

Changes in the Wage Structure in EU countries

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Abstract

This paper studies changes in the wage structures in nine EU countries over the period 1995-2002. Using comparable cross-country microeconomic data, we compute, at each decile of the wage distribution, the part of the observed wage change that is due to changes in the composition of workers, employers and jobs' characteristics and the part due to changes in the returns to these characteristics, i.e. the so called composition and returns (or price) effects. Using the decomposition results, we show that exogenous or mechanical composition effects derived from changes in age, gender or education of the labour force had a minor contribution to the observed wage dynamics. In contrast, return and composition effects derived from changes in characteristics that could be driven by economic developments are found most relevant to explain the observed changes, thus pointing to an important role for demand, supply and institutional developments in shaping the wage distribution. To provide further evidence on this we relate changes in wages with macroeconomic and structural trends. We find that technology and globalisation are positively associated with wage increases; migration is associated with declines in wages; whereas the effect of labour market institutions has been mixed.

Keywords: *Wage Structure, Quantile Regressions.*

JEL Codes: J31

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1. Introduction

The determinants of relative wages, wage inequality and, in general, the wage structure are among the most recurrent themes in Labour Economics. Over the last two decades, studies on these topics have proliferated taking advantages of the wealth of microeconomic data sets that are becoming available, including those that contain matched employer-employee characteristics. This literature has provided relevant insights on the reasons for wage differentials among workers of different skills (i.e. returns to education, etc.), among similar workers performing different jobs (i.e. compensating differentials), theories of wage determination, the impact of labour market institutions on the wage structure, the nature of complementarities among production factors, or, most recently, wage dispersion within firms of some particular characteristics.

Most of these studies have focused on the US and the UK and have provided ample evidence that the wage distribution has been widening since the 1980s, but there is still an open debate about the nature, causes and timing of this trend. Some authors claim that the widening of the US wage distribution was an one-time event associated with changes in labour market institutions (de-unionisation, changes in the minimum wages) and mechanical compositional effects (exogenous changes in labour force features), while others claim that it has continued throughout the 1990s and 2000s and was due to skill-biased technological change.¹ This literature is too wide to be adequately quoted here (a comprehensive survey is Katz and Autor, 1999), with several other hypothesis apart from technological and institutional shifts being tested; among them, the impact of trade integration and the occupational bias in technological change reducing the demand for “routine tasks”.²

Regarding continental Europe, the conventional wisdom is that changes in the wage structure have been less marked than in the US and the UK.³ The prevalent explanation for this is that the lack of wage flexibility - largely seen as a consequence of strict labour market regulation - has resulted in wage compression, which is in turn responsible for the increase in unemployment among unskilled workers in the 1980s and early 1990s (Krugman, 1994). More recently, however, some studies have showed changes in the wage structure of some European countries that seem similar to those

¹For evidence on the first view see DiNardo et al. (1996) and Lemieux (2006a, 2006b); for evidence on the second, see Autor, Katz and Kearney (2008) and Machin and van Reenen (1998).

²Studies claiming that there has been a change in the relative demand for skills originated in the technology are, for instance, Bound and Johnson (1992), Krueger (1993), Berman, Bound, and Griliches (1994), Autor, Katz, and Krueger (1998), Machin and van Reenen (1998) and Chennells and van Reenen (1999). On the impact of institutions, see DiNardo et al. (1996); on trade integration and the wage structure, see Lawrence and Slaughter (1993) and Leamer (2000). On the “routinization” hypothesis, see Autor, Levy and Murnane (2003) and Goos and Manning (2007). Regarding wage dispersion within firms, see Lazear and Shaw (forthcoming).

³Table A1 reports some raw statistics of wage inequality in the countries of our sample.

observed in the US but have happened a few years later. For example, the 2007 OECD Employment Outlook (OECD, 2007) shows a widening of the wage distribution from 1994 to 2005 in the vast majority of the OECD countries (with the exception of Ireland, Japan and Spain). Similarly, Koeniger, Leonardi and Nunziata, (2007) document increasing inequality for a number of OECD countries using macro data. Recently, some country-specific European studies using micro data have also documented sizeable changes in the wage structure (see, for example, Machado and Mata (2005) for Portugal, and Schönberg, Dustmann and Ludsteck (2009) for Germany).

To this date, however, there is little systematic accounting of cross-country differences in wage dynamics in EU countries over the past decade,⁴ and this is due to one main difficulty; namely, the lack of comparable microeconomic data that could allow the computation of wage variables after controlling for workers and job characteristics. Any existing cross-country studies on wage-changes rely on imperfectly comparable indicators of wage inequality or dispersion obtained from various sources. Without controlling for predetermined changes in personal and job characteristics, though, such cross-country comparisons of wage changes are contaminated by employment compositional effects and, therefore, any observation of how the wage structure has been adjusting in response to macroeconomic shocks and institutional changes is blurred. The current paper is an attempt at filling this gap.

Our sample is composed of nine countries (Austria, Belgium, Germany, Greece, Hungary, Italy, Ireland, the Netherlands and Spain) over the period 1995-2002 (with some exceptions) for which comparable cross-country microeconomic data (from the *Structure of Earnings Survey*) are available. The period of analysis, although imposed by data availability, is very interesting for the countries examined, being characterised by substantial labour demand shocks, as derived, for instance, from technological change and globalisation, as well as significant labour supply shocks, such as those coming from demographic trends (e.g. immigration, population ageing, and changes in female participation and in the composition of the labour force by educational levels, etc.). Deregulation in product markets and labour market reforms have also been prevalent, affecting the way labour markets operate. In this respect, Table 1 provides some indicators showing substantial time and cross-country variations in terms of some macroeconomic developments, such as GDP

⁴Recent work on wage differentials for European countries includes several papers produced within the Pay Inequality and Economic Performance project (PIEP) which used 1995 data (see Marsden, 2005). Currently, several studies within the Wage Dynamic Network (WDN) analyse relative wages across industries using 1995 and 2002 data. Du Caju et al (2010) summarise the WDN evidence on industry wage differentials for a sample of 8 EU countries. In addition a number of detailed country specific projects that look at changes in the wage distribution along deciles are ongoing work within the WDN (see Pointner and Stiglbauer, 2008, for Austria, Dybczak and Galuscak, 2008 for Czech Republic, and Christopoulou and Kosma, 2009 for Greece).

growth, trade balance, productivity growth, female labour participation, immigration flows and wage-setting institutions. For instance, this is a period of increasing openness (as shown by variations in the trade balance and the globalization index), increasing GDP growth only in Greece and Hungary, low productivity growth (even negative in Spain and Italy) with increasing contribution of Information and Communication Technologies (ICT), increasing female labour force participation, and large immigration flows in Greece, Ireland, Italy and Spain.

Table 1a. Indicators of growth, trade and technology

Period	Real GDP growth		Trade balance of goods and services as a % of GDP		Dreher Globalization index		TFP (value added based) growth		Contribution of ICT capital services to output growth	
	c.1995	c.2002	c.1995	c.2002	c.1995	c.2002	c.1995	c.2002	c.1995	c.2002
Austria	2.23	1.65	-1.5	4.2	85.7	91.0	99.8	103.4	0.4	0.5
Belgium	3.42	1.85	3.1	2.7	93.1	92.1	98.6	97.4	1.1	0.6
Germany	1.89	1.24	-0.9	2.1	71.4	83.0	100.0	103.5	0.3	0.5
Greece	2.10	3.44	-2.4	-6.4	60.7	72.7				
Hungary	1.32	4.15	0.0	-3.9	75.3	80.1	105.8	124.3	-1.1	0.5
Ireland	9.63	6.43	10.4	16.7	78.7	84.0	100.0	112.8		0.1
Italy	2.83	0.45	3.9	0.1	71.3	79.3	100.0	98.4	0.2	0.2
Netherlands	3.12	0.08	6.2	5.2	88.0	89.7	100.0	101.6	0.3	0.3
Spain	2.76	2.70	-0.2	-3.8	75.2	82.7	100.0	94.8	0.3	0.2

Notes: Data for trade balance and real gdp growth are taken from OECD. Stat. The technology indicators are derived from the EUKLEMS 2008 database. The globalization index is from Dreher (2006). c.: circa

Table 1b. Indicators of demographics and labour market institutions

Period	Female labour force participation rate		Proportion of foreign labour force		Union density		Bargaining coordination	Bargaining centralization
	c.1995	c.2002	1996	2002	c.1995	c.2002	2000	2000
Austria	61.5	63.9	10.0	10.9	40.1	35.4	2.0	2.0
Belgium	56.2	59.7	8.4	8.6	55.1		2.0	2.0
Germany	61.5	64.3	8.9	9.2	29.2	23.5	2.5	2.0
Greece	45.2	51.6	3.7	5.5	29.2	23.2		
Hungary	50.2	52.9	0.5	1.0	63.4	19.9		
Ireland	47.8	57.8	3.5	5.5	47.1	35.7	3.0	3.0
Italy	42.8	48.4	2.9	3.8	38.1	34.0	2.5	3.0
Netherlands	59.3	66.7	3.9	3.7	25.7	22.1	3.0	2.0
Spain	47.5	53.9	1.0	4.5	16.3	13.9	2.0	2.0

Notes: Data for female labour force participation and proportion of foreign labour force are taken from OECD. Stat. Union density, bargaining centralization and bargaining coordination indicators are from the OECD-CEP (2006) database, supplemented with some data from national sources for Greece and Hungary. c.: circa.

By using Mincerian (quantile) wage regressions and the Machado and Mata (2005) procedure, we compute at each decile of the wage distribution for each of the nine countries in our sample, the part of the observed wage changes that is due to changes in the composition of workers' and jobs characteristics, and the part of wage changes that is due to changes in the returns to these characteristics (i.e. the composition and price components of wage changes). As the data makes it possible to control for both personal and job characteristics, we take a step forward from the type of

exercises performed in the wage inequality literature, in which only changes in returns to personal characteristics such as education, gender, and age are analysed, by also including jobs characteristics as covariates in the estimated regressions, so that changes in the remunerations to specific workers-jobs matches can be observed. Thus, while in the inequality literature the main goal is to measure changes in the returns to personal (predetermined) characteristics such as gender, age, and education, here we are also concerned on changes in the returns to specific worker-job matches, described by the combination of observable personal and job characteristics.

Obviously, composition effects, computed considering both personal and job characteristics, can no longer be assumed as independent of market forces, as they now include quantity-side adjustments to demand and supply shifts (e.g. changes in sectoral composition, firm size, etc). But the associated return effects can properly be interpreted as the “price” of a “specific job task”, as defined by both worker and job characteristics. Hence, this component of wages provides a better indication of the prevalence of relative wage rigidities than the overall wage change or wage changes resulting after controlling only for predetermined personal characteristics. Moreover, given that the decomposition analysis is conducted for each covariate separately, we are able to separate any composition effects that may be responsive to market forces from those that are largely predetermined. Thus, we can observe two different measures of market-driven wage changes; one that reflects the effect of market forces on the returns to characteristics only, and one that also includes the effect of market forces that takes place via quantity/composition effects.

