follows:

$$\text{Replacement rate} = \frac{\text{average unemployment benefit}}{\text{average wage income in the official sector}}.$$  

So, by definition the replacement rate does not exceed one because working in the official sector will be more profitable than the social benefit for an unemployed person. The replacement rate approaches one if the financial distance between working and not working becomes smaller. It is close to zero if the earned wage in the official sector is high in comparison with the unemployment benefit.

Empirical evidence also shows that the replacement rate affects the wage rate positively. The case of an increasing replacement rate, so a smaller distance between working and not working, will put an upward pressure on the wage rate in the long term. The wage rate has to compensate for the difference between both situations. The smaller the distance, the larger the wage compensation. In the extreme case where the distance is zero, i.e. the replacement rate is equal to one, the employee has no financial incentive to work. He will require a wage compensation before taking part in the paid labour process. A tight (loose) labour market will increase (decrease) the denominator of the replacement rate. Shortage (abundance) of the work force exerts expectedly more (less) pressure on the wage rate. This pressure will raise (lower) the
average wage in the economy. The numerator of the replacement rate on the other hand experiences more influence from changes in social security, like unemployment benefits, other social security payments, taxes, social contributions, and so on.

A higher unemployment rate exerts, as one may expect because of the higher demand for than supply of paid jobs, a downward pressure on the wage rate. The effect of the unemployment rate on the wage rate is thus negative. The extent of this effect depends on the replacement rate. The unemployment rate moderates the wage rate most when unemployment is high and the replacement rate low. This situation is a combination of a loose labour market where at the same time working is much more profitable than not working. In this situation many people are involuntarily unemployed. The wage moderating effect of unemployment will be higher as long as not working is less remunerative. In times of a relatively high replacement rate that is almost equal to one, the difference between remuneration in case of working as compared to non-working is by definition small. The replacement rate itself exerts a positive effect on the wage rate. The reservation wage increases, which causes the employee to require a higher wage claim in order to achieve his optimal level of utility. The effect on the wage rate depends at the same time, as stated earlier, on the unemployment rate. So the unemployment and replacement rate interactively affect wages.

The specified wage bargaining model aims to describe the wage formation suitably. The special feature of the resulting wage equation concerns the non-linear character. As a consequence a 1 percentage point change in, for example, the unemployment rate affects the wage rate not necessarily to the same extent at different points in time. The wage ‘flexibility’ can thus change over time. These partial effects or elasticities are calculated for all six determinants for a certain sample based on estimated parameters that appear in the model. These are presented and discussed in the next section.

Some remarks are to be made concerning deficiencies of the model. One of the points is the constancy of the negotiation power of the employer and employee, represented in the model as parameter $\alpha$. Due to, for instance, a tightening labour market a shift of the relative power position from employers to employees may in reality take place. The specified model as such does not allow such shifts. A second remark is that alternative factors relevant to the negotiation process, like working hours, refresher courses and other secondary labour conditions, are not included. Moreover, institutional alterations and government regulation affecting the labour market can exert influence on the bargaining process.
3 ON THE ESTIMATION OF THE WAGE EQUATION

This section presents details on the estimation strategy in subsection 3.1 and the estimation results in subsection 3.2. For those readers not interested in the technical details of the estimation strategy section 3.1 can be skipped.

3.1 Estimation strategy

The derived equation in equation (7) for the gross wage rate can be considered a long-term Nash equilibrium. In the short run the gross wage may deviate from this equilibrium wage. For this reason an Error Correction Model is specified as

$$\Delta \log W = \sum \phi_i \Delta \log X_i + \eta \left( \log W_{t-1} - \log W_{t-1}^* \right).$$

(8)

where \( \log W^* \) equals the highly non-linear right hand side of equation (7) at time \( t-1 \) with the deep parameters \( \alpha, \beta, \gamma \) and \( \rho \). The first terms in (8) consider the short-term effects \( \phi_i \) of the explanatory variables \( X_i \).

