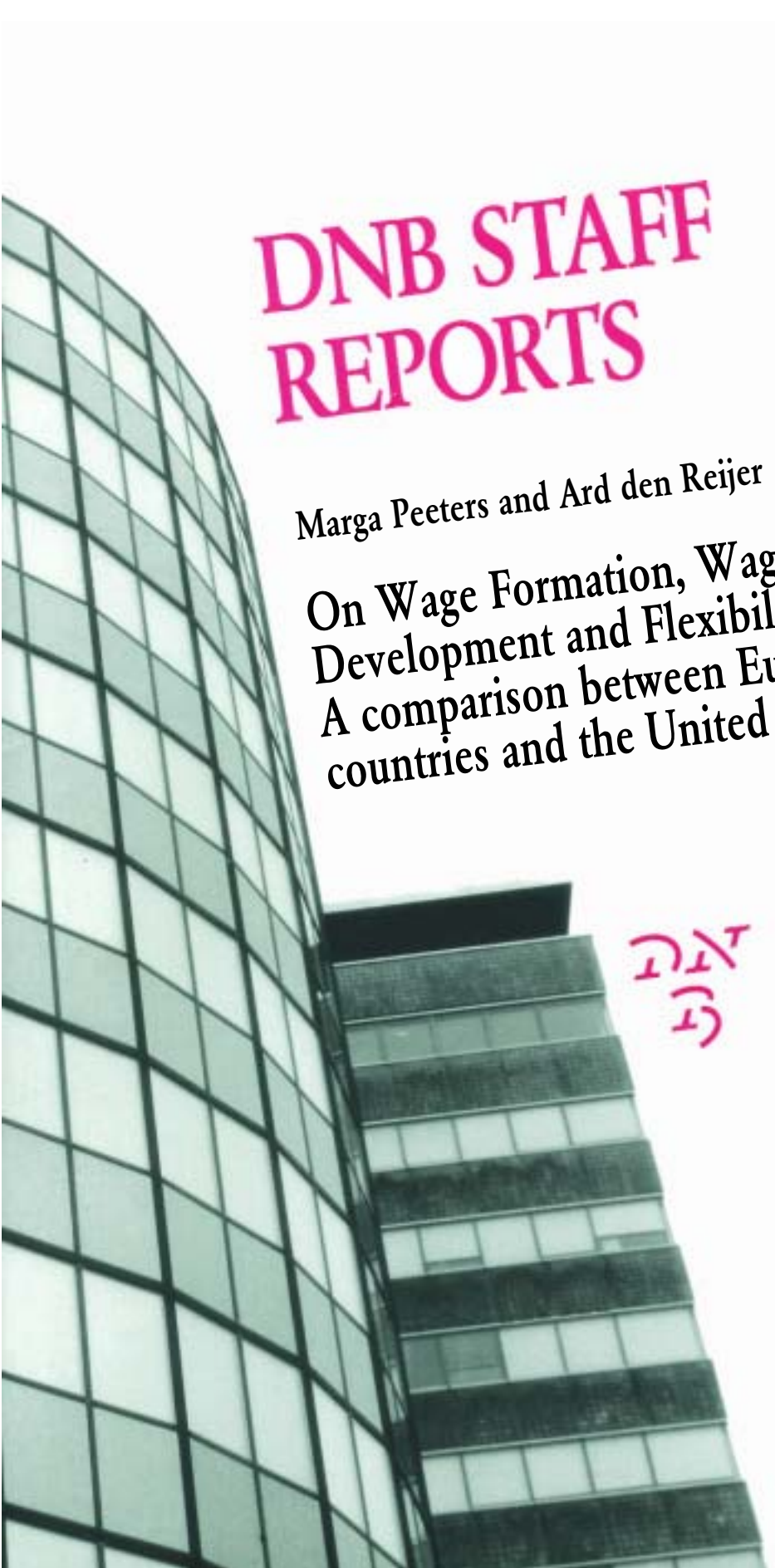

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ON WAGE FORMATION, WAGE DEVELOPMENT AND FLEXIBILITY:
a comparison between European countries and the United States [*]

Marga Peeters and Ard den Reijer [**]

October, 2003

Abstract

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 wages with respect to 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.

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

[*] 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. It is further a revised version of WO Research Memorandum no. 712.

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1 INTRODUCTION

This study goes into the complexity of wage formation. The aim is to study wage developments, 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 and also in the US, wage formation seems to have changed considerably during the last decade. We study here in particular wage developments in order to illuminate the differences across European countries, but also with the United States.

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). One main difference of the model used here is that no longer a unity elasticity of wages with respect to labour productivity. A second difference is that this model is estimated for Germany, Spain, France, the Netherlands and the United States and the accompanying elasticities are calculated whereas Graafland and Huizinga estimated the model for the Netherlands only. As a third difference, special attention is paid to the estimation strategy in order to have a solid framework for the deduction of (policy) conclusions. The theoretical model is fully consistent with the empirical analyses. To the best of our knowledge no other studies exist where the here presented wage bargaining model is used or with a strong coherence between theoretical and empirical results on wage bargaining.

The non-linear nature of the wage equation derived has the advantage that the elasticities of wages 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 can differ over time. Moreover, we are able to quantify the partial contributions of the different determinants to the wage increase. These calculations are presented during almost thirty years. The determinants that turn out to be dominant during the three different decades will be investigated. Furthermore, not only flexibility in the long term, but also wage flexibility in the short term, real as well as nominal, gains 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 wage formation and Section 7 pays attention to real and nominal wage flexibility. Section 8 summarises and concludes.

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 '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. We specify this combined objective of the employer and employee as

$$q \equiv \Pi^{\alpha} Q^{1-\alpha} \tag{1}$$

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

Profits are defined as turnover T minus costs C, so profits equals $T - C$. Turnover equals the price (P) times the number of goods sold (S). 'Inventories', ie. non-sold goods or services, are not necessarily zero. So, the number of goods produced may differ from S. Costs only consist of wage costs, ie. $C = W.L$ where W is the gross wage and L the number of employees. Profits are then defined per employee as

$$\Pi \equiv P q^{\rho} - W \quad \text{where} \quad \rho \leq 1 \tag{2}$$

where sales per employee equals q^{ρ} and q is labour productivity. In case $\rho = 1$ each unit produced per employee is fully sold. In case $\rho < 1$ labour productivity gains not fully translate into an equal increase in sales. So this profit specification allows for an increase of labour

productivity that is not necessarily fully translated in a proportional increase in sales. In case $\rho < 1$ profit is lower due to the lower revenues per employee, but higher as a consequence of the lower gross wage as becomes clear from equation (7). See also Bell, Nickell en Quintini (2000) for a similar specification.