We find substantial differences across countries regarding changes in the wage structure. Specifically, in the Netherlands, Germany, Greece, Italy and Belgium wage growth rates trend upwards along the wage distribution, with the consequent widening of the wage distribution. In contrast, in Hungary, Ireland and Spain the wage distribution has become more compressed, as the larger wage increases have taken place for low paid jobs. Lastly, the wage distribution in Austria has remained roughly unchanged. We also find that purely mechanical/predetermined compositional changes have hardly contributed to the determination of the observed wage changes, and that wage changes have been generally driven by components that are responsive to economic factors. In fact, the compression of the wage distribution observed in Spain, Hungary and Ireland is mostly due to changes in return effects, while the widening of the distribution in the Netherlands, Germany and Greece is mostly attributable to composition effects that are not purely mechanical or predetermined (age, gender, etc.). This evidence points to a relevant role for economic developments in shaping wages changes. To further investigate this claim we relate changes in wages with macroeconomic developments and structural trends; we do so for observed wage changes, as well as for wages changes net of mechanical composition effects and wage changes net

of total composition effects, i.e. returns effect. We show that changes in technology are positively associated with wage increases, with the effect being stronger for very high and very low paid jobs; globalisation is associated with wage increases, but less so for the lowest wages; increases in migration are associated with declines in wages; and, finally, the effect of labour market institutions on wage changes differs among institutional indicators (increases in union density bring about wage drops, while high levels of bargaining centralization or coordination are associated with wage increases).

The paper has the following structure. Section 2 describes the data and the methodological approach for measuring changes in the wage distribution. Section 3 displays the main results regarding the changes in wage structures in EU countries, and the component of these changes. Section 4 interprets these changes in relation to cross-country variability in institutions, macroeconomic and structural trends. Finally, Section 5 concludes.

2. Data and methodology

Our database comprises microdata from the *Structure of Earnings Survey* (SES henceforth) for two time waves. The SES data is collected at the firm level: a large sample of firms randomly selected from the Social Security General Register records or similar firm registers is interviewed to obtain information on both the firm's characteristics and on a random sample (ca. 20%, depending on the size of the firm) of their employees. Information obtained about the workers includes several measures of the pay and hours of work, age, gender, and educational attainment, while information obtained about the job or the employer refers to the type of contract, the sectoral and occupational classification, tenure, firm ownership status, firm size, the nature of the pay bargaining regime etc.

The SES is uniquely suitable for our study as (i) it is comparable across countries: this survey has been run by the national statistical office of 20 European countries on comparable basis, first occasionally and now every four years, so that currently two harmonised waves exist, 1995 and 2002, (ii) it is a matched employer-employee database and, therefore, will allow us to estimate Mincer equations controlling for individual, job-specific and firm-specific features and, thus, to “condition out” from observed wage changes composition effects from workers characteristics as well as from employers and job's characteristics and (iii) its data is collected at the firm level, which gives us more accurate information on pay and earnings, variables that are usually very noisy in household surveys.

However, not all the data for EU countries and waves are made available for research. So far, we have been able to gain access to data for nine countries (Austria, Belgium, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, and Spain).⁵ After excluding outliers, the top and bottom 1% wages, workers with missing/not accurate observations for some relevant variables, and those in sectors that were missing for most of the countries and or waves (mainly education, health and recreational activities), we end up with the country-samples sizes shown in Table 2. The large number of individual observations allows us, first, to construct detailed measures of earnings including or excluding several kinds of wage components, and, secondly, to control for detailed personal and/or jobs characteristics so that changes in the remuneration of particular “tasks” can be measured.

Table 2. Sample size per country and wave

	1st wave			2nd wave		
	1995	1996	1999	2001	2002	2005
Austria		93,941			85,481	
Belgium			101,302			97,409
Germany	652,676			467,932		
Greece	38,071				41,449	
Hungary		91,578			119,019	
Ireland	36,727				16,359	
Italy	79,501				73,692	
Netherlands	66,196				37,860	
Spain	170,697				173,487	

Observed wage changes can be thought as the result of the changes due to the different characteristics of workers and jobs and the changes in the returns to those characteristics. To separate these two components we rely on the estimation of extended Mincer (1974) equations for log (real) hourly wages using quantile regressions, as follows:

$$\ln w_{it}^g = Q^\theta(\ln w_{it} / X'_{it}) + \varepsilon_{it} = \alpha_{it}^g + \sum_j \beta_{jt}^g X_{jit}^g + \varepsilon_{it}, \quad Q^\theta(\varepsilon_t / X'_{it}) = 0 \quad (1)$$

where w_{it} is the wage of individual i in year t , $Q^\theta(\ln w_{it} / X'_{it})$ refers to the quantile of wages conditional on the vector of characteristics X_{it} and g denotes the quantile. α is a constant, and ε is the stochastic error.

⁵Results for Greece have been borrowed from Christopoulou & Kosma (2009), which is also a WDN research paper, follows the same methodology and uses same data and codes as this paper. Estimations for Italy, Ireland and Spain were done at the Safe Center in Eurostat and the ones for Germany via remote access at Statistics Germany. Alfred Stiglbauer, Philip Du Caju, Steven Poelhekke and Gabor Katay were kind enough to run our codes on the Austrian, Belgian, Dutch and Hungarian SES data available at their respective national central banks.

We have used three different variables measuring individual wages: basic hourly wage excluding payment for overtime; hourly wage including regular bonuses and payment for overtime; and hourly wage including irregular bonuses and other complements. We only show here results for hourly wage including regular bonuses and payment for overtime. We choose this variable for the sake of comparability with other SES studies that have also used it, and because we can construct it for practically all the countries and waves of our sample.⁶ The covariates, X_{jit} , include workers' characteristics (education, gender, age) and employers' and job observable features (type of contract, sector, region, etc., in most occasions captured by dummies). We apply the procedure proposed by Machado and Mata (2005) that partitions the observed changes in the distribution of wages into quantity (changes in characteristics) and price (changes in returns) components, and that computes the impact of each one of these components on changes in overall wage dispersion. Machado and Mata (2005) do this via simulations based on mean characteristics of the individuals who are in each one of the quantiles of the wage distribution.⁷ Taking averages by quantile and subtracting between two periods, equation (1) yields:

$$\ln w_{t_1}^g - \ln w_{t_0}^g = (a_{t_1}^g - a_{t_0}^g) + \sum_j \beta_{t_1}^g (\bar{X}_{jt_1}^g - \bar{X}_{jt_0}^g) + \sum_j (\beta_{t_1}^g - \beta_{t_0}^g) \bar{X}_{jt_0}^g + (\bar{\varepsilon}_{t_1}^g - \bar{\varepsilon}_{t_0}^g) \quad (2)$$

where w_t^g is the g^{th} quantile of the wage distribution in year t , \bar{X}_{jt}^g is the vector of mean characteristics of quantile g and year t , and $\bar{\varepsilon}_t^g$ is the mean of the unobserved component. From this, the wage change for each quantile can be decomposed into:

- A quantity component (the composition effect): $\sum_j \beta_{t_1}^g (\bar{X}_{jt_1}^g - \bar{X}_{jt_0}^g)$. This represents the wage changes that would have occurred due to changes in employer or employee observable characteristics if the returns to these characteristics had remained unchanged. Composition effects may reflect mechanical changes that do not respond to market forces (e.g. predetermined or largely predetermined changes in the composition of education, age, sex of the labour force etc.) or they may reflect adjustments that respond to economic developments (e.g. sectoral shifts, changes in type of contracts, etc.).⁸

⁶Except for Hungary, for which we cannot calculate the payment for overtime in the first wave (1996) and we use a measure that excludes that payments, nevertheless we believe that this is a good proxy as paid overtime is very low in Hungary and the variables with and without overtime payment in 2002 in Hungary are very similar.

⁷The Machado and Mata method is an extension of the canonical Oaxaca (1973) decomposition of effects on mean wages to the entire wage distribution. Autor, Katz and Kearney (2005) show that the Machado- Mata decomposition corrects shortcomings of the original Juhn, Murphy and Pierce (1993) decomposition and nests the Kernel reweighing in DiNardo, Fortin and Lemieux (1996), Lemieux (2002) and Lemieux et al (2007).

⁸ The covariates included in the wage regression are: age, gender, education, tenure, industry, type of contract, firm size, region, occupation, market, public firm, and full vs. part time workers. Interactions among covariates are not included.

- A price component (the returns effect): $(a_{t_1}^g - a_{t_0}^g) + \sum (\beta_{t_1}^g - \beta_{t_0}^g) \bar{X}_{jt_0}^g$. This is due to changes in the returns to the characteristics only. Specifically, under the assumption that the characteristics remained unchanged, this term includes changes in the constant (i.e. due to changes in unobservable features common among all employees and/or changes in the coefficients of the omitted dummies) and changes in the returns to the observable characteristics. Price or returns effects arise exclusively from shifts in supply and demand and from institutional changes.
- An unobserved or residual component: $(\bar{\varepsilon}_{t_1}^g - \bar{\varepsilon}_{t_0}^g)$. This is due to changes in the remaining unobserved factors determining wages, which are not common among employees.

These counterfactual decompositions are accounting decompositions based on the estimated model (1), and their validity relies on the partial equilibrium assumption that prices and quantities can be seen as independent. This could introduce some bias in the estimation of the components as it ignores the feedback between composition and returns.

3. Wage changes and their components

Figure 1 provides an overview of the magnitude and patterns of the changes observed at each decile of the wage distribution in observed (log) hourly wage (incl. overtime), in hourly wage net of predetermined compositional changes, and in the part of hourly wage attributable to price effects only. Figure 1a refers to the whole sample, while figures 1b and 1c refer to the males and females sample, respectively.⁹

Looking first at the observed changes in real wages during the sample period (navy line), they have been mostly positive along the whole range of wage levels in the nine countries of our sample, with the only exceptions being wages of the lowest paid jobs in Germany and Greece and wages in the middle part of the wage distribution in Spain. Both the magnitude and shape of the changes observed in real wages differ substantially across countries. Observed real wages in the Netherlands, Germany, and Greece have increased more the higher the wage level, i.e. real wages changes trend upwards along the wage distribution, with the consequent widening of the wage distribution and an increase in wage inequality. A widening of the observed wage distribution is also observed in Belgium and Italy, but less pronounced. In contrast, the wage distribution in Hungary, Ireland, and to a lesser extent in Spain has become more compressed. In fact, the observed

⁹ In addition, a set of summary indicators of changes in the wage distribution by country is presented in Table A2 in the Appendix.

increase in real wages in these countries has been lowest in the middle part of the wage distribution while the largest increases have taken place for low paid jobs. Finally, in Austria wage changes from 1996 to 2002 are positive, very small and similar along the whole distribution with no noticeable effect on the wage distribution.

This diversity in the patterns of wage changes across countries suggests that there might be an analogous diversity in the forces driving the observed changes. More specifically, the upward sloping pattern of wage changes along the wage distribution in Germany, Greece, Italy, Belgium and the Netherlands, is a standard symptom of the conventional skill-bias technical change hypothesis, suggesting the presence of forces that favour the more skilled and better paid workers. In contrast, the “U-shaped” pattern of the wage changes along the wage distribution observed in Spain, Hungary, and Ireland is an indication of the “routinization” hypothesis; i.e. it has been typically identified as being driven by technological changes that replace routine jobs or jobs that require intermediate skills, generally found in middle-wage jobs.¹⁰ Finally, the absence of any substantial movement in wage inequality in Austria could raise considerations regarding labour market institutions.