The wage equation (8) is estimated for Germany, Spain, France, the Netherlands and the United States with annual data for the period 1970-2001. Test statistics show that endogeneity problems arise as, the domestic consumer and value added price \( p_c \) and \( p \) -that are highly significant in the short term- are influenced by the variable to be explained, i.e. the domestic nominal wage. For this reason instruments are used to obtain unbiased estimates. The instruments taken in the analyses are three and four year lagged exogenous variables of the own country, in addition to three and four quarter lagged US consumer prices for each of the European countries. Vice versa, next to the three to four quarter lagged US variables, three and four quarter lagged German consumer prices are used as instruments in the US equation. The inclusion of the lagged instruments enforces us to drop the first five observations so that the estimation sample period is 1975-2001.

The deep parameters resulting from the theoretical model are estimated directly, so all non-linear restrictions according to (7) are imposed in the long-run relationship for each of the countries. The identification of both the parameters \( \beta \) and \( \gamma \) turns however out to be difficult. For this reason we calibrate \( \beta \), being the fraction of the official to average wage (i.e. official wage in the informal sector), at
the value between 0.85 and 0.99 that provides the highest $t$-value of $\gamma$. In the short-run we start with a general to specific approach where all six explanatory variables are included with no, one and two lags. Those variables that turn out not to be significant at the 5%-level are dropped so that a more specific model remains.

The Two-Stage-Least Squares (2-SLS) estimates are presented in Table 1a. In addition to these estimates we present in Table 1b the estimates of the system of equations by instruments, that is Three-Stage-Least Squares (3-SLS) where one weighting by means of variance covariance matrix of the residuals is applied. The economic reasoning behind this estimation strategy is that the countries, and foremost the European countries, have encountered common shocks during the sample period 1975-2001. A comparison between the 2- and 3-SLS estimation results in respectively Tables 1a and 1b shows that an efficiency gain is often obtained by the latter and some parameter estimates change significantly. For this reason we only consider the 3-SLS results in the following.

One drastic step could further be made by assuming wage co-ordination across countries, or assuming that some countries in their domestic wage negotiations take account of developments in e.g. inflation of a neighbouring country. Considering the significant differences in parameter estimates across countries, and lacking assignable evidence about the wage negotiations in the countries under consideration, this step has deliberately not been taken. So, no cross-equation parameter restrictions are imposed.

Neither are any parameters restricted to predetermined values. Our interest concerns the impact of the determinants on wages as provided by the wage bargaining model and the data. Unlike other studies, for example, the impact of labour productivity on wages in the long run is not imposed to be equal to one. These estimation results therefore give us the opportunity to study on the basis of the data and model each of the estimated determinants' impact in full depth.

### 3.2 The estimation results

The estimated equations all have a high goodness-of-fit of about 0.80 for the US up to 0.98 for France. All parameter estimates are used in the next sections where the wage elasticities and determinants'  

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2 Belgium would in this case be an appropriate example (but is not included in the sample). Wage negotiations in Belgium are dominantly determined by wage settlements in France, Germany and the Netherlands.
contributions to wage growth are discussed. A few remarks have however to be made here. A remarkable finding is the quite high short-term elasticities of prices in both Germany and Spain (of more than 1%). Further, in France and the Netherlands labour productivity contributes significantly less than fully to wage growth in the long run. Surprisingly for Spain, the parameter $\gamma$, indicating the relative productivity in the informal sector in comparison with the formal sector exceeds one. This implies that, on average, real wage income is higher when not-working instead of working. Further, and probably most remarkable, is the fact that in the US neither $\alpha$ nor $\gamma$ are significant. It seems that neither the unemployment nor the replacement rate is relevant for the formation of the US wage.
Table 1a Two-Stage-Least-Squares estimates

