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ABSTRACT

Understanding Inter-Industry Wage Structures in the Euro Area*

This paper focuses on the euro area wage structure and its potential determinants from a sectoral viewpoint. Merging information from the OECD Structural Analysis database with data from the EU Labour Force Survey, we construct a cross-country panel of 22 industries in 8 euro area countries for 1991-2002. Data inspection confirms the existence of a fairly stable inter-industry wage structure that is similar across countries. We then apply panel data techniques to identify factors explaining inter-industry wage differentials in the euro area. Both workforce characteristics (*e.g.*, human capital variables) and firm-related characteristics (*e.g.*, capital intensity, productivity) contribute significantly. However, considerable wage heterogeneity across sectors remains. Idiosyncratic sector and country specifics, reflecting different socio-cultural and institutional backgrounds, appear to bear a major role. While our empirical analysis only uses direct evidence from workforce and firm-related characteristics, we also try to relate the remaining heterogeneity to institutional characteristics, based on related literature.

JEL Classification: J31, J24, J51

Keywords: euro area, inter-industry wage differentials, panel estimation, firm and workforce characteristics, labour market institutions

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Non-technical summary

This paper focuses on the euro area wage structure and its potential determinants from a sectoral point of view. Merging information from the OECD Structural Analysis database with data from the EU Labour Force Survey, we construct a cross-country panel suitable to study inter-industry wage differentials in the euro area. The panel captures 22 industries (comprising agriculture, utilities, construction, and various branches of manufacturing and services) in eight euro area countries representing more than 90% of euro area GDP (Belgium, Germany, Spain, France, Italy, The Netherlands, Austria, and Finland) for the period 1991-2002.

Descriptive inspection of this data set confirms the existence of a stable inter-industry wage structure which is rather similar across euro area countries and which exhibited only fairly small changes over the 1990s. For example, average wages are traditionally low in agriculture, in textile industries, hotels and restaurants, or in social and personal services. Highest average wages are observed in utilities and financial intermediation.

Drawing on the vast theoretical and empirical literature on potential determinants of inter-industry wage differentials, we then apply panel data techniques in order to identify factors explaining the euro area industry wage structure between the early 1990s and the early 2000s. Wage differentials are found to reflect the sectoral composition of the workforce and characteristics of the firms operating within the sectors. Still, idiosyncratic sector and country specifics reflecting different socio-cultural and institutional backgrounds appear to bear a major role. While our empirical analysis only uses direct evidence from workforce and firm-related characteristics, we also try to relate the remaining heterogeneity to institutional characteristics based on related literature, such as the extent of unionisation or the degree of centralisation and coordination of collective bargaining. In particular, characteristics of the workforce such as the importance of part-time work, the shares of young, older, and female workers, or the share of self-employment in a sector are relevant variables for explaining differences in average wages across sectors. Firm characteristics such as capital intensity and apparent labour productivity also have a significant impact. However, while our preferred model captures reasonably well the overall wage structure, it also reveals the non-negligible importance of idiosyncratic factors, which appear to bear a major role, especially for some industries such as agriculture or the health sector. These unobservable sector-specific factors may, on occasions, exert pressure on wages that counterbalances or even overcompensates for the influence of traditional observable determinants.

Contents

1. Introduction

According to the Optimal Currency Area theory, a number of criteria need to be fulfilled in order to maximize economic efficiency among countries sharing the same currency. It is widely admitted that the euro area scores quite highly according to a number of these (*e.g.*, economic openness, diversification in production and consumption, price stability and some aspects of financial integration), whilst it scores less well in other areas such as some facets of financial integration and, in particular, price and wage flexibility. In a single monetary union, flexible labour markets are needed to enhance the ability of individual countries to respond to specific circumstances and economic shocks. Wages in particular may need to adapt strongly and/or quickly and adjustments may need to closely reflect regional and/or sectoral productivity differences.

Hence, understanding sectoral wage differentiation in the euro area is an important issue for policy makers. Yet existing literature from an inter-industry perspective is sparse. Genre, Momferatou and Mourre (2005) provide some descriptive evidence on the magnitude and the development of wage differentials in euro area countries throughout the 1980s and 1990s. Their key finding that there are substantial and persistent differences in relative wage levels between various sectors of the euro area economy — such as agriculture, utilities, construction and various branches of manufacturing and services — is a common finding in the empirical literature on inter-industry wage differentials since the early observations of Slichter (1950).

A number of determining factors of inter-industry wage differentials — ranging from workforce characteristics to firm-, sector-, and work-environmental factors — have been identified in the literature. Our paper extends upon the existing literature by examining determinants of the inter-industry wage structure for the euro area economy. We merge information from different data sets at the two-digit industry level and apply panel data techniques in order to identify various factors that may explain inter-industry wage differentials in the euro area between the early 1990s and the early 2000s, using a panel of 22 industries in eight euro area countries. This approach offers several advantages. On the one hand, euro area countries share some common structural features, such that a joint approach appears to be sensible. On the other hand, we can also account for potential heterogeneity across countries and/or sectors which may be due to different institutional structures, such as wage bargaining systems or degrees of job protection.

Our analysis confirms the existence of a stable inter-industry wage structure which is rather similar across euro area countries and which exhibited fairly small changes over the 1990s. Both workforce characteristics (*e.g.*, human capital variables) and firm-related characteristics (*e.g.*, capital intensity or apparent productivity) appear to significantly contribute to the observed wage differentials. However, even when controlling for both observed and unobserved effects, considerable wage heterogeneity across sectors remains. In other words, beyond traditional determinants of wage differentials, some idiosyncratic factors, especially in some sectors of the economy, must be at play in shaping the euro area wage structure. The importance of these idiosyncratic factors differs widely across sectors. We also find some, albeit more limited, differences across countries. We therefore also touch upon the country-specific effects and trends, to have a more complete overview of the factors behind inter-industry differentials in the euro area countries.

The paper is organized as follows. Section 2 briefly reviews theoretical rationales for inter-industry wage differentials and summarises related empirical evidence. Section 3 presents our data and stylised facts for the euro area, as well as the methodology for and the results of our econometric analysis. Despite our focus on inter-industry wage dispersion, this section also includes a brief analysis of the country-specific factors influencing inter-industry wage differentials in the euro area. Section 4 concludes.

2. Inter-industry wage differentials: theory and empirical evidence

Although a textbook competitive labour market model would argue that wages should be the same for equivalent workers working in equivalent jobs, it has long been noted that there are substantial differences in wages across industries for workers with similar characteristics doing apparently similar jobs (Slichter, 1950). Empirically, substantial wage differentials have been found in many countries and they are surprisingly persistent over time. A number of theoretical arguments have been put forward to explain this phenomenon.

2.1 The theoretical rationale for inter-industry wage differentials

On the one hand, standard competitive theories argue that wage differentials reflect labour productivity differences among the workforce resulting from differences in individual human capital endowments (Becker, 1964; Mincer, 1974). Workers' characteristics such as educational attainment, professional experience or age are thus crucial to explain individual wage levels. As employees working in the same industry may require similar skills, these differences may largely translate into industry differences.

Alternatively, differences in wage levels might also compensate for non-pecuniary aspects of work that directly affect a worker's utility, such as available social benefits or an atypical work environment (see Purse, 2004). For example, strenuous jobs, particularly common in industry, may offer higher wages compared with office jobs which are more common in some service sectors.

Another possible explanation put forward by the tenants of competitive theories is that wage differentials may just reflect a temporary disequilibrium in response to shifts in labour demand or supply wherever labour is imperfectly mobile, notably in the short run. In this case, inter-industry reallocations are hampered by frictions. Search and matching models (see Mortensen and Pissarides, 1999) extend upon the concept of frictions. In case there are informational asymmetries and job search is costly, wages fall short of marginal productivity. In models with on-the-job search, firms can follow different equilibrium strategies: either they pay low wages invoking a high employee turnover or they pay higher wages resulting in lower turnover. Again, this may translate to the sectoral level as firms in the same industry can be expected to face similar frictions.

In sum, competitive theories imply that in the long-run and beyond temporary frictions, sectoral wage differentials should largely reflect individual differences that translate into sector-specific differences.

On the other hand, tenants of new wage determination theories, unlike those of competitive theories, focus on reasons why firms may find it more profitable to pay higher wages than those suggested by the equilibrium level resulting from market forces at play. These models rely on the major assumption that there is imperfect market competition — which may result from barriers to international trade, national regulation, monopolistic competition stemming from innovations or specialisation in certain niches, or any other relevant factor — and therefore, firms are able to extract rents from their product markets and pay higher wages. Moreover, firms distribute parts of this rent to their employees in the form of a wage premium.

Rent sharing may be motivated by a number of reasons. Much attention has been given to "efficiency wage" models that attempt to explain why firms may pay more than the reservation wage to basically select the most efficient workers (Yellen, 1984; Akerlof and Yellen, 1986). Several different versions of the efficiency wage model have been proposed in the literature:[1]

- According to "turnover models", firms may wish to pay higher wages to reduce quits and turnover (see Salop, 1979; Stiglitz, 1974 and 1985). Higher wage rates make jobs more attractive and workers less likely to switch to other jobs. These models predict that high wage industries are those in which turnover costs are highest.

- In "shirking models" (Shapiro and Stiglitz, 1984), firms engage in some monitoring of their employees and fire those workers caught shirking. Employees have an incentive to shirk if they can be re-employed in another firm at the going wage rate after having been fired by the current employer. By paying above market wages, firms decrease the incentive to shirk, as the risk of unemployment makes dismissals costly to the employee. According to these models, high wage industries are those with high monitoring costs and/or those which bear a relatively high cost of employee shirking.
- "Adverse selection models" (Stiglitz, 1976; Weiss, 1980; Greenwald, 1986) assume that the average quality of the pool of job applicants increases together with the wage rate. In these models, industries which are more sensitive to labour quality differences or have higher costs of measuring labour quality will offer higher wages in order to raise the average quality of the workforce.
- Finally, so-called "fair wage models" (Akerlof, 1982 and 1984; Akerlof and Yellen, 1990), suggest that employees will exert more effort if they think they are paid fairly. These models predict that high wage industries are those where teamwork and workers' cooperation are particularly important. Also, along this line of reasoning, industries with high profits should be those which pay higher wages.

From a sectoral perspective, firms within the same industry are likely to face similar product market conditions and hence share similar characteristics that may influence the average wage level and differentiate it from the average wage level in different industries. For example, specific production technologies or the concentration of large firms which makes employees' productivity more difficult to monitor, may contribute to increasing the average wage level in a specific industry. Other sectoral variables, such as the exposure to international competition, are also likely to influence the amount of product market rents and therefore the capability to pay higher wages.

Finally, the actual outcome of rent sharing between employers and employees crucially depends on the relative bargaining power of the involved parties, as well as on institutional settings. The presence of strong and coordinated trade unions is likely to induce higher wages for the represented market segments (Naylor, 2003). Unions are traditionally strong in manufacturing

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[1] See Groshen (1991) for a survey including a categorisation of different approaches.

industries and in public sector services, whereas they are less prevalent in private service industries. In "insider-outsider models" (see Lindbeck and Snower, 1988), firms may find it more profitable to pay more than competitive wages to insiders in order to avoid strikes or an increase in unionisation, and to maintain industrial peace. Moreover, insiders, who have gained firm-specific skills, are likely to be more productive than outsiders. This experience makes them less easy to replace and puts them in a good position to claim and obtain higher wages. These models based on bargaining power imply that the wage level will depend on a number of different factors: the nature of jobs (*e.g.*, the proportion of skilled occupations in an industry), the size of firms (which affects employers' ability to replace numerous wage claimers at the same time) and the firms' ability to pay (*i.e.*, market power). In addition, labour market institutions such as wage setting regimes or legal labour market requirements affect the speed of wage adjustments (see Blau and Kahn, 1999). Labour market institutions such as bargaining co-ordination and employment protection is generally thought to have a compressing effect on the wage structure (see Bertola *et al.* 2000; Haffner *et al.* 2001; Devroye and Freeman 2002). Beyond firm or sector specific effects, different institutional frameworks should be visible at the country level.