It is clear, however, that, in order to obtain reliable evidence on how the wage structure has been adjusting in response to cross-country variability in macroeconomic developments and institutional changes, it is necessary to ‘clean’ the observed wage changes from the influence of predetermined compositional changes that are not responsive to market forces. This is something that is customarily done in the literature of wage inequality when analysing “residual inequality” (or inequality within the same age, education and gender groups), by estimating ‘simple’ Mincerian equations (i.e. wage equations controlling only for employee characteristics) and “conditioning out” the part of the observed wage changes that is due to changes in the age, gender and education composition of the labour force.

In our case, as we have already mentioned in our methodology section, taking advantage of the nature of our data that allows controlling for a rich set of both workers and jobs’ characteristics, we

¹⁰The ‘routinization’ or job-polarization hypothesis is a recently developed variant of the skill-biased technical change hypothesis. It has been developed and supported by empirical evidence in a group of studies (see Autor, Levy and Murnane 2003; Goos and Manning, 2007; Autor, Katz, and Kearney, 2008) that puts emphasis on the role of information technology as a driver of the complexity of the pattern of wage changes in the US and the UK. They argue that computers most strongly complement the non-routine tasks of high-wage jobs, substitute for the routine tasks typical of middle-wage jobs, and may have little direct impact on non-routine manual tasks in relatively low-wage jobs. Thus, computerisation can help to explaining the observed polarization of the US and UK labour markets characterized by middle range wages and jobs growing the least, high-wages and jobs growing the most, and low wages and jobs remaining basically unchanged.

depart somehow from the inequality literature and we estimate a model that includes not only personal characteristics (age, education, sex) but also jobs characteristics (industry, type of contract, firm size, region, etc).¹¹ As a result, we can estimate the compositional changes both of the employee characteristics, which can be assumed as predetermined, and of the job/employer characteristics, which are expected to be largely responsive to economic developments, with only a few exceptions. Thus, we are able to define the two alternative measures of composition-conditional wage changes also plotted in Figure 1. The first one, displayed as a green dotted line, represents wage changes net of the composition effects of age, education, gender, and region, (i.e. the characteristics that we regard to be predetermined or largely predetermined) and is bound to include some ‘noise’¹². The second one, displayed as a red dotted line, represents the part of changes in wage attributable to price or returns effects only; i.e. wage changes that are net of (i) the composition effects of all the variables in the regressions, including both predetermined characteristics (as above) and a large number of individual, employees and job’s characteristics which cannot be regarded as immune or irresponsive to economic developments; and (ii) of a small error term from the estimation.

As can be clearly seen in Figure 1a, when plotting wage changes net of predetermined compositional effects, the resulting line in most countries is either very close to the line of observed (gross) wage changes or it is more or less parallel to this line.¹³ The only exceptions are the Netherlands at the first wage decile, and Austria, which is not a very interesting case in this respect, as wages there have moved very little. This evidence suggests that exogenous or predetermined compositional effects have played hardly any role in shaping the distribution of wage changes and they have also had a negligible contribution both to the determination of mean wage (excl. the cases of Ireland and Italy). Interestingly, this is despite the fact that exogenous changes in the employment composition taking place in European countries over this period have been large. To this end, Table A2 is very illustrative, showing that, firstly, there has been a significant rise in the weight of female employment, most noticeably in Southern European countries, Ireland, and the Netherlands, but also in Central Europe, especially among the top deciles. Secondly, educational

¹¹ The estimated models work, overall, rather well, so the residuals explain a very small proportion of the total change. See figures A1a-A1c in the Appendix for the break down of the wage changes by country - a more detailed decomposition is available from the authors.

¹² We have been quite ‘conservative’ on what we classify as a predetermined characteristic (mainly the employee characteristics that are usually included in ‘simple’ mincer equations and region), because the composition of the remaining characteristics (tenure, sector, occupation, firm size, contract type, ownership status) is expected to be significantly affected by market forces. Still, market forces are not expected to be solely responsible for the entire compositional shift in these characteristics – a part of this shift is bound to be mechanical, thus introducing ‘noise’ in the net measure of wage changes, if that is to be taken as reflecting market-driven wage changes.

¹³ Similar patterns, with small variations prevail if only the effects of age, gender, and education are conditioned out from observed wages after estimating the extended version of equation (1), as well as after estimating a simple Mincer equation, including only workers characteristics.

levels, as measured by years of schooling, increased in all the deciles of the wage distribution for all countries (with the only exception of the Netherlands, in the lowest deciles). Finally, there is also an increasing trend in employee's age (except for Spain and Greece).

The little role played by predetermined composition effects suggests that the observed wage changes are mostly shaped by those wage components that are responsive to market forces and institutional changes; namely, by the non-exogenous compositional changes¹⁴ and the changes in returns. When looking at returns effects, it appears that for the Netherlands, Germany and Greece these are roughly constant along the whole wage distribution, thus, suggesting that the observed increase in wage inequality is mostly attributable to compositional changes that are not purely exogenous to economic conditions. These changes have been negative for the low and middle wage jobs in all three countries, mostly due to changes in tenure levels for Greece; change in firm size and permanent contracts composition for Germany; and changes in permanent and sectoral composition for the Netherlands.

In Ireland, Hungary and Spain the return effects display a U-shape similar to the one of observed wage changes or even strengthened. Return effects are the predominant force explaining the compression of the wage distribution in these countries, while composition effects are less but not negligibly relevant for the observed changes. More specifically, in Spain market-responsive composition-effects also form a U-shape pattern across the distribution, thus reinforcing the contribution of the returns effects to wage compression. In Hungary these composition effects have been sizeable enough across the distribution to keep wages subdued, while in Ireland composition effects account for some improvement of wages at the top of the distribution. In the case of Spain the largest negative component of the changes in wages is due to changes in tenure composition, while in Hungary other job characteristics dominate the compositional effects.

In Belgium and Italy the predominant force explaining the slight widening of the observed wage distribution is also the return effects, but somehow similarly to what happened in the case of Spain, composition effects have been varying substantially across the wage distribution. Interestingly, in Italy the two effects work against each other (i.e. market-responsive composition effects work towards lower wage inequality, while return effects work towards higher wage inequality and dominate, thus resulting in the mild widening of the wage distribution), while in Belgium the two

¹⁴ Apart from exogenous changes in employment composition, Table A2 also shows that not-purely-exogenous changes have also been substantial, e.g. those regarding job-specific tenure and type of job (permanent and full-time versus temporary and part-time). Other such changes, e.g. regarding sectors of activity, and occupations (not reported) are also prevalent.

effects reinforce each other, both being upward sloping along the wage distribution. Finally, in Austria, the very small wage changes from 1996 to 2002 do not hide any composition and return effects working in opposite directions, but simply these return and composition components hardly change along the wage distribution.

It is notable that, while composition effects have been negative in Ireland, Belgium, Italy and Austria (very small in the last three cases), returns effects have been positive for all the nine countries of our sample, except for Italy at the lower end of the wage distribution. This result for Italy is consistent with the opening wage gap between younger new entrants and older workers in Italy as documented in Rosolia and Torrini (2008).

