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Why do macro wage elasticities diverge?

A meta analysis

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Abstract in English

This study analyses macro elasticities of the gross yearly wage per employee. From some 90 books, articles and working papers, more than 1000 elasticities have been extracted. The results indicate that the dynamic specification of the wage equation, the choice of explanatory variables and restrictions on estimated coefficients all have their impact on estimated elasticities. From the results, we generate benchmark values for each type of elasticity that may be useful to calibrate policy simulation models.

Key words: elasticity of pay, meta analysis

JEL code: C42, J30

Abstract in Dutch

Dit onderzoek probeert de variatie in macro loonelasticiteiten te verklaren vanuit studiekarakteristieken met behulp van een meta-analyse. Uit 90 artikelen en boeken zijn ongeveer 1000 elasticiteiten gedestilleerd. De resultaten geven aan dat met name de specificatie van de oorspronkelijke vergelijking belangrijk is. Op basis van de uitkomsten is het mogelijk om per type elasticiteit een referentiewaarde te bepalen. Deze kunnen hun waarde bewijzen bij de kalibratie van modellen voor beleidsanalyse.

Steekwoorden: loonelasticiteit, meta-analyse

Contents

Summary

This study analyses macro wage elasticities. From some 90 books, articles and working papers, more than 1000 elasticities have been extracted and computed. These concern elasticities of pay on labour productivity, payroll taxes, average and marginal income tax, consumer and producer prices, the net replacement ratio and the unemployment rate. There is a wide variety in applied wage definitions, so the first step is to transform elasticities to meet a common wage definition: the gross yearly wage per employee. Next, the data have been analyzed in eight separate meta analyses. These aim to attribute differences in each elasticity of pay to variations in study characteristics, economic or institutional variables and the econometric specification of underlying wage equations? I have used dummy variables that discriminate between country blocks, time periods, estimation techniques and econometric specifications. Due to the limited size of the common sample of all types of elasticities, variations in each type have been analyzed separately rather than in one system regression.

I have applied the robust Least Absolute Deviation estimator rather than common Least Squares methods that are more sensitive to outliers. The results indicate that notably the econometric specification of the reported wage equation matters. The dynamic specification, the choice of explanatory variables and restrictions on estimated coefficients all have their impact on estimated elasticities. For example, the reported value of the output price elasticity of pay is sensitive to restrictions on the consumer price and vice versa. In case of tax elasticities, the dynamic specification matters, and the value of the replacement ratio elasticity of pay based on sectoral data is higher than the one obtained from macro data. The results for the unemployment elasticity of pay are close to those found in the wage curve literature. Finally, from the results I have generated benchmark values for each type of elasticity.

1 Wages through the ages

Many studies have investigated the impact of wages on economic performance. Roughly spoken, there are three lines of approach. The first explores the relation between wages, production and prices. This research was partly triggered by high inflation rates in de sixties and seventies of the 20th century (see e.g. Nickell (1987)). The second line focuses on wages and unemployment, initiated in 1958 by A.W. Phillips in his classic review on the relation between the rate of change of nominal wages and unemployment. Although his approach has been questioned (see e.g. Phelps (1968), Blanchflower and Oswald (1994)), high or persistent unemployment has triggered a lot of research to closely examine wage formation (Drèze and Bean (1990), Layard *et al* (1991)). A third scope is linked to economic policy reforms (Sørensen (1997)). The use of large computer models to analyze the possible impact of policy reforms on the performance of the labour market requires a sound theoretical and empirical underpinning of the role of wages (see also Graafland *et al* (2001)).

Empirical information is mainly summarized through estimated wage elasticities. This is of major practical importance, as irrespective the theoretical model, it is virtually always possible to derive and compute wage elasticities and compare the results with findings of others. Yet general overviews of elasticities are scarce. Partial overviews of tax (wedge) elasticities can be found in Calmfors and Nymoen (1990), Sørensen (1997), Leibfritz *et al* (1997) and van der Horst (2003). In addition, Graafland and Huizinga (1999) report replacement rate elasticities. The path breaking work of Blanchflower and Oswald (1995) on the wage curve supplies an extensive overview of unemployment elasticities of pay. In Blanchflower and Oswald (2005), they update the overview.

The first goal of this paper is to provide an overview of long-run macro wage elasticities. Following the approach of Tyrvainen (1995) eight elasticities of interest have been selected: productivity, payroll taxes, average and marginal income tax, producer and consumer price, the net replacement ratio and the unemployment rate. The second aim is to explain the variation in elasticities across studies. To explore this, I perform a meta analysis for each type of elasticity. Finally, I use the results of these analyses to compute benchmark values for all elasticities of interest.

A main issue in the analysis is the impact of parameter restrictions in the wage equation on computed elasticities. Wage equations may contain separate tax and price variables or tax and price wedges; does this yield different values of tax and price elasticities? Do real and nominal wage equations yield similar elasticities? Does the elasticity of the net replacement ratio change if we omit payroll taxes from the wage equation? We will deal explicitly with those problems of completeness, normalization and restrictions.

The results indicate that the dynamic specification of the wage equation, the choice of explanatory variables and restrictions on estimated coefficients all have their impact on estimated elasticities. Short-term values of elasticities of payroll and income taxes differ from their long-term equivalents. If the output price or the consumer price is omitted from the wage equation, the elasticity of the remaining price is biased upwards. The value of the replacement ratio elasticity of pay based on sectoral data is higher than the one obtained from macro data. Finally, the results for the long-run macro unemployment elasticity of pay are close to those found in the wage curve literature.

The structure of the paper is as follows. Section 2 is about the theoretical background of wage equations and the numerous definitions of the concept 'wage'. In section 3, we discuss the construction and sample characteristics of the data. Section 4 deals with the specification of moderator variables and in section 5, I present the results of the meta analysis and compute benchmark values for all types of elasticities. Section 6 concludes.

2 Wage equations and elasticities

2.1 Wage formation in the literature

In this paper, I do not formally derive a wage equation, yet it may be useful to summarize which variables may have an impact on wage formation. The neoclassical theory predicts that in the absence of unions, wages are determined by market clearing conditions only. At the other extreme, government measures may fully prescribe wage developments. In practice, usually both employers and unions have an impact on wage setting.

In the standard wage bargaining theory, wages result from negotiations between employers' and employees' organizations (see e.g. Layard, Nickell and Jackman (1991)). Efficiency in wage bargaining requires that all elements that affect the utility of the agents are subject of the wage bargain (Manning (1987)). As the wage resulting from the bargain has a decisive impact on the employment perspectives of the employees, an efficient bargain will include a contract on wages as well as on employment. In practice, employers' organisations may prefer to negotiate on wages only: individual employers should be able to adjust employment to shifts in demand. The 'right -to-manage' model captures this situation: unions and employers organizations negotiate on wages only, whereas individual firms have the right to choose employment at desired levels.

So, we may expect both variables that are related to consumer utility (consumer prices, income tax rates, the replacement ratio) and those that determine total profits and employment (payroll tax, productivity, output prices, unemployment rates) to have an impact on wage formation.

In practical applications, three possible strategies exist. A number of authors (e.g. Alogoskoufis and Manning (1988), Brunello and Sonedda (2006), Dolado and Bentolila (1993)) start with a careful theoretical description of the labour market and the bargaining process and derives relations for wages, prices and (un)employment. These relations serve as a starting point for estimation and testing. This is a fruitful approach in developing a policy evaluation model or if one wants to add specific elements in the bargaining process that are not standard. A second line is to apply a common wage equation from the literature (Dolado et al (1986)), Lauer (1999), Nunziata (2005)). Finally, a number of papers directly specify a wage equation, usually inspired by a wage bargaining process but not formally derived from it. This is a common way if one 'needs' a wage equation to analyze e.g. wage stickiness, unemployment or inflation. Examples are Carruth and Schnabel (1993), Fritsche et al (2005), Guichard and Laffargue (2000) and Pehkonen (1999).

A first practical implication is that wage equations may be 'incomplete': they do not contain all variables that are related to the elasticities of interest. Second, to collect wage elasticities it is not sufficient to search for publications on 'wage equations' or 'wage formation' but on has also to explore items like 'unemployment ', 'inflation' and 'tax policy'. A final point to note is that wage elasticities are not always reported, as sometimes it is beyond the scope of a publication. In those cases, they have to be computed; this usually implies that elasticities depend on specific values of additional variables.

2.2 Selection of publications

The data base contains 116 publications. The list is not exhaustive but it covers time series, cross section and panel data studies on countries and firms, published either in books, official journals or as working or conference papers. They have been collected mainly by scanning electronic issues of journals and publications of research institutes and conferences. In a second round, also relevant cited papers were examined.

Two selection rules have been applied. First, the publication should contain an aggregate wage equation. The qualification ‘aggregate’ does not necessarily refer to average (contract) wage per worker in the whole economy; it may also be the average wage in a specific sector or region. I did not include individual earnings equations that link the wage of a specific person to his or her level of education, working experience, age, marital status, union membership, and other variables. In the wage curve literature, they play a crucial role and they are a rich source of information on the unemployment elasticity of pay. An additional reason not to use these elasticities in our study is that the unemployment elasticity of pay is also quite popular in macro wage equations: the number of elasticities in the meta sample exceeds 200.