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Spain</th>
<th>France</th>
<th>The Netherlands</th>
<th>United States</th>
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<tbody>
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</tr>
<tr>
<td>$\alpha$</td>
<td>0.71</td>
<td>0.88</td>
<td>0.87</td>
<td>0.80</td>
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<tr>
<td>$\beta$</td>
<td>0.92</td>
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<tr>
<td>$\gamma$</td>
<td>0.90</td>
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<tr>
<td>$\rho$</td>
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<td>0.90</td>
<td>0.34</td>
<td>0.66</td>
<td>0.99</td>
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<tr>
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</tr>
<tr>
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<tr>
<td>$\Delta \log q$</td>
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<td></td>
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<td>0.98</td>
<td>0.95</td>
<td>0.84</td>
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<tr>
<td>Standaard error(*100)</td>
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<td>0.70</td>
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<tr>
<td>Jarque-Bera</td>
<td>0.44 [p=0.80]</td>
<td>0.01 [p=0.99]</td>
<td>0.72 [p=0.70]</td>
<td>0.36 [p=0.83]</td>
<td>0.88 [p=0.65]</td>
</tr>
</tbody>
</table>

Note: the parameters $\beta$ are calibrated at values that provide the highest $t$-statistics for $\gamma$. Moreover for the US, the parameter estimates for the $\alpha$ and $\gamma$ are not significant.
Table 1b Three-Stage-Least-Squares-estimates

<table>
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<td><strong>Long-term coefficients</strong></td>
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<td>0.80</td>
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<td>0.89</td>
</tr>
<tr>
<td>$\gamma$</td>
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<td>0.95</td>
<td>0.68</td>
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<tr>
<td>$\rho$</td>
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<td><strong>Short-term coefficients</strong></td>
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<tr>
<td>$\Delta \log W_{-1}$</td>
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<tr>
<td>$R^2_{adj}$</td>
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<tr>
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<td>1.42</td>
<td>0.71</td>
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<tr>
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<td>0.58 [p=0.75]</td>
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<td>0.40 [p=0.82]</td>
<td>0.22 [p=0.89]</td>
<td>0.85 [p=0.65]</td>
</tr>
</tbody>
</table>

Note: the parameters $\beta$ are calibrated at values that provide the highest $t$-statistics for $\gamma$. Moreover for the US, the parameter estimates for the $\alpha$ and $\gamma$ are not significant.
5 ON THE CALCULATED WAGE ELASTICITIES

For each of the determinants in the wage equation elasticities are calculated and shown in Graph 1a to Graph 1f along with the determinants. The precise formulas for the long-run elasticities are provided in appendix A.

The wage elasticity of labour productivity is constant. As follows directly from Table 1b by means of the estimate for $\rho$, Graph 1a shows that this elasticity is highest for the Spain (0.94) whereas it is lowest for France (0.38). The development of the labour productivity in the US turns out to have increased considerably at the end of the nineties. Spain, on the other hand, shows a slow-down.

Graphs 1b and 1c provide the wage elasticities of the two prices, the value added and consumer price. For each point in time they add to one by definition, for each of the countries. It follows that the elasticity of the consumer price increased over time, at the cost of the elasticity of the value added price. At the end of the period, however, for some countries the size of the elasticity diminishes. According to these estimates the reaction of wage growth to the consumer price is highest in Spain and lowest in the US.

Most interesting cases are the unemployment and the replacement rates. The semi-elasticities are plotted in Graphs 1e and 1f. On average the wage semi-elasticity of unemployment is highest in Spain and the Netherlands and lowest in the US. Interesting is further that Graph 1f clearly shows that at the end of 20th century the elasticity increased –in absolute terms- in the Netherlands and Spain, along with the fall in the unemployment rate. In Germany, on the other hand, the reactivity of the wage rate to unemployment was lowest and even significantly lower than during any other year in the period 1976-2001. In France the reactivity of the wage growth to unemployment was –in absolute terms- also relatively low, but diminished a little at the very end of the period. At this point we want to stress that the semi-elasticity of unemployment is dependent upon the unemployment rate itself, the replacement rate and the deep parameters $\alpha$ and $\beta$ (see (A.4) in appendix A). As follows from the strong similarity of the development of the calculated unemployment elasticities in Graph 1e and the replacement rates as given in Graph 1f the dominance of the replacement rate is apparent. So, for this reason, we can argue that the decrease in the replacement rate at the end of the nineties as a consequence of a higher average wage rate and probably a relatively lower unemployment benefit contributed to the higher flexibility of wages. The high replacement rate in Germany, in contrast, lowered the flexibility of the German wage.
Graph 1a: Wage elasticity labour productivity and labour productivity
Graph 1b: Wage elasticity value added price and value added price