Figure 1a. (Log) Wage changes by decile, all

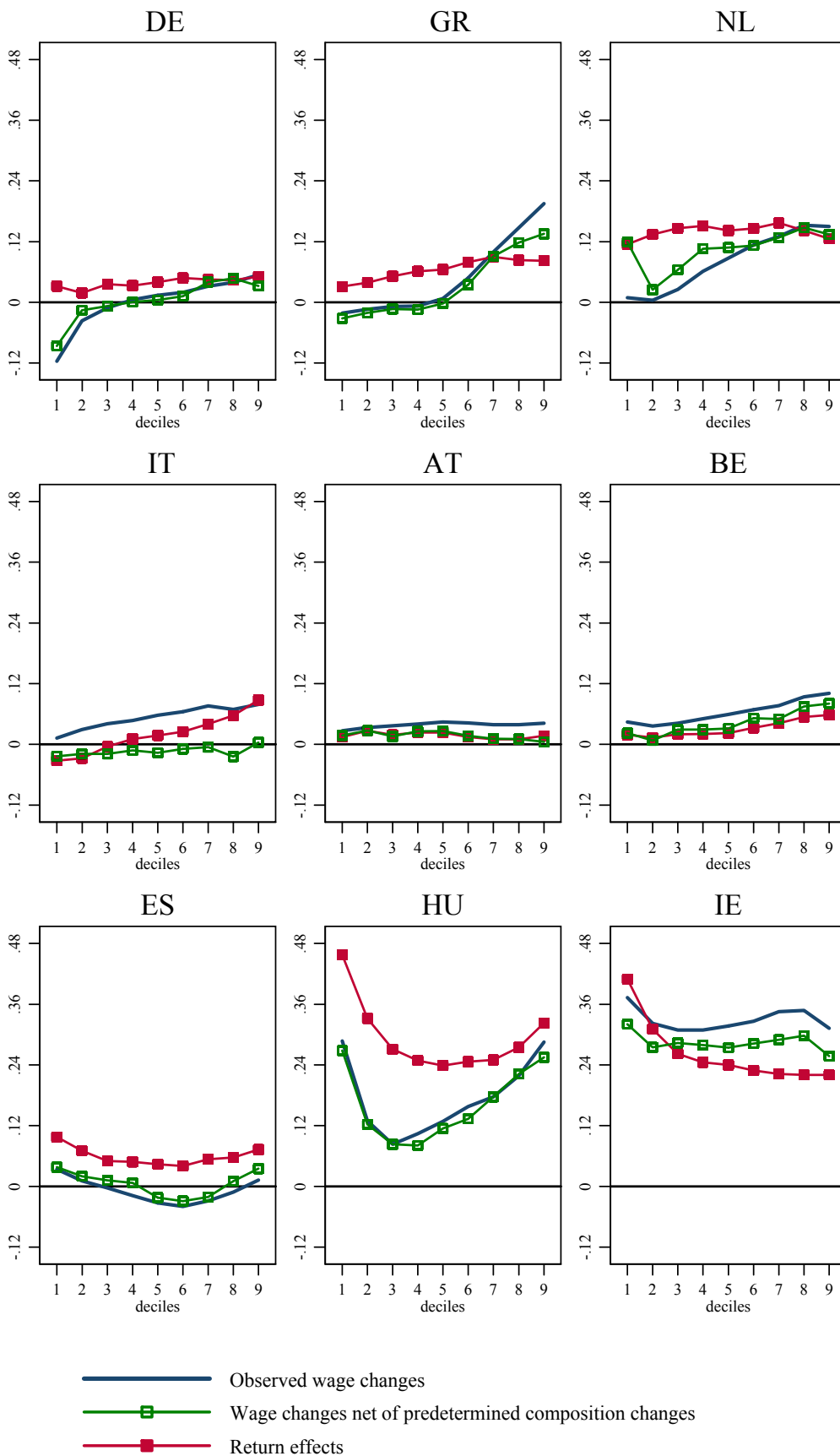


Figure 1b. (Log) Wage changes by decile, males

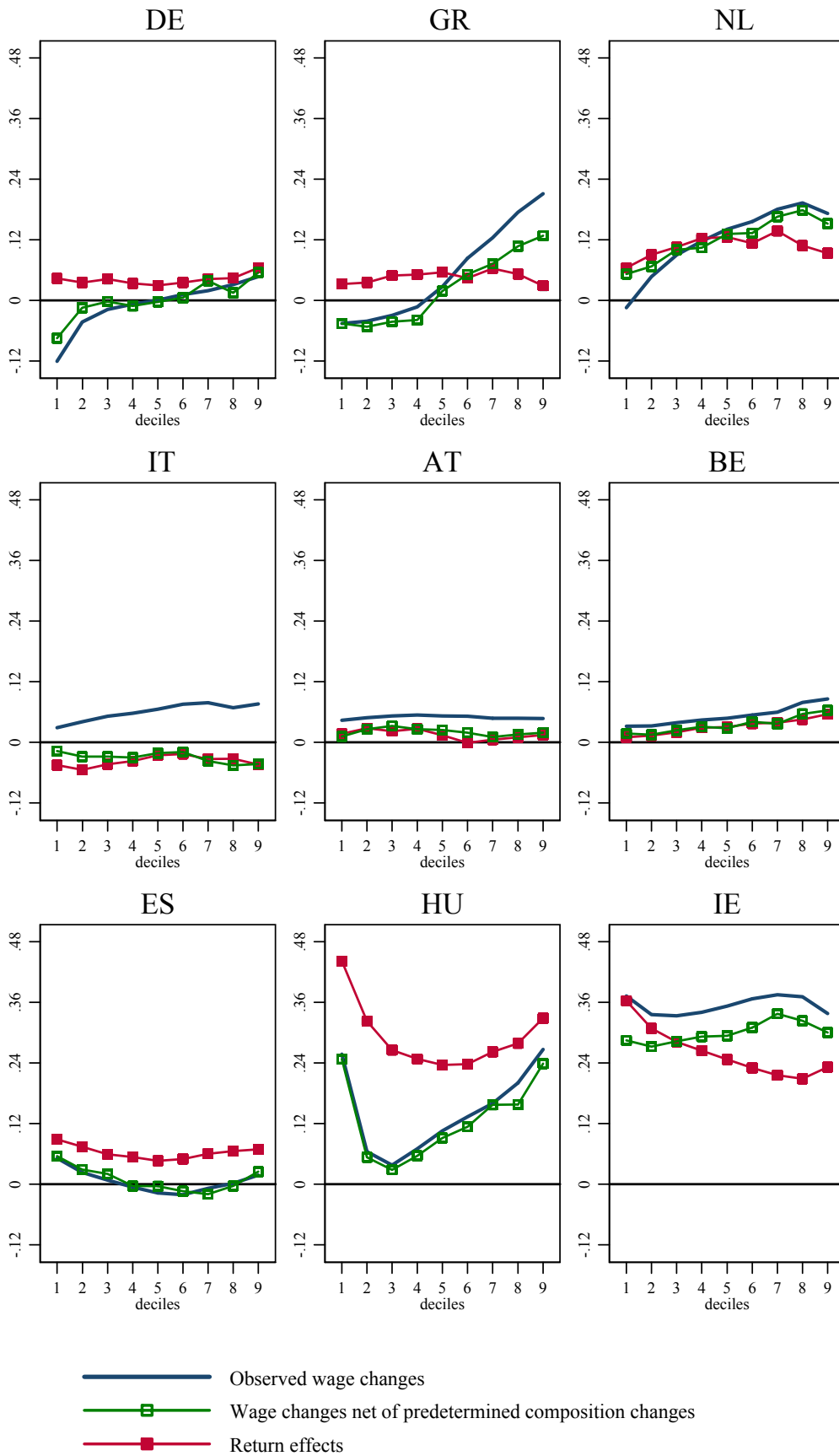
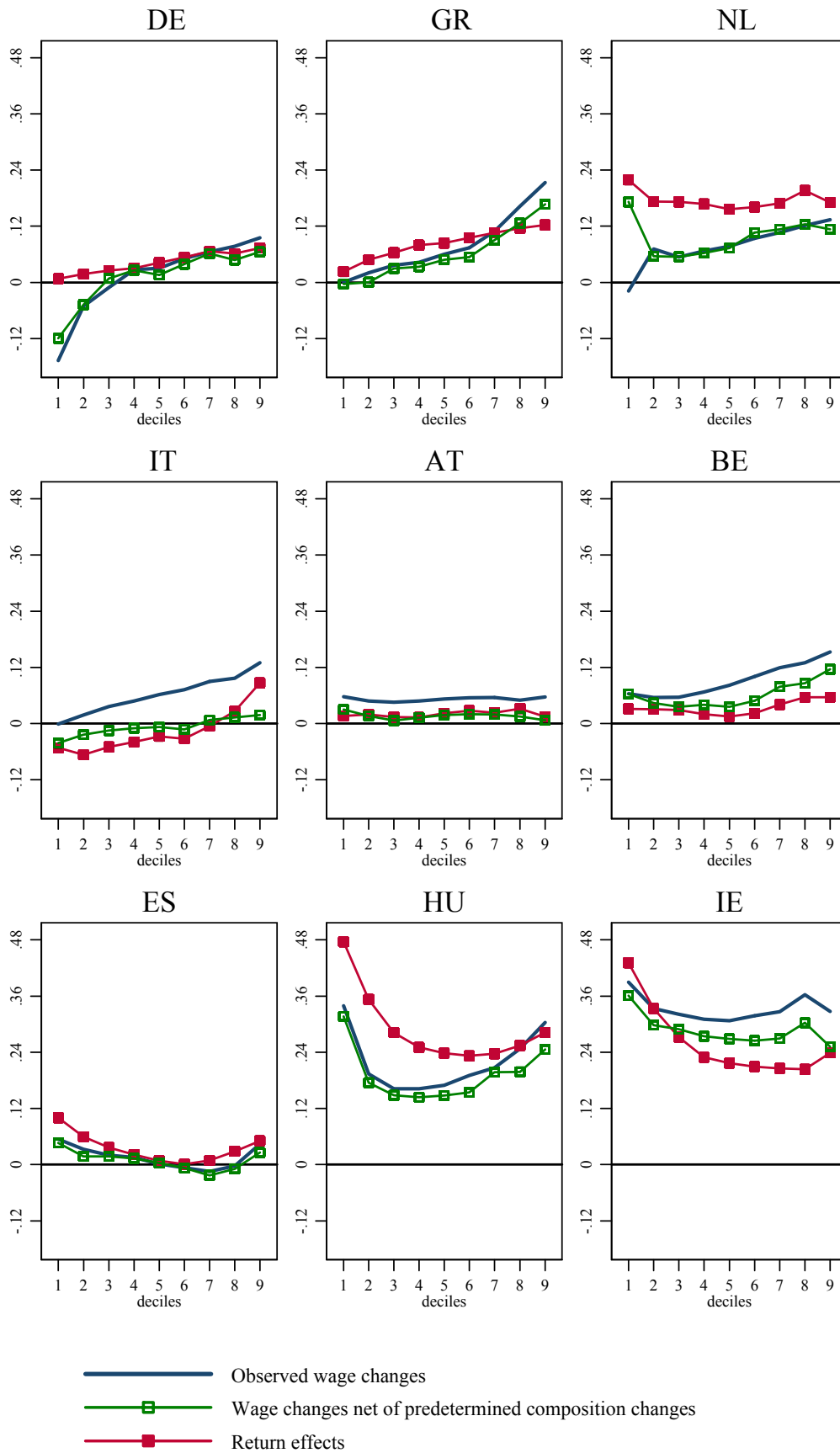


Figure 1c. (Log) Wage changes by decile, females



In order to give a more general view of the changes in wages reported above, Table 3 summarizes mean changes in each of the our three wage measures (observed wage changes, wage changes net of predetermined compositional changes and wage changes due only to returns) across countries in three segments of the wage distribution; the three lowest, middle, and top deciles (conditional on country effects)¹⁵. For observed wages and wage-changes net of predetermined compositional changes, regardless of the sample used (all, males, and females), the changes are increasing along the distribution. However, once all compositional effects and any non-observables are “purged out”, there is clear evidence of some “polarisation” in the distribution of wage changes, with highest increases at the three lowest and the three top deciles.¹⁶

Table 3. Mean Observed Wage Changes and Mean Changes in Returns

	ALL			MALES			FEMALES		
	Observed wage changes	Net wage changes	Changes in returns	Observed wage changes	Net wage changes	Changes in returns	Observed wage changes	Net wage changes	Changes in returns
three lowest deciles	-0.031 [0.016]*	-0.017 [0.012]	0.038 [0.009]***	-0.040 [0.014]**	-0.016 [0.011]	0.046 [0.006]***	-0.033 [0.026]	-0.017 [0.021]	0.041 [0.016]**
three middle deciles	-0.001 [0.009]	-0.003 [0.007]	0.032 [0.006]***	-0.010 [0.008]	-0.006 [0.004]	0.032 [0.005]***	0.016 [0.012]	0.011 [0.010]	0.031 [0.008]***
three top deciles	0.032 [0.008]***	0.030 [0.008]***	0.045 [0.004]***	0.023 [0.009]**	0.025 [0.009]**	0.046 [0.003]***	0.056 [0.015]***	0.039 [0.012]***	0.055 [0.009]***
R-squared	0.84	0.85	0.95	0.83	0.82	0.96	0.82	0.81	0.92

Note: Net wage changes are wage changes net of predetermined compositional changes. Regressions include country fixed effect. Country omitted: Germany. Total observations: 81. Standard Errors clustered at the country level are in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Weighted by the average sample size of the regressions used to compute changes in returns.

4. Explaining changes in the wage structure

After reporting the observed changes in the wage structure of EU countries and their components, we now make an attempt at associating cross-country differences in wage changes with some candidate causal factors. As already mentioned, there are several theories about the causes of the changes in the wage distribution. Most of the empirical literature refers to skill-biased technological change and to labour market institutions. Since European countries have been subject to both technological changes and some other institutional and structural transformations (e.g. to monetary

¹⁵ Table 3 presents the coefficients of the regressions of each measure of wage changes for each decile (9x9 observations) on three dummies: one for the three lowest deciles, another for the three middle deciles and one for the three top deciles.

¹⁶ This is likely to be driven by Hungary and Ireland; when dropping these countries from our sample the U shape turns into an upward sloping pattern.

integration, or increasing competition and international mobility of labour) to different degrees, we can exploit the observed cross-country variability in wage changes along the wage distribution to account for the role of these macroeconomic and structural medium-run trends in shaping the observed wage changes. Thus, we can document to what extent the wage determination process has accommodated those trends by changing either the relative composition of particular characteristics or the relative remuneration of particular “tasks”, and whether the impact of each factor has been different at different segments of the labour market.

Given the wide set of proposed hypothesis to explain changes in the wage structure, there could be many plausible factors to be considered. Here we focus on four: demographics, globalisation, technology and institutional change.¹⁷ In terms of demographics, there have been two important developments in European countries over the last decade; namely, the rise of female labour force participation, in particular, in Southern European countries, and the acceleration of migration inflows.¹⁸ With regard to globalisation, some synthetic indexes available in the literature show that every country in our sample has experienced an increase in international exposure, which is larger in Austria, Germany, and Spain than in the rest of the countries.¹⁹ As for technology, there have been differential trends among EU countries: a fall in productivity growth is observed in Belgium, Italy and Spain, while the remaining countries have experienced increases. Finally, facing these changes, European product and labour markets have been under stress, and regulatory reforms have been at the core of the political agendas in Europe. In fact, there is substantial cross-country heterogeneity in labour and product market institutions in EU countries and, although the process of reform has reduced this heterogeneity to some extent, not all the countries have progressed at the same pace. According to the intensity of the reform indicator by Brandt, Burniaux, and Duval (2005), which give a measure of the closeness to the ideal of labour market competition as recommended by the OECD Jobs Strategy, the leaders in this regard are the Netherlands, Germany and Belgium, with Italy, Greece, Ireland, and Spain lagging behind.