2.2 Evidence from the empirical literature

Empirical evidence shows the existence of substantial and persistent inter-industry wage differentials in various countries. Starting with Slichter (1950), a large body of literature estimated wage differentials using individual-level data, which allow controlling for a number of individual and match-specific determinants of wage differences. In a seminal paper, Krueger and Summers (1988) concluded that considerable differences between US industries remained even after accounting for observed as well as unobserved individual heterogeneity. This finding fostered a dense line of empirical research, which largely confirmed that wage differentials across industries remain a significant and quite stable phenomenon over time and across countries (see Groshen, 1991). Katz and Summers (1989) introduced a two-step approach. In a first step, they used individual micro data to estimate inter-industry wage differentials net of observable individual characteristics. In a second step, they related these estimates to industry-specific determinants such as average establishment size or composition of the workforce at the two-digit industry level. Their findings also confirm the existence of substantial wage differentials across sectors. Abowd, Kramarz, and Margolis (1999) used linked employer-employee data and controlled for individual as well as firm heterogeneity (both observed and unobserved). Again, even though the addition of firm heterogeneity considerably reduces inter-industry differentials, sizeable differences in wage levels across sectors remain.

Industry-level analyses can benefit from internationally comparable data sets and thus provide the possibility of cross-country comparisons. There are a few studies which focus on cross-country comparisons of inter-industry wage differentials.[2] Gittleman and Wolff (1993) collect evidence for some OECD countries for different years between 1970 and 1985. As a main result, they note that the rank order of industry differences remained fairly stable over time. They also undertake bivariate comparisons of wage differentials with possible determinants such as productivity growth, output growth, capital intensity, or export orientation. Albæk *et al.* (1996) analyse wage differentials in the Nordic countries. Using country-specific individual-level data, they estimate unconditional as well as conditional inter-industry wage differentials and compare these across countries by means of correlation coefficients and variance decompositions. The two main conclusions are that dispersion between countries is smaller than the dispersion between industries, and that although controlling for individual characteristics considerably reduces variability, it leaves the general pattern of differentials unchanged. Erdil and Yetkiner (2001) focus on differences in wage structures between industrialized and developing countries. Looking at rank correlations, they find rather small differences between the two groups of countries. Their attempt to regress wage differentials on possible determinants (international competitiveness, labour productivity, industry profitability, firm size, and the share of women in the work force) uses pooled data without controlling for worker characteristics or industry-specific effects. Jean and Nicoletti (2002) examine the impact of product market regulation on industry wage premia in European and North American countries. Following the two-step approach of Katz and Summers (1989) and using a cross-section of data from different OECD databases in 1996, they estimate positive impacts of different measures for product market regulation on industry-level wages.[3] However, the approach which controls for the impact of human capital variables already at the first stage does not allow the authors to investigate additional determinants of wage differences between sectors.

As a first step towards investigating inter-industry wage structures for the euro area as a whole, Genre, Momferatou, and Mourre (2005) provide descriptive evidence on the magnitude and the development of wage differentials since the early 1980s and motivate possible determinants by

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2 See Dickens and Katz (1987) and Krueger and Summers (1987) for surveys of sector-level studies for single countries.

3 Jean and Nicoletti refer to the two-step approach put forward by Dickens and Katz (1987) and Katz and Summers (1989). However, as they employ industry-level data not only at the second, but also at the first stage, the set-up masks an analogous one-step representation.

means of bivariate correlation measures. Again, they find substantial differences in wage levels between various sectors, largely similar across euro area countries, the UK and the US. Moreover, the inter-industry structure in the euro area economy is found to be fairly stable throughout the 1980s and 1990s, with only a small increase in overall wage dispersion across industries during this period.

3. Inter-industry wage differentials in the euro area: an in-depth investigation

3.1 Data and stylised facts for the euro area

Our study extends upon this empirical literature by analyzing inter-industry wage differentials for the euro area by means of panel data techniques. Using data from the Structural Analysis (STAN) database of the OECD and from the European Union Labour Force Survey (LFS), it is possible to construct various indicators for a panel of 22 branches of economic activity (covering construction, utilities — *i.e.*, electricity, gas and water supply — and several sub-sectors of manufacturing and services) in eight euro area countries[4] between 1991 and 2003 (see appendix A). The STAN database provides data for compensation of employees and employment which enable us to calculate the average wage in sector i in country j at time t, w_{ijt}, as the ratio of total compensation to the number of employees. Wage differentials y_{ijt} are then defined as the relative deviation of sector i's wage w_{ijt} from the overall country average w_{jt}:

$$y_{ijt} \equiv \ln(w_{ijt} / w_{jt}) \,. \tag{1}$$

Descriptive evidence confirms the existence of substantial and persistent differences in average wage levels in the various sectors of the euro area. Figure 1 shows the percentage deviation of the average level of compensation per employee in each sector from the average wage level for the euro area economy as a whole, in the period 1991-2002. Clearly, there is a great degree of wage dispersion across sectors, with strongly negative wage differentials (more than 50% in agriculture, but also quite significant ones in textile industries, hotels and restaurants, and in social and personal services) and strongly positive ones (up to nearly 50% in utilities and financial intermediation).

INSERT FIGURE 1 HERE

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4 These are Belgium, Germany, Spain, France, Italy, The Netherlands, Austria and Finland, which represent more than 90% of euro area GDP.

Figure 2 summarises the information across countries, in form of a box plot diagram. Overall, the same pattern is visible, with sectors like agriculture, textile industries or social services exhibiting strongly negative wage differentials compared with the rest of the economy. At the other end of the spectrum, financial intermediation services and utilities are generally the sectors where wages are highest in all euro area countries. The level of variation differs across countries to some degree. For example, Portugal shows the most pronounced differentials, reflecting some striking outliers, as in the cases of large positive differentials in electricity, gas and water supply and in financial intermediation, and large negative differentials in basic metals and fabricated metal products. Finland on the other hand, appears in most cases very close to the average wage line, implying a much flatter wage structure across sectors. Moreover, there exists some degree of relative sectoral variation across countries despite the overall similar picture of wage dispersion.[5] For example, figure 2 shows a tendency for larger negative wage differentials in hotels and restaurants in some countries (*e.g.*, Germany, The Netherlands) than in others (*e.g.*, France). In general, it appears that there are somewhat larger differences across countries in service sectors than in manufacturing, where the wage structure tends to be more similar. This result may to some extent be explained by the greater exposure of manufacturing sectors to global forces and competition, compared with the relatively more insulated service sectors. In addition, the role of the public sector, which would be especially relevant for services, may also contribute to heterogeneity across countries.

INSERT FIGURE 2 HERE

Changes in inter-industry wage differentials between the years 1991 and 2002 are illustrated in figure 3. The average euro area wage structure remained remarkably stable over this period and the sectors which paid relatively well at the beginning of the 1990s continued to do so in 2002. However, while the overall structure remained nearly unchanged, there has been some visible increase in the degree of dispersion over time.

INSERT FIGURE 3 HERE

Figure 4 displays the evolution of weighted within-country standard deviation of wage differentials

$$\sigma_{jt} \equiv \sqrt{N^{-1} \sum_{i=1}^{N} g_i y_{ijt}^{\ 2}}\ , \qquad (2)$$

where g_i denotes employment weights of sectors i (cp. table A.1 in the appendix A). Increasing dispersion across industries is common to most euro area countries with the notable exceptions

[5] See also figure 4 below in this section.

of Spain, where wage differentials tended to narrow, and of Italy and Austria, where the overall wage dispersion did not change much between 1991 and 2002. The increase in average euro area wage dispersion during the 1990s thus is mainly driven by three of the largest euro area countries, namely Germany, France, and The Netherlands.

By and large, the notable cross-country differences in within-country wage dispersion remain rather stable over time. Three different groups of countries emerge from an inspection of figure 4: On the one hand, Portugal and Spain exhibit the highest level of wage dispersion; on the other hand, Finland exhibits the lowest; and finally the rest of the countries cluster around the middle, with Austria at a somewhat lower level by 2002. Such country level differences likely result from country-specific institutional factors beyond compositional differences in worker or firm characteristics. Some country-level studies highlight the existence of different features of wage bargaining systems which could give rise to different wage structures. For example, a recent study in the context of the Wage Dynamics Network (du Caju *et al.*, 2008), investigates a wide range of such characteristics based on countries' replies to an according questionnaire. The focus of our paper is to examine wage differentials at the sectoral level, using worker and firm characteristics. However, we also conduct an analysis of the cross-country heterogeneity and see to what extent country effects can be reconciled with existing literature on wage setting institutions. Ex ante, the country differences in figure 4 could be attributed to the impact of immigrant labour in Spain and Portugal and a segmented, rigid labour market keeping wages in certain industries relatively low, while preserving much higher ones in some services. In Finland on the other hand, the higher flow rates in the labor market as well as the redistributional aspects implied by the "flexicurity" regime could be behind the relatively low wage dispersion witnessed. We discuss cross-country differences further when interpreting our regression results below.

INSERT FIGURE 4 HERE

To sum up, the descriptive evidence of overall inter-industry wage dispersion in the euro area during the 1990s and early 2000s confirms the picture drawn in Genre, Momferatou and Mourre (2005) for the 1980s and 1990s. There are substantial differences in average wage levels across sectors of the euro area economy. The degree of inter-industry wage dispersion varies across countries, although the overall wage structure remains quite similar and sectors with particularly high average wages are generally the same in all countries. There is much less variation in the wage structure across time, although there has been some tendency for sectoral wage levels to grow apart in the euro area during the 1990s.

In addition to data required to compute compensation per employee and wage differentials, the STAN database offers information which allows for the construction of a number of additional indicators such as export intensity and import penetration ratios, apparent labour productivity, or capital intensity. Moreover, we merge the STAN data with information form the European Union Labour Force Survey (LFS) provided by Eurostat in order to increase the number of available indicators and refine the overall picture of wage differentials and possible determining forces. In particular, the LFS provides sectoral indicators for skills of the workforce, types of occupation, gender, and age. It also provides data on part-time work, extent of self-employment, average size of firms, or hours worked in sectors of the economy (see appendix A for details on these indicators).

Our combined dataset thus provides a large number of variables that may be used in light of the different rationales for inter-industry wage differentials. Nonetheless, a direct mapping of these variables to relevant theories is not completely straightforward as several variables may be consistent with multiple theories. Our aim is to make use of the theoretical lines of argument to select possible determinants and try to explain as much of the inter-industry wage variation as possible.

3.2 Estimation approach

In order to disentangle possible determinants of the euro area wage structure and to derive conditional inter-industry wage differentials, we take advantage of the panel nature of the data. Using data for sectors $i=1,\ldots,N$ in countries $j=1,\ldots,J$ at time (years) $t=1,\ldots,T$, we consider the basic error components wage regression

$$\ln(w_{ijt} / P_{jt}) = X_{ijt}\beta + u_{ijt}, \tag{3}$$

where $\ln(w_{ijt} / P_{jt})$ denotes log real wages; X is a vector of observed covariates and β is a coefficient vector to be estimated. In addition to a constant, the set of covariates X includes workforce – or employee – characteristics on the one hand and firm – or employer – characteristics on the other. More precisely, employee-related variables include information on age and skill structure of the workforce[6], on its composition in terms of occupations, on the share of employees working part-time[7], the share of female employees[8], the share of temporary

6 See Becker (1964) and Mincer (1974) for the traditional human capital argument.

7 The extent of part-time work has been rising over the past decades (OECD, 2006), and hourly wages have been proven to be lower for part-timers compared with full-timers (OECD, 1999).

employment[9], the degree of self-employment,[10] and on average hours worked per week. Employer-related characteristics include variables such as real capital intensity and apparent labour productivity[11], firm size[12] and the exposition to foreign trade measured by import penetration ratios and export orientation[13].