- Germany
- Spain
- France
- Netherlands
- United States
Graph 1c: Wage elasticity consumer price and consumer price
Graph 1d: Wage semi-elasticity tax rate and tax rate
Graph 1e: Wage semi-elasticity unemployment rate and unemployment rate
Graph 1f: Wage semi-elasticity replacement rate and replacement rate
6 ON THE CALCULATED WAGE CONTRIBUTIONS

The contributions of all determinants are calculated on the basis of the elasticities as shown in Graph 1 and the changes of the determinants themselves (see (A.6) in appendix A). All these contributions, the total wage growth in the long run according to the model, and the observed wage growth over the past three decades are shown in Graph 2 for each country. Several findings catch the eye.

During the seventies and early eighties all countries show high wage growth as well as high price contributions, reflecting the transmission of prices spiralling into wages. Wage growth diminishes at the end of the 20th century, but the contribution of prices remains relatively high.

The contribution of labour productivity is also important, particularly in Germany and in the US at the end of the period. The contribution of labour productivity is even more important than the contribution of prices, or any other determinant for the US in the nineties.

The role of unemployment in wage determination is most dominant in Spain and the Netherlands. In the beginning of eighties and nineties the increase in domestic unemployment moderated wage growth considerably. At the end of the nineties the decrease in unemployment contributed, on the contrary, positively to wage growth. In Spain unemployment contributed even more than prices or any other wage determinant. The 'real' flexibility of wages, i.e. the reaction of the wage to unemployment was thus highest in these two countries. As was pointed out in the previous section it is predominantly the decline in the replacement rate causing this effect. So, although the replacement rate does not seem to contribute a lot to wage growth in view of all contributions in Graph 2, it plays an important role in the determination of the unemployment elasticity and therefore unemployment contributions to wage growth.
Graph 2: Observed wage rise, model based wage rise and the constituting determinants’ parts

**Germany**

**Spain**
7 ON THE REAL AND NOMINAL WAGE FLEXIBILITY

A high wage flexibility is often considered to be a virtue in view of the functioning of the labour market. ‘Real’ flexibility, i.e. the reaction of the wage to unemployment changes, is often more desired than ‘nominal’ flexibility, i.e. the reaction of the wage to price changes. To go deeper in (a)symmetry detail, the reaction of the wages to unemployment increases would from a welfare point of view often be more desirable than the reaction of the wage to unemployment declines.

As followed from the previous sections, nominal wage flexibility turned out to be high during the full period whereas real wage flexibility was strongest for Spain and the Netherlands. Significant moderation of wage rises due to unemployment increases occurred in the beginning of the eighties and nineties, while the acceleration of wage increases due to unemployment decreases took place at the end of the nineties. Table 2 summarises the wage elasticities of unemployment in this study with those found and often cited by Layard, Nickell and Jackman (1991) from a sample not covering the nineties. Despite the different samples and methodology the US turns out to be the least flexible according to both studies. Spain, on the other hand, shows the most flexibility according to this study.