Typically, in international comparisons of changes in wage structures, the number of countries for which data are available is much lower than the number of potential candidates to explain changes in some single indicators of wage dispersion. We face the same problem here. Nevertheless, we take advantage of the wealth of microeconomic data used for the measurement of wage changes in the nine countries in our sample and i) we use alternative measures of wage changes, either observed

¹⁷ Table A3 in the Appendix presents relevant indicators by country.

¹⁸ For evidence on the impact of immigration on wage determination, see Bentolila, Dolado and Jimeno (2008).

¹⁹ See, Dreher (2006) for a globalisation index, computed from data on goods and capital flows (international trade, FDI, portfolio investments and income payments to foreign nationals) and restrictions (import barriers, tariffs, taxes on international trade and capital account restrictions).

ones or some of their components identified from the extended Mincer equations using the Machado Mata (2005) decomposition, so that we can investigate to what extent changes in the returns to labour force or job/employer characteristics are relevant when searching for the relationship between macroeconomic and institutional developments and wage changes; and ii) we use wage changes at different positions of the wage distribution, so that we can investigate if macroeconomic and institutional developments have had a differential impact on low-paid and high-paid workers. Thus, we estimate the following set of regressions:

$$\Delta w_s^\theta = \lambda_s + \lambda_{g'} + \sum_{j=1}^3 \beta_j \lambda_{g'} x_s + \varepsilon_s \quad (3)$$

where Δw_s^θ are alternative measures of the wage change at decile θ in country s , λ_s is a country dummy, $\lambda_{g'}$ is a dummy for position at the wage distribution (three lowest, middle and top deciles, indexed by $j=1,2,3$) and x_s is a variable representing either demographic, macroeconomic or institutional changes. As covariates (included separately in alternative regressions) we choose some demographic variables (change in the female participation rate and change in the stock of foreigners in the labour force from the OECD datasets), some representing changes in the international economy (changes in trade balance in goods and services as a percentage of GDP, from the OECD, and change in the globalisation index, as computed by Dreher, 2006), some technological variables (change in Total Factor Productivity and change in the contribution of ICT capital to GDP growth from the EU KLEMS database), and some indicators of labour markets institutions (levels of centralisation and coordination of collective bargaining in 2000, and changes in union density as computed by the OECD). Standard errors are computed by clustering at the country level.

Some results are displayed in Tables 4 to 8 below. There are four kind of information contained in these results. First, there is the issue of the impact of each particular factor on wages. Secondly, we can observe the association of each factor with each of the three different wage measures; that is, observed wage changes, wage changes net of predetermined compositional changes and wage changes due only to returns. Thirdly, as we run two sets of regressions, one for males another for females, we can observe any “gender-bias” that each factor may introduce in the change of the wage distribution. Finally, as already mentioned, we can investigate the different impact of each factor on workers’ wages at different deciles of the wage distribution.

We start by relating changes in the wage structure to GDP growth (Table 4). As for both overall wage changes and wage changes net of predetermined composition effects, there seems to be a

negative statistical association along the whole wage distribution, so that real wage growth is lower in high-growth countries. However, changes in returns, once other composition effects are taken into account, are positively related to growth but only in the lowest deciles of the wage distribution. Admittedly, our sample contains only nine countries, and the high-growth countries (Ireland, Spain, and Hungary) are rather heterogeneous as far as the sources of growth in this period are concerned.²⁰ The previous result, nevertheless, suggests that studies focusing on the impact of growth on the wage structure should explicitly uncover the effects working through changes in the composition of “job-workers” matches and changes in the “price” of those matches.

As for the rest of the results (Tables 5 to 8), the estimates confirm the statistical association between wage changes and the demographic, macroeconomic and structural trends mentioned above: female labour participation, globalisation, technological change, centralization and coordination of collective bargaining are positively associated with wage changes, while immigration and changes in union density are negatively associated with them.²¹ Given that all measures of wage changes are on average positive, these estimated correlations suggest that the expansion in female labour force participation, the increase in trade openness, the sustainment of high levels of coordination and centralization in bargaining, the weakening of union density observed in all countries over the examined period, as well as the acceleration in technical change observed in Austria, Hungary, Ireland and the Netherlands, have all contributed towards higher wage increases all along the wage distribution. In contrast, the general increase in the proportion of foreign labour force, and the deceleration in technological change observed in Belgium, Italy, and Spain have contributed toward lower wage increases.

Notably, the association of technological change and change in union density is strongest with pure changes in returns, less strong with wage changes net of predetermined compositional effects, and least strong with changes in observed wages. In other words, the association is higher the ‘purer’ the measure of market-driven wage changes, thus, suggesting that technology and labour unions affect wages mostly via changes in returns. On the contrary, changes in observed wages associated with centralization levels, changes in female participation, and changes in the trade balance are generally larger than the corresponding wage changes net of predetermined compositional effects, and these are, in turn, larger than the changes in pure returns. The implication is that these forces affect wages

²⁰ During the sample period, Ireland growth was based on higher productivity growth and a housing boom, Spain growth was demand-driven, credit-fuelled, supported by large immigration flows and with very low productivity growth, and Hungary is the case of a catching-up economy, exploiting the gains from transition to a market economy.

²¹ The opposite signs in the estimated coefficients between union density and bargaining centralization/coordination is consistent with the literature on the Calform and Driffils (1988) hypothesis and the related empirical evidence, according to which highly coordinated and centralised wage bargaining can increase bargainers’ awareness of the macro-level consequences of wage arrangements, and thus lead to ‘bargained flexibility’.

both via price-effects and via compositional changes. For the remaining variables no particular pattern is observable.

As far as gender differences in the estimated correlations are concerned, we do not find any striking evidence. In the majority of cases, the examined forces affect male and female wage changes in the same direction and with similar magnitude. The only notable exception concerns immigration, which shows a stronger negative association with price-effects in the case of females than males.

Finally, regarding differences along the wage distribution, we find that the association of wage changes with globalization is stronger at the top of the wage distribution, a pattern consistent with the conventional skill-biased technical change hypothesis. Against expectations, we also find that wage changes are more strongly correlated with immigration at the top of the distribution, whereas one would assume that foreign workers are on average low skilled and would, instead, affect wage changes more at the bottom of the distribution.²² More plausibly, we find that the variables capturing technological changes, and especially changes in the contribution of ICT capital to GDP growth, are positively associated with wage changes, with a larger coefficient at the top and bottom of the distribution (U shape). This constitutes direct evidence in favour of the “routinization” hypothesis that technological change affects most positively non-routine tasks which are more prevalent at the tails of the wage distribution and, quite timely, complements recent evidence of polarization on the employment-side of labour market outcomes in Europe provided by Goos, Manning, and Salomons (2009).

Table 4. Regressions on real output growth

Dependent variable	ALL			MALES			FEMALES		
	Observed wage changes	Net wage changes	Changes in returns	Observed wage changes	Net wage changes	Changes in returns	Observed wage changes	Net wage changes	Changes in returns
three lowest deciles	-0.019 [0.004]***	-0.017 [0.003]***	0.017 [0.006]**	-0.032 [0.005]***	-0.027 [0.004]***	0.015 [0.004]***	-0.009 [0.007]	-0.010 [0.007]	0.018 [0.009]*
three middle deciles	-0.035 [0.003]***	-0.030 [0.003]***	-0.003 [0.004]	-0.044 [0.002]***	-0.036 [0.002]***	-0.005 [0.002]*	-0.027 [0.005]***	-0.021 [0.005]***	-0.0002 [0.005]
three top deciles	-0.023 [0.004]***	-0.014 [0.003]***	0.001 [0.003]	-0.029 [0.005]***	-0.022 [0.004]***	0.005 [0.002]*	-0.021 [0.003]***	-0.016 [0.003]***	-0.003 [0.005]
R-squared	0.85	0.86	0.96	0.84	0.83	0.97	0.82	0.82	0.93

Note: Standard errors clustered at the country level are in brackets. * significant at 10%; ** significant at 5%; *** significant at 1% . Weighted by the average sample size of the regressions used to compute changes in returns. Real GDP growth is taken from OECDStat.

²² Note that there is a small mismatch in the period for which data is available for the dependent wage variables and the immigration growth variable, which could be accountable for this odd result.

Table 5. Regressions on demographic variables

Dependent variable	Observed wage changes		Wage changes net of pred/ned compositional changes		Total returns effects	
	Change in female participation	Change in foreign labour force	Change in female participation	Change in foreign labour force	Change in female participation	Change in foreign labour force
	All					
Interacted with three lower deciles	0.045 [0.008]***	-0.003 [0.003]	0.039 [0.005]***	-0.011 [0.003]**	0.029 [0.005]***	-0.016 [0.003]***
Interacted with three middle deciles	0.034 [0.003]***	-0.033 [0.003]***	0.032 [0.003]***	-0.032 [0.002]***	0.026 [0.002]***	-0.026 [0.002]***
Interacted with three highest deciles	0.034 [0.003]***	-0.037 [0.002]***	0.028 [0.002]***	-0.037 [0.002]***	0.026 [0.002]***	-0.024 [0.002]***
R-squared	0.85	0.88	0.86	0.88	0.95	0.95
	Males					
Interacted with three lower deciles	0.046 [0.008]***	-0.010 [0.003]***	0.039 [0.006]***	-0.014 [0.002]***	0.028 [0.004]***	-0.007 [0.003]**
Interacted with three middle deciles	0.038 [0.003]***	-0.039 [0.002]***	0.034 [0.002]***	-0.033 [0.001]***	0.030 [0.002]***	-0.013 [0.002]***
Interacted with three highest deciles	0.036 [0.003]***	-0.044 [0.002]***	0.030 [0.003]***	-0.043 [0.002]***	0.025 [0.001]***	-0.015 [0.002]***
R-squared	0.84	0.86	0.83	0.85	0.96	0.96
	Females					
Interacted with three lower deciles	0.053 [0.010]***	0.010 [0.008]	0.045 [0.007]***	-0.005 [0.007]	0.035 [0.007]***	-0.025 [0.005]***
Interacted with three middle deciles	0.036 [0.002]***	-0.025 [0.004]***	0.031 [0.002]***	-0.027 [0.006]***	0.025 [0.001]***	-0.043 [0.003]***
Interacted with three highest deciles	0.033 [0.003]***	-0.036 [0.003]***	0.027 [0.002]***	-0.040 [0.003]***	0.025 [0.002]***	-0.046 [0.003]***
R-squared	0.84	0.86	0.84	0.85	0.92	0.93
Decile fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81	81	81	81	81	81

Notes: Standard errors clustered at the country level are in brackets. Data for female labour force participation rate and proportion of foreign labour force is taken from OECD.Stat. All remaining information as in Table 3.