The employee bargains about the wage, taking account of many factors like the number of working hours, refresher courses and other secondary labour conditions or employment. Of all these factors the wage itself is the essential factor. We use a specification for the 'utility' of the employee that is simplified but useful for empirical purposes. It is assumed that the utility of the employee equals just the net wage. This is the gross wage after deduction of taxes and social contributions, *t*, paid by the employer as well as by the employee in deviation of the reservation wage $\underline{W}$,

$$Q \equiv W(1-t) - \underline{W}. \tag{3}$$

The reservation wage is the wage or benefit the employee would receive in case he would not fulfil 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 $\underline{W}$ 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,

$$\underline{W} \equiv \beta\, \underline{W}_{official} + (1-\beta)\, \underline{W}_{informal} \tag{4}$$

The parameter β 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 inversely equal the fraction of unemployed persons in the labour force, say (1-*u*). The unemployment rate *u* and the so called replacement ratio *R* play a role in determining the wage in the official sector $\underline{W}_{official}$, that is

$$\underline{W}_{official} \equiv u\ R\hat{W}(1-t) + (1-u)\hat{W}(1-t) \tag{5}$$

The wage in the official sector $\underline{W}_{official}$ equals $\hat{W}(1-t)$ in case of no unemployment ($u = 0$) and, as another extreme case, $R\hat{W}(1-t)$ 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 $\hat{W}$ is the gross average 'market' wage. The gross benefit received when unemployed equals $R\hat{W}$ 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 γ 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 $\underline{W}_{informal}$, is further assumed conditional on the consumer price $P_{c,}$

$$\underline{W}_{informal} \equiv \gamma P_c q^{\rho} \quad . \tag{6}$$

So the real wage earned in the informal sector, $\frac{\underline{W}_{informal}}{P_c}$ is lower than or equal to the productivity in the formal sector in case $\gamma \leq 1$ and $\rho = 1$ (see (2)). In case $\rho < 1$ some 'goods' produced do not raise money at all.

It is sometimes argued that the 'informal' sector does hardly or does not exist. In this case parameter *b* should equal one (see (4)). In our empirical analyses we test this restriction.

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

$$\begin{aligned} \log W = \log P + \rho \log q + \log\left[1+\left(\frac{\alpha(1-\beta)\gamma}{1-\alpha+\alpha(1-\beta)\gamma}\right)\left(\frac{P_c}{P(1-t)}-1\right)\right] \\ -\log\left[1+\frac{\alpha}{1-\alpha}\left[1-\beta\left(1-u\left(1-R\right)\right)\right]\right]+\log\left[1+\frac{\alpha(1-\beta)\gamma}{1-\alpha}\right] \end{aligned} \tag{7}$$

From this wage equation it follows that prices fully translate in gross wage increases. A 1% increase in the value added price and the consumer price, increases the gross wage by 1%. Productivity does not necessarily translate fully in wage increases. In case productivity increase by 1%, gross wage increase by ρ, where ρ is not necessarily equal to 1. In case $\rho < 1$ the employee receives less wage than in case $\rho = 1$ and at the same time the employer pays less due to lower wage costs. Due to a lower turnover the employer may even not benefit much from the

lower wage costs (see equation (2)). This is the case where some goods or services produced are not sold, so there are inefficiencies. Further, in the extreme case where the employer dominates the bargaining process, i.e. $\alpha=1$, the employee is paid just enough to keep him at work. Going through the algebra in the appendix shows that the two last terms in (7) vanish and from the third term it 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. $\alpha=0$, 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^{ρ}.

On the basis of (7) it follows that in the long run the optimal gross wage (W) depends on six factors: value added price (P), consumer price (P_c), labour productivity (q), average and marginal taxes and social contributions (t), 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 in the long run an increase in the *labour productivity* of 1% increases the wage rate by ρ. In case $\rho=1$ each change in labour productivity is fully compensated for in wages. The econometric analyses in the next section, where ρ is estimated freely, will show whether the hypothesis of full compensation is accepted for the countries under investigation.

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

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

So, by definition the replacement rate does not exceed one because working in the official sector will be higher 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 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 is expected to exert 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 leads, as one may expect because of the higher demand for than supply of paid jobs, to downward pressure on the wage rate. The effect of the unemployment rate on the wage rate is thus negative. The magnitude 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 while 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. As stated earlier, the effect on the wage rate at the same time depends on the unemployment rate. So the unemployment and replacement rate interactively affect wages.

The specified wage bargaining model aims to describe wage formation appropriately. 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. Wage ‘flexibility’ may 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.

One important remark is finally to be made concerning the model. Institutional changes and government regulation affecting the labour market can exert influence on the bargaining process. The model only accounts for these changes to the extent that they appear in the replacement rate.

4 ON THE ESTIMATION OF THE WAGE EQUATION

This section presents details on the estimation strategy in subsection 4.1 and the estimation results in subsection 4.2. For those readers not interested in the technical details of the estimation strategy section 4.1 can be skipped.

4.1 Estimation strategy

The derived result (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 (ECM) is specified as

$$\Delta \log W = \sum \phi_i \, \Delta \log X_i + \eta \left(\log W_{-1} - \log W^*_{-1} \right). \tag{8}$$

where $\log W^*$ equals the highly non-linear right hand side of equation (7) at time $t-1$, with the deep parameters α, β, γ and ρ. The first terms in (8) consider the short-term effects ϕ_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 consistent 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 β and γ turns out to be difficult. For this reason we calibrate β, being the fraction of the official to average wage (i.e. official wage in the

informal sector), at a value between 0.85 and 0.99 that provides the highest t-value of γ. In order to specify the short term dynamics we start with a general to specific approach with all six explanatory variables included with no, one and two lags. 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 in Table 1b we present the estimates of the system of equations by instruments, that is Three-Stage-Least Squares (3-SLS) where one weighting by means of the 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 in the following we only consider the 3-SLS results.

Table 1a Two-Stage-Least-Squares estimates

	Germany	Spain	France	The Netherlands	United States
Long-term coefficients					
α	0.71	0.88	0.87	0.80	0.27
	(3.83)	(7.30)	(4.80)	(12.68)	(0.52)
β	0.92	0.89	0.80	0.93	0.89
γ	0.90	1.26	0.81	0.99	0.29
	(19.30)	(13.94)	(40.14)	(41.19)	(0.14)
ρ	0.90	0.90	0.34	0.66	0.99
	(7.77)	(4.50)	(2.17)	(11.21)	(5.26)
η	-0.36	-0.35	-0.26	-0.29	-0.42
	(3.08)	(2.94)	(4.91)	(3.02)	(1.95)
Short-term coefficients					
$\Delta \log W_{-1}$				0.41	0.74
				(2.69)	(2.76)
$\Delta \log P$	1.23			0.47	
	(6.87)			(2.34)	
$\Delta \log P_c$		1.05	0.95		0.53
		(5.18)	(16.00)		(2.21)
$\Delta \log q$	0.61				0.62
	(2.94)				(2.59)
Statistics					
R^2_{adj}	0.91	0.95	0.98	0.95	0.84
Standaard error(*100)	0.82	1.62	0.67	0.70	0.91
Jarque-Bera	0.44	0.01	0.72	0.36 [p=0.83]	0.88 [p=0.65]
	[P=0.80]	[p=0.99]	[P=0.70]		

Note: the parameters β are calibrated at values that provide the highest t-statistics for γ. Moreover for the US, the parameter estimates for the α and γ are not significant.