Table 2  Wage increase (%) due to a 1 percentage point decrease in unemployment in the long term

<table>
<thead>
<tr>
<th>Country</th>
<th>This study 1975-2001</th>
<th>Layard, Nickell and Jackman (1991)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>0.74 to 0.81</td>
<td>1.01</td>
</tr>
<tr>
<td>Spain</td>
<td>1.60 to 2.60</td>
<td>1.21</td>
</tr>
<tr>
<td>France</td>
<td>0.80 to 1.10</td>
<td>4.35</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1.00 to 1.25</td>
<td>2.28</td>
</tr>
<tr>
<td>The United States</td>
<td>0.55 to 0.58</td>
<td>0.94</td>
</tr>
</tbody>
</table>

Until so far, only the long run effects were considered. In the measurement of ‘flexibility’ the adjustment towards the long run is however also of importance along with the level of (some of) the determinants. A slow adjustment towards a ‘high flexibility’ in the long run could, after all, hardly be called a virtue. To investigate this adjustment process we we perform two shocks in the wage model as reported in Table 1b. The first shock concerns a price shock, being a 1% shock to both value added and consumer prices, and the second shock concerns a 1 percentage point decrease in unemployment. Both shocks are performed for each of the countries. As the model is non-linear, the sign of the shock as well as the timing of the shock matters. The price and unemployment shocks performed are carried out at the end of the seventies, in 1977-1984, where both inflation and unemployment were relatively low and, in 1993-2001 were...
unemployment and prices started declining. Graph 3a shows the results of the two price shocks, Graph 3b of the two unemployment shocks.

In the long term the 1% increase in prices should increase the wage by 1% as followed from the model and shown in Graph 1b-1c. Graph 3a shows that the increase in prices during eight years in the seventies and during eight years in the nineties increases the wage by unity indeed. The adjustment speed towards this long-term value is though very different across the countries. Germany overshoots the 1% after one year due to the large short-term price elasticities, France adjusts wages also almost fully in the second year, while Spanish wages adjust only slowly. The Netherlands and the US overshoot the 1% after some years due to the persistence in the wage equation. A comparison between the shock performed in the seventies with the shock in the nineties per country differs only slightly.

The adjustment of wages due to a shock in unemployment is quite different from the adjustment due to the price shock. The adjustment speeds show similarities whereas the differences in long-term effects are big, as expected given the elasticities in Table 2. The effects vanish after the first shock period, towards the beginning of the nineties. Wages in the Netherlands and the US do not return to base immediately, but increase wages for some time due to the persistence. The difference between the two shocking periods per country is moreover stronger for each country than in case of the price shock. The adjustment speed itself remains the same, but the long-term elasticities for Germany, Spain and France are lower in absolute terms in the nineties than in the seventies and the unemployment rate –for instance- is higher. In sum, wage ‘flexibility’ is lower (for Germany 0.76 in 2001 in comparison with 0.79 in 1985, for Spain 1.82 to 1.90, for France 0.83 and 0.92). For the Netherlands and the US the wage increase is slightly higher (1.21 to 1.18 and 0.53 to 0.52, respectively).
Graph 3A: Simulation of a price shock

Graph 3B: Simulation of an unemployment shock
8 SUMMARY AND CONCLUSIONS

A non-linear wage equation is derived from a theoretical framework describing the wage bargaining process between employers and employees. The wage rate is determined by labour productivity, the value added price and the consumer price, the marginal and average tax rates and further, interrelatedly, the unemployment and replacement rates. This wage equation is estimated by means of a Error-Correction Model using annual time series of the last three decades of Germany, Spain, France, the Netherlands and the US. In comparison with the study of Graafland and Huizinga (1999), who developed this wage bargaining model and estimated the wage equation for the Netherlands up to 1993, and Peeters and Den Reijer (2001), who applied it to Ireland, Spain and the Netherlands, main attention is paid here to the end nineties where unemployment sharply dropped. Moreover, labour productivity is no longer assumed to have a unity elasticity in the long run. The importance of dropping this restriction turns out to be important for the estimates and consequently goodness-of-fit of the model. Three-Stage-Least-Squares is applied to estimate the model consistently and efficiently in view of the endogeneity of prices in the short-term and common shocks respectively. So, the ECM is estimated in a system of five equations. In the long run the non-linear wage relationship with its determinants is imposed and the deep parameters are identified directly. The estimation results are satisfying, confirming the solidity of the theoretical wage bargaining framework in combination with the data. The estimated coefficients are used to compute the (non-constant) elasticities and contributions of the wage determinants to wage growth. Finally, real and nominal wage flexibilities are assessed in the individual countries.