Table 6. Regressions on trade openness variables

Dependent variable	Observed wage changes		Wage changes net of pred/need compositional changes		Total returns effects	
	Change in Dreher globalization index	Change in trade balance as a % of GDP	Change in Dreher globalization index	Change in trade balance as a % of GDP	Change in Dreher globalization index	Change in trade balance as a % of GDP
	All					
Interacted with three lower deciles	0.003 [0.003]	0.023 [0.003]***	0.002 [0.003]	0.021 [0.003]***	0.004 [0.003]	0.018 [0.003]***
Interacted with three middle deciles	0.008 [0.002]***	0.031 [0.002]***	0.005 [0.002]***	0.028 [0.001]***	0.007 [0.001]***	0.022 [0.002]***
Interacted with three highest deciles	0.007 [0.001]***	0.027 [0.003]***	0.005 [0.001]***	0.024 [0.003]***	0.006 [0.001]***	0.018 [0.002]***
R-squared	0.85	0.86	0.86	0.86	0.95	0.95
	Males					
Interacted with three lower deciles	0.003 [0.003]	0.026 [0.003]***	0.001 [0.003]	0.024 [0.003]***	0.004 [0.002]	0.020 [0.002]***
Interacted with three middle deciles	0.008 [0.002]***	0.033 [0.001]***	0.003 [0.002]*	0.029 [0.001]***	0.004 [0.001]***	0.022 [0.002]***
Interacted with three highest deciles	0.008 [0.001]***	0.029 [0.003]***	0.004 [0.001]**	0.028 [0.003]***	0.004 [0.001]***	0.021 [0.001]***
R-squared	0.84	0.84	0.82	0.83	0.96	0.96
	Females					
Interacted with three lower deciles	0.001 [0.005]	0.017 [0.005]***	-0.001 [0.004]	0.016 [0.004]***	0.002 [0.004]	0.012 [0.004]**
Interacted with three middle deciles	0.011 [0.001]***	0.029 [0.002]***	0.009 [0.002]***	0.026 [0.002]***	0.008 [0.001]***	0.021 [0.001]***
Interacted with three highest deciles	0.011 [0.001]***	0.028 [0.004]***	0.008 [0.001]***	0.025 [0.003]***	0.009 [0.001]***	0.019 [0.003]***
R-squared	0.85	0.84	0.86	0.84	0.93	0.93
Decile fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81	81	81	81	81	81

Notes: Standard errors clustered at the country level are in brackets .The globalization index is taken from Dreher(2006) and the trade balance on goods and services as a percentage of the GDP is taken from OECD.Stat. All remaining information as in Table 3.

Table 7. Regressions on technical change indicators

Dependent variable	Observed wage changes		Wage changes net of pred/ned compositional changes		Total returns effects	
	Change in TFP (value added based) growth	Change in contribution of ICT capital services to output growth	Change in TFP (value added based) growth	Change in contribution of ICT capital services to output growth	Change in TFP (value added based) growth	Change in contribution of ICT capital services to output growth
	All					
Interacted with three lower deciles	0.005 [0.002]*	0.054 [0.014]***	0.008 [0.002]***	0.058 [0.009]***	0.016 [0.002]***	0.154 [0.008]***
Interacted with three middle deciles	0.005 [0.002]**	0.030 [0.011]**	0.007 [0.001]***	0.030 [0.009]**	0.012 [0.001]***	0.096 [0.008]***
Interacted with three highest deciles	0.008 [0.001]***	0.066 [0.006]***	0.011 [0.001]***	0.075 [0.006]***	0.012 [0.001]***	0.105 [0.003]***
R-squared	0.85	0.79	0.86	0.81	0.96	0.96
	Males					
Interacted with three lower deciles	0.003 [0.002]	0.036 [0.013]**	0.006 [0.002]***	0.036 [0.008]***	0.019 [0.001]***	0.149 [0.003]***
Interacted with three middle deciles	0.003 [0.002]*	0.022 [0.010]*	0.007 [0.001]***	0.023 [0.004]***	0.015 [0.001]***	0.092 [0.004]***
Interacted with three highest deciles	0.007 [0.001]***	0.066 [0.006]***	0.011 [0.001]***	0.067 [0.006]***	0.016 [0.001]***	0.113 [0.002]***
R-squared	0.85	0.77	0.85	0.75	0.97	0.97
	Females					
Interacted with three lower deciles	0.008 [0.004]*	0.075 [0.025]**	0.010 [0.003]***	0.074 [0.021]**	0.018 [0.003]***	0.156 [0.018]***
Interacted with three middle deciles	0.007 [0.002]***	0.037 [0.015]**	0.009 [0.001]***	0.043 [0.015]**	0.014 [0.001]***	0.098 [0.009]***
Interacted with three highest deciles	0.009 [0.002]***	0.060 [0.011]***	0.011 [0.001]***	0.061 [0.009]***	0.014 [0.001]***	0.092 [0.009]***
R-squared	0.82	0.78	0.82	0.77	0.93	0.94
Decile fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72	63	72	63	72	63

Notes: Standard errors clustered at the country level are in brackets. Data on Total Factor Productivity (value added based) growth, 1995=100, and on the contribution of Internet and Computer Technology capital services in output growth (percentage points) are derived from EUKLEMS 2008 database. All remaining information as in Table 3.

Table 8. Regressions on labour market institutions

Dependent variable	Observed wage changes			Wage changes net of predetermined compositional changes			Total price effects		
	Change in union density	Bargaining coordination (2000 levels)	Bargaining centralization (2000 levels)	Change in union density	Bargaining coordination (2000 levels)	Bargaining centralization (2000 levels)	Change in union density	Bargaining Coordination (2000 levels)	Bargaining centralization (2000 levels)
	All								
Interacted with three lower deciles	-0.004 [0.001]***	0.006 [0.046]	0.144 [0.032]***	-0.004 [0.001]***	0.029 [0.041]	0.139 [0.025]***	-0.008 [0.0002]***	0.085 [0.034]**	0.072 [0.052]
Interacted with three middle deciles	-0.002 [0.001]***	0.107 [0.013]***	0.124 [0.005]***	-0.002 [0.0002]***	0.094 [0.016]***	0.119 [0.007]***	-0.005 [0.0002]***	0.104 [0.011]***	0.075 [0.011]***
Interacted with three highest deciles	-0.004 [0.001]***	0.130 [0.004]***	0.116 [0.002]***	-0.004 [0.0003]***	0.109 [0.005]***	0.096 [0.001]***	-0.006 [0.0001]***	0.089 [0.004]***	0.094 [0.009]***
R-squared	0.85	0.87	0.83	0.86	0.86	0.84	0.96	0.94	0.94
	Males								
Interacted with three lower deciles	-0.002 [0.001]***	0.006 [0.041]	0.155 [0.030]***	-0.003 [0.001]***	0.011 [0.035]	0.141 [0.029]***	-0.008 [0.0001]***	0.090 [0.029]**	0.109 [0.031]**
Interacted with three middle deciles	-0.001 [0.0003]***	0.116 [0.011]***	0.140 [0.005]***	-0.002 [0.0001]***	0.078 [0.012]***	0.134 [0.014]***	-0.005 [0.0001]***	0.098 [0.012]***	0.110 [0.004]***
Interacted with three highest deciles	-0.003 [0.0003]***	0.138 [0.005]***	0.122 [0.001]***	-0.004 [0.0004]***	0.117 [0.005]***	0.099 [0.003]***	-0.006 [0.0001]***	0.088 [0.003]***	0.084 [0.005]***
R-squared	0.84	0.90	0.85	0.83	0.89	0.86	0.97	0.96	0.96
	Females								
Interacted with three lower deciles	-0.005 [0.001]***	-0.012 [0.085]	0.157 [0.055]**	-0.005 [0.001]***	0.016 [0.073]	0.145 [0.044]**	-0.008 [0.001]***	0.058 [0.058]	0.086 [0.064]
Interacted with three middle deciles	-0.002 [0.0003]***	0.104 [0.018]***	0.116 [0.010]***	-0.002 [0.0002]***	0.088 [0.023]***	0.106 [0.009]***	-0.005 [0.0002]***	0.089 [0.011]***	0.068 [0.013]***
Interacted with three highest deciles	-0.004 [0.001]***	0.139 [0.009]***	0.122 [0.004]***	-0.004 [0.001]***	0.114 [0.008]***	0.010 [0.004]***	-0.004 [0.0003]***	0.095 [0.006]***	0.096 [0.010]***
R-squared	0.82	0.80	0.76	0.82	0.77	0.74	0.94	0.90	0.89
Decile fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	72	63	63	72	63	63	72	63	63

Notes: Standard errors clustered at the country level are in brackets. Data on institutions are from the CEP-OECD(2006) institutions database. Union density is Union membership/Employment (series *udnet_vis*); bargaining coordination and centralization indexes range from 1 to 3 (series *cow* and *cew*, respectively). These series were supplemented with numbers from national sources for Greece and Hungary. All remaining information as in Table 3.

5. Concluding remarks

In this paper we document changes in the wage structure of nine EU countries over the 1995-2002 using micro data on wages and on workers and jobs characteristics that are comparable across countries. We disentangle the composition effects and the returns effects that are behind observed wage changes and, exploiting the cross-country variability in this regard, relate different measures of wage changes to demographics, structural and macroeconomic trends.

Our results provide evidence on two fronts. First, given the nature of the data, they offer new insights on changes in the wage distribution across EU countries, and on whether these changes are mostly due to predetermined compositional changes, or due to market-driven changes either in the remuneration or in the composition of particular tasks and characteristics. In fact, this is the first time in the wage-inequality literature that sufficient emphasis is put on the issue of quantity-side/compositional responsiveness to economic developments, and an attempt to formally address this issue is made in a Mincerian equation framework. Secondly, our results inform the literature on how wage changes and their different components are associated with the strong demographic, structural, and macroeconomic trends that have taken place in Europe.

We find that real wages have increased from 1995 to 2002 along the whole range of wage levels in the nine countries of our sample, with the only exceptions being the wages of the lowest paid jobs in Germany and Greece and the wages in the middle part of the distribution in Spain. Both the magnitude and shape of the changes observed in real wages differ substantially across countries. While observed real wages in the Netherlands, Germany, Greece, Italy and Belgium trend upwards along the distribution, leading to a widening of the wage distribution, the wage distribution in Hungary, Ireland and Spain has become more compressed. The magnitude of the changes is relatively small in Italy, Belgium and Spain, and there is virtually no change in Austria. According to our decomposition results, the contribution of mechanical compositional changes to these wage dynamics have been minor; instead, it is the contribution of market forces and labour market institutions that has been driving wage changes, mostly by affecting the returns to employee and jobs characteristics, but also by inducing compositional shifts.

The role of economic developments is confirmed when we examine the responsiveness of changes in the wage structure in EU countries to macroeconomic and structural trends. We find that observed changes in technology are positively associated with wage increases, with the effect being stronger for very high and very low paid jobs – a typical symptom of the routinization hypothesis.

Globalisation is also associated with wage increases, but less so for the lowest wages. Finally, increases in migration are associated with declines in wages.