Table 1b Three-Stage-Least-Squares-estimates

	Germany	Spain	France	The Netherlands	United States
Long-term coefficients					
α	0.58	0.95	0.76	0.77	0.40
	(2.44)	(13.94)	(3.10)	(9.34)	(0.93)
β	0.92	0.83	0.80	0.92	0.89
γ	0.83	0.98	0.83	0.95	0.68
	(8.04)	(19.16)	(28.67)	(31.13)	(0.96)
ρ	0.88	0.94	0.38	0.67	0.93
	(10.94)	(5.41)	(2.27)	(9.31)	(4.53)
η	-0.38	-0.36	-0.29	-0.32	-0.39
	(3.59)	(3.44)	(3.70)	(3.12)	(2.15)
Short-term coefficients					
$\Delta \log W_{-1}$		0.26		0.40	0.63
		(1.99)		(3.48)	(3.60)
$\Delta \log P$	1.38			0.52	
	(8.26)			(3.25)	
$\Delta \log P_c$		0.88	0.95		0.55
		(3.96)	(10.50)		(2.52)
$\Delta \log q$	0.64				0.74
	(4.43)				(2.79)
Statistics					
R^2_{adj}	0.90	0.96	0.98	0.95	0.84
Standaard error(*100)	0.84	1.42	0.71	0.69	0.88
Jarque-Bera	0.58	0.05	0.40	0.22 [P=0.89]	0.85 [P=0.65]
	[P=0.75]	[P=0.97]	[P=0.82]		

Note: the parameters β are calibrated at values that provide the highest t-statistics for γ. Moreover for the US, the parameter estimates for the α and γ are not significant.

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.[1] Considering the significant differences in parameter estimates across countries, 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 on wages of the determinants as provided by the wage bargaining model and the data. These estimation results therefore give us the opportunity to study each of the estimated determinants' impact in full depth.

[1] Belgium would be an appropriate example (but is not included in the sample) of such a case. Wage negotiations in Belgium are dominantly determined by wage settlements in France, Germany and the Netherlands.

4.2 The estimation results

The estimated equations all have a high goodness-of-fit from about 0.84 for the US up to 0.98 for France. All parameter estimates are used in the next sections where the wage elasticities and determinants' contributions to wage growth are discussed. A few remarks have to be made here. A remarkable finding is the quite high short-term elasticities of prices in Germany (of more than 1%). Moreover, the labour productivity in France and the Netherlands contributes significantly less than fully to wage growth in the long run. In particular in France the parameter estimate of ρ is very low, implying that despite higher productivity goods or probably many services are not sold. Further, and probably most remarkable, is the fact that in the US neither α nor γ are significant. It seems that neither the unemployment nor the replacement rate is relevant for the formation of the US wage. As follows from equations (1)-(3) this result implies that wage negotiations in European countries are much more dominated by employers than in the US. Moreover, the informal sector in the US is far less important than the informal sector in the European countries probably due tot the differences in social security arangements across the two continents.

5 ON THE CALCULATED WAGE ELASTICITIES

For each of the determinants in the wage equation elasticities are calculated and shown in Graph1a to Graph 1f along with the determinants. The precise formulas for the long-run elasticities are provided in appendix A.

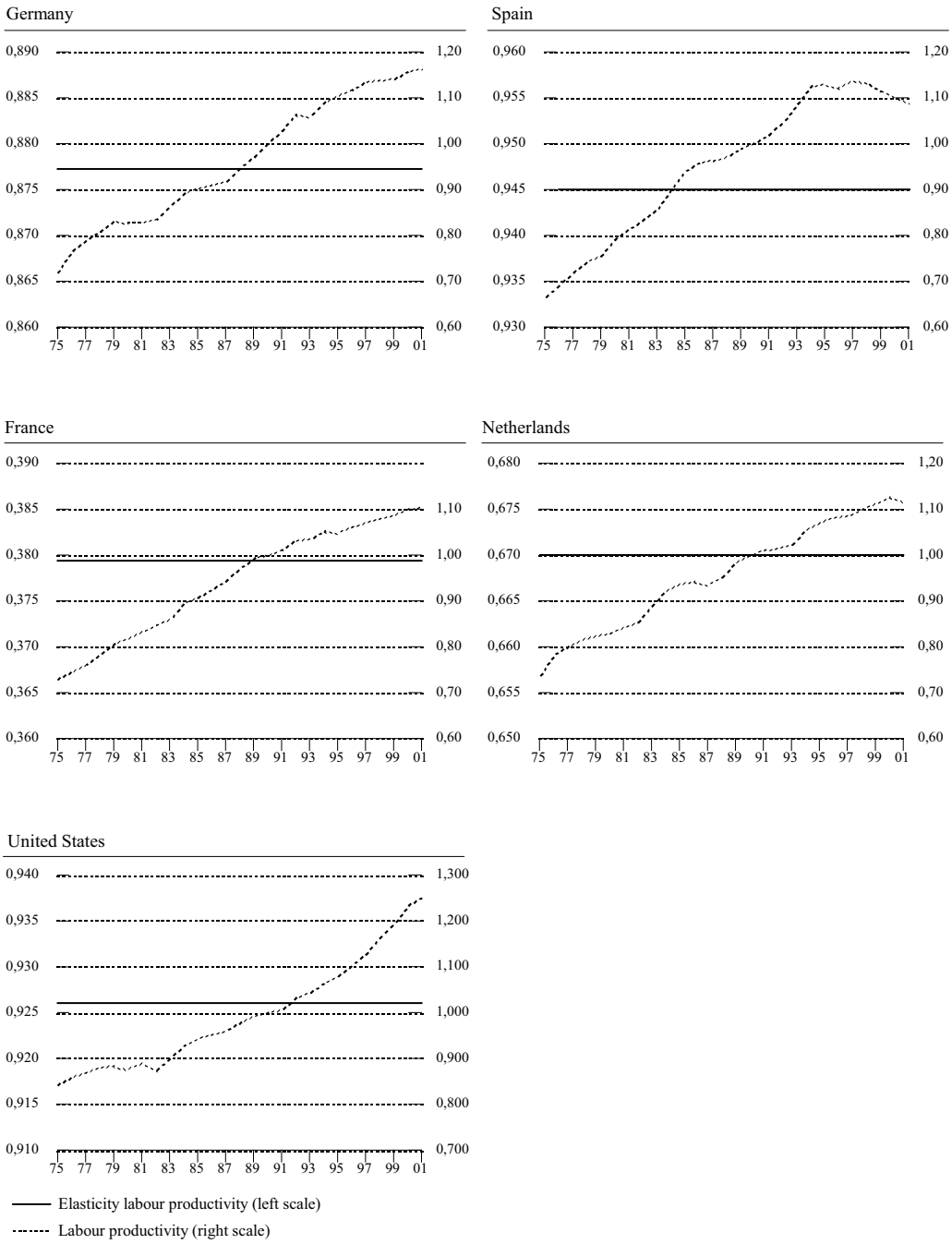
The elasticity of wages with respect to labour productivity is constant. As follows directly from Table 1b by means of the estimate for ρ, Graph 1a shows that this elasticity is low for France and the Netherlands while this parameter is not significantly different to 1 for some other countries. In case of the Netherlands the low spillover of productivity growth into wages during the last 25 years may reflect the policy of wage moderation pursued during most of this period. In the Wassenaar treaty of 1982 employers and employees agreed on full price compensation and on partially transmission of productivity improvements into wage increases. However, the fairly low value of ρ for France remains puzzling. 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. We emphasize further that the findings of ρ lower than 1 for some countries justifies equation (7) where this parameter allows for the empirical flexibility of not translating productivity changes one-to-one in wages, like confirmed by many empirical studies that estimate unrestricted form wage equations. In the structural model used here, equation (2) is the underlying source of the justification.