The error term u_{ijt} contains country-specific effects μ_j, industry-fixed effects μ_i, time effects μ_t, and an idiosyncratic term ε_{ijt}:

$$u_{ijt} = \mu_t + \mu_j + \mu_i + \varepsilon_{ijt} \,. \qquad (4)$$

The set of time effects μ_t takes account of euro area-wide business cycle effects in a flexible way. The country and sector-specific effects, μ_j and μ_i, capture general economic conditions or socio-cultural and institutional backgrounds — such as the extent of unionisation or the degree of centralisation and coordination of collective bargaining.[14] In appendix B we show that the full set of sector effects μ_i, which yields the conditional inter-industry structure net of all observed impacts, can be estimated by means of orthogonalised weighted industry dummies. The conditional inter-industry wage structure can then be compared with the unconditional, observed wage differentials y_{ijt}.

Alternative specifications of (4) would include, for example, sector and country time trends:

$$u_{ijt} = \delta_j t + \delta_i t + \mu_j + \mu_i + \varepsilon_{ijt} \,. \qquad (5)$$

The country-by-sector dimensioning of the data provides a large cross-section, but there is only a limited number of periods available (at maximum 12 years). Moreover, as it turned out in the descriptive analysis above, there is rather little variation of the industry structure across time. Estimation thus relies on fixed-T asymptotics.

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8 The existence of gender wage gaps has been extensively documented in the literature (see Altonji and Blank, 1999).

9 Ceteris paribus, workers with temporary contracts receive lower wages than those with permanent contracts (Booth, Francesconi, and Frank, 2002).

10 See Hamilton (2000) for wage effects of self-employment.

11 See Abowd, Kramarz, and Margolis (1999) on productivity differences. Blanchflower, Oswald, and Sanfrey (1996) note that wage increases follow earlier movements in profits.

12 See Brown and Medoff (1989) and Oi and Idson (1999) for employer-size wage effects.

13 See Johnson and Stafford (1999) and IMF (2006) for the impact of international trade and globalization on industry-level price and wage formation. Both import and export variables are available for manufacturing industries only.

14 See the synopses in Aidt and Tzannatos (2002), du Caju *et al.* (2008), Flanagan (1999), OECD (1997, 2004), and Rowthorn (1992).

Under standard assumptions, pooled OLS (POLS) estimation of (3) provides consistent results. However, as evidence on the persistence of wage differences suggests, some autocorrelation is likely to be present and thus needs to be accounted for. One option to do so is to compute robust standard errors (Newey and West, 1987). A more efficient alternative, however, is to run a panel GLS estimation that uses the autocorrelation structure for weighting. Finally, a third approach would be to add lagged log wages $\ln(w_{ijt-1} / P_{jt-1})$ to the regression, yielding the following dynamic panel[15]

$$\ln(w_{ijt} / P_{jt}) = \ln(w_{ijt-1} / P_{jt-1})\gamma + X_{ijt}\beta + u_{ijt} . \tag{6}$$

In this case, consistency of POLS hinges on the prerequisite that ε_{ijt} exhibits no first-order autocorrelation.

A more complex specification of the error term allows for interaction of country and sector-specific unobserved effects μ_{ij}:

$$u_{ijt} = \mu_t + \mu_{ij} + \varepsilon_{ijt} . \tag{7}$$

In this case, first differencing (FD) or quasi-differencing (estimation with fixed effects, FE) our basic specification would remove the time-invariant μ_{ij}. Country and sector effects in the differenced equation would then correspond to country and sector trends in specification (4).

In case of the dynamic specification (6), results from FE or FD estimations would be biased (Nickell 1981). However, consistency can be achieved by using the generalized methods of moments (GMM) estimation following Anderson and Hsiao (1982) and Arellano and Bond (1991). In this case, the error of the differenced equation must not exhibit second order autocorrelation.

3.3 Results

Table 1 summarises our main results, based on panel GLS estimations of equation (3), including time, country, and industry-specific effects and allowing for first-order autocorrelation. Column 1 of Table 1 reports a specification that includes workforce characteristics only. The estimated

[15] Note that the dynamic specification without reference to a structural model is subject to the incidental parameter problem.

determinants are in line with a priori expectations.[16] In particular, a high share of young or low-skilled employees in an industry *ceteris paribus* comes along with lower real wages, while industries with a high share of older employees pay higher wages. Moreover, significantly lower wages are paid in sectors with high shares of women and part-timers.

INSERT TABLE 1 HERE

The specification in column 2 only focuses on firm characteristics. This substantially limits the number of available observations, since some of the variables are only available for manufacturing industries. Again, the results are broadly in line with a priori expectations. In particular, high apparent labour productivity brings about significantly higher wages. Since apparent productivity is defined as the ratio of real value added to the number of employees, it does not only measure labour productivity but also gives an indication on the size of rents (in per worker units) which can be distributed between workers and capital owners. Consequently, the estimated coefficient would be in line with a positive direct effect of labour productivity as well as with the argument of profit sharing. Capital intensity also enters positively and significantly into the specification. High capital intensity, reflecting, for example, the use of specialised machinery, increases workers' productivity and thus leads to a higher average wage. Moreover, capital-intensive industries are likely to be characterised by a high degree of firm concentration and are thus most likely to extract product market rents.[17] Again in line with the literature, larger firms, and in particular those with more than 50 employees, pay higher wages than smaller ones. Finally, although export orientation turns out insignificant in this specification, the import penetration ratio of an industry shows a significant and positive coefficient — firms which are more internationally integrated are *ceteris paribus* more likely to extract gains from trade, which can then be distributed between employers and employees.

Column 3 reports results for a specification that brings together all workforce and firm characteristics. Interestingly, the partial effects of most workforce characteristics become insignificant. This finding could be due to two effects. First, when making use of both workforce

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[16] Note that the set of workforce characteristics does not include occupation variables since occupation and skill categories turn out to be highly correlated. The same reasoning applies to average hours worked, which is highly correlated with the part-time indicator.

[17] The inclusion of labour productivity and capital intensity as regressors might generally result in an endogeneity problem. Consider a basic sectoral production technology where inputs capital and labour are substitutes. Then capital intensity in a sector depends the relative price of capital in that sector and therefore on labour costs, *i.e.*, wages. Labour costs also determine the amount of labour used, which would in turn have repercussions on labour productivity. In addition, both wages and labour productivity could be correlated to omitted third variables in the empirical framework. Unfortunately it is not possible to account for the possible endogeneity as finding valid instruments generally proves intricate at this level of aggregation. Following the standard approach in empirical labour economics when estimating wage equations, the regression coefficients should thus be interpreted as descriptive rather than causal effects.

and firm characteristics, the sample covers manufacturing industries only and thus exhibits less variation in sector specifics, as compared to the full sample. Second, the extent of collinearity between workers' and firms' characteristics is likely to be larger in manufacturing than in the rest of the economy. For example, bigger firms in manufacturing may tend to systematically employ more high-skilled workers due to the use of complex machineries and equipment in their production technology.[18]

Hence, our preferred specification presented in column 4 of table 1 contains workforce characteristics and a slightly reduced set of firm characteristics, thus circumventing the problem of sample reduction. By and large, the joint inclusion of worker and employer characteristics confirms the coefficient estimates of specifications (1) and (2), suggesting that multicollinearity is a minor issue. Yet some worker characteristics reveal slightly smaller partial effects. For example, the coefficient of the share of female employees is lower by 9 percentage points. This finding hints towards some selectivity bias in specification (1), in which the effect of the omitted firm characteristics is taken up by the workforce variables. In addition, a few additional variables are significant in the preferred specification. For example, the share of older workers has a significantly positive impact, which would be in line with human capital theory or seniority-based remuneration schemes. The share of self-employment in an industry now shows a significantly negative coefficient, confirming the empirical evidence that, on average, self-employed tend to earn less than other workers with similar characteristics. One possible explanation could be that, to the extent that self-employed workers are in direct competition with wage-earners, the presence of self-employed in a sector lowers the bargaining power of employees. Also, sectors with a high share of self-employed are typically labour-intensive. Ceteris paribus, this would contribute to a lower average wage.

Sensitivity checks with respect to the specification of the error component and to the choice of the estimation strategy are undertaken in tables 2 and 3. Table 2 confirms the robustness of our preferred specification. It investigates the sensitivity of the estimated coefficients with respect to different specifications of the error term u_{ijt} and different sample restrictions. Our preferred specifications reappear in columns 1 and 2 of table 2. The specification in column 3 uses our preferred set of covariates (as in column 2) but restricts the sample to manufacturing industries (as in column 1)[19]. Estimated coefficients are rather similar to those of the benchmarks. More specifically, they lie within the range spanned by the respective estimates in columns 1 and 2,

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[18] We examine the contributions of the two issues in table 3 below.

[19] Note that the numbers of observations in columns 1 and 3 are not exactly equal because of single missing values in the additional variables used in column 1.

but most of the worker characteristics are insignificant. This result suggests that in fact both the higher degree of similarity among the workforce and the larger extent of collinearity between worker and firm characteristics inclined by the restriction of the sample contribute to the deviation of the full specification from our preferred one.

INSERT TABLE 2 HERE

The specifications in columns 4 and 5 of table 2 include country and sector-specific time trends instead of the full sets of country, sector, and year effects. While allowing for differences in unobserved effects across countries and across sectors, this approach comes at the price of reduced flexibility regarding business cycle effects. The coefficient estimates remain broadly the same, but again the impact of some worker characteristics is estimated less precisely. This finding supports the understanding that, for example, trends towards skill upgrading or increased female labour force participation show different patterns across countries and sectors of the economy.

Finally, columns 6 and 7 present specifications that estimate wage differentials y_{ijt} rather than log wage equations. Just as in the benchmark specifications, unobserved industry effects are accounted for, and again the results broadly match those of the benchmark.[20] However, it should be noted that the impact of human capital variables is estimated less reliably. Subtracting country-by-time averages presumably takes away too much variation and thus renders the estimation of coefficients more problematic.

Table 3 investigates the sensitivity of our results according to different estimation techniques. Compared with the results of the GLS benchmark reported in column 1, POLS estimates in column 2 show the same sign, but in most cases are larger in absolute value. We consider these results less reliable because — even though being consistent — the estimation does not take advantage of the autocorrelation structure in the data. Column 3 reports POLS estimates using the lagged endogenous variable as a regressor. Again the (short run) ceteris paribus effects are of the same sign as the benchmark coefficients, but the large persistency parameter renders most of them insignificant. Moreover, as the persistency parameter does not provide additional information regarding the economic determinants of wage differences, the approach is judged inferior to the benchmark specification.

INSERT TABLE 3 HERE

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[20] Only the coefficient of the share of low-skilled workers changes its sign, while losing in significance. The share of high-skilled workers becomes significant with a positive coefficient as expected.