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APPENDIX

Table A1. Measures of wage inequality by country and sex-group

		All (Males & Females)					Males					Females				
		Std. Dev.	Median	P90/P10	P50/P10	P90/P50	Std. Dev.	Median	P90/P10	P50/P10	P90/P50	Std. Dev.	Median	P90/P10	P50/P10	P90/P50
AT	1996	0.36	2.23	1.52	1.22	1.24	0.34	2.30	1.46	1.18	1.24	0.35	2.07	1.53	1.21	1.26
	2002	0.37	2.28	1.52	1.23	1.24	0.35	2.35	1.45	1.18	1.23	0.36	2.13	1.51	1.20	1.25
	Change	0.01	0.04	0.00	0.01	-0.01	0.01	0.05	-0.01	0.00	-0.01	0.01	0.05	-0.02	-0.01	0.00
BE	1999	0.32	2.41	1.39	1.15	1.21	0.32	2.43	1.38	1.13	1.22	0.31	2.32	1.38	1.15	1.2
	2005	0.35	2.46	1.41	1.15	1.22	0.35	2.48	1.40	1.14	1.23	0.34	2.41	1.41	1.16	1.22
	Change	0.03	0.05	0.02	0.00	0.01	0.03	0.05	0.02	0.01	0.01	0.03	0.09	0.03	0.01	0.02
DE	1995	0.35	2.64	1.40	1.19	1.18	0.33	2.71	1.37	1.17	1.17	0.31	2.46	1.37	1.17	1.17
	2001	0.47	2.65	1.51	1.26	1.20	0.47	2.71	1.47	1.23	1.19	0.44	2.49	1.54	1.29	1.19
	Change	0.12	0.01	0.11	0.07	0.02	0.14	0.00	0.10	0.06	0.02	0.13	0.03	0.17	0.12	0.02
ES	1995	0.48	1.83	1.90	1.39	1.37	0.47	1.90	1.85	1.38	1.34	0.45	1.61	1.91	1.35	1.41
	2002	0.46	1.80	1.86	1.33	1.40	0.45	1.89	1.79	1.32	1.36	0.43	1.61	1.86	1.29	1.44
	Change	-0.02	-0.03	-0.04	-0.06	0.03	-0.02	-0.02	-0.05	-0.06	0.02	-0.02	0.00	-0.05	-0.06	0.03
GR	1995	0.38	1.88	1.69	1.30	1.30	0.38	1.98	1.67	1.32	1.27	0.32	1.67	1.59	1.21	1.31
	2002	0.47	1.89	1.85	1.33	1.40	0.48	2.01	1.86	1.37	1.36	0.41	1.73	1.74	1.25	1.39
	Change	0.09	0.01	0.16	0.02	0.10	0.10	0.03	0.20	0.06	0.09	0.09	0.06	0.15	0.04	0.08
HU	1996	0.53	5.82	1.27	1.12	1.13	0.53	5.89	1.27	1.13	1.12	0.51	5.74	1.26	1.12	1.12
	2002	0.53	5.95	1.25	1.09	1.15	0.55	5.99	1.26	1.10	1.15	0.50	5.91	1.23	1.08	1.14
	Change	0.00	0.13	-0.01	-0.04	0.02	0.01	0.11	-0.01	-0.03	0.02	-0.01	0.17	-0.02	-0.04	0.02
IE	1995	0.48 ^a	2.11	1.84	1.36	1.35	0.50	2.20	1.79	1.34	1.34	0.45	1.98	1.78	1.35	1.32
	2002	0.47 ^a	2.43	1.65	1.26	1.30	0.49	2.56	1.63	1.27	1.29	0.44	2.29	1.59	1.23	1.29
	Change	-0.01	0.32	-0.20	-0.10	-0.05	-0.01	0.35	-0.16	-0.07	-0.05	-0.02	0.31	-0.20	-0.12	-0.04
IT	1995	0.35	2.09	1.46	1.17	1.25	0.36	2.12	1.48	1.17	2.27	0.29	1.99	1.40	1.14	1.23
	2002	0.36	2.15	1.50	1.19	1.25	0.36	2.19	1.49	1.19	1.25	0.33	2.05	1.48	1.18	1.26
	Change	0.01	0.06	0.03	0.02	0.00	0.01	0.07	0.02	0.02	-1.01	0.04	0.06	0.08	0.04	0.03
NL	1995	0.43	2.41	1.50	1.24	1.22	0.40	2.47	1.44	1.19	1.21	0.43	2.20	1.55	1.28	1.21
	2002	0.49	2.49	1.57	1.28	1.23	0.47	2.61	1.54	1.27	1.21	0.47	2.28	1.64	1.34	1.23
	Change	0.07	0.09	0.07	0.04	0.02	0.07	0.14	0.09	0.08	0.00	0.04	0.08	0.10	0.06	0.02

Note: Median figures are in euros for all countries except for HU, for which they are measured in national currency (HUF). ^a indicates inferred number.

Table A2. Means/proportions of selected employee (sex, education, age, tenure) and job (firm ownership, contract type) characteristics by country and decile

Deciles Waves	10		20		30		40		50		60		70		80		90	
	w1	w2	w1	w2	w1	w2	w1	w2	w1	w2	w1	w2	w1	w2	w1	w2	w1	w2
AUSTRIA																		
Females	57.2	70.4	41.0	53.0	32.2	39.0	25.0	32.8	24.2	29.2	23.8	30.4	21.8	28.4	23.4	26.4	20.6	21.4
Years of education	9.5	9.7	9.9	10.0	9.9	10.3	10.1	10.2	10.2	10.4	10.4	10.7	10.4	11.1	10.9	11.3	11.2	11.8
Years of age	34.5	36.5	33.8	36.1	34.4	36.0	35.1	37.3	35.3	36.9	37.3	38.5	38.4	38.5	40.0	40.6	42.1	41.9
Years of job-specific tenure	5.3	5.5	6.2	6.1	7.0	7.6	8.5	8.2	8.9	8.9	10.0	10.2	11.5	10.3	13.0	12.4	14.6	12.9
Private firm ownership	96.2	97.6	93.0	98.0	96.2	97.6	94.0	97.2	94.0	95.8	92.4	97.8	92.6	95.6	92.6	96.0	92.8	94.0
BELGIUM																		
Females	51.0	47.4	44.8	43.4	31.4	33.2	26.8	26.0	25.0	24.8	27.8	31.6	30.6	34.0	30.6	31.4	22.8	30.0
Years of education	10.1	10.6	10.3	10.7	10.5	11.0	10.1	11.1	10.1	11.2	10.7	11.6	11.3	12.1	12.2	12.8	12.4	13.6
Years of age	33.5	34.9	33.1	36.3	34.8	36.0	36.3	36.9	37.6	39.5	38.3	39.4	38.1	40.0	39.9	40.7	41.8	41.6
Years of job-specific tenure	4.5	4.9	5.1	6.2	6.5	6.7	7.7	7.6	8.2	8.7	8.5	8.4	8.7	9.5	9.2	9.4	10.1	8.8
Private firm ownership	98.4	96.2	97.4	92.8	98.0	96.8	97.6	97.6	97.4	95.2	97.2	95.6	96.6	95.2	96.0	97.4	97.0	98.6
Indefinite contracts	97.4	99.4	98.4	98.2	99.2	99.8	99.6	100	99.6	99.8	98.8	99.4	98.8	99.8	99.8	99.8	99.8	99.6
Full-time contracts	78.6	74.6	86.8	85.4	89.2	88.2	89.2	91.8	88.4	90.6	91.2	89.8	88.4	87.2	94.0	89.0	92.8	93.0
GERMANY																		
Females	53.0	52.2	49.6	45.4	40.0	39.2	33.8	33.0	24.2	29.0	21.6	21.6	18.4	21.8	17.6	21.0	13.6	13.4
Years of education	12.2	12.4	12.3	12.4	12.3	12.5	12.3	12.5	12.6	12.7	12.7	12.9	12.9	13.1	13.3	13.4	13.9	14.3
Years of age	38.8	39.6	38.0	39.3	39.1	39.8	38.4	39.8	39.7	40.7	39.8	42.1	40.1	41.1	41.0	42.0	42.7	44.1
Years of job-specific tenure	8.3	6.9	8.7	8.0	10.6	9.5	10.7	11.0	11.9	11.5	12.3	13.2	13.8	12.8	13.8	12.9	15.1	14.3
Private firm ownership	95.2	98.4	94.0	96.0	93.6	94.6	95.4	93.2	91.6	93.2	92.8	92.2	92.8	87.8	92.2	91.6	94.6	91.6
Indefinite contracts	98.8	93.0	98.2	93.6	99.2	95.4	99.6	97.6	99.4	98.4	100	97.0	99.4	98.0	99.6	98.0	99.8	97.0
Full-time contracts	88.0	78.4	88.6	80.8	92.8	85.6	91.6	91.4	93.4	92.8	94.0	95.8	96.6	93.8	95.0	93.6	94.2	94.4
SPAIN																		
Females	41.8	49.0	31.6	42.2	26.8	34.0	20.0	28.8	21.8	27.2	20.4	24.4	17.2	21.0	12.4	22.0	13.2	19.4
Years of education	8.2	8.3	8.2	8.4	8.1	8.6	8.6	8.8	8.7	9.4	9.1	9.8	9.5	10.5	10.0	10.8	11.4	11.8
Years of age	31.7	33.4	33.1	33.9	36.0	35.2	37.4	35.6	38.3	36.7	40.0	36.8	41.5	38.7	42.7	40.1	43.7	42.2
Years of job-specific tenure	3.9	2.7	4.9	3.8	7.3	4.1	8.5	4.8	10.2	6.9	12.1	7.6	13.8	10.1	15.5	11.9	16.2	14.9
Private firm ownership	98.0	98.2	97.2	98.6	96.2	98.2	95.4	95.0	94.8	96.8	91.4	95.4	88.4	94.8	87.4	95.8	85.6	92.4
Indefinite contracts	42.8	59.0	52.8	63.4	65.2	64.8	70.0	63.8	77.4	74.0	85.2	79.4	91.0	79.6	94.0	86.8	95.2	91.8
Full-time contracts	93.0	86.0	96.2	90.4	97.8	90.0	97.4	93.4	96.6	93.6	98.4	95.8	98.2	96.2	99.2	95.6	98.2	95.2
GREECE																		
Females	51.2	49.8	52.0	50.8	43.0	51.8	35.0	43.4	30.8	32.4	23.8	33.8	22.4	34.2	18.4	27.4	12.0	17.6
Years of education	9.8	10.5	9.7	10.7	9.9	10.8	9.8	10.7	10.4	11.1	10.4	11.6	11.3	11.8	11.4	12.3	11.6	12.9

Table A2 (cont.)