Graphs 1b and 1c provide the elasticities of wages with respect to the two prices, the value added and consumer price. For each point in time they add up to one by definition, for each of the countries. It follows that the consumer price elasticity increased over time, at the cost of the value added price one. 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.

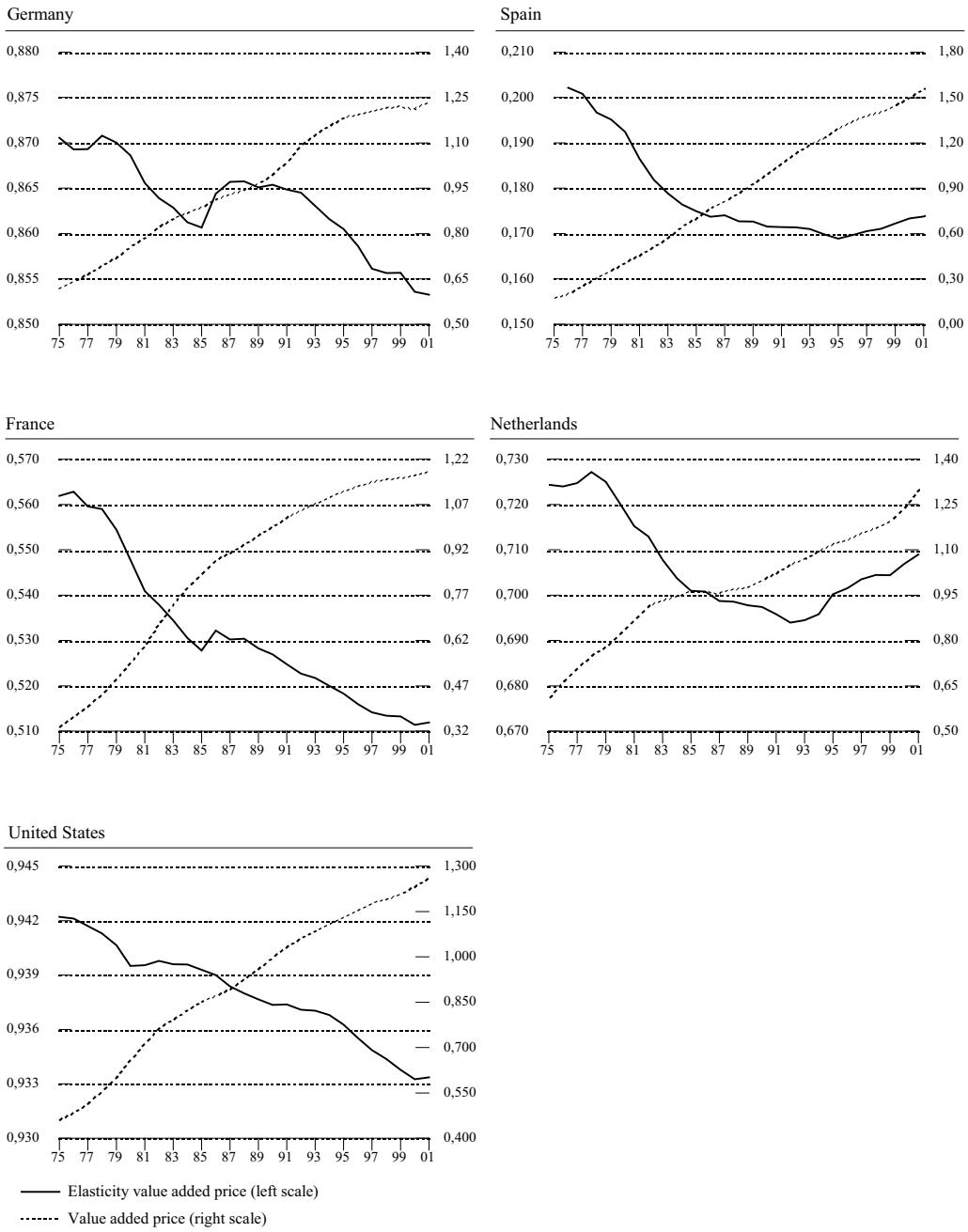
Most interesting cases are the unemployment and the replacement rates. The semi-elasticities are plotted in Graphs 1e and 1f. On average the semi-elasticity of wages with respect to unemployment is highest in Spain and the Netherlands and lowest in the US. Interesting is furthermore that Graph 1f clearly 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 responsiveness of the wage rate to unemployment was fairly low and lowered even further during the end of the sample period. In France the responsiveness of 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 wages with respect to unemployment is dependent upon the unemployment rate itself, the replacement rate and the deep parameters α and β (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. More information about labour market policy affecting the replacement rate in the countries under investigation here is found in Peeters and Den Reijer (2001).

The low responsiveness of wages to unemployment in the US might be rationalised by the functioning of its labour market. The US labour market likely moves towards equilibrium more by quantity adjustments than by wage adjustments. Because of the loose job protection measures for employees firms more easily dismiss people when they are no longer sufficiently productive. As will be shown shortly, the labour productivity turns out to be a dominant contributer to wages in the US.