Main empirical results are the following. Price increases contributed most to wage growth in the seventies and eighties in all four European countries under investigation and also in the US. Also the role of labour productivity was important, particularly in Germany and the US. In the US the contribution of labour productivity to wage growth even dominates at the end of the nineties. The contributions of taxes and the replacement rate are negligible for all countries. The wage elasticities of unemployment are highest in Spain and the Netherlands and lowest in the US. At the end of the nineties the unemployment elasticity increased in absolute terms and unemployment reduced drastically in both Spain and the Netherlands. For these two reasons the contributions of unemployment to wage growth became more important. For Spain, the contribution of unemployment was even the dominant factor in the formation of wages in the nineties. The clear turning point in Spain and the Netherlands for the reduction in unemployment were probably the favourable labour market policies conducted in the eighties that reduced the replacement rate. The replacement rate plays its dominant role in the unemployment contributions as it is an important determinant in the calculated unemployment elasticities. The higher flexibility of the wages to
unemployment alterations for Spain and the Netherlands contrast to Germany, where the replacement rate did not decrease at the end of the period, and consequently the unemployment elasticity reduced (in absolute terms).

Similar to the labour market study results of Layard, Nickell and Jackman (1991) we also confirm that the US cannot be called more flexible than the three largest European countries or the Netherlands. ‘Real flexibility’, ie. the reaction of the wage to unemployment changes is by far smaller for the US than for these countries.
APPENDIX A: DERIVATION OF WAGE EQUATION, WAGE ELASTICITIES AND CONTRIBUTIONS

In comparison with the wage model used in Graafland and Huizinga (1999) and Peeters and Den Reijer (2001) the model specified in section 2 takes into account the possibility of diminishing instead of constant returns of production. Below follows the derivation of the wage equation.

In order to derive the optimal wage the objective function

\[ \Omega \equiv (Pq^\theta - W)^\alpha (W - T(W) - W)^{1-\alpha} \]  

(1)

where \( T(W) \) is the taxes paid by the employee as a function of \( W \), is differentiated with respect to \( W \):

\[ \frac{\partial \Omega}{\partial W} = -\alpha (Pq^\theta - W)^{\alpha-1} (W - T(W) - W)^{\alpha} + (Pq^\theta - W)^\alpha (1- \alpha)(W - T(W) - W)^{\alpha} (1 - \frac{\partial T}{\partial W}) = 0 \]

\[ \Leftrightarrow \]

\[ W \left[ \alpha \frac{1-t}{1-t_m} + (1-\alpha) \right] = (1-\alpha)Pq^\theta + \frac{\alpha}{1-t_m} - \frac{W}{1-t_m} \]

(A1)

where \( t_m = \frac{\partial T}{\partial W} \) and \( W - T(W) = W(1- \eta) \).

The wage earned in the official sector

\[ W_{\text{official}} = u R \bar{W}(1-t) + (1-u) \bar{W}(1-t) \]

(4)

and the informal wage

\[ W_{\text{informal}} = \gamma P_c q^\rho \]

(5)

can be substituted into the reservation wage equation

\[ W = \beta W_{\text{official}} + (1-\beta) W_{\text{informal}} \]

such that the reservation wage equals

\[ W = \bar{W}(1-t) \beta (1-u (1-R)) + (1-\beta) \gamma P_c q^\rho. \]

(A2)