The second criterion is the computational effort required to extract the desired elasticities. As they could not be computed directly from data supplied by the authors generally, I extensively used the Labour Market Institutions Database of Nunziata and Nickell (2001). In a number of cases, I decided not to include publications in the data base as very specific additional data were needed. For example: average regional or sectoral unemployment rates for a given period, the average opportunity wage outside the manufacturing industry or income tax rates for specific population groups.

2.3 Intra and inter study variation

The distinction between within-study and between-study variation in wage elasticities needs specific attention here. It is common in empirical economics for one study to generate more than one estimate of the parameter of interest. Some authors report just the final equation while others also publish intermediate results. Selection of one parameter value per study may be misleading and inefficient as additional variation is ignored (Florax (2002)). As is well known, including more than one value per study introduces interdependency across the meta sample: some group of elasticities may be correlated with another group as they have been estimated on the same sample and using the same theoretical specification.

In our case, there may be an additional correlation. If various types of elasticities (e.g. those of payroll and income taxes) have been obtained from the same study, then a subset of the meta sample of payroll tax elasticities may be correlated with observations on income tax elasticities.

To keep the analysis tractable, if all specifications within a specific study are estimated using the same data set, then I take just one of them. In most cases, I prefer the results that the authors regard as 'best' (see also Stanley (2001)); in some cases, there is an alternative that better meets the goal of the analysis and that cannot be statistically rejected. The possible correlation between different types of elasticities obtained from the same wage equation is accounted for, however. We will discuss this topic in section 4.3.

2.4 Towards a suitable wage definition

All studies in the sample contain at least one wage equation, but there is not much uniformity in the definition of the dependent variable. From table 2.1, it follows that wage equations explain variations in nominal wage costs, yearly, quarterly, monthly and hourly wages, gross and net wages, real and nominal wages. The number of definitions is even larger as the word 'real' may refer to deflation by consumer prices, output prices or the GDP price index. What is a suitable definition to compare wage elasticities?

Table 2.1 Empirical wage definitions

Definition	Number of cases
Gross wage per employee	91
Gross wage costs per employee	27
Real gross wage per employee	21
Real gross wage costs per employee	46
Net wage per employee	37
Gross hourly wage	1
Gross hourly wage costs	1
Real gross hourly wage costs	8
Real net hourly wage	43
Real consumer wage	10
Ratio of real consumer wage and real post tax benefits	2
Nominal monthly wages	1
Real monthly wages	7
Quarterly gross wages per employee	1
Nominal unit Labour costs	6
Total	296

The concept of wage costs is closest to the price of labour paid by the employer. On the other hand, if I had started from the definition of labour productivity as the hourly production per employee I would use the hourly wage concept. So I should prefer hourly wage costs per employee, but this is not a practical definition, however. To convert all other wage concepts into hourly wage costs per worker one needs additional data on the payroll tax rate, the number of hours worked (which may change from year to year) as well as the amount of extra allowances (for overtime work or holidays, for example). This is a time consuming activity.

Therefore, I have selected the gross yearly wage per employee as a common definition. All reported and derived elasticities related to other wage definitions can rather straightforward be transformed to elasticities of the gross yearly wage.

Define the set A as:

$$A:\{\varepsilon_q, \varepsilon_{1+s}, \varepsilon_{1-a}, \varepsilon_{1-m}, \varepsilon_c, \varepsilon_y, \varepsilon_\rho, \varepsilon_u\}$$

ε	elasticity of the gross yearly wage per employee
q	labour productivity
s	producer payroll tax, elasticity ε_{1+s}
t_a	average income tax rate, elasticity ε_{1-a}
t_m	marginal income tax rate, elasticity ε_{1-m}
p_c	consumer price, elasticity ε_c
p_y	output price, elasticity ε_y
ρ	net replacement ratio
u	unemployment rate

A contains all desired elasticities of the gross yearly wage per employee. Now it is straightforward to derive the elasticity of wage costs W^p with respect of the payroll tax rate:

$$\frac{1+s}{W^p}\frac{\partial W^p}{\partial(1+s)} \equiv \frac{1+s}{W(1+s)}\frac{\partial W(1+s)}{\partial(1+s)} = 1+\frac{1+s}{W}\frac{\partial W}{\partial(1+s)} \equiv 1+\varepsilon_{1+s} \qquad (2.1)$$

In a similar way elasticities of the real wage and net wage can be transformed into gross wage elasticities. In case of elasticities of the wage per hour I assume that extra remunerations above the hourly wage rate are proportional to hourly wages. If, in addition the total number of hours worked per employee per year h_y is independent of the hourly wage then one may write yearly gross wage per employee W in terms of the hourly wage rate W^h:

$$W = W^h(1+v)h_y \quad (2.2)$$

with v the additional payments per hour worked, expressed as share of the hourly wage rate. From equation (2.2), it follows that, given our assumptions the labour productivity, elasticities of pay based on hourly and yearly wages are similar. Quarterly or monthly wages can be treated similarly.

A number of wage equations include tax variables in a tax wedge Λ and prices in a price wedge Π:

$$\Lambda = \frac{1+s}{1-\tau_a}, \quad \Pi = \frac{p_c}{p_y} \quad (2.3)$$

In these cases the wedge elasticities have been transformed into elasticities of the individual tax and price variables. A wage equation that contains wedges is generally more restrictive; therefore we will discuss possible consequences for wage elasticities derived from this type of equations below.

2.5 Short and long-term elasticities

Many reported wage equations obey a dynamic specification that yields both short and long-term elasticities. In this case, I just take the long-term values, as this is the main scope of the analysis. Moreover, in this case short-term elasticities usually depend on (changes in) prices and general business indicators only. In some publications, however, all variables are expressed in first differences: absolute, relative or in logarithms. The corresponding wage equations yield short-term elasticities only. These values are included in the sample, as they usually supply information on the desired elasticities. Moreover, they enable test whether 'average' short and long-term elasticities differ.

3 Description of the meta samples

3.1 General characteristics

Table 3.1 illustrates the distribution of estimated elasticities over countries.

Table 3.1 Number of elasticities by type and country

Country	ε_q	ε_{1+s}	ε_{1-a}	ε_{1-m}	ε_c	ε_y	ε_ρ	ε_u	Total
Australia	2	2	2	1	5	2	1	4	19
Austria	5	1	1		2	3		6	18
Belgium	4	1	2		3	2		5	17
Bulgaria					1			1	2
Canada	4	2	3	1	3	3	1	7	24
Denmark	6	4	1	1	2	5	5	10	34
Finland	8	21	19	1	18	23	10	13	113
France	10	5	6	1	9	9	2	14	56
Germany	14	6	5	1	7	12	2	17	64
Hungary					1			1	2
Ireland	3	2	2	1	1	2	1	4	16
Italy	8	5	6	1	4	7		12	43
Japan	5	3	2	1	3	3		5	22
The Netherlands	39	32	36	1	29	32	27	39	235
New Zealand	0	1	1		1			2	5
Norway	5	7	5		5	9	5	14	50
Poland					1			3	4
Portugal	2				1	1		2	6
Romania					1			1	2
Spain	6	5	4	1	5	6	6	10	43
Sweden	7	8	9	2	7	11	2	14	60
Switzerland					1			2	3
UK	10	11	12	2	7	13	8	20	83
USA	7	6	5	1	6	8	2	12	47
Country groups	4	6	10	2	6	1	2	5	36
Nordic countries	26	40	34	4	32	48	22	51	257
Anglo Saxon countries	26	24	25	6	23	28	13	49	194
The Netherlands	39	32	36	1	29	32	27	39	235
Other countries	58	32	36	7	45	44	12	84	318
Total	149	128	131	18	129	152	74	223	1004

Roughly spoken, there are 3 main groups: the Nordic countries (Norway, Sweden, Denmark, Finland), Anglo-Saxon countries, and other European countries with Germany, France, the Netherlands and Italy as main representatives. A number of elasticities refers to pooled estimates for country groups, like Nordic Countries or (a sample of) OECD countries. Estimates of the unemployment elasticity of pay are most abundant while the elasticity of the marginal retention rate is relatively scarce.

The number of elasticities corresponding to the Netherlands (235) seems extremely high; it must be noted however that 140 of these have been obtained from one publication only: Graafland and Verbruggen (1993) estimate on average 7 elasticities for 20 production sectors.