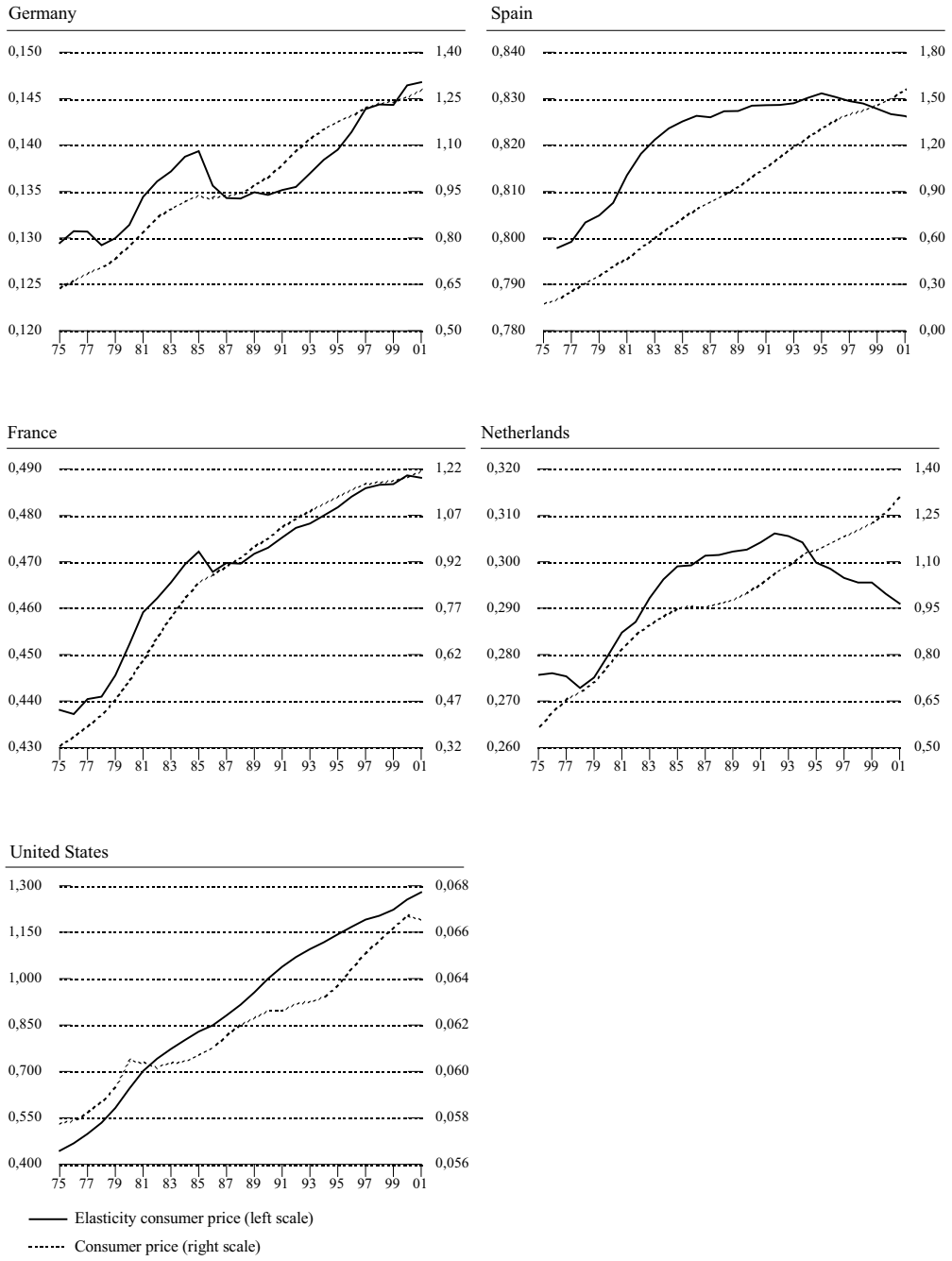
Graph 1a Elasticity of wages with respect to labour productivity and labour productivity



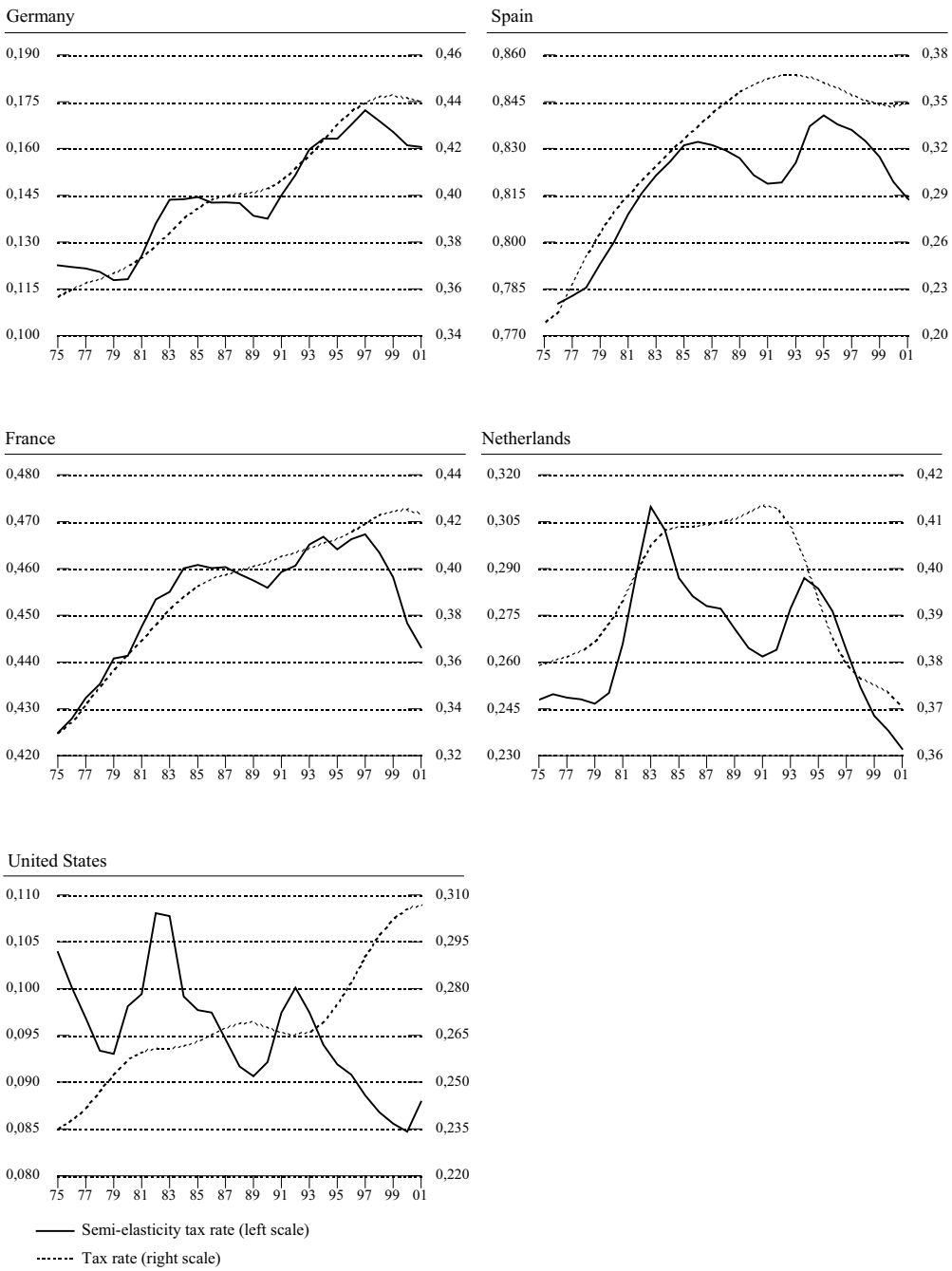
Graph 1b Elasticity of wages with respect to value added price and value added price