15-24 year-olds	16.6	22.8	9.2	17.8	7.0	9.8	2.6	5.2	1.4	4.0	0.8	0.4	1.0	1.2	0.2	0.4	0.2	0.8
25-34 year-olds	50.6	45.0	46.6	46.0	42.2	46.6	38.4	38.4	33.2	40.6	27.2	36.0	19.2	24.2	14.8	19.2	10.8	9.0
35-44 year-olds	20.6	18.6	23.8	22.0	28.6	25.0	33.2	34.4	41.8	30.6	42.8	35.8	45.2	41.4	43.0	40.6	36.4	33.8
45-54 year-olds	8.8	10.4	14.8	11.0	13.4	13.8	18.6	17.2	18.4	19.4	20.8	21.8	25.2	26.6	33.2	33.0	40.0	49.6
Years of job-specific tenure	4.1	2.0	5.5	3.2	7.0	4.5	8.6	5.6	10.0	6.1	11.3	8.5	13.6	11.0	15.2	13.3	16.2	16.9
Private firm ownership	85.6	94.2	88.0	95.0	81.8	94.2	74.2	91.8	70.2	88.0	61.0	82.4	51.4	72.8	52.4	66.6	50.2	68.6
HUNGARY																		
Females	54.6	36.4	51.6	50.6	46.8	49.8	46.0	50.0	46.4	42.8	39.4	37.8	34.0	42.0	37.2	38.6	39.2	34.4
Years of education	10.4	11.1	10.4	10.6	10.6	10.7	10.4	11.0	10.8	11.0	11.0	11.3	11.4	11.6	12.0	12.0	12.9	13.2
Years of age	35.2	36.6	35.9	37.0	37.2	37.9	38.2	39.9	39.4	39.4	38.9	41.0	40.5	40.4	40.5	41.8	41.9	41.4
IRELAND																		
Females	56.2	71.0	55.0	57.0	46.2	54.8	41.6	51.4	39.2	46.6	34.4	38.4	31.8	32.4	25.2	32.6	28.0	24.6
Years of education	11.0	11.4	10.7	11.4	10.8	11.6	10.9	11.7	11.0	12.1	11.2	12.1	11.7	12.8	11.9	13.3	12.6	13.4
Years of age	26.6	33.6	29.9	34.7	32.0	34.6	33.0	35.5	34.0	36.3	34.5	36.7	36.1	37.1	37.3	37.7	39.2	41.3
Years of job-specific tenure	3.0	5.5	5.1	6.7	6.6	7.0	7.9	8.2	8.6	8.7	9.0	9.6	9.5	10.0	10.8	10.7	12.9	14.1
Private firm ownership	99.4	99.8	100	99.4	99.8	98.8	99.6	99.0	97.0	96.2	95.8	95.8	95.2	94.6	94.8	89.8	91.2	81.0
Indefinite contracts	88.8	83.6	92.4	82.8	94.8	87.0	94.6	90.4	92.8	89.0	96.2	91.2	93.8	92.8	96.6	92.6	97.8	92.6
Full-time contracts	62.0	65.6	81.8	75.4	91.2	82.6	92.6	87.6	93.0	92.8	95.0	91.6	96.6	96.2	97.8	95.8	96.2	97.0
ITALY																		
Females	36.4	49.8	32.6	40.2	31.4	35.8	27.6	37.2	21.6	30.6	19.8	27.2	25.2	29.4	20.6	25.8	16.4	23.6
Years of education	8.7	9.4	8.7	9.6	8.7	10.0	9.0	10.0	8.7	10.3	9.6	10.4	10.1	10.9	10.5	11.6	11.6	12.6
Years of age	33.4	35.3	35.0	36.3	36.3	36.7	38.0	38.1	39.1	39.2	39.3	39.7	39.6	40.0	41.4	41.3	43.5	42.2
Years of job-specific tenure	5.6	6.9	7.4	8.3	9.3	8.4	10.0	11.3	12.0	12.2	11.8	11.5	12.1	12.5	13.8	13.6	15.8	13.9
Indefinite contracts	89.4	90.6	90.2	93.2	94.0	94.4	94.4	96.8	96.4	96.2	97.4	97.2	97.0	96.2	98.8	97.6	99.0	98.2
Full-time contracts	92.4	86.0	95.0	88.4	95.2	92.6	95.8	87.8	94.0	90.4	96.2	92.6	94.0	88.4	94.4	89.8	96.6	90.6
NETHERLANDS																		
Females	57.2	63.2	43.4	59.4	37.4	52.0	28.2	41.6	16.8	33.4	18.2	24.2	17.2	23.4	12.0	23.6	14.8	14.8
Years of education	11.3	10.0	11.8	10.5	11.9	10.7	11.9	11.1	11.8	11.5	12.1	12.0	12.4	12.5	13.0	13.4	14.2	14.4
Years of age	31.4	30.3	32.6	35.8	34.9	36.9	37.1	36.9	38.0	38.8	38.9	40.6	40.0	40.7	40.7	41.2	42.0	42.7
Indefinite contracts	84.8	53.2	89.8	73.4	95.0	78.0	94.6	86.6	96.6	89.6	96.8	92.0	96.8	95.2	96.4	95.8	94.6	94.8
Full-time contracts	57.4	30.2	68.4	39.4	74.4	56.8	77.4	66.6	82.4	72.4	81.0	79.4	82.0	81.0	87.6	84.2	85.8	86.6

Figure A1a. Break down of observed wage changes by country and decile, all

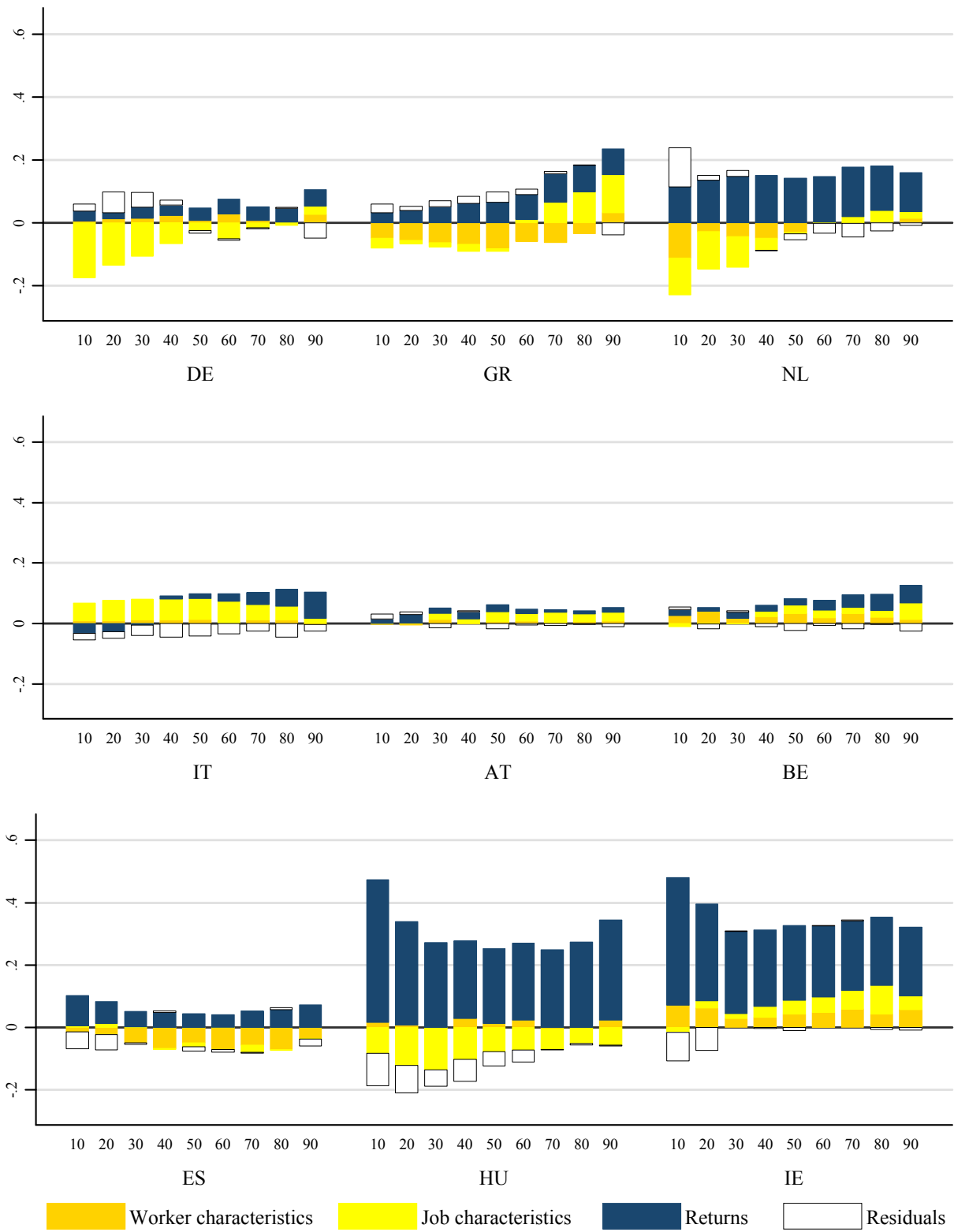


Figure A1b. Break down of observed wage changes by country and decile, males

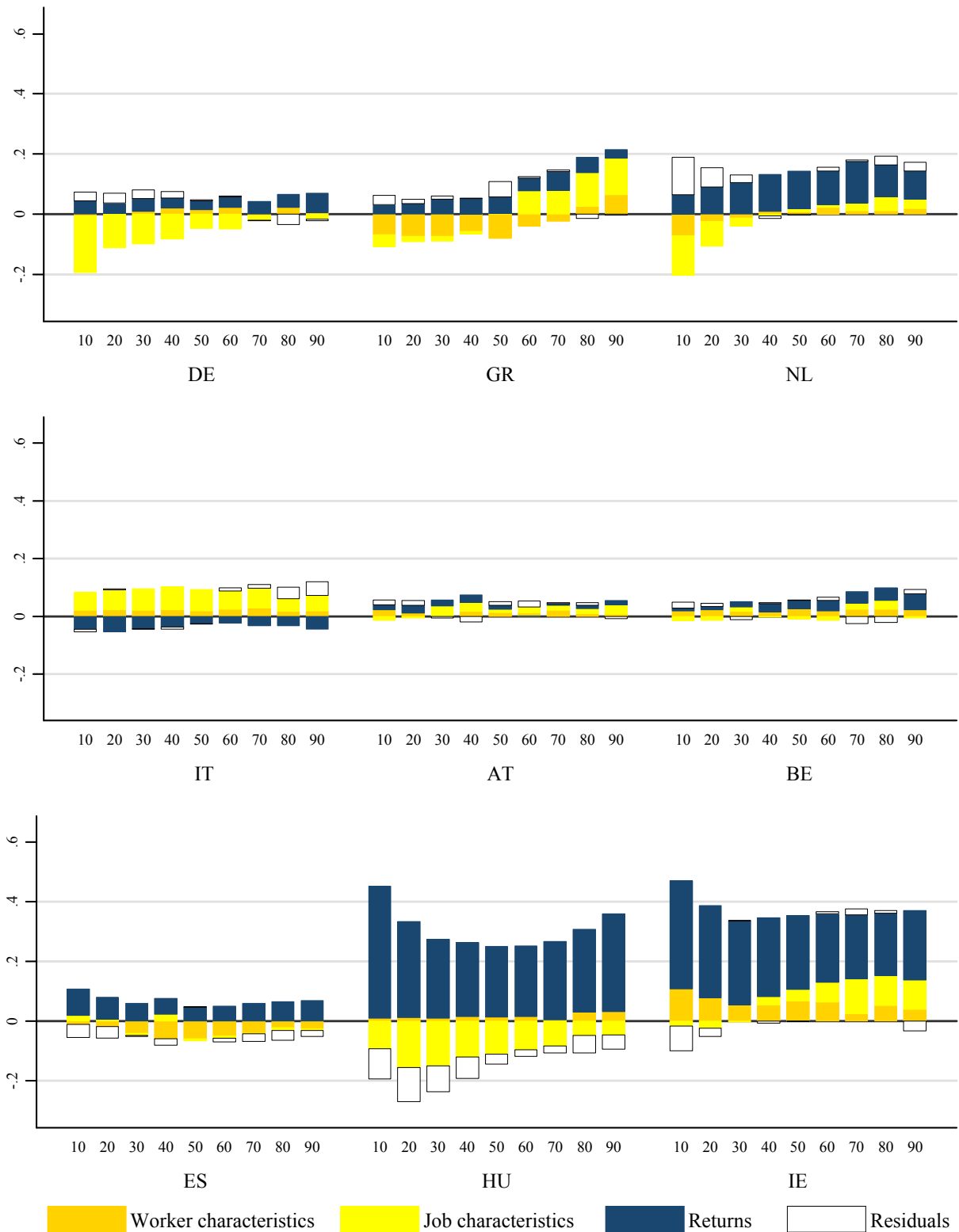


Figure A1c. Break down of observed wage changes by country and decile, females