The last three columns of table 3 report specifications which allow for interactions of country and sector-specific unobserved effects as defined in equation (7). These fixed effects are removed by means of FD (column 4), FE (column 5), or GMM estimation following Arellano and Bond (1991, column 6), respectively. Again, the inclusion of year effects takes account of business cycle effects. The effects of worker characteristics turn out to be insignificant in all three specifications. This result comes as no surprise since the descriptive analysis above confirmed the small degree of variation in wages over time, or — put differently — the little variation within the combined country-by-sector cross-sectional units. The estimates, which remove between-cell variation and thus rely merely on within-cell variation, are therefore mainly unreliable.

The benchmark specification in column 4 of table 1 thus remains our preferred one. This specification is estimated using a full set of orthogonalised weighted industry dummies as explained in appendix B. The estimated inter-industry wage differentials, conditional on our benchmark specification (and henceforth conditional differentials), thus illustrate "pure" sector effects and are compared with the observed wage structure for the euro area in the year 2002 in figure 5.

INSERT FIGURE 5 HERE

Overall, our model achieves a noticeable reduction in the variability in the wage structure. Once the impact of all worker and firm characteristics has been taken into consideration, the remaining employment-weighted standard deviation in wage levels across sectors due to the "pure" sector effects is 0.183. This corresponds to about two thirds of the standard deviation given by the observed differentials (0.240). This result, however, also means that a significant part of sectoral wage differentials remains after controlling for observable worker and firm characteristics. In line with the results provided by the literature, the general pattern of differentials across sectors remains the same. Interestingly, the model captures the euro area wage structure for some sectors better than for others. For example, the worker and firm variables included in the model explain a large part of the positive spike for the utilities sector (12) or of the negative spike for the textile industry (3) — in these sectors the estimated sector-specific effect is considerably smaller than the observed differential. For other sectors, we detect a higher impact of idiosyncratic industry specifics which remain uncaptured by any of our observed variables. This holds, for example, for the agricultural sector (1). In some cases the "pure" sector effect and the observed differential even have opposite signs. In these sectors the idiosyncratic industry specifics are overcompensated by other determinants of the wage structure. In case of the health and social work sector, for example, the "pure" sector effect is positive, but it only serves to mitigate the negative wage impacts stemming from the composition of the workforce, firms' capital intensity, and apparent productivity in that sector.

After having looked at the sector effects, we now turn briefly to look at wage differentials due to country-specific factors, which are not captured by our structural covariates but attributed to country trends in the error term. In equation (8) we analyse the evolution of within-country dispersion, σ_{jt} as defined in equation (2) above. Again using panel GLS, we regress σ_{jt} on a set of weighted country-level covariates $X_{jt} = N^{-1}\sum_{i=1}^{N} g_i X_{ijt}$:

$$\sigma_{jt} = X_{jt}\beta + u_{jt} . \tag{8}$$

Results for our preferred set of covariates are reported in table 4. While column (1) displays a basic specification without country-specific or time-specific effects, both country and time effects are included in column (2). In column (3) the error term u_{jt} includes country-specific time trends (including country-specific intercepts). The latter specification is our preferred one, as it reduces the strong autocorrelation in u_{jt} to a minimum.

INSERT TABLE 4 HERE

Workforce characteristics – in particular the age structure and determinants like the share of part-timers or self-employed – significantly contribute to explaining within-country wage dispersion. What is more, figure 6 displays the estimated conditional country trends, which can reasonably be compared to the observed country trends in wage dispersion in figure 4.[21]

INSERT FIGURE 6 HERE

As in figure 4, Spain and Portugal appear at the top, and their observed evolution of wage dispersion appears to be largely explained by country specificities. Both of these countries have experienced an unprecedented influx of immigrant labour throughout the 1990s and early 2000s. As the largest proportion of this additional workforce works in low-wage industries, this effect contributes to the persistently high degree of (conditional) wage dispersion. Germany and France maintain an upward slope in figure 6, suggesting that for reasons not related to worker or firm characteristics, there has been a tendency for wage dispersion to increase. In case of Germany, this might be linked to the reduction in trade union power during this period and the introduction of opening clauses in collective wage bargaining agreements. In addition to these institutional aspects, structural change in the years following German unification likely also played a role.[22].

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[21] Note that, while the relative positions of the countries (*i.e.*, the differences in dispersion) as well as the developments over time can directly be compared between figures 4 and 6, the overall (regression baseline) level in figure 6 does not match the (observed) level in figure 4.

[22] See Kohn (2006), Dustmann *et al.* (2008), and Fitzenberger *et al.* (2008). Cp. also du Caju *et al.* (2008).

The lowest levels of conditional dispersion are observed in the Netherlands and Finland. In case of the Netherlands, our covariates are largely sufficient to capture the increase of wage dispersion observed in figure 4 – the remaining country trend in figure 6 turns out flat.[23] In Finland though, the country-specific impact on wage dispersion has steeply increased in the period 1991-2002. This could be due to the fact that Finland belongs to a group of small countries in which the average pay increases of competitor and trading countries are taken into consideration. The opening up of markets and increased international competition would then have increased inter-industry dispersion in wages through a downward push in traded sectors.

In contrast to the stronger dominance of sector-level negotiations in the rest of the countries in our sample, Finland exhibits a high level of corporatism – wage increases are negotiated at a highly centralised level and thus closely reflect macroeconomic developments and account for distributional objectives. This is reflected in the level of wage dispersion in Finland, which still remained low. "Flexicurity regime"-types of labour market reforms adopted in Finland, coming along with higher than average shares of women, young and part-time workers in total employment,[24] in turn compensated partly for the upward country-specific trend.

4. Conclusion

This paper focuses on the euro area wage structure and its potential determinants from a sectoral point of view. Drawing on the vast theoretical and empirical literature on the determinants of inter-industry wage differentials at the country level provides us with a number of possible variables likely to explain differences in wage levels across various branches of the euro area economy. Our analysis then extends upon previous studies by using a large cross-country data set for the euro area as a whole, combining the detailed STAN database provided by the OECD with data from the European Union Labour Force Survey, and by using panel data estimation techniques.

Our results confirm the existence of large and persistent wage differentials across sectors of the euro area economy. The traditional determinants offered by the literature explain a significant part of these differences, as well as of the slight increase in sectoral wage dispersion during the 1990s. In particular, characteristics of the workforce such as the importance of part-time work, the shares of young, older, and female workers, or the share of self-employment in a sector are

[23] Kouwenberg and van Opstal (1999) show that industry wage differentials in the Netherlands are positively and significantly correlated to industry profits. Similar results are drawn for six European countries in Gannon *et al.* (2007).

relevant variables for explaining differences in average wages across sectors. Firm characteristics such as capital intensity and apparent labour productivity in a sector also have significant impacts. However, while our preferred model captures reasonably well the overall wage structure, it also reveals the non-negligible importance of idiosyncratic factors, which appear to bear a major role, especially for some industries such as agriculture or the health sector. These unobservable sector-specific factors may, on occasions, exert pressure on wages that counterbalances and, at times, overcompensates for the influence of traditional observable determinants.

As a first step towards understanding the determinants of the inter-industry wage structure in the euro area, our analysis opens several avenues for future research. For example, a comparison with the US, using a similar dataset, would put the extent of wage differentials in the euro area and its evolution into perspective. Another route to follow would be to explore sectoral differences using micro-level data, such as the linked employee-employer data provided by the European Structure of Earnings Survey. This could possibly yield additional insights on those sector-specific factors which are unobserved so far. Finally, while this paper specifically sought to capture and study inter-industry dispersion in the euro area as whole, differences across countries also emerged. As further steps in understanding inter-industry wage differentials and a follow-up to this paper, a more detailed investigation of this heterogeneity could be pursued.

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[24] See du Caju *et al.* (2008).

References

Abowd, J. M., F. Kramarz and D. N. Margolis (1999): "High Wage Workers and High Wage Firms," *Econometrica* 67(2), 251-333.

Aidt, T. and Z. Tzannatos (2002): *Unions and Collective Bargaining- Economic Effects in a Global Environment*, The World Bank, Washington, D.C.

Akerlof, G. A. (1982): "Labor Contracts as Partial Gift Exchange," *Quarterly Journal of Economics* 97(4), 543-569.

Akerlof, G. A. (1984): "Gift Exchange and Efficiency Wages: Four Views," *American Economic Review, Papers and Proceedings* 74(2), 79-83.

Akerlof, G. A. and J. L. Yellen (eds., 1986): *Efficiency Wage Models of the Labor Market*, Cambridge University Press, Cambridge.

Akerlof, G. A. and J. L. Yellen (1990): "The Fair Wage-Effort Hypothesis and Unemployment," *Quarterly Journal of Economics* 105(2), 255-283.

Albæk, K., M. Arai, R. Asplund, E. Barth and E. S. Madsen (1996): "Inter-Industry Wage Differentials in the Nordic Countries," in N. Westergård-Nielsen (ed.), *Wage Differentials in the Nordic Countries*, part 1 of E. Waldensjö (ed.), The Nordic Labour Markets in the 1990's, Elsevier, Stockholm, pp.83-111.

Altonji, J. G. and R. M. Blank (1999): "Race and Gender in the Labor Market," in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3C, North-Holland, Amsterdam, pp. 3143-3259.

Anderson, T. W. and C. Hsiao (1982): "Formulation and Estimation of Dynamic Models Using Panel Data," *Journal of Econometrics* 18(1), 47-82.

Arellano, M. and S. Bond (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations," *Review of Economic Studies* 58(2), 277-297.

Becker, G. S. (1964): *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*, 3rd ed. 1993, University of Chicago Press, Chicago.

Bertola G., T. Boeri and S. Cazes (2000): "Employment protection in industrialized countries: a case for new indicators", *International Labor Review*, 139, 57-72.

Blanchflower, D. G., A. J. Oswald, and P. Sanfrey (1996): "Wages, Profits, and Rent-Sharing," *Quarterly Journal of Economics* 111(1), 227-251.

Blau, F. D. and L. M. Kahn (1999): "Institutions and Laws in the Labor Market," in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3A, North-Holland, Amsterdam, pp. 1399-1461.

Booth, A. L., M. Francesconi and J. Frank (2002): "Temporary Jobs: Stepping Stones or Dead Ends?," *Economic Journal* 112(480), F189-F213.

Brown, C. and J. Medoff (1989): "The Employer Size–Wage Effect," *Journal of Political Economy* 97(5), 1027-1059.

Dickens, W. T. and L. F. Katz (1987): "Inter-Industry Wage Differences and Industry Characteristics," in K. Lang and J. S. Leonard (eds.), *Unemployment and the Structure of Labor Markets*, Basil Blackwell, Oxford, pp. 48-89.

Devroye D. and R. Freeman (2002): "Does inequality in skills explain inequality of earnings across advanced countries?", CEP Discusison Paper 552, LSE, London.

Du Caju, Ph., E. Gautier, D. Momferatou and M. Ward-Warmedinger (2008): "Institutional Features of Wage Bargaining in 23 EU Countries, the US and Japan", ECB Working Paper, forthcoming.

Dustmann, Ch., J. Ludsteck and U. Schönberg (2008): "Revisiting the German Wage Structure", *Quarterly Journal of Economics*, forthcoming.

Erdil, A. and I. H. Yetkiner (2001): "A Comparative Analysis of Inter-Industry Wage Differentials: Industrialized versus Developing Countries," *Applied Economics* 33(13), 1639-1648.

Fitzenberger, B., K. Kohn and A. C. Lembcke (2008): "Union Density and Varieties of Coverage: The Anatomy of Union Wage Effects in Germany", IZA Discussion Paper 3356.

Fitzenberger, B. and C. Kurz (2003): "New insights on earnings trends across skill groups and industries in West Germany," *Empirical Economics* 28(3), 479-514.