Graph 1c Elasticity of wages with respect to consumer price and consumer price

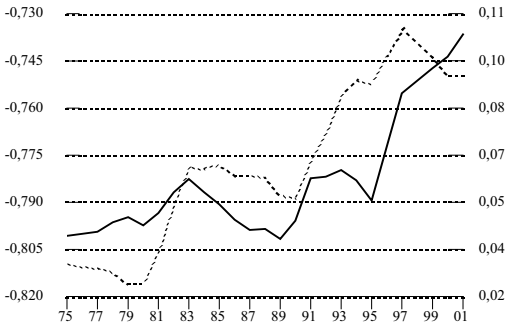


Graph 1d Semi-elasticity of wages with respect to tax rate and tax rate



Graph 1e Semi-elasticity of wages with respect to unemployment and unemployment

Germany

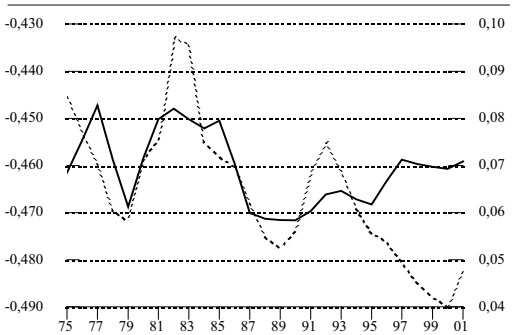


Spain

France

Netherlands

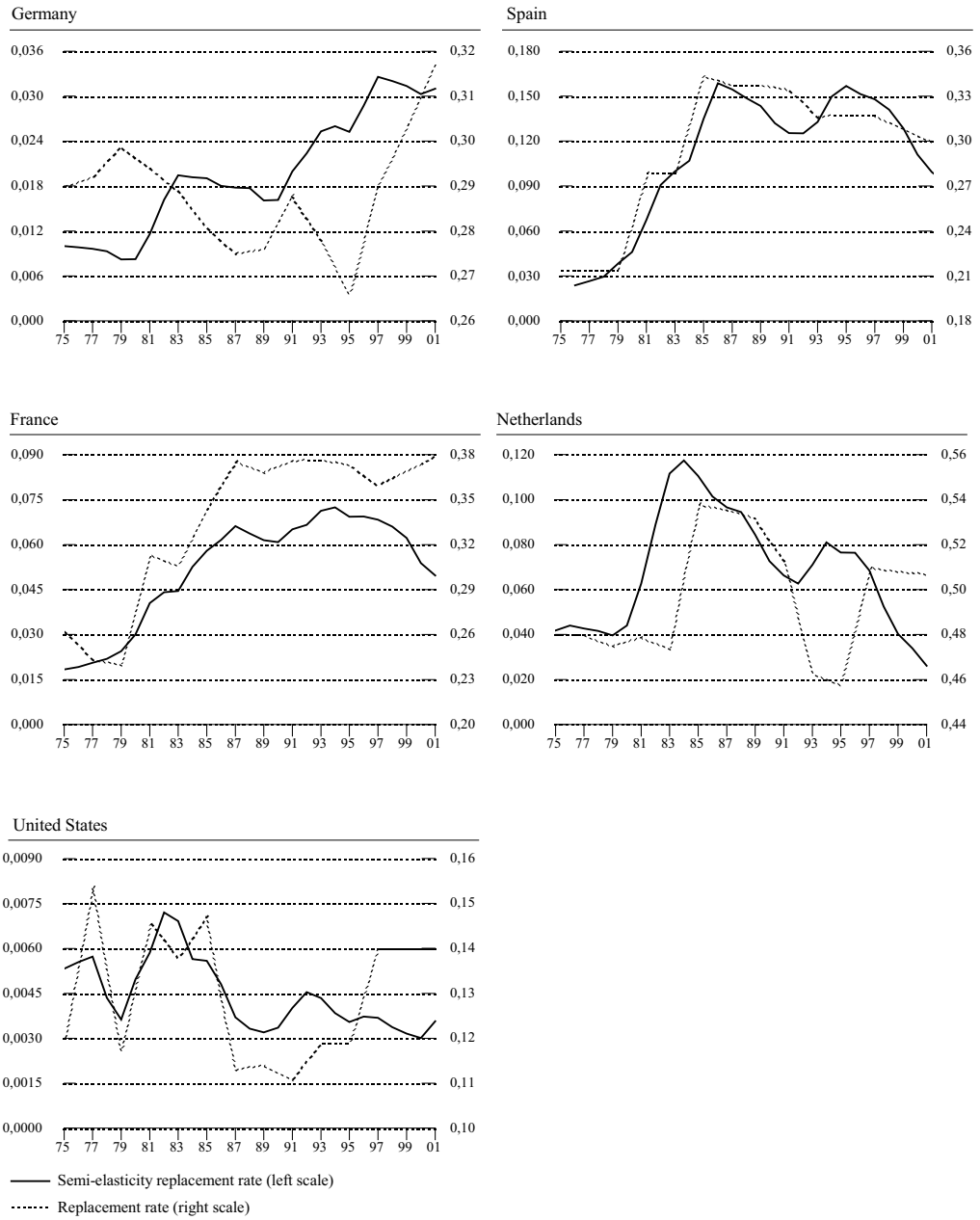
United States



Semi-elasticity unemployment (left scale)

Unemployment (right scale)

Graph 1f Semi-elasticity of wages with respect to 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.

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

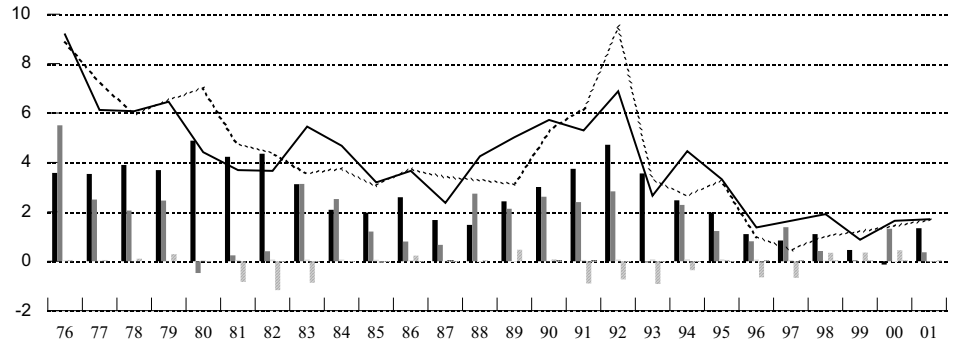
The role of unemployment in wage determination is most dominant in Spain and the Netherlands. At the beginning of the eighties and nineties the increase in domestic unemployment moderated wage growth considerably. At the end of the nineties the decrease in unemployment contributed, on the contrary, positively to wage growth. In Spain unemployment contributed even more than prices or any other wage determinant. The 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.