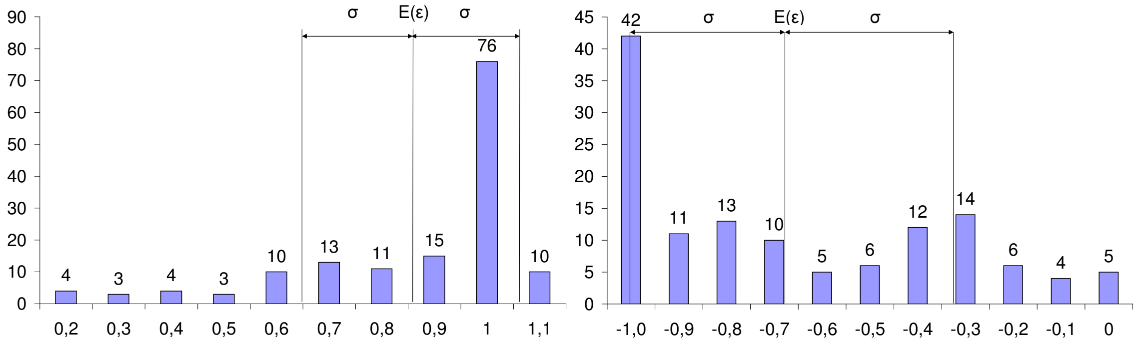
Table 3.2 Elasticities of pay by type

	Number	Sample mean	Sample median	Standard error	Minimum	Maximum
Labour productivity (q)	146	0.875	1	0.199	0.250	1.121
Payroll tax($1+s$)	138	– 0.659	– 0.720	0.323	– 1	0
Average retention ratio ($1-t_a$)	131	– 0.390	– 0.368	0.277	– 1	0.100
Marginal retention ratio ($1-t_m$)	18	0.226	0.200	0.245	– 0.120	0.650
Producer price (p_y)	152	0.725	0.790	0.273	0	1.140
Consumer price (p_c)	129	0.657	0.774	0.363	0	1.090
Replacement ratio (ρ)	74	0.349	0.322	0.274	0	1.080
Unemployment rate (u)	223	– 0.089	– 0.064	0.093	– 0.498	0.160
Total	1011					

Table 3.2 supplies summary statistics of the meta sample by type of elasticity. Income tax variables are expressed as income retention ratio's ($1-t_a$) and ($1-t_m$) rather than income tax rates. Some numbers in the table appear as integers indicating that their values have been fixed a priori in the reported equation. In section 4.3, I will consider how the possible impact of these econometric restrictions on reported elasticities of pay can be taken into account.

Figures 3.1 to 3.4 illustrate the distribution of the eight types of elasticities. Numbers at the horizontal axes are midmark values. In each diagram, 3 vertical lines have been drawn. The central line indicates the mean value of the elasticity; the other two are one standard deviation away from the mean value.

Figure 3.1 Elasticities: labour productivity payroll tax (1+*s*)



There is a lot of variation in the diagrams: the elasticities of wages with respect to labour productivity and the unemployment rate are rather concentrated around their mean values. The distributions of the elasticities of tax rates on the other hand tend to be more dispersed.

In figure 3.1, more than 35% of the labour-productivity elasticities in the sample was a priori set at a value of 1. Despite of this, the sample mean is just about 0.86, which implies that the mean value of the free estimates is about 0.78. The data do not suggest an unambiguous reason for this difference. All relevant studies use time series data; in some cases low values correspond to specific countries (Drèze and Bean (1990), Fritsche et al. (2005), Guichard and Laffargue (2000)), but the data also indicate that short-run elasticities tend to be somewhat smaller in size than long-run values.

More than 40 payroll tax elasticities have been set to − 1 a priori; most of these correspond to wage equations in which the dependent variable is expressed as wage cost per employee while the payroll tax does not enter the equation as explanatory variable. Apart from these values, the distribution is rather uniform. The sample mean of −0.67 indicates that on average 33% of a payroll tax increase is borne by the producer; 67% of the burden is shifted on to the employee. It is reasonable to assume that this process takes some time to settle; hence the short-run elasticity may differ from the long-run value. Furthermore, 41 out of 128 elasticities were computed from tax wedge elasticities; the sample mean of these restricted estimates is about −0.60, which implies that the mean of the unrestricted elasticities is about −0.72. The deviation from the sample mean (− 0.05) is not that large (some 40% of the standard error) but it may be significant.

Figure 3.2 **Elasticities: average retention ratio** **marginal retention ratio**

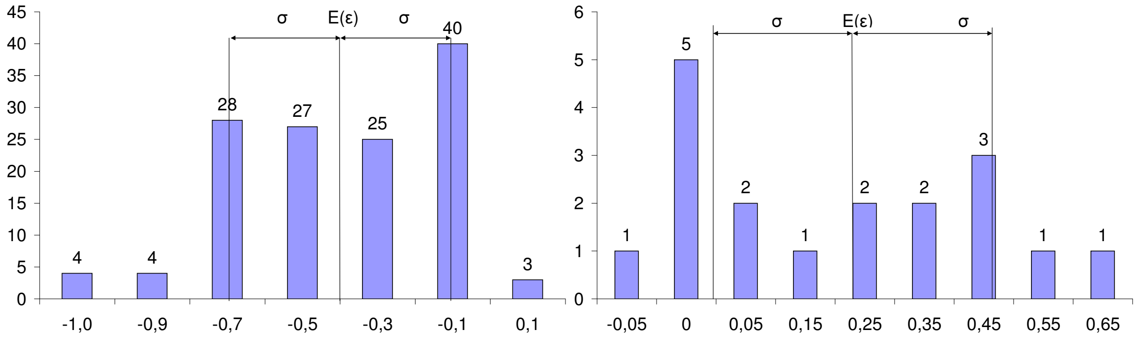


Figure 3.2 shows that the values of the elasticity of the average retention rate are roughly between −0.7 and −0.1. Like in case of payroll taxes, we expect short and long-run values of the elasticity to differ. The direction of the adjustment process will be opposite, however: the impact on the long run will be smaller (in absolute value) than the sort-term elasticity. The sample mean of the 41 values extracted from price wedge estimates is virtually the same as the overall sample mean of −0.39. Therefore in this case I expect that the impact of the restrictions is small and insignificant.

The sample of marginal retention rate elasticities contains 18 observations only, of which 10 were obtained from Tyrväinen (1995b); 5 of these were put to zero after a statistical test. Another 4 elasticities are in the range 0.5 - 0.6, while the pooled estimation of Brunello and Sonedda (2007) yields very small values (around zero). It remains to be seen whether any conclusions can be drawn from the regressions.

Figure 3.3 **Elasticities: consumer price** **output price**

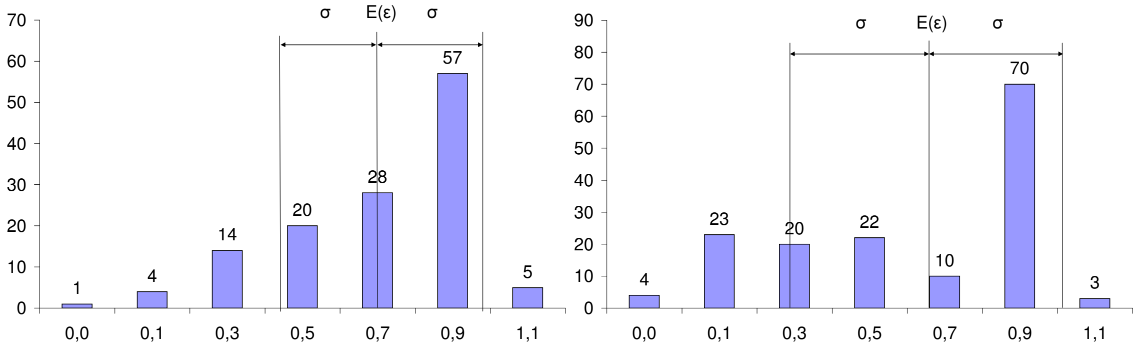
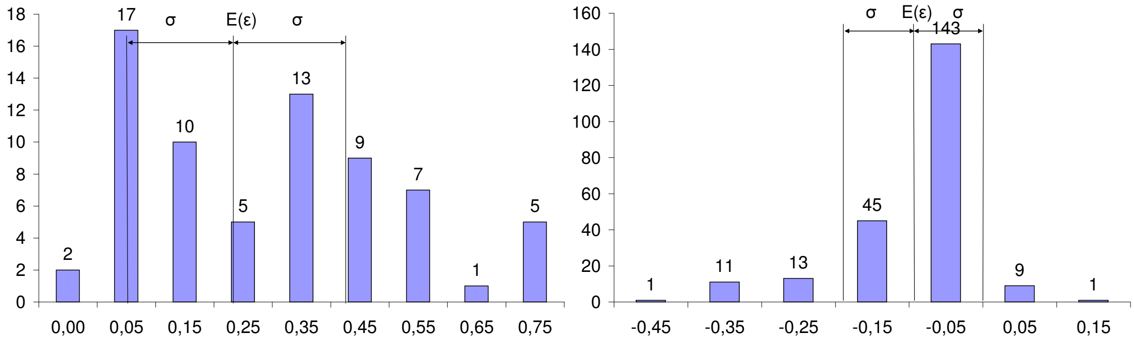


Figure 3.3 displays the price elasticities of the wage rate. Many publications estimate real wage equations; in these cases the output price or the consumer price is used as deflator. If the price variable does not enter the right hand side of the equation the corresponding wage elasticity is 1 by assumption. In case of p_y 54 elasticities are fixed to 1 by applying p_y as wage deflator; 25 values of the consumer price elasticity are set to 1. Restrictions also play a crucial role here: 26 producer price elasticities and 27 consumer price wage elasticities were obtained from regressions that include a price wedge or a combined price wedge and tax wedge.