Flanagan, R. J. (1999): "Macroeconomic Performance and Collective Bargaining: An International Perspective," *Journal of Economic Literature* 37(3), 1150-1175.

Gannon B., R. Plasman, F. Rycz and I. Tojerow (2007): "Inter-Industry Wage Differentials and the Gender Wage Gap: Evidence from European Countries", *Economic and Social Review* 38 (1), 135-155.

Genre, V., D. Momferatou and G. Mourre (2005): "Wage Diversity in the Euro Area – An Overview of Labour Cost Differentials across Industries," ECB Occasional Paper 24/2005.

Gittleman, M. and E. N. Wolff (1993): "International Comparison of Inter-Industry Wage Differentials," *Review of Income and Wealth* 39(3), 295-312.

Greenwald, B. C. (1986): "Adverse Selection in the Labor Market," *Review of Economic Studies* 53(4), 325-347.

Groshen, E. L. (1991): "Five Reasons Why Wages Vary Among Employers," *Industrial Relations* 30(3), 350-381.

Haffner R., S. Nickell, G. Nicoletti and S. Scarpetta (2001): "European integration, liberalisation and labour market performance", in G. Bertola, T. Boeri and G. Nicoletti (eds.), *Welfare and Employment in a United Europe*, MIT Press, Cambridge, MA.

Hamilton, B. H. (2000): "Does Entrepreneurship Pay? An Empirical Analysis of the Returns to Self-Employment", *Journal of Political Economy* 108(3), 604-631.

IMF (2006): *World Economic Outlook – Globalization and Inflation*, April 2006, International Monetary Fund, Washington.

Jean, S. and G. Nicoletti (2002): "Product Market Regulation and Wage Premia in Europe and North America: An Empirical Investigation," OECD Economics Department Working Paper 318.

Johnson, G. and F. Stafford (1999): "The Labor Market Implications of International Trade," in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3B, North-Holland, Amsterdam, pp. 2215-2288.

Katz, L. F. and L. H. Summers (1989): "Industry Rents: Evidence and Implications," *Brookings Papers on Economic Activity: Microeconomics*, 209-275.

Kohn, K. (2006): "Rising Wage Dispersion, After All! The German Wage Structure at the Turn of the Century", IZA Discussion Paper 2098.

Kouwenberg, J. and R. van Opstal, (1999): "Inter-industry Wage Differentials: Evidence from Micro Data", *Quarterly Review of CPB Netherlands Bureau for Economic Policy Analysis*, CPB Report 1999/3, pp. 26-29.

Krueger, A. B. and L. H. Summers (1987): "Reflections on the Inter-Industry Wage Structure," in K. Lang and J. S. Leonard (eds.), *Unemployment and the Structure of Labor Markets*, Basil Blackwell, Oxford, pp. 17-47.

Krueger, A. B. and L. H. Summers (1988): "Efficiency Wages and the Inter-Industry Wage Structure," *Econometrica* 56(2), 259-293.

Lindbeck, A. and D. J. Snower (1988): *The Insider-Outsider Theory of Employment and Unemployment*, MIT Press, Cambridge, MA.

Mincer, J. (1974): *Schooling, Experience and Earnings*, Columbia University Press, New York.

Mortensen, D. T. and C. A. Pissarides (1999): "New Developments in Models of Search in the Labor Market," in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3C, North Holland, Amsterdam, pp. 2567-2627.

Naylor, R. (2003): "Economic models of union behaviour," in J. T. Addison and C. Schnabel (eds.), *International Handbook of Trade Unions*, Edward Elgar, Cheltenham and Northampton, pp. 44-85.

Newey, W. K. and K. D. West (1987): "A Simple, Positive Semi-Definite, Heteroscedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica* 55(3), 703-708.

Nickell, S. J. (1981): "Biases in Dynamic Models with Fixed Effects," *Econometrica* 49(6), 1417-1426.

OECD (1997): *OECD Employment Outlook*, Organisation for Economic Co-operation and Development, Paris.

OECD (1999): *OECD Employment Outlook June 1999*, Organisation for Economic Co-operation and Development, Paris.

OECD (2004): *OECD Employment Outlook*, Organisation for Economic Co-operation and Development, Paris.

OECD (2006): *OECD Employment Outlook 2006 – Boosting Jobs and Incomes*, Organisation for Economic Co-operation and Development, Paris.

Oi, W. and T. L. Idson (1999): "Firm Size and Wages," in O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 3B, North-Holland, Amsterdam, pp. 2101-2163.

Purse, K. (2004): "Work-related fatality risks and neoclassical compensating wage differentials," *Cambridge Journal of Economics* 28(4), 597-617.

Rowthorn, R. E. (1992): "Centralisation, Employment and Wage Dispersion," *Economic Journal* 102(412), 506-523.

Salop, S. C. (1979): "A Model of the Natural Rate of Unemployment," *American Economic Review* 69(1), 117-125.

Shapiro, C. and J. E. Stiglitz (1984): "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review* 74(3), 433-444.

Slichter, S. (1950): "Notes on the Structure of Wages," *Review of Economics and Statistics* 32(1), 80-91.

Stiglitz, J. E. (1974): "Wage Determination and Unemployment in L.D.C.s: The Labor Turnover Model," *Quarterly Journal of Economics* 88(1), 194-227.

Stiglitz, J. E. (1985): "Equilibrium Wage Distribution," *Economic Journal* 95(379), 595-618.

Weiss, A. M. (1980): "Job Queues and Layoffs in Labor Markets with Flexible Wages," *Journal of Political Economy* 88(3), 526-538.

Yellen, J. L. (1984): "Efficiency Wage Models of Unemployment," *American Economic Review, Papers and Proceedings* 74(2), 200-205.

Appendix A: Data

We use data from different sources. The Structural Analysis database (STAN) of the Organisation for Economic Co-operation and Development (OECD) provides annual data for OECD countries. It is primarily based on national accounts data and uses data from other sources such as industrial surveys or censuses to estimate missing details.[25] On principle, data are available for the period 1970–2003. Due to missing data, however, we restrict our sample to the years 1991–2002. The euro area aggregation used in this paper consists of the eight countries Germany, Spain, France, Italy, The Netherlands, Austria, Portugal, and Finland, which together cover more than 90% of the euro area in terms of GDP. Insufficient data were available for Belgium, Greece, Ireland, and Luxemburg. Table A.1 displays our classification of 22 industries as well as respective weights based on employment shares in the euro area.

Definitions of variables taken or calculated from STAN are as follows:

- *Compensation of employees* comprises wages and salaries of employees paid by producers as well as supplements such as contributions to social security, private pensions, health insurance, life insurance and similar schemes.
- The *number of employees* includes all persons in employment, disregarding self-employed and unpaid family workers. In case of missing values for the number of employees in single sectors and years, numbers were backcast based on growth rates of corresponding employment numbers which include self-employed.
- *Export intensity* and *import penetration* are calculated as the respective ratios of exports or imports to total output (available for manufacturing industries only).
- *Apparent productivity* is measured by real value added (base year 2000) per employee.
- *Capital intensity* is calculated as real gross fixed capital formation (base year 2000) per employee.

[25] Data might have been assembled with a varying degree of accuracy for different countries and sectors of the economy. In particular, caution should be exercised when comparing results for European countries with those for the United States (whose data rely on a slightly different industrial classification). However, consistency checks against alternative data sets in Genre, Momferatou, and Mourre (2005) showed a high degree of concordance between different data sets.

Eurostat further supplied cell-level information from the European Union Labour Force Survey (LFS). The LFS is a quarterly[26] household survey administered by the national statistical institutes of European Union (EU) and Candidate Countries in accordance with International Labour Organisation (ILO) guidelines. The EU LFS micro data collection started in 1983, but as the survey has not been mandatory until the early 1990's, data are mainly available from 1993 onwards only. However, several country-series start in later years only, as observations with inconsistencies between the LFS waves had to be excluded. The definition of variables taken from LFS statistics is as follows:

- The *number of employees* includes all persons in employment, disregarding self-employed and family workers. It is broken down by several dimensions, including three *age groups* (below 25 years, 25–54 years, and above 55 years); three *skill classes* in accordance with the International Standard Classification of Education (ISCED: low-skilled workers with at most a lower secondary degree, medium-skilled with an upper secondary degree, and high-skilled employees holding a tertiary degree); three *occupation groups* in accordance with the International Standard of Occupations, ISCO (management and professional workers ISCO 1-2, base category ISCO 3-8, elementary occupations ISCO 9); *gender* (share of female employees); the share of *part-time* employees; and the share of employees holding a *temporary work* contract.
- The extent of *self-employment* is captured by the ratio of self-employed to the number of employees.
- *Establishment size* reports the shares of employees in four size brackets (up to 10 employees, 11–19, 20–49, and 50 or more employees).
- *Hours worked* are defined as the average number of hours usually worked per week.

Finally, we calculate country-specific price deflators using harmonized indices of consumer prices (HICP, base year 2000) provided by Eurostat.

[26] Data have traditionally been reported for one reference quarter per year. Between 1996 and 2005 the LFS has gone through a transition towards a continuous quarterly survey. We chose the second quarter as reference when multiple quarters were available.

Table A.1: Industry classification

No.[a]	Sector	NACE [b]	ISIC [c]	Employment Weight [d]
1	Agriculture, hunting, forestry and fishing	A-B	01-05	4.5
	Mining and Quarrying	*C*	*10-14*	
	TOTAL MANUFACTURING	**D**	**15-37**	**19.0**
2	Food products, beverages and tobacco	DA	15-16	2.5
3	Textiles, textile products, leather and footwear	DB-DC	17-19	1.8
4	Wood, products of wood and cork	DD	20	0.6
5	Pulp, paper, paper products, printing and publishing	DE	21-22	1.4
6	Chemicals, rubber, plastics and fuel products	DF-DH	23-25	2.0
7	Other non-metallic mineral products	DI	26	1.0
8	Basic metals and fabricated metal products	DJ	27-28	2.7
9	Machinery and equipment	DK-DL	29-33	4.1
10	Transportation equipment	DM	34-35	1.8
11	Manufacturing nec; recycling	DN	36-37	1.1
12	Electricity, gas and water supply	E	40-41	0.7
13	Construction	F	45	7.2
	TOTAL SERVICES	**G-Q**	**50-99**	**68.8**
14	Wholesale and retail trade, repairs	G	50-52	15.4
15	Hotels and restaurants	H	55	4.7
16	**Transport, storage and communication**	**I**	**60-64**	**5.6**
	Transport and storage	60-63	60-63	
	Post and telecommunications	64	64	
17	Financial intermediation	J	65-67	3.0
18	Real estate, renting and business activities	K	70-74	11.7
19	Public administration and defence; compulsory social security	L	75	7.6
20	Education	M	80	6.2
21	Health and social work	N	85	8.7
22	Other community, social and personal service activities	O	90-93	5.9
	Private households	*P*	*95-97*	
	Extra-territorial organizations and bodies	*Q*	*99*	
	TOTAL	**A-Q**	**01-99**	**100.0**

Note: Aggregates in bold. Italics: sectors not included due to too many missing values.
[a] Classification used in the empirical analysis.
[b] Classification of Economic Activities in the European Community, revision 1.
[c] International Standard Industrial Classification of all economic Activity, revision 3.
[d] Industry share in percent of total employment in the euro area 2002, disregarding employment in sectors not included in the analysis.