7 ON WAGE FLEXIBILITY

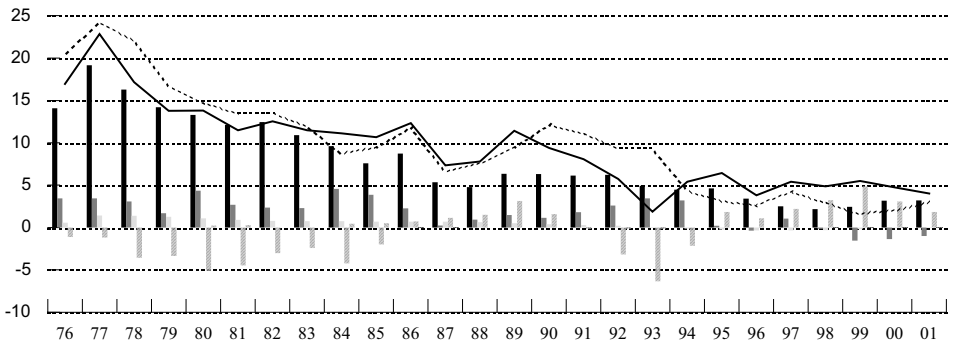
A high wage flexibility is often considered to be a virtue in view of the functioning of the labour market. Reactions of wages to unemployment changes is often more desired than the reactions of the wages to price changes. According to the model in the long run prices are fully transmitted into wages. So, only the short term dynamics towards this long run equilibrium matters. The responsiveness of wages to unemployment changes turns out to be quite different over countries and over time, both in the short term dynamics as well as in the long run equilibrium. We will investigate this feature in this section by means of a simulation.

Graph 2 Observed wage rise, model based wage rised and the constituting determinants 'parts'

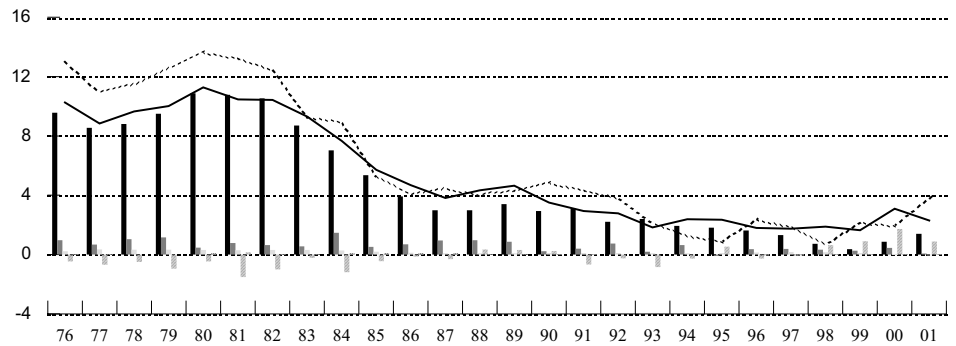
Germany



Spain



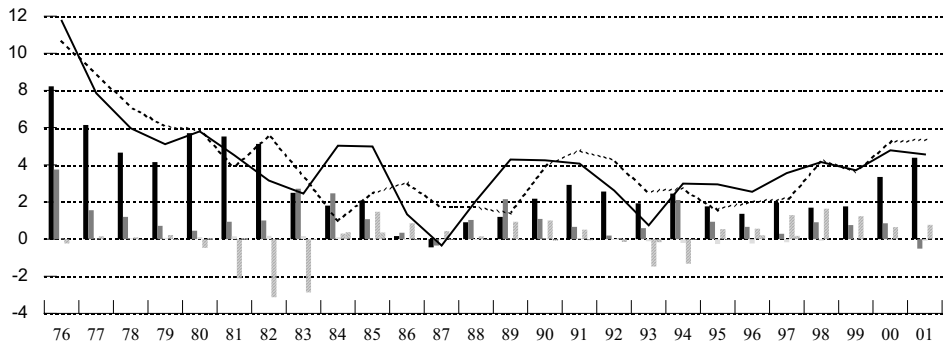
France



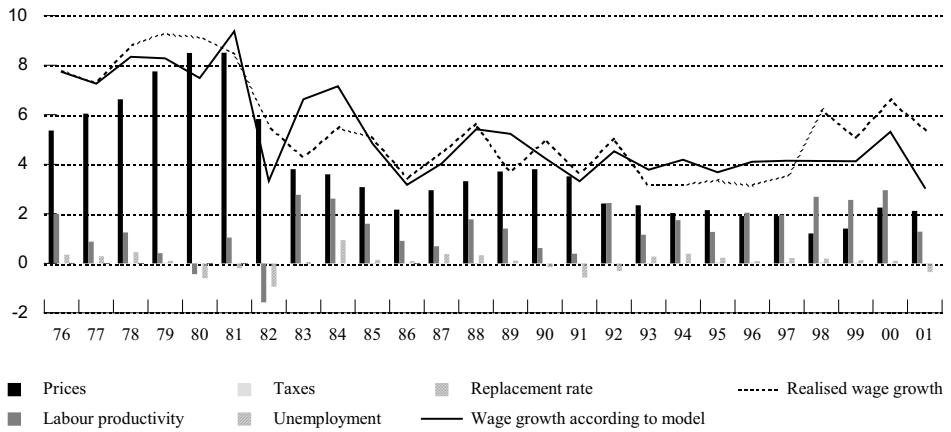
Prices
Labour productivity
Taxes
Unemployment
Replacement rate
Wage growth according to model
Realised wage growth

Graph 2 Observed wage rise, model based wage rised and the constituting determinants 'parts' (continued)

Netherlands



United States



As followed from the previous sections flexibility, that is the responsiveness of wages to unemployment alterations, 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.

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 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% 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 1977-1986, when both inflation and unemployment were relatively low and, in 1993-2001 when unemployment and prices started declining. The period 1987-1993 is not subdued to any shock and therefore only reflects the short run adjustment towards the baseline. The simulation basically tells us what would have happened

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

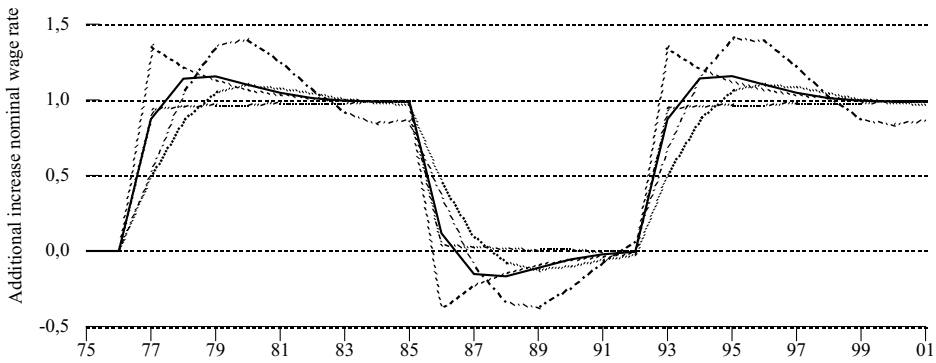
	This study 1975-2001	Layard, Nickell and Jackman (1991)
Germany	0.74 to 0.81	1.01
Spain	1.60 to 2.60	1.21
France	0.85 to 1.15	4.35
Netherlands	1.00 to 1.25	2.28
The United States	0.44 to 0.48	0.94

to the wage increases according to the model if prices or unemployment would have been 1% higher. The results of the simulation are shown in Graph 3a for the two price shocks and in Graph 3b for the two unemployment shocks. The presented figures display the development of the additional increases of the nominal wage due to the additional rise in prices or unemployment.