Figure 3.4 Elasticities: net replacement ratio unemployment rate



Most observations on the net replacement ratio elasticity of wages are in the range 0.0 - 0.5. There is an important peak between 0 and 0.1, and roughly the same number of elasticities is greater than 0.4. What is the reason of this dispersion? One possible explanation is the difference across countries in the generosity of the welfare state. In countries where the levels of benefits (and hence, net replacement ratio's) are relatively high, the unemployed have less incentives to easily accept a job and a rise in the replacement ratio requires an increase in the wage rate to encourage search efforts of unemployed workers. If that were true, one would expect a significant impact of country dummies in the meta regression. A second explanation may be the difference in outside options between the sectoral and the aggregate replacement ratio. The latter is often called benefit replacement ratio: the alternative wage corresponds to a situation that a person is unemployed and dependent on welfare or unemployment benefits. In a sectoral wage equation, the alternative wage is often the average wage in the rest of the economy. In this case the replacement ratio is a measure of the relative attractiveness of other production sectors. So we may expect a higher sensitiveness of sectoral wages to changes in the replacement ratio.

Finally, let's inspect the values of the unemployment elasticity of pay. Almost 85% of the elasticities differs less than one standard error from the sample mean. This sample mean is close to the results reported by Blanchflower and Oswald (1994), Nijkamp and Poot (2005) and Clar *et al.* (2007). This is remarkable, as most of our estimates have been obtained from long-run macro or sectoral wage equations while the well known wage curve relates real individual earnings to local labour market conditions. Does this support the 'empirical law of economics' hypothesis (Card (1995))? We will explore this below.

3.2 Expectations from economic theory

What do we expect from the meta-analysis? In the long run, improvements in labour productivity will be reflected in higher wages. Producers will try to shift the burden of increasing wages to the consumer. This may be a problem to firms operating in highly competitive markets. The long-run macro elasticity of labour productivity however, may expected to be close to 1.

As to tax elasticities, producers will partly shift the burden of higher payroll taxes to the employees through lower wage offers. Trade unions however, may aim to compensate employees for increased income taxes through higher wage claims. If the impact on wages does not depend on which side of the market is taxed, then we may expect the wage elasticities of payroll taxes and income taxes to sum up to -1. In that case the real after tax wage is affected through changes in the tax wedge only.

Consumer prices are related to output prices. If both are included in a wage equation, the impact of prices on the real wage is often captured through the price wedge only. In that case the price elasticities of the nominal wage should add up to 1.

A higher net replacement ratio will decrease the search effort of the unemployed. In that case it takes more time to fulfil existing vacancies and the employer has to offer higher wages to stimulate the unemployed to accept a job offer. This impact on wages may depend on the type of the welfare state. In relatively generous welfare states the replacement ratio elasticity of the wage may be higher than in Anglo Saxon countries.

A final point to note is that the unemployment elasticity of pay may depend on the level of the net replacement ratio and vice versa (Graafland and Huizinga (1999), Peeters and den Reijer (2001, 2002), Kranendonk and Verbruggen (2006)). If unemployment is low, spells of unemployment are only short and changes in the net replacement ratio will have only a small impact on wages. On the other hand, the influence of the unemployment rate on wages may diminish with the level of the replacement ratio. It may be close to zero if the replacement ratio equals one.

To sum up, we have formulated 5 hypotheses on the long-run macro elasticities of the nominal wage:

1. The long-run labour productivity elasticity is close to 1.
2. The tax elasticities add up to minus 1.
3. The price elasticities add up to 1.
4. The size of the net replacement ratio elasticity is higher in more generous welfare states.
5. The unemployment elasticity of pay depends on the level of the net replacement ratio and vice versa.

Note that these hypotheses are formulated in terms of elasticities. As the meta results do not allow to compute appropriate test statistics, we are not able to formally test them. Therefore the hypotheses will be used to perform a sensitivity analysis in section 5.4. The 4th and 5th hypothesis are directly linked to the estimation results; hence they may be tested.

4 Specification and dummy selection

4.1 Specification of the meta equations

The meta sample consists of 8 series: one for each elasticity of pay. All vectors of elasticities ε_i i=1,...,8 have a common length equal to the number of included wage equations. This has the advantage that the k-th component of all vectors ε_i corresponds to the same wage equation. The variation within each vector ε_i is explained by a vector of general constants α_{i0} and a set of dummy vectors d_j (value 0 or 1). Before discussing the estimation method, I first introduce the various dummy types.

4.2 General dummies

Table 4.1 summarizes dummy variables. Some need a short explanation.

Table 4.1 Overview of dummy variables

Dummy variable	Condition value =1
Country dummy the Netherlands	The Netherlands
Dummy Anglo Saxon countries	UK,USA, Canada, Australia, New Zealand
Dummy Nordic countries	Denmark, Finland, Norway, Sweden
Publication dummy	Publication in peer reviewed journal
Time series dummy	Based on time series data
OLS dummy	Use of single equation estimation technique
Bargaining dummy	Specification based on wage bargaining model
Union density	If included in source equation
First difference estimation	All variables in source equation in first differences
Dummy level estimation	Source equation formulated in level variables only
Autoregressive Distributed Lag dummy	Source equation estimated in ADL format
Sector dummy	Sectoral wage equations
Time dummy 50-69	If mid sample year in period 1950 - 1969
Time dummy 90-08	If mid sample year in period 1990 - 2008

Wage bargaining and union density

Economic theory suggests that wage equations derived from or based on a theoretical wage bargaining model may differ from equations in other types of models (see section 2.1). To account for possible differences in estimated coefficients the bargaining dummy has a value of 1 only if the equation is related to a wage bargaining model. I also use the union density dummy: it indicates whether a specific elasticity has been obtained from an equation that includes union density as an explanatory variable, or not. Union density serves as a measure for bargaining power; it is defined as the number of union members relative tot the total number of employees.

Publication dummy

The analysis does not permit to test or correct for possible selection bias (Card and Krueger (1995)), as standard errors of elasticities are often not available. Yet it may be useful to make a distinction between peer reviewed articles and working or conference papers.

Economic specification

It is well known that estimates obtained from time series data generally differ from the results from panel or cross section analysis; hence the use of the times series dummy. Another empirical observation is that many wage equations are not stand alone: a price, a tax or an employment equation may have been estimated simultaneously. Therefore, an OLS dummy captures differences between coefficients estimated from single equations and the results from the use of simultaneous techniques.

A third point to note is that the dynamic specification of the wage equation determines the estimates of the elasticities. This can be taken into account by introducing three dummies. The first marks wage equations in which all variables are in first differences; they yield short-run elasticities only. The second type (level estimation) indicates that the equation does not account for any dynamics: just current levels matter. Finally, the third dummy relates to estimates obtained from autoregressive distributed lag (ADL) equations. The latter contain both endogenous and exogenous variables in levels and differences. Error correction models are a particular case of this type. By definition the 3 dummies are interrelated: their sum equals 1. Therefore only two of them should be included; as on average some 70% of the elasticities has been obtained from an ADL equation, this will be the reference case. Hence I will use the first difference dummy and the level estimation dummy.

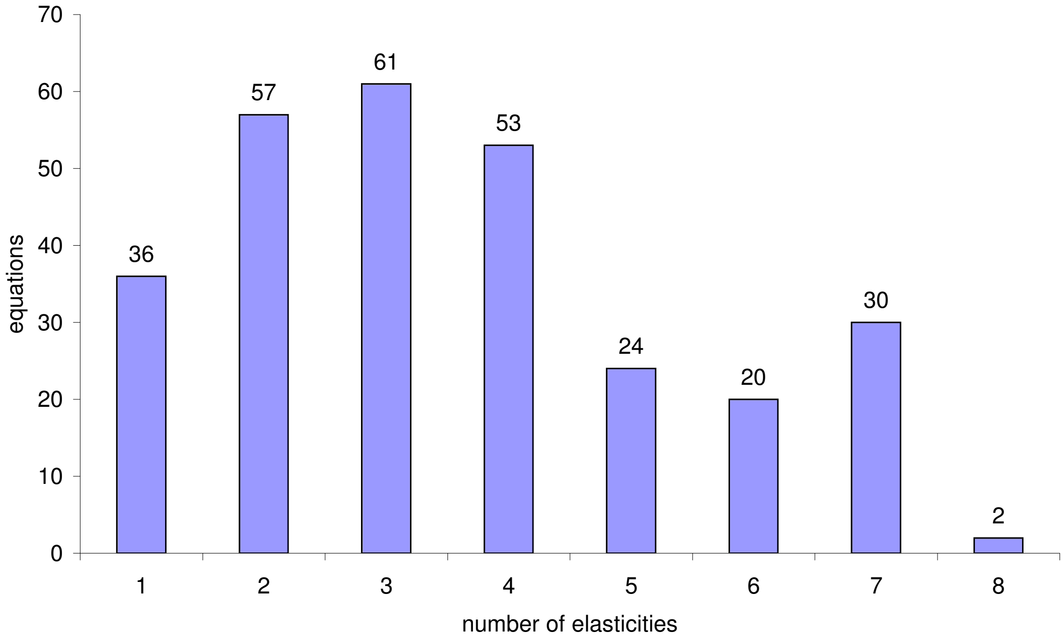
Non-linearities

The 5th hypothesis in section 4.2 can be tested by adding the corresponding sample average of the unemployment rate ($\overline{u}$)in the meta regression for the elasticity of the replacement ratio and vice versa.