Appendix B: Using weighted orthogonalised industry dummies

The conditional inter-industry wage structure is obtained from a regression using weighted orthogonalised industry dummies as established by Fitzenberger and Kurz (2003). We estimate

$$\begin{aligned}\ln(w_{ijt}/P_{jt}) &= X_{ijt}\beta + \mu_t + \mu_j + \mu_i + \varepsilon_{ijt} \\ &= X_{ijt}\beta + \mu_t + \mu_j + \sum_{i=1}^{22} \delta_i DS_{ijt} + \varepsilon_{ijt}\end{aligned} \tag{A.1}$$

$$\text{subject to } \sum_{i=1}^{22} g_i \delta_i = 0, \tag{A.2}$$

where DS_{ijt} denotes industry dummies for all i=1,…,22 industries, δ_i the corresponding industry dummy coefficients, and g_i employment weights of the sectors subject to $\sum_{i=1}^{22} g_i = 1$. We choose euro area employment numbers for the year 2002 (compare table A.1) as weights. The constraint (A.2) requires the coefficients on the industry dummies to denote deviations from an employment-weighted mean. It is implemented by redefining the industry dummies as follows.

Choosing, without loss of generality sector 1 with $g_1 > 0$ as a reference industry, (A.2) can be written as

$$\delta_1 = -\sum_{i=2}^{22} \frac{g_i}{g_1} \delta_i = -\sum_{i=2}^{22} \tilde{g}_i \delta_i \text{, where } \tilde{g}_i = \frac{g_i}{g_1}. \tag{A.3}$$

Therefore,

$$\begin{aligned}\sum_{i=1}^{22} \delta_i DS_{ijt} &= \sum_{i=2}^{22} \delta_i DS_{ijt} - \sum_{i=2}^{22} \tilde{g}_i \delta_i DS_{ijt} \\ &= \sum_{i=2}^{22} \delta_i (DS_{ijt} - \tilde{g}_i DS_{ijt}).\end{aligned} \tag{A.4}$$

Defining the weighted orthogonalised industry dummies

$$\tilde{D}S_{ijt} = DS_{ijt} - \tilde{g}_i DS_{ijt}, \tag{A.5}$$

we directly estimate $(\delta_2, ..., \delta_{22})$ from

$$\ln(w_{ijt}/P_{jt}) = X_{ijt}\beta + \mu_t + \mu_j + \sum_{i=2}^{22} \delta_i \tilde{D}S_{ijt} + \varepsilon_{ijt}. \tag{A.6}$$

The effect for the reference industry 1 is obtained from equation (A.3).

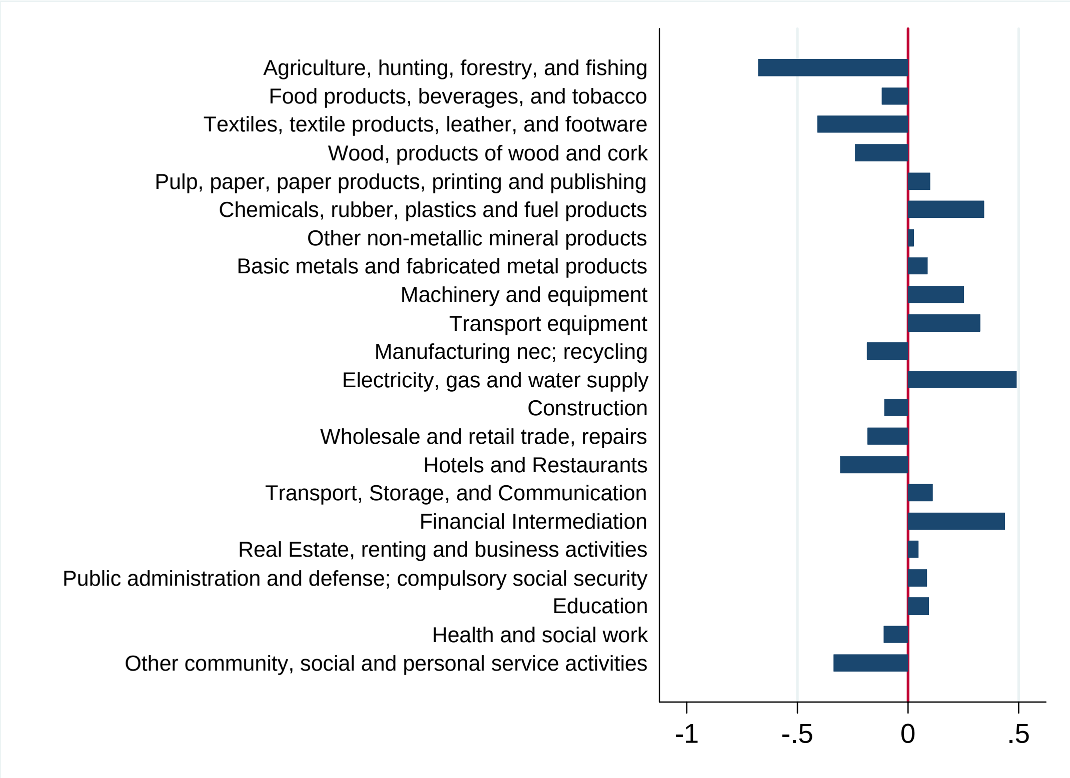
Estimation of (A.6) automatically yields an estimate of the variance-covariance matrix $\tilde{V}_{(k-1)\times(k-1)}$ of all k–1 coefficient estimates except for δ_1. Again using (A.3), one obtains an estimate of the variance-covariance matrix $V_{k\times k}$ for the full set of k coefficients, including δ_1: Define the transformation matrix

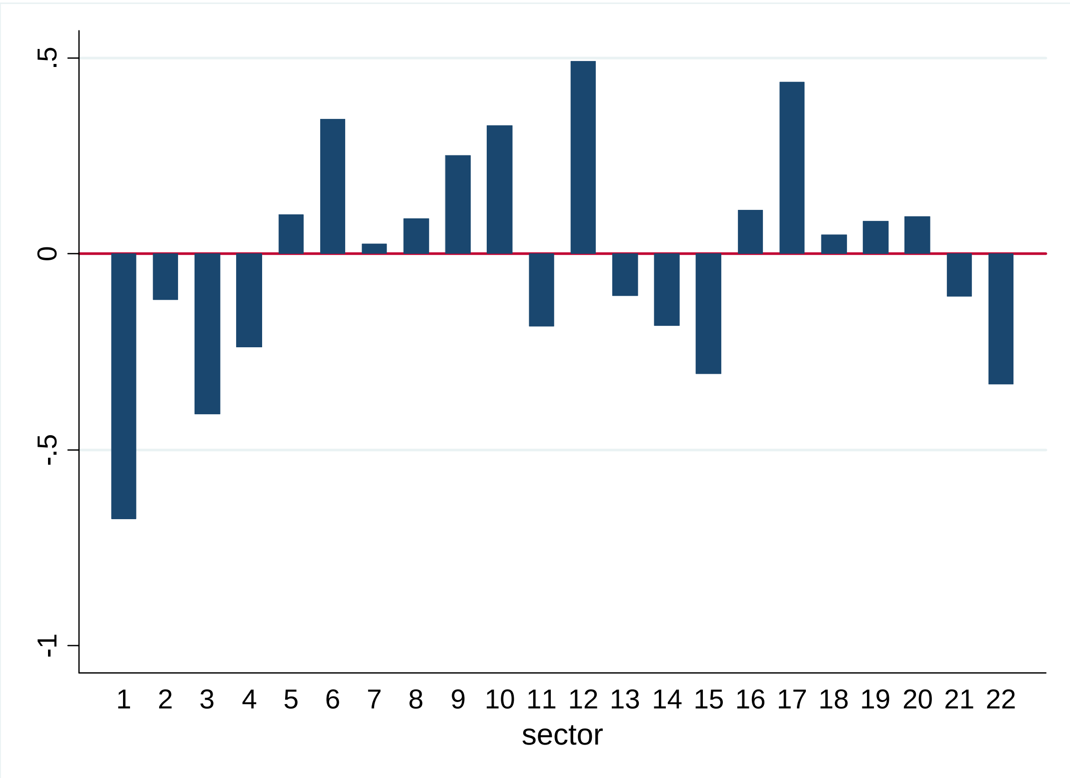
$$T_{k\times(k-1)} = \begin{pmatrix} & & & I_{k-1} & \\ 0 & \dots & 0 & -\tilde{g}_2 \dots & -\tilde{g}_{22} \end{pmatrix}, \tag{A.7}$$

where I_{k-1} denotes a (k–1) identity matrix. Then,

$$V = T\tilde{V}T'. \tag{A.8}$$

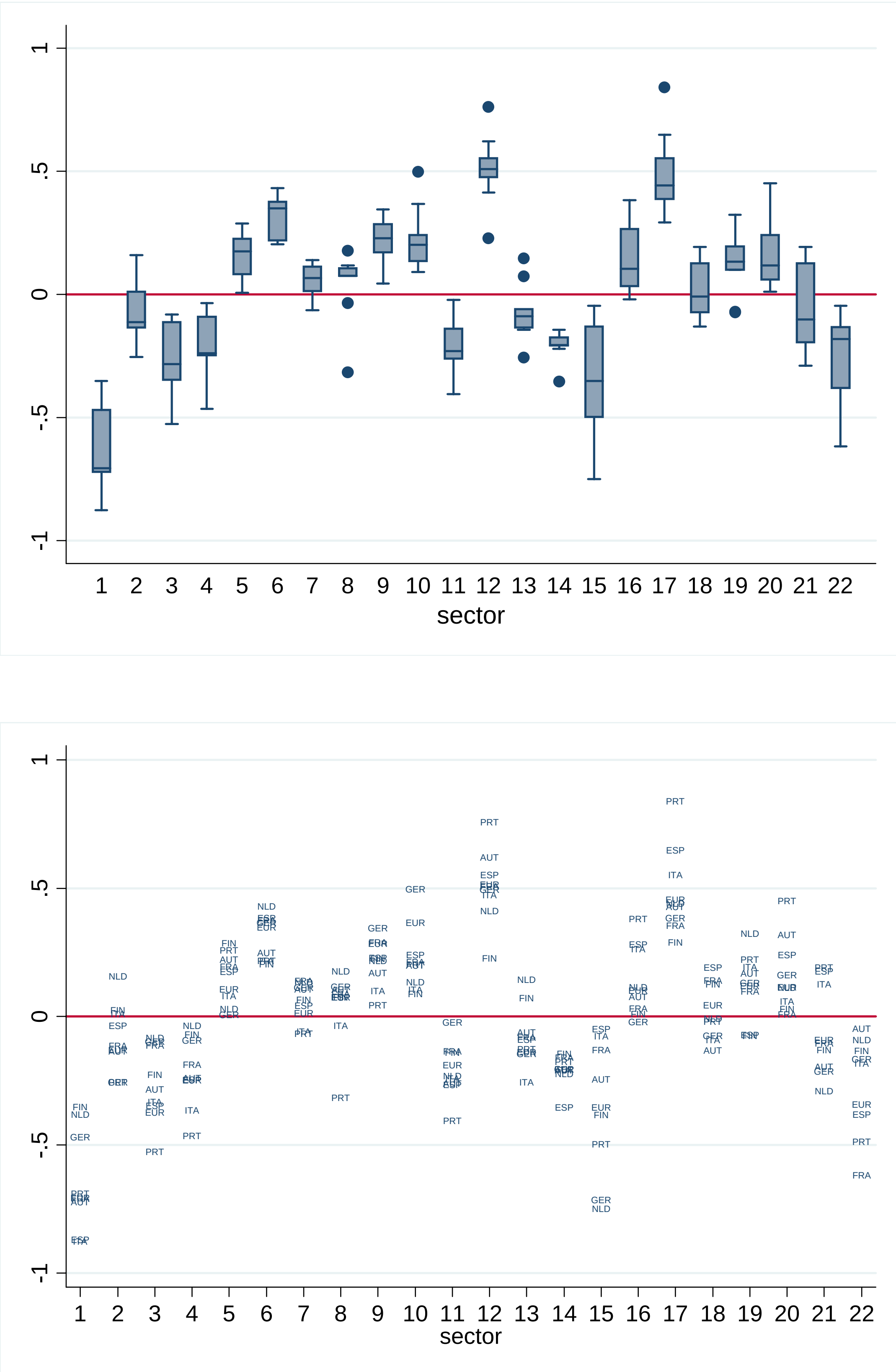
Figure 1: Inter-industry wage differentials in the euro area, average 1991-2002