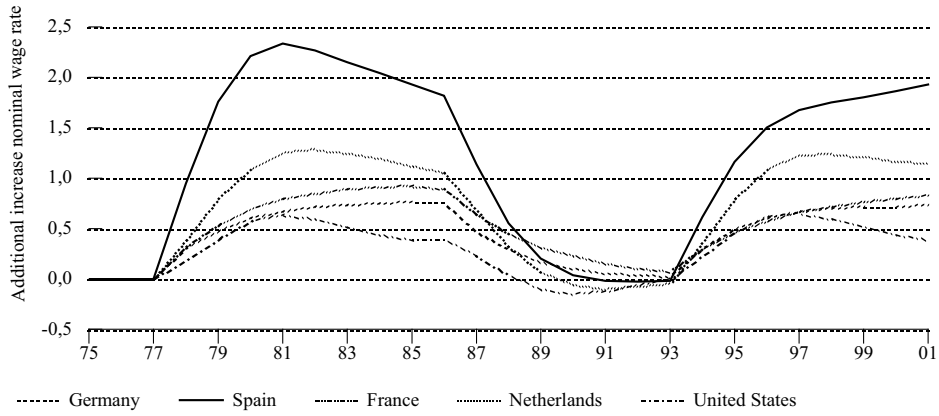
In the long term the 1% increase in prices should increase the wage by 1% as followed from the model and shown in Graph 1b-1c. Graph 3a shows that the increase in prices during eight years in the seventies and during eight years in the nineties increases the wage by unity indeed. The adjustment speed 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 shows only slightly different results. Almost all countries overshoot initially and most countries are close to long run equilibrium within a couple of years.

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

Graph 3a Simulation of a price shock



Graph 3b Simulation of a unemployment shock



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 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).

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 an Error-Correction Model using annual time series of the last three decades for 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 of the nineties when unemployment sharply dropped. Moreover, wages are no longer assumed to have a unity elasticity with respect to labour productivity in the long run. However, with the exception of France and the Netherlands this paramater turned out not to differ significantly from unity. 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 for the individual countries.

The 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 wage elasticity with respect to unemployment increased in absolute terms and unemployment fell drastically in both Spain and the Netherlands. For these two reasons the contribution 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. In Spain and the Netherlands a clear turning point in unemployment developments were probably triggered by favourable labour market policies conducted in the eighties. These policies led to a reduction of 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 wages for unemployment alterations for Spain and the Netherlands contrasts to Germany, where the replacement rate did not decrease at the end of the period, and consequently the unemployment elasticity fell (in absolute terms).

Similar to the labour market study results of Layard, Nickell and Jackman (1991) we also confirm that the wage formation in the US cannot be called more flexible than in the three largest European countries or the Netherlands. The flexibility, that is the reaction of wages to unemployment changes, is by far smaller for the US than for these countries. This feature is particularly shown in the simulation analysis. Moreover, the short run adjustment in the US of wages to price changes reveals some stickiness. The low responsiveness of wages to unemployment in the US might be rationalised by the functioning of its labour market. This market may adjust towards equilibrium more by quantity adjustments than by wage adjustment.

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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

$$\Omega \equiv (Pq^{\rho} - W)^{\alpha}(W - T(W) - \underline{W})^{1-\alpha}, \tag{1}$$

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

$$\frac{\partial \Omega}{\partial W} \equiv -\alpha(Pq^{\rho} - W)^{\alpha-1}(W - T(W) - \underline{W})^{1-\alpha} + (Pq^{\rho} - W)^{\alpha}(1-\alpha)(W - T(W) - \underline{W})^{-\alpha}(1 - \frac{\partial T}{\partial W}) = 0 \quad \Leftrightarrow$$

$$-\alpha(W - T(W) - \underline{W}) + (Pq^{\rho} - W)(1-\alpha)(1 - \frac{\partial T}{\partial W}) = 0 \quad \Rightarrow$$

$$W\left[\alpha\frac{1-t}{1-t_m} + (1-\alpha)\right] = (1-\alpha)Pq^{\rho} + \frac{\alpha}{1-t_m}\underline{W} \tag{A1}$$

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

The wage earned in the official sector

$$\underline{W}_{official} = u\,R\,\hat{W}(1-t) + (1-u)\,\hat{W}(1-t) \tag{4}$$

and the informal wage

$$\underline{W}_{informal} = \gamma\,P_c\,q^{\rho} \tag{5}$$

can be substituted into the reservation wage equation

$$\underline{W} = \beta\,\underline{W}_{official} + (1-\beta)\,\underline{W}_{informal} \tag{3}$$

such that the reservation wage equals

$$\underline{W} = \hat{W}(1-t)\ \beta\ (1-u\ (1-R)) + (1-\beta)\ \gamma\ P_c\ q^{\ \rho}. \tag{A2}$$

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

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

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

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

In this last step an arrangement is made to separate the term Pq^{ρ} and the constant term, virtues that follow from the wage equation expressed in logarithms below.

Because, taking logarithmes the wage equation equals

$$\begin{aligned}\log W = {} & \log P + \rho \log q + \log\left[1 + \left(\frac{\alpha\ (1-\beta)\gamma}{1-\alpha+\alpha\ (1-\beta)\gamma}\right)\left(\frac{P_c}{P(1-t_m)} - 1\right)\right] \\ & - \log\left[1 + \frac{\alpha}{1-\alpha}\frac{1-t}{1-t_m}\left[1-\beta\left(1-u\left(1-R\right)\right)\right]\right] + \log\left[1 + \frac{\alpha\ (1-\beta)\ \gamma}{1-\alpha}\right]\end{aligned} \tag{7}$$

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 $\in_P$ and $\in_{P_c}$ respectively, add to one as it can be derived that

$$\in_P + \in_{P_c} \equiv \frac{\partial \log W}{\partial \log P} + \frac{\partial \log W}{\partial \log P_c} = 1\,.$$

The elasticity of wages with respect to productivity, the *semi*-elasticities of wages with respect to unemployment and the replacement rate are respectively

$$\in_q \equiv \frac{\partial \log W}{\partial \log q} = \rho \tag{A3}$$

$$\in_u \equiv \frac{\partial \log W}{\partial u} = -\frac{\alpha}{1-\alpha}\frac{\beta\ (1-R)}{1+z} \tag{A4}$$

$$\in_R \equiv \frac{\partial \log W}{\partial R} = -\frac{\alpha}{1-\alpha}\frac{\beta\, u}{1+z} \tag{A5}$$

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

The differential equation

$$d\log W = \sum_{i=P,P_c,q,t,u,R} \frac{\partial \log W}{\partial \log i}\frac{\partial i}{i}$$

equals approximately

$$\Delta \log W = \sum_{i=P,P_c,q,t,u,R} \in_i \frac{\Delta i}{i} \tag{A6}$$

where $\Delta \log W$ represents the change of the the gross wage W. In case of semi-elasticities, multiplication by Δi 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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