4.3 Restriction dummies

The overview of table 3 is not complete. I want to address the problem of possible interdependency of elasticities obtained from the same wage equation (see section 2.3). Figure 4.1 illustrates the problem. The figure classifies the estimated wage equations by number of included elasticities from the set $A:\left\{\varepsilon_q,\varepsilon_{1+s},\varepsilon_{1-a},\varepsilon_{1-m},\varepsilon_c,\varepsilon_y,\varepsilon_\rho,\varepsilon_u\right\}$. Almost 25% of all equations include at most 2 of the desired elasticities, but only 2 wage equations include all. Does this (in)completeness have an impact on estimated elasticities? And second, if so, does it matter whether relevant coefficients have been estimated under restrictions?

Figure 4.1 Classification of reported wage equations by number of elasticities



To answer these questions, I introduce 3 dummies for each observed element of the vectors ε_i. Recall that all corresponding elements of the vectors ε_i, i=1,..8 correspond to the same wage equation. The first dummy, F_{ij} answers the question: does the wage equation from which we obtain elasticity of type i also yield a free estimate of elasticity type j? The second dummy, R_{ij} indicates whether this possible coefficient of elasticity j was estimated under an equality restriction. For example, an equation that contains a tax wedge imposes that ε_{1+s} and ε_{1-a} are equal in absolute value. Finally, the dummy C_{ij} equals 1 if ε_i has been obtained from a wage equation in which the value of ε_j was fixed. By definition, if ε_i is observed, then $F_{ii} + R_{ii} + C_{ii} = 1$. In this case I do not include F_{ii}: a free estimate is the reference case.

4.4 Estimation: specification and technique

Using the dummies discussed above, the empirical equation for elasticity ε_i can be written as:

$$\varepsilon_i = \alpha_{i0} + \sum_{j=1}^{13} \alpha_{ij} d_j + \sum_{k=1,k\neq i}^{8} \beta_{ik} F_{ik} + \sum_{k=1}^{8} \gamma_{ik} R_{ik} + \sum_{k=1}^{8} \delta_{ik} C_{ik} + \lambda_i \overline{\rho}_i + \mu_i \overline{u}_i + v_i \quad i \in A \tag{4.1}$$

The equation of ε_i, $\varepsilon_i \in A$ contains a constant, 13 dummy vectors d_j (see table 3), 7 dummy vectors F_{ij}, 8 dummy vectors R_{ij} and 8 vectors C_{ij}. Here, $\overline{u}_i$ is the mean of the unemployment rate in case the replacement ratio elasticity of pay is observed and zero else. Similarly, $\overline{\rho}_i$ is the average replacement ratio in the sample where ε_u is observed and zero else. The elements of the vector of error terms v_i are identically and independently distributed.

I have estimated equation (4.1) for all relevant elasticities, applying the Least Absolute Deviation (LAD) method. As Rousseeuw and Leroy (1987) argue, its application yields a considerable gain in robustness compared to Least Squares estimates, as the estimator is less sensible to outliers in the dependent variable. Asymptotic standard errors have been computed using a Huber Sandwich method (see e.g. Freedman (2006)). Details can be found in Folmer (2009).

To obtain a benchmark value for each wage elasticity, we may apply equation (4.1) with all parameters replaced by their estimated values. Of course, we also have to consider the preferred values of the dummy variables. Should they be set at 0 or 1 or is it better to take a sample mean? I will return to this point in section 5.2. In section 5.3, I will also present benchmark values obtained from OLS regressions.

5 Results and applications

5.1 Estimation results

This section presents a global overview of the results. To prevent spurious correlations, dummies that only have nonzero values in less than 10% of the sample have been excluded from the regression. A detailed description can be found in Folmer (2009), appendix C. Section 5.2 computes benchmark values for all types of elasticities using estimated coefficients and specific values of dummy variables. Section 5.3 explores the possibility to compute benchmark elasticities for wage equations that contain a wedge variable. Finally, section 5.4 discusses the robustness of the benchmark elasticities.

Table 5.1 summarizes regression results. The table displays the signs of the estimated coefficients. Coefficients with p-values above 0.10 have been single marked, if the p-values are smaller than 0.10, then double marks have been used. The $\overline{R}^2$ statistic reported is a pseudo $\overline{R}^2$ (Koenker and Machado, 1999). In case of the elasticity of the marginal income retention ratio $1-t_m$ the sample size limits the number of dummies in the regression. Therefore, in this case only the country dummies have been included.

Table 5.1 Elasticities of pay: signs of coefficients and general statistics

	Elasticity of pay corresponding to:							
	q	$1+s$	$1-t_a$	$1-t_m$	p_c	p_y	ρ	u
Constant	++	–	–	+	++	++	–	–
The Netherlands dummy	–	–	+	+	+	–	+	–
Anglo Saxon dummy	+	+	–	+	–	+	–	++
Dummy Nordic countries	+	–	–	+	–	+	–	–
Publication dummy	+	+	– –		+	–	+	–
Time series dummy		–	–		–	–	++	–
Hourly wage dummy	+	–	+		++	–	+	+
Single equation estimator	+	–	+		+	+	–	+
Bargaining dummy	–	–	–		+	–	+	+
Union density		–				–		
First difference estimation	–	++	–		+	–		
Level estimation	+	–	+		–	–	–	–
Sector dummy	+	+	+		+	–	+	+
Time dummy 1990-2008						–		+
Volume unemployment rate							+	
Pseudo $\overline{R}^2$	0.169	0.413	0.169	– 0.008	0.304	0.607	0.119	0.021
Mean value	0.875	– 0.659	– 0.390	0.226	0.725	0.657	0.349	– 0.089
Observations	146	138	131	18	129	152	74	223

Table 5.2 summarizes the impact of the restriction dummies F, R and C on the estimated elasticities. Symbols refer to the type of dummy that embodies the relationship. To gain a clear view we have restricted the possible impact to dummies that show coefficients with p-values < 0.1. For example, the row indicating elasticities of the payroll tax (1+*s*) shows that elasticities differ if the payroll tax elasticity is fixed a priori (C dummy equals 1) and if the elasticity of the consumer price is included through a wedge variable (R = 1).

Table 5.2 Elasticities of pay: signs of coefficients and general statistics

Elasticity of pay	Depends on inclusion of							
	q	$1+s$	$1-t_a$	$1-t_m$	p_c	p_y	ρ	u
Labour productivity (q)								
Payroll taxes ($1+s$)		C			R			
Average retention rate ($1-t_a$)								
Marginal retention rate ($1-t_m$)								
Consumer price (p_c)			R			F		F
Producer price (p_y)	FC				FR	RC		F
Replacement ratio (ρ)		R						
Unemployment rate (u)		C						

From the overall regression results the following conclusions emerge:

Labour productivity

The size of the general constant is about 80% of the sample mean and its standard error is small. Country dummies hardly have any impact. The size of the C dummy of labour productivity indicates that wage equations that estimate this elasticity yield on average lower values than if it is fixed a priori (in this case: at a value of 1).

Payroll taxes

The results indicate a substantial difference between short and long-term elasticities. Price variables matter especially. If the wage equation contains a price wedge, then this yields smaller elasticities (in absolute value). The C dummies of the payroll tax and both price variables indicate that equations formulated in terms of wage costs or real wages deflated by the producer price index result in higher elasticities (in absolute value). Deflation of wages using the consumer price index decreases the absolute size of the payroll tax elasticity.

Average income retention rate

The overall results are similar to those of the payroll tax elasticity: long-term elasticities differ from short-term. Wage equations estimated in levels only (without any dynamics) yield substantially higher (i.c. less negative) elasticities.

Marginal income retention rate

In this case, the sample consists of 18 observations only. The results indicate that the sample mean (or median) is possibly the best estimate of the elasticity

Consumer prices

The use of single equation estimation methods produces higher elasticities. The inclusion of the output price has a significant negative impact, which is consistent with the results on the elasticity of p_y (see below).

Output prices

Elasticities based on sector analysis are lower than their macro equivalents. The results also suggest the output price elasticity of the wage rate is substantially lower if the consumer price is included in the wage equation, either through a freely estimated parameter or a price wedge. We may conclude that if one of the prices p_y or p_c is omitted from the wage equation, the elasticity of the remaining price is pushed upwards.