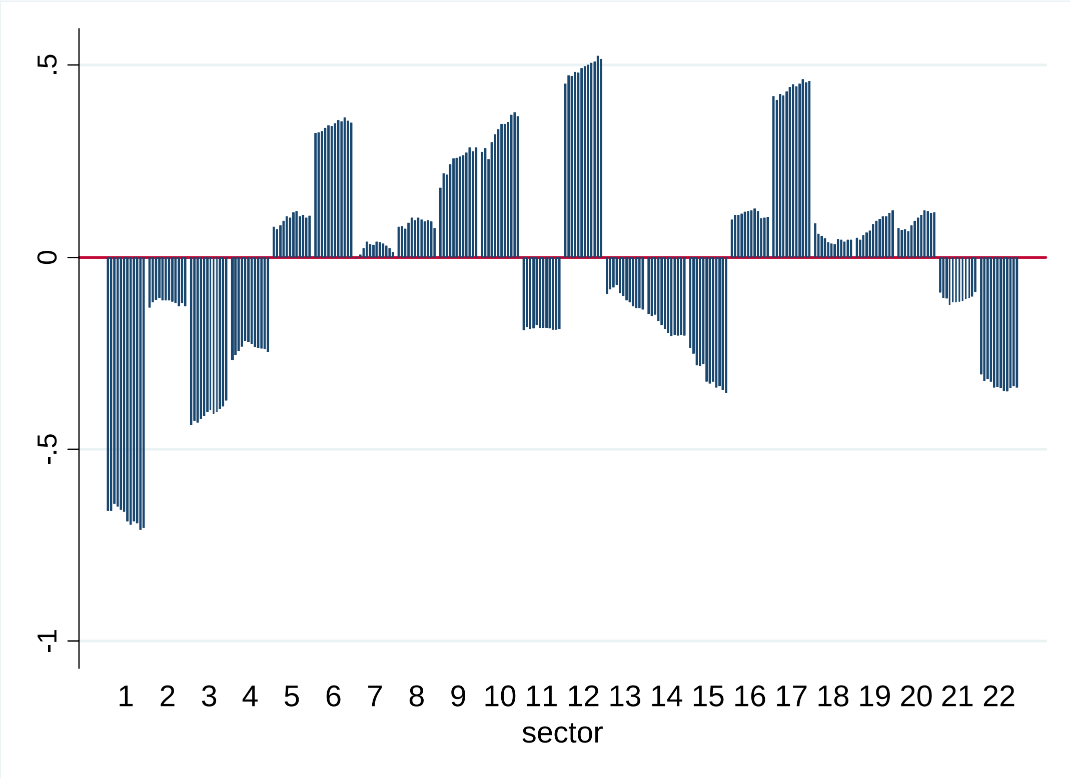
Deviations of industry wages from euro area average.
Data source: OECD STAN.

Figure 2: Inter-industry wage differentials across euro area countries, 2002



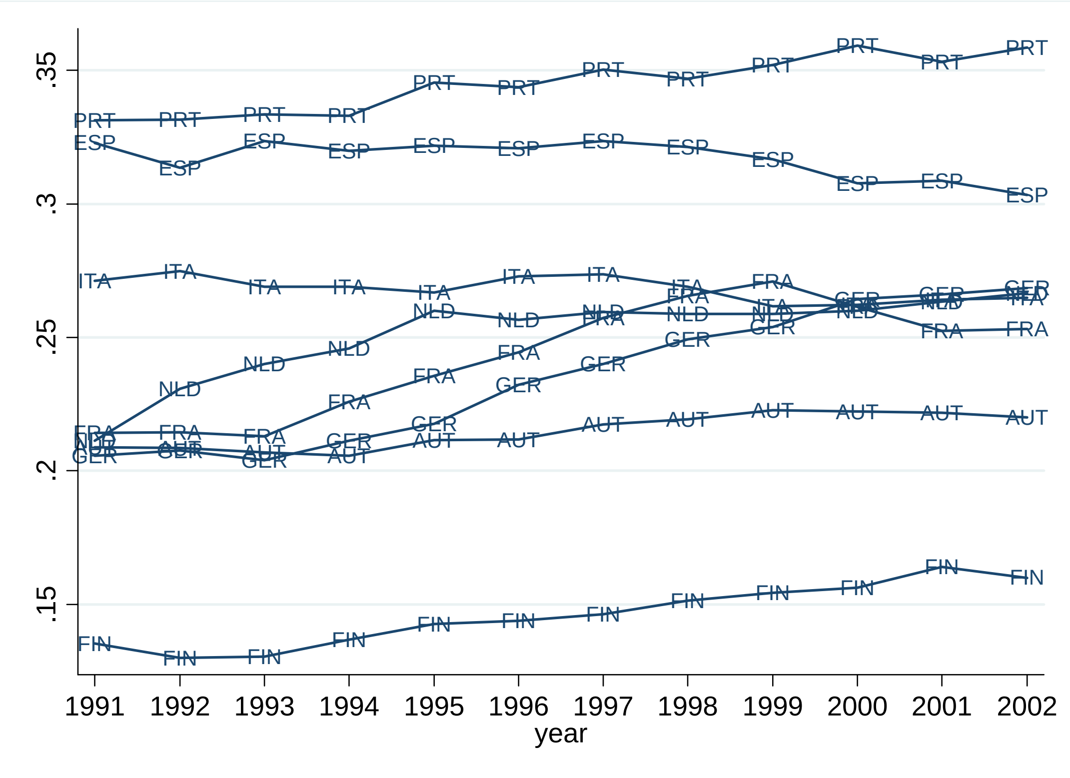
Deviations of industry wages from country averages.
Data source: OECD STAN.

Figure 3: Inter-industry wage differentials across time (1991-2002), euro area



Deviations of industry wages from euro area average.
Data source: OECD STAN.

Figure 4: Evolution of inter-industry wage dispersion within euro area countries



Weighted standard deviation of wage differentials.
Data source: OECD STAN.

Table 1: Preferred specifications: Panel GLS

	(1)	(2)	(3)	(4)
	ln(W/P)	ln(W/P)	ln(W/P)	ln(W/P)
SHAREYOUNG	-0.130***		-0.025	-0.084**
	(0.046)		(0.062)	(0.041)
SHAREOLD	0.109*		0.049	0.117**
	(0.065)		(0.087)	(0.059)
SHARELOWSKILL	-0.127***		-0.084	-0.095***
	(0.035)		(0.051)	(0.031)
SHAREHIGHSKILL	0.029		-0.104	-0.032
	(0.044)		(0.065)	(0.039)
SHAREPARTTIME	-0.368***		-0.117	-0.259***
	(0.050)		(0.073)	(0.044)
SHARETEMP	0.033		0.015	-0.005
	(0.041)		(0.056)	(0.037)
SHAREFEMALE	-0.159***		-0.039	-0.073**
	(0.038)		(0.052)	(0.034)
SHARESELF	-0.012		-0.032***	-0.045***
	(0.010)		(0.009)	(0.009)
LOGCAPINT		0.029***	0.048***	0.025***
		(0.007)	(0.009)	(0.006)
LOGPROD		0.225***	0.220***	0.260***
		(0.018)	(0.020)	(0.013)
SHARESIZE19		0.071	0.139*	
		(0.061)	(0.073)	
SHARESIZE49		0.037	0.116**	
		(0.049)	(0.059)	
SHARESIZE50+		0.063*	0.119***	
		(0.036)	(0.042)	
EXPINT		-0.033	-0.072**	
		(0.028)	(0.028)	
IMPPEN		0.060***	0.052**	
		(0.022)	(0.022)	
Observations	1613	769	656	1543
RHO	0.86	0.79	0.73	0.86

Estimation by panel GLS, allowing for first-order autocorrelation (RHO).
All specifications additionally include country, sector, and year specific effects.
Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: Sensitivity analyses I: Different covariates, sample restriction

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	LOG(W/P)	LOG(W/P)	LOG(W/P)	LOG(W/P)	LOG(W/P)	Y	Y
SHAREYOUNG	-0.025	-0.084**	-0.031	-0.005	-0.047	0.047	-0.022
	(0.062)	(0.041)	(0.046)	(0.066)	(0.040)	(0.052)	(0.037)
SHAREOLD	0.049	0.117**	0.078	0.069	0.085	0.054	0.091*
	(0.087)	(0.059)	(0.065)	(0.091)	(0.057)	(0.067)	(0.051)
SHARELOWSKILL	-0.084	-0.095***	0.014	-0.127**	-0.113***	-0.015	0.034*
	(0.051)	(0.031)	(0.039)	(0.052)	(0.030)	(0.028)	(0.021)
SHAREHIGHSKILL	-0.104	-0.032	-0.082*	-0.096	-0.014	0.063	0.106***
	(0.065)	(0.039)	(0.049)	(0.066)	(0.038)	(0.046)	(0.031)
SHAREPARTTIME	-0.117	-0.259***	-0.078	-0.130*	-0.277***	0.013	-0.160***
	(0.073)	(0.044)	(0.058)	(0.076)	(0.043)	(0.054)	(0.032)
SHARETEMP	0.015	-0.005	-0.069	-0.067	-0.081**	-0.003	-0.004
	(0.056)	(0.037)	(0.044)	(0.057)	(0.035)	(0.041)	(0.029)
SHAREFEMALE	-0.039	-0.073**	0.003	-0.031	-0.053	-0.049	-0.097***
	(0.052)	(0.034)	(0.039)	(0.053)	(0.033)	(0.041)	(0.030)
SHARESELF	-0.032***	-0.045***	-0.026***	-0.040***	-0.053***	-0.015*	-0.021**
	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.009)
LOGCAPINT	0.048***	0.025***	0.033***	0.051***	0.029***	0.017**	0.014***
	(0.009)	(0.006)	(0.006)	(0.009)	(0.005)	(0.007)	(0.005)
LOGPROD	0.220***	0.260***	0.225***	0.234***	0.280***	0.134***	0.161***
	(0.020)	(0.013)	(0.016)	(0.020)	(0.013)	(0.017)	(0.011)
SHARESIZE19	0.139*			0.158**		0.117**	
	(0.073)			(0.075)		(0.059)	
SHARESIZE49	0.116**			0.119**		-0.006	
	(0.059)			(0.060)		(0.048)	
SHARESIZE50+	0.119***			0.138***		0.153***	
	(0.042)			(0.042)		(0.032)	
EXPINT	-0.072**			-0.069**		-0.044	
	(0.028)			(0.028)		(0.028)	
IMPPEN	0.052**			0.050**		0.058**	
	(0.022)			(0.021)		(0.023)	
COUNTRY EFFECTS	yes	yes	yes				
SECTOR EFFECTS	yes	yes	yes			yes	yes
YEAR EFFECTS	yes	yes	yes				
COUNTRY TRENDS				yes	yes		
SECTOR TRENDS				yes	yes		
Observations	656	1543	906	656	1543	656	1541
RHO	0.73	0.86	0.83	0.69	0.86	0.84	0.89

Estimation by panel GLS, allowing for first-order autocorrelation (RHO).