Substitution of (A2) into (A1) and using \( W = \bar{W} \) gives

\[ W \left[ \alpha \frac{1-t}{1-t_m} + (1-\alpha) \right] = (1-\alpha)Pq^\theta + \frac{\alpha}{1-t_m} \left[ W (1-t) \beta (1-u (1-R)) + (1-\beta) \gamma P_c q^\rho \right] \]

\[ \Leftrightarrow \]

\[ W \left[ 1 + \frac{\alpha}{1-\alpha} \frac{1-t}{1-t_m} \left[ 1-\beta (1-u (1-R)) \right] \right] = Pq^\theta + \frac{\alpha (1-\beta) \gamma P_c q^\rho}{1-\alpha} \]

\[ \Leftrightarrow \]

\[ W \left[ 1 + \frac{\alpha}{1-\alpha} \frac{1-t}{1-t_m} \left[ 1-\beta (1-u (1-R)) \right] \right] = Pq^\theta \left( 1 + \frac{\alpha (1-\beta) \gamma P_c q^\rho}{1-\alpha + \alpha (1-\beta) \gamma P(1-t_m) - 1} \right) \]

Taking logarithms the wage equation equals
\[ \log W = \log P + \rho \log q + \log \left[ 1 + \left( \frac{\alpha (1-\beta) \gamma}{1 - \alpha + \alpha (1-\beta) \gamma} \right) \left( \frac{P_c}{P (1-t_m)} - 1 \right) \right] \]
\[ -\log \left[ 1 + \frac{1-t}{1-\alpha} \left[ 1 - \beta \left( 1 - u(1-R) \right) \right] \right] + \log \left[ 1 + \frac{\alpha (1-\beta) \gamma}{1 - \alpha} \right] \]  \hfill (7)

In the econometric analyses \( t = t_m \) is imposed due to lack of data on the marginal tax rates for all countries. From this equation the elasticities (see Graph 1) can be calculated. It follows that the sum of the wage elasticities of value added prices and consumer prices, defined as \( \varepsilon_p \) and \( \varepsilon_c \) respectively, add to one as it can be derived that

\[ \varepsilon_p + \varepsilon_c = \frac{\partial \log W}{\partial \log P} + \frac{\partial \log W}{\partial \log P_c} = 1. \]

The wage elasticity of productivity, the wage semi-elasticities of unemployment and the replacement rate are respectively

\[ \varepsilon_q = \frac{\partial \log W}{\partial \log q} = \rho \] \hfill (A3)
\[ \varepsilon_u = -\frac{\partial \log W}{\partial u} = -\frac{\alpha \beta (1-R)}{1-\alpha (1+z)} \] \hfill (A4)
\[ \varepsilon_R = -\frac{\partial \log W}{\partial R} = -\frac{\alpha \beta u}{1-\alpha (1+z)} \] \hfill (A5)

where \( z \equiv \frac{\alpha}{1-\alpha} \left[ 1 - \beta \left( 1 - u (1-R) \right) \right] \)

The differential equation

\[ d \log W = \sum_{i=P,Q,t,u,R} \frac{\partial \log W}{\partial \log i} \frac{\partial i}{i} \]

equals approximately

\[ \Delta \log W = \sum_{i=P,Q,t,u,R} \varepsilon_i \frac{\Delta i}{i} \] \hfill (A6)

where \( \Delta \log W \) represents the change of the the gross wage \( W \). In case of semi-elasticities, multiplication by \( \Delta i \) instead of the \( \frac{\Delta i}{i} \) is taken. The six individual contributions in (A6) and the wage growth according to the model are provided in Graph 2 for each country in the empirical analyses.

**APPENDIX B: DATA SOURCES**

The time series \( W, P, P_c, q, t, u \) come from EUROMON, the multi-country model of De Nederlandsche Bank. The gross replacement rates are two-year annual series from 'Benefits and wages', OECD Indicators, from the OECD (2002). These series were interpolated for the purpose of the analyses here. All series can be received upon request.
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