Net replacement ratio

The sector dummy has a positive impact: the elasticity is higher than may be expected on basis of pure macroeconomic data. The 5th formulated in section 3.2 that the elasticity depends on the level of the unemployment rate finds some support: the estimated coefficient has the right (positive) sign, but standard errors are relatively high. Just like in case of both tax elasticities of pay, entering tax variables through a wedge variable matters, but here the net impact is very modest.

Unemployment rate

The coefficient of the level of the replacement ratio (λ_i in equation (8)) doesn't have the expected sign: a higher replacement ratio increases the absolute value of the unemployment elasticity of pay. Therefore, the level of unemployment has been omitted from the final regression. The Anglo Saxon dummy is negative; its size (− 0.04) does not change if the equation is estimated by OLS rather than LAD. In the OLS regressions, its t-value is slightly above 2.0. The C dummy of the payroll tax indicates that equations that explain wage costs (in that case the C dummy equals 1) yield higher unemployment elasticities of pay in absolute value than equations that explain gross wages.

An obvious result from the meta regressions is that the output price elasticity of pay depends on the inclusion of the consumer price in the wage equation and vice versa. Both prices also have an important impact on tax elasticities. The producer taxes and output prices are the main determinants of wage elasticities.

5.2 Benchmark values

Suppose we have derived a wage equation from some theoretical concept and we want to quantify the related wage elasticities. How can we apply the results of the meta analysis? First, the results do not serve the rejection of a specific wage equation in favour of another. For example, we cannot judge of elasticities obtained from fixed, restricted or freely estimated parameters. Second, the theoretical specification of the wage equation determines the optimal values of the dummy variables.

The benchmark values supplied below merely serve as an illustration of this point. Let's assume that our derived wage equation is log linear in its arguments. Then we may set the corresponding dummy values as reported in table 5.3. As can be seen, the F, R and C dummies have been fixed at their sample means. This implies that information of all types of wage equations is used: whether coefficients have been estimated free, restricted or fixed.

Table 5.3 Settings of dummy variables

Dummy variable	Preferred value
Publication dummy	Sample mean
Time series dummy	1
Single equation estimation dummy	0
Bargaining dummy	1
Union density	0
First difference dummy	0 (long run) or 1 (short run)
Dummy level estimation	0 (short run) or sample mean (long run)
Sector dummy	0 (macro) or 1 (aggregate)
Time dummy 1950-1969	0
Time dummy 1990-2008	1
F, R and C dummies of p_c and p_y , elasticities $\varepsilon_c, \varepsilon_y, \varepsilon_u$	Sample mean in common sample of p_c and p_y
F, R and C dummies, all other cases	Sample mean in full sample

The discussion above on wage elasticities of prices suggests that wage equations that just contain either of the two prices may yield biased elasticities for the remaining one. Therefore, to compute benchmark values for ε_c and ε_y we will use only results of wage equations that contain both price variables. Therefore the sample means of the restriction dummies of p_c and p_y in the common sample of both elasticities will be used.

Benchmark values show up in table 5.4 by country group, and short and long-term elasticities. Wage elasticities of 1+s, 1-t_a and 1-t_m can be converted to elasticities of tax rates s, t_a and t_m .This requires country specific data however on average producer and income tax rates (s and t_a) and the marginal income tax rate t_m. Hence, estimated elasticities will also depend on the particular values chosen for these exogenous variables. Country specific elasticities are close to the sample means (see table 3.2). In all cases, long-run elasticities for labour productivity are smaller than one. A possible explanation of the relatively low values for the

Netherlands is that on average 50% of the elasticities of labour productivity originates from sectoral wage equations, while this share is just 20% on average for all other countries.

Table 5.4 Long- and short-term elasticities of the gross wage by type and country group

elasticity	The Netherlands		Anglo-Saxon countries		Nordic Countries		Other Countries	
	long term	short term	long term	short term	long term	short term	long term	short term
Labour productivity	0.830	0.812	0.919	0.901	0.919	0.901	0.919	0.901
Payroll tax (1+rate)	− 0.785	− 0.392	− 0.726	− 0.333	− 0.756	− 0.363	− 0.736	− 0.342
Average income tax (1-rate)	− 0.191	− 0.364	− 0.273	− 0.446	− 0.265	− 0.438	− 0.269	− 0.442
Marginal income tax (1-rate)	0.272	0.272	0.200	0.200	0.246	0.246	0.011	0.011
Consumer price	0.536	0.577	0.532	0.573	0.472	0.513	0.532	0.573
Producer price	0.393	0.334	0.450	0.391	0.549	0.490	0.450	0.391
Net replacement ratio	0.400	0.400	0.260	0.260	0.238	0.138	0.297	0.297
Unemployment rate	− 0.083	− 0.083	− 0.046	− 0.046	− 0.094	− 0.094	− 0.082	− 0.082

Long- and short-term values of estimated tax elasticities substantially differ. In the short run, 36% of an increase of producer payroll taxes is borne by employees; in the long run this amounts to 75%. If real wages are sticky in the short run, producers adjust wage offers in later periods to shift the larger part of a past increase in payroll taxes to the employee. The opposite effect occurs in case of the average income retention ratio: the instantaneous impact (0.42) is about 60% higher than the long-run impact (0.25). If nominal wages are fixed in the short run, an increase in income taxes is to a large extent borne by the employees. In future wage negotiations, employees (or unions) succeed in partially compensating the increase in income tax through higher wages. Note that the sum of the average long-run elasticities of the payroll tax (0.75) and the average income retention ration (0.25) is close to 1, which is in line with hypothesis 2 in section 3.2. This also implies that in the long run 25% of an increase in payroll or income taxes is borne by the producer and 75% by the employee.

The elasticities of the marginal retention ratio are all around the sample mean of 0.25, except in case of other countries, where it is close to zero. Maybe the latter is due to the small sample size.

The sum of the two long-run price elasticities is rather close to 1. This is what we expected in hypothesis 3. If we use the average value of the corresponding restriction dummies in the complete meta sample then the sum of both elasticities would be about 1.5. If either of the two prices is used to deflate wages (in that case the C dummy equals 1) or if the wage equation contains a price wedge (R dummies are equal to 1) then different benchmark values may result.

The size of the Anglo Saxon unemployment elasticities of pay is about 50% lower than in case of all other countries. A reason may be that the Anglo Saxon type of welfare state is less generous (Esping Andersen (1990)). The lower the real unemployment benefits, the stronger the incentive to look for a new job in case of unemployment and the lower the reservation wage. So an additional rise in unemployment may have a lesser impact on search intensity and wages than in more generous welfare states like those of Nordic countries and the Netherlands.

5.3 Sensitivity analysis

So far LAD regression results ere used to obtain benchmark wage elasticities. This section compares benchmark values that have been obtained using alternative estimation techniques. The first alternative uses restricted LAD estimates. A number of coefficients has large standard errors and high p-values. If the size of the parameter in the LAD regressions is small and computed standard errors are large then I have imposed zero restrictions on the estimated coefficients. To test the restrictions I applied a Quasi Likelihood Ratio (QLR) test, which is asymptotically $\chi^2(k)$ distributed with k the number of restrictions imposed by the null hypothesis (Koenker and Basset (1982)). I have also estimated all meta equations using OLS rather than LAD.

Possible correlations between elasticities obtained from the same wage equation have been taken into account through the restriction dummies F, R and C. The results in table 5.2 suggest that wage elasticities of price and tax variables may be mutually dependent and the same holds for elasticities of prices and unemployment. To further investigate this I have estimated all elasticities in the subsets $\{\varepsilon_{1+s}, \varepsilon_{1-a}, \varepsilon_c, \varepsilon_y\}$ and $\{\varepsilon_u, \varepsilon_c, \varepsilon_y\}$ using common observations only. The first subsystem contains 63 common observations, the second system includes 48.

Tables 5.5 - 5.8 compare long-term macro elasticities obtained from various estimation techniques by country group.

Tax elasticities seem not very sensitive to the estimation method: the difference between short and long-term values emerges from all regressions. The sum of the long-term elasticities of $1+s$ and $1-t_a$ is still close to 1. Short-term elasticities of the average retention rate tend to be higher in least squares regressions, however.

Although the sum of the wage elasticities of p_c and p_y is fairly stable, in the system regressions the elasticity of the consumer price tends to increase, leading to low values of ε_y, especially in case of the Nordic countries. Benchmark elasticities of the unemployment elasticity of pay obtained from the system regressions confirm the earlier conclusions that the size of the elasticity in Anglo Saxon countries is roughly half that of other country groups.