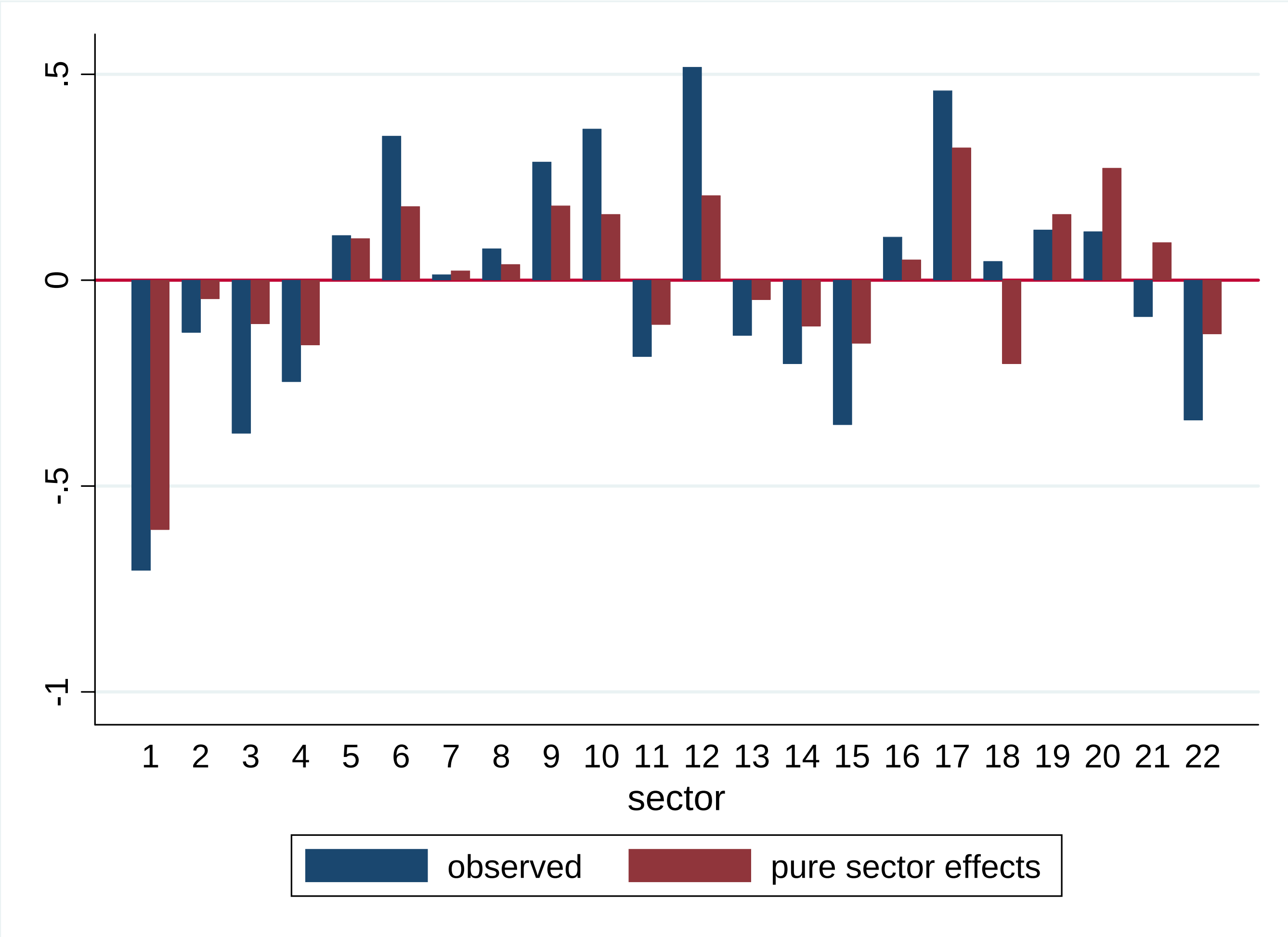
Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Sensitivity analyses II: Different estimation strategies

	(GLS) LOG(W/P)	(POLS) LOG(W/P)	(POLS_Lag) LOG(W/P)	(FD) LOG(W/P)	(FE) LOG(W/P)	(GMM) LOG(W/P)
SHAREYOUNG	-0.084**	-0.390***	0.004	0.058**	0.029	0.018
	(0.041)	(0.103)	(0.016)	(0.029)	(0.029)	(0.021)
SHAREOLD	0.117**	0.342**	0.006	0.005	0.050	0.022
	(0.059)	(0.158)	(0.037)	(0.043)	(0.039)	(0.026)
SHARELOWSKILL	-0.095***	-0.404***	-0.027**	0.040*	0.027	0.015
	(0.031)	(0.059)	(0.011)	(0.023)	(0.024)	(0.018)
SHAREHIGHSKILL	-0.032	-0.057	0.002	0.007	0.028	-0.017
	(0.039)	(0.079)	(0.012)	(0.027)	(0.028)	(0.024)
SHAREPARTTIME	-0.259***	-0.311***	-0.020*	-0.034	-0.057	-0.036
	(0.044)	(0.070)	(0.011)	(0.035)	(0.037)	(0.025)
SHARETEMP	-0.005	-0.031	0.005	-0.015	-0.013	0.024
	(0.037)	(0.081)	(0.012)	(0.026)	(0.026)	(0.021)
SHAREFEMALE	-0.073**	-0.290***	-0.004	-0.004	-0.001	0.006
	(0.034)	(0.068)	(0.011)	(0.030)	(0.024)	(0.021)
SHARESELF	-0.045***	-0.094***	-0.006***	-0.017*	-0.010	-0.030***
	(0.009)	(0.016)	(0.002)	(0.009)	(0.009)	(0.006)
LOGCAPINT	0.025***	0.045***	0.007***	0.023***	0.020***	0.021***
	(0.006)	(0.013)	(0.003)	(0.005)	(0.004)	(0.003)
LOGPROD	0.260***	0.311***	0.010***	0.138***	0.138***	0.088***
	(0.013)	(0.022)	(0.003)	(0.018)	(0.015)	(0.010)
LOGW/P(-1)			0.966***			0.655***
			(0.006)			(0.025)
Observations	1543	1545	1523	1345	1372	1323

Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.
(GLS) Estimation by panel GLS, allowing for first-order autocorrelation.
Additional controls: country, sector, and year effects.
(POLS) Estimation by pooled OLS, standard errors allowing for heteroscedasticity and first-order autocorrelation.
Additional controls: country, sector, and year effects.
(POLS_Lag) Estimation by pooled OLS, standard errors allowing for heteroscedasticity.
Additional controls: country, sector, and year effects. Test for autocorrelation: p-value = 0.951.
(FD) Estimation in first differences, standard errors allowing for heteroscedasticity.
Additional controls: country and sector effects. Test for autocorrelation: p-value = 0.403.
(FE) Estimation with (sector X country) fixed effects, allowing for first-order autocorrelation.
Additional controls: year effects.
(GMM) Estimation by two-stage GMM, instrumentation a la Arellano/Bond (1991).
Additional controls: year effects. Test for second-order autocorrelation: p-value 0.506.

Figure 5: Pure sector effects versus observed inter-industry wage differentials, euro area 2002



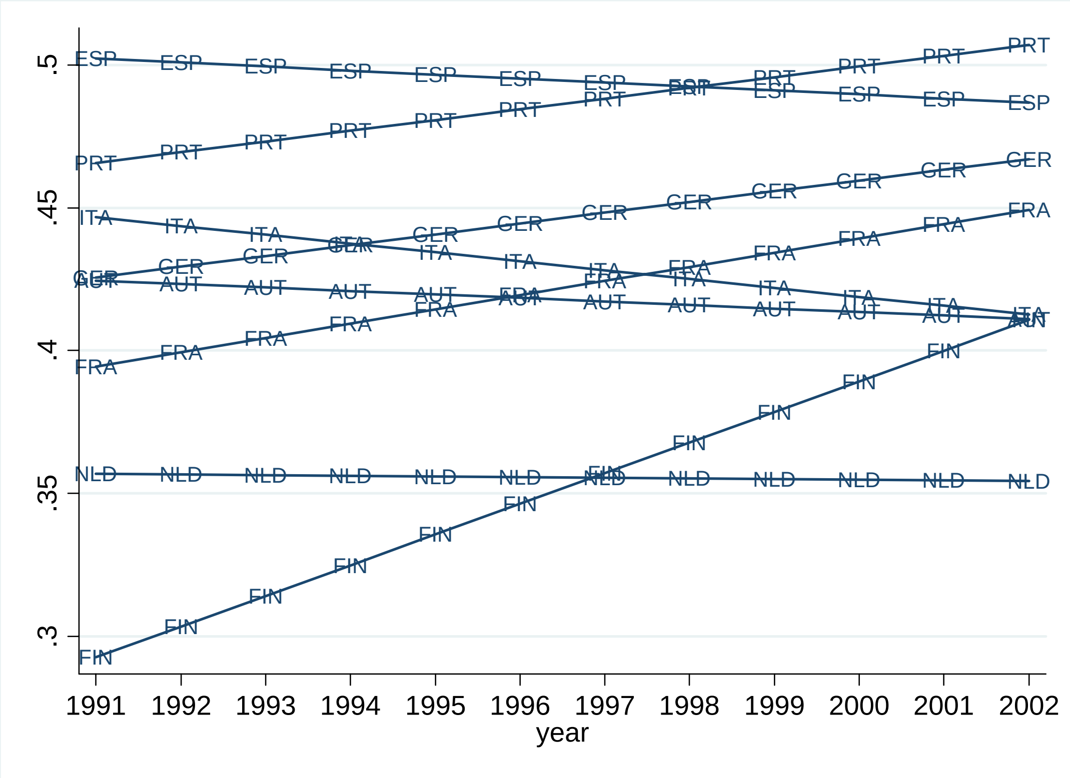
Observed: Deviations of industry wages from euro area average.
Pure sector effects: Weighted orthogonalised industry effects based on specification (4) of table 1.

Table 4: Regression of within-country wage dispersion

	(1) SIGMA	(2) SIGMA	(3) SIGMA
SHAREYOUNG	-0.280**	0.077	-0.294***
	(0.136)	(0.087)	(0.108)
SHAREOLD	0.319*	-0.036	-0.425***
	(0.170)	(0.130)	(0.149)
SHARELOWSKILL	0.134**	0.375***	0.104
	(0.053)	(0.066)	(0.068)
SHAREHIGHSKILL	-0.202***	0.026	-0.004
	(0.059)	(0.057)	(0.071)
SHAREPARTTIME	0.243***	-0.153	0.441***
	(0.043)	(0.099)	(0.116)
SHARETEMP	0.207***	0.041	-0.031
	(0.062)	(0.063)	(0.084)
SHAREFEMALE	-0.059	-0.057	-0.096
	(0.054)	(0.060)	(0.063)
SHARESELF	0.100	0.200**	0.181***
	(0.068)	(0.083)	(0.070)
LOGCAPINT	0.038	-0.072***	0.018
	(0.023)	(0.023)	(0.013)
LOGLABPROD	-0.096***	0.018	-0.061
	(0.028)	(0.060)	(0.057)
COUNTRY EFFECTS		yes	yes
YEAR EFFECTS		yes	
COUNTRY TRENDS			yes
Observations	70	70	70
RHO	0.72	0.20	0.01

Estimation by panel GLS, allowing for first-order autocorrelation (RHO).
Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%.

Figure 6: Country-specific trends in inter-industry wage dispersion within euro area countries



Country-specific time trends (including country base effects) based on specification (3) of table 4.