Table 5.5 Long and short-term macro gross wage elasticities

The Netherlands

	LAD		LAD restricted		OLS		System 1 LS		System 2 LS	
Variable	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST
q	0.830	0.812	0.838	0.838	0.811	0.712				
1+*s*	– 0.777	– 0.384	– 0.724	– 0.329	– 0.753	– 0.273	– 0.743	– 0.326		
$1\text{-}t_a$	– 0.185	– 0.357	– 0.255	– 0.334	– 0.280	– 0.452	– 0.235	– 0.522		
$1\text{-}t_m$	0.272	0.272			0.272	0.272				
p_c	0.414	0.455	0.485	0.485	0.422	0.434	0.451	0.485	0.554	0.554
p_y	0.415	0.356	0.465	0.404	0.505	0.328	0.380	0.364	0.357	0.357
ρ	0.250	0.250	0.400	0.400	0.346	0.346				
u	– 0.087	– 0.087	– 0.093	– 0.093	– 0.130	– 0.130			– 0.099	– 0.099

Table 5.6 Long and short-term macro gross wage elasticities

Anglo-Saxon countries

	LAD		LAD restricted		OLS		System 1 LS		System 2 LS	
Variable	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST
q	0.830	0.812	0.838	0.838	0.811	0.712				
1+*s*	– 0.777	– 0.384	– 0.724	– 0.329	– 0.753	– 0.273	– 0.743	– 0.326		
$1\text{-}t_a$	– 0.185	– 0.357	– 0.255	– 0.334	– 0.280	– 0.452	– 0.235	– 0.522		
$1\text{-}t_m$	0.272	0.272			0.272	0.272				
p_c	0.414	0.455	0.485	0.485	0.422	0.434	0.451	0.485	0.554	0.554
p_y	0.415	0.356	0.465	0.404	0.505	0.328	0.380	0.364	0.357	0.357
ρ	0.250	0.250	0.400	0.400	0.346	0.346				
u	– 0.087	– 0.087	– 0.093	– 0.093	– 0.130	– 0.130			– 0.099	– 0.099

Table 5.7 Long and short-term macro gross wage elasticities

Nordic countries

	LAD		LAD restricted		OLS		System 1 LS		System 2 LS	
Variable	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST
q	0.830	0.812	0.838	0.838	0.811	0.712				
1+*s*	– 0.777	– 0.384	– 0.724	– 0.329	– 0.753	– 0.273	– 0.743	– 0.326		
$1\text{-}t_a$	– 0.185	– 0.357	– 0.255	– 0.334	– 0.280	– 0.452	– 0.235	– 0.522		
$1\text{-}t_m$	0.272	0.272			0.272	0.272				
p_c	0.414	0.455	0.485	0.485	0.422	0.434	0.451	0.485	0.554	0.554
p_y	0.415	0.356	0.465	0.404	0.505	0.328	0.380	0.364	0.357	0.357
ρ	0.250	0.250	0.400	0.400	0.346	0.346				
u	– 0.087	– 0.087	– 0.093	– 0.093	– 0.130	– 0.130			– 0.099	– 0.099

Table 5.8 Long and short-term macro gross wage elasticities

Other countries

	LAD		LAD restricted		OLS		System 1 LS		System 2 LS	
Variable	LT	ST	LT	ST	LT	ST	LT	ST	LT	ST
q	0.830	0.812	0.838	0.838	0.811	0.712				
$1+s$	– 0.777	– 0.384	– 0.724	– 0.329	– 0.753	– 0.273	– 0.743	– 0.326		
$1-t_a$	– 0.185	– 0.357	– 0.255	– 0.334	– 0.280	– 0.452	– 0.235	– 0.522		
$1-t_m$	0.272	0.272			0.272	0.272				
p_c	0.414	0.455	0.485	0.485	0.422	0.434	0.451	0.485	0.554	0.554
p_y	0.415	0.356	0.465	0.404	0.505	0.328	0.380	0.364	0.357	0.357
ρ	0.250	0.250	0.400	0.400	0.346	0.346				
u	– 0.087	– 0.087	– 0.093	– 0.093	– 0.130	– 0.130			– 0.099	– 0.099

5.4 Restricted estimates

In this section, we will compute benchmark values for all elasticities imposing hypotheses 1 and 3. First, we impose that the wage elasticity of labour productivity equals 1. In the second step we also require that the elasticities of output and consumer prices add up to 1.

To compute benchmark values if $\varepsilon_q = 1$ requires that the C dummy of labour productivity equals 1 and the corresponding F and R dummies are zero. A value of 1 for the C dummy of productivity only indicates that the elasticity of the labour productivity is fixed, without specifying a particular value. In the meta sample the value always equals 1 in this case. Table 5.9 displays the results for benchmark values of the macro wage elasticities if $\varepsilon_q = 1$.

Table 5.9 Benchmark values of macro wage elasticities if $\varepsilon_q = 1$, long and short term

	The Netherlands		Anglo Saxon countries		Nordic countries		Other countries	
	Long	Short	Long	Short	Long	Short	Long	Short
Labour productivity (q)	0.910	0.892	0.999	0.981	0.999	0.981	0.999	0.981
Payroll tax($1+s$)	– 0.716	– 0.323	– 0.657	– 0.264	– 0.688	– 0.294	– 0.667	– 0.274
Average income tax ($1-t_a$)	– 0.329	– 0.502	– 0.411	– 0.584	– 0.403	– 0.576	– 0.407	– 0.580
Marginal income tax ($1-t_m$)	0.272	0.272	0.200	0.200	0.246	0.246	0.011	0.011
Consumer price (p_c)	0.534	0.575	0.530	0.571	0.470	0.511	0.530	0.571
Producer price (p_y)	0.465	0.405	0.521	0.462	0.620	0.561	0.521	0.462
Replacement ratio (ρ)	0.525	0.525	0.384	0.384	0.362	0.362	0.421	0.421
Unemployment rate (u)	– 0.090	– 0.090	– 0.052	– 0.052	– 0.100	– 0.100	– 0.089	– 0.089

The first row shows that the restriction $\varepsilon_q = 1$ is not exactly reproduced in case of the Netherlands. As we will se below (table 5.10), the sample mean of the C dummy of labour productivity is just above 0.2; nevertheless the extrapolation towards a value of 1 is quite good. Second, other elasticities also change, but not that much. The sum of both price elasticities is for all countries in the range 1.0 - 1.1, which is slightly higher than reported in tables 6.5 - 6.8. It is still reasonable to impose our second restriction that this sum equals 1.

Suppose we have concluded from a theoretical model or a literature review that our preferred wage equation is log linear in its arguments. Then, if we impose the restrictions $\varepsilon_q = 1$ and $\varepsilon_c + \varepsilon_y = 1$, we may rewrite this equation as:

$$\ln \frac{W}{p_y} = \ln q + \varepsilon_{1+s} \ln(1+s) + \varepsilon_{1-a} \ln(1-t_a) + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln \Pi + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \quad (5.1)$$

Note that, given that the log linear specification is the true model, elasticities in equation (5.1) refer to real wages. In this case the restrictions imply that the impact of prices on the real wage is fully captured by the price wedge; the implicit assumption is that the output price is independent of the right hand side variables in equation (5.1) and on wages.

Table 5.10 summarizes all restrictions on moderator values that are implied by equation (5.2). The sample mean of each dummy, given that elasticity *i* is observed differs from the mean value in case we observe elasticity *j*. The weighted sample mean is computed using the number of observations on each elasticity as weight. The table shows that restricted dummy values may substantially differ from the full sample means. Table 5.11 displays the resulting benchmark elasticities.

Table 5.10 Dummy restrictions corresponding to equation (5.2)

Wage elasticity	Dummy type	Range of sample means	Weighted sample mean	Restricted value
Labour productivity	F	0.3 - 0.7	0.430	0
Labour productivity	R	0.0	0.000	0
Labour productivity	C	0.1 - 0.3	0.228	1
Consumer price	F	0.3 - 0.6	0.473	0
Consumer price	R	0.0 - 0.7	0.244	1
Consumer price	C	0.0 - 0.1	0.037	0
Output price	F	0.3 - 0.7	0.543	0
Output price	R	0.1 - 0.7	0.230	1
Output price	C	0.0 - 0.4	0.111	0

Table 5.11 Benchmark values of macro real wage elasticities in equation (6.2), long and short term

	The Netherlands		Anglo Saxon countries		Nordic countries		Other countries	
	Long	Short	Long	Short	Long	Short	Long	Short
Labour productivity (q)	0.842	0.824	0.931	0.913	0.931	0.913	0.931	0.913
Payroll tax(1+s)	– 0.522	– 0.129	– 0.463	– 0.070	– 0.493	– 0.100	– 0.473	– 0.079
Average income tax (1-t_a)	– 0.419	– 0.592	– 0.501	– 0.674	– 0.493	– 0.666	– 0.497	– 0.670
Marginal income tax (1-t_m)	0.272	0.272	0.200	0.200	0.246	0.246	0.011	0.011
Consumer price (p_c)	0.398	0.439	0.394	0.435	0.334	0.375	0.394	0.435
Producer price (p_y)	0.554	0.495	0.611	0.552	0.709	0.650	0.611	0.552
Replacement ratio (ρ)	0.115	0.115	– 0.025	– 0.025	– 0.047	– 0.047	0.012	0.012
Unemployment rate (u)	– 0.133	– 0.133	– 0.095	– 0.095	– 0.143	– 0.143	– 0.131	– 0.131

Compared to earlier results, a number of things have changed:

1. The elasticity of labour productivity is lower than before, but still close to 1 for most countries;
2. The sum of the wage elasticities of p_c and p_y is about 1.0, except for the Netherlands (= 0.95).
3. Elasticities of the average income retention rate (1-t_a) have increased in size, both in the long and the short run;
4. Payroll tax elasticities are substantially smaller in absolute value; – 0.38 in the long run and slightly positive in the short run.
5. Unemployment elasticities of pay almost double in size;
6. The elasticity of the replacement rate falls down to almost zero or becomes even negative.

The earlier outcomes of table 5.4 virtually obey the restrictions imposed; why do the results of table 5.11 differ so much? The first reason is that output prices and wages may be mutually dependent: in this case real wage elasticities differ from nominal wage elasticities. Second, from table 5.10 it follows that the number of restrictions on dummies (:9) is relatively high; in this case our extrapolations may lose accuracy. Finally, our sample is not balanced: the number of observations differs across elasticities and some wage equations are more ‘complete’ than others; see figure 4.1. In other words: the thickness of the ice is not uniform: if we impose too many restrictions we move away from the safe place and get in thin ice. This may explain the unexpected values for the replacement rate elasticity: the number replacement elasticities obtained from a real wage equation that contains a price wedge is only 2.

Some preliminary conclusions may be drawn:

1. Elasticities of nominal and real wages generally differ, notably with respect to taxes, net replacement rates and the unemployment rate;
2. Price elasticities based on nominal and real wage equations are roughly the same. If the sum of both price elasticities of the nominal wage is close to one, it may not be bad to assume that this will also hold in case of price elasticities of the real wage;
3. The elasticity of producer taxes is highly sensitive to the deflation of wages. A possible explanation is that output prices react on changes in producer taxes. In this case we may write the total payroll tax elasticity E_{1+s} as:

$$E_{1+s} \equiv \frac{1+s}{W}\frac{dW}{d(1+s)} = \left(\frac{p_y}{W}\frac{\partial W}{\partial p_y}\right)\left(\frac{1+s}{p_y}\frac{\partial p_y}{\partial(1+s)}\right) + \frac{1+s}{W}\frac{\partial W}{\partial(1+s)} = \varepsilon_y \omega_{1+s} + \varepsilon_{1=s} \quad (5.2)$$

The total payroll tax elasticity of wages E_{1+s} equals the partial elasticity ε_{1+s} plus the product of the output price elasticity of wages ε_y and the payroll tax elasticity of the output price ω_{1+s} . If we assume that the latter is positive, it follows that $|E_{1+s}| < |\varepsilon_{1+s}|$.

4. The unemployment elasticity of pay is more than doubled. Inspection of the sample shows that only 19 out of 223 observations of the unemployment elasticity of pay refer to wage equations that contain a price wedge. Therefore not much value should be attached to the reported unemployment elasticity in table 5.11.

The tax wedge and Dalton's law

A number of authors (Layard *et al* (1991), Bean *et al* (1986)) argue that the key variable that explains the distortion of labour taxes on wage formation is the tax wedge. This is in line with the "most basic theorem of public finance" (Blinder(1988)) that if a tax is levied in a perfect competitive market (with fixed labour supply) it does not matter who pays the tax on labour: it is the gap between payroll and employee taxes that matters. This result is known as Dalton's law (Muysken *et al* (1999). The law implies that a neutral shift from producer payroll taxes to income tax has no impact on employment and wages.

This neutral shift can be defined in two ways (Goerke (2000)). When the shift leaves total tax revenue unchanged, the law does not hold if the shift affects the structure of the tax system, e.g. when the tax bases are unequal due to income tax allowances (Koskela and Schöb (1999)). An alternative tax shift leaves the tax wedge unchanged. Goerke (2000) uses this definition to apply Dalton's law to social security taxes. He argues that if labour supply depends on the alternative income (e.g. an unemployment benefit), the wedge neutral tax shift will lower the net replacement ratio if unemployment benefits are also subject to social security taxes. Do the meta results add something to this discussion?

From section 5.3, it follows that an increase in payroll taxes is partly shifted to employees: the long-run wage elasticity exceeds its short-run value. A rise in the average retention ratio however dampens out: the long-run elasticity is smaller in size than the short run. These results confirm the common view that shifting the tax burden takes time, and so Dalton's law may hold in the long run only.

The results of table 5.4 indicate that the sum of the elasticities of payroll tax and the average income retention rate is virtually -1: $\varepsilon_{1+s} + \varepsilon_{1-a} = -1$. Hence we may rewrite a log linear wage equation like (5.1) in terms of gross wage costs or net wages:

$$\ln W(1+s) = \varepsilon_q \ln q + (1+\varepsilon_{1+s}) \ln \Lambda + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u$$

$$\ln W(1-t_a) = \varepsilon_q \ln q + \varepsilon_{1+s} \ln \Lambda + \varepsilon_{1-m} \ln(1-t_m) + \varepsilon_c \ln p_c + \varepsilon_y \ln p_y + \varepsilon_\rho \ln \rho + \varepsilon_u \ln u \tag{5.3}$$

A wedge neutral shift in taxes may alter gross wage costs and net wages through a change in the marginal retention ratio and the net replacement ratio.

Let's examine the numerical consequences and compute benchmark values given the restriction on tax elasticities. This can be done by setting the R dummies for (1+*s*) and (1-t_a) to 1 (and F and C dummies to 0). Table 5.12 displays the results.

Table 5.12	**Benchmark values of macro real wage elasticities in equation (6.7), long and short term**							
	The Netherlands		Anglo Saxon countries		Nordic countries		Other countries	
	Long	Short	Long	Short	Long	Short	Long	Short
Labour productivity (*q*)	0.894	0.876	0.983	0.965	0.983	0.965	0.983	0.965
Payroll tax(1+*s*)	– 0.687	– 0.294	– 0.629	– 0.236	– 0.659	– 0.266	– 0.638	– 0.245
Average income tax (1-t_a)	– 0.238	– 0.411	– 0.321	– 0.493	– 0.312	– 0.485	– 0.316	– 0.489
Marginal income tax (1-t_m)	0.272	0.272	0.200	0.200	0.246	0.246	0.011	0.011
Consumer price (p_c)	0.607	0.648	0.603	0.644	0.543	0.584	0.603	0.644
Producer price (p_y)	0.388	0.329	0.445	0.386	0.544	0.484	0.445	0.386
Replacement ratio (ρ)	0.198	0.198	0.057	0.057	0.035	0.035	0.094	0.094
Unemployment rate (*u*)	– 0.095	– 0.095	– 0.057	– 0.057	– 0.105	– 0.105	– 0.094	– 0.094

The sum of ε_{1+s} and ε_{1-a} is indeed close to 1 in the long run. The elasticity of the replacement ratio declines but is still above 0.2 in most countries. Elasticities of labour productivity and prices are somewhat higher, and the unemployment elasticity is stable.

Even a wedge neutral shift from payroll tax to income tax that does not change the average tax burden on the average wage, increases the tax burden on unemployment and welfare benefits: the net replacement ratio declines. This results from the reduction in the tax credit or tax exemption that is imposed to induce the shift. This can be avoided of course, but in that case the marginal tax rate will increase. From the table it follows that both the elasticity of the marginal income retention rate and the elasticity of the replacement rate differ from zero. So a wedge neutral tax shift will affect wages through changes in the tax structure and the replacement ratio. There may also be indirect effects though changes in (un)employment and output prices.

6 Conclusions

A meta analysis is a quantitative instrument to support a literature survey. Did it give any support? The answer is clearly yes. One of the merits of this meta analysis is that it shows that benchmark values of wage elasticities may differ from sample statistics like the mean and median. The reason is of course that variation is not just white noise, it is in part systematic. One of the conclusions is that part of the variation is due to different specifications of the reported wage equations. Moderator variables should not just include institutional, time or regional dummies, but also variables that account for completeness, parameter restrictions and normalization. Moreover, the dynamic specification of the wage equation matters. Although not surprising, long and short-run values of elasticities may differ. The impact of changes in the average retention rate declines in the long run, while the impact of payroll taxes and productivity changes gain strength in the long term.

The results for the unemployment elasticity of pay support those found in the literature on wage curves. Sample means, median values and elasticities obtained from this analysis are close to the findings of Blanchflower and Oswald (1994), Nijkamp and Poot (2005) and Clar *et al* (2007).

From the sensitivity analysis, it follows that some conclusions are rather robust: (i) the size of the unemployment elasticity of pay in Anglo Saxon countries is roughly half of that in other countries; (ii) short and long-term values of tax elasticities differ; (iii) the sum of the wage elasticities of p_c and p_y is close to 1; this also holds in case of the real wage (iv) the sum of the long-run tax elasticities ε_{1+s} and ε_{1-a} is close to -1.

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