Real Wage Cyclicality in the Euro zone before and during the Great Recession: Evidence from micro-data

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Abstract

We study the response of real wages to the business cycle in major Euro zone countries before and during the crisis. Average real wages are found a-cyclical but this reflects in a large part the effect of changes in the composition of the labour force related to unemployment variations over the cycle. Using longitudinal microdata from the ECHP and SILC panel to control for composition effects, we estimate elasticities of real wages to unemployment increases between −0.7 and −1.9 over the period 1994-2008. Importantly, we find that this elasticity varies dramatically with the inflation level, with a larger response of real wages during periods with higher inflation rate. We use this result to investigate whether real wages have been particularly rigid during the Great Recession. We first highlight that composition effects have been particularly large after 2008 and explain most of the stagnation or increase in average wage observed in some countries from 2008 to 2011. In contrast, at constant composition of the labour force in terms of education and experience, the figures indicate a significant decrease in average wages during the downturn, particularly in countries most affected by the crisis.

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Introduction

The evolution of real wages over the business cycle is observed with great attention by policy makers and forecasters. When downturns occur, real wage adjustments are considered as being of first order importance to reequilibrate the labour market and adjust external imbalances. In particular, during the recent economic crisis in Europe, it has been argued that the observed downward rigidity of real wages can explain a significant part of the large unemployment increases that occurred in many countries (Schmitt-Grohé and Uribe, 2013). These development have put serious doubts on the long term viability of the Euro zone since wage flexibility is seen as crucial in a currency union where internal migrations have been until here too low to ensure a significant macroeconomic adjustment (Anderton et al. 2012 ; Krugman 2013).

However, most of these conclusions relied on figures from quarterly aggregate wage data from national accounts, which are the only comparable cross-country data rapidly available on a regular basis. A problem with these aggregate statistics is that their evolution is difficult to interpret, in particular during exceptional crisis periods, because the composition of the labour force changes significantly over the cycle.

Cyclical changes in the composition of the labour force reflect the fact that unemployment concerns disproportionately low wage workers. When unemployment increases, the labour force tends to become older and more skilled. This affects the average wage in a counter-cyclical way, the average wage increasing mechanically simply because the share of low wage workers in the population diminishes. If these composition effects are large, they may completely mask the response of wages to the cycle in the aggregate series.

Many studies have shown that composition biases are quantitatively important and, that, as a result, there is a large difference between the cyclical behaviour of wages observed in aggregate or individual level data. While this issue is relatively well known in the academic literature since the empirical studies on US of Bils (1985) and Solon, Barsky and Parker (1994) and is discussed in standard macroeconomic textbooks (Romer 2006, p 264), this question has received relatively little attention during the Great recession in continental Europe in spite of the fact that unemployment

changes have been particularly dramatic.[2] From 2007 to 2012, unemployment increased by 16 p.p. in Spain and Greece, 7.8 p.p. in Portugal and 4.6 p.p. in Italy. As unemployment has been disproportionally concentrated on unskilled and young workers, the characteristics of employees changed dramatically. In Spain, the share of low educated workers among employees decreased by 8 p.p. from 44% to 36% between 2007 and 2012, while the share of university graduate workers increased symmetrically by 8 p.p.[3] Because of these large changes, it is unclear how much the evolution of the aggregate wages during the Great recession reflected a change in the price of labour or in the composition of the labour force.

An investigation of the cyclical behaviour of real wages in European labour markets appears also particularly useful to derive whether more generally wages are relatively more rigid in Europe, which might explain in part the observed strong persistence of unemployment there. While some important and recent works using microdata on the cyclicality of wages on several major European countries are now available[4], the results are often difficult to compare since the construction of the sample, the data source and the period used in the estimates vary in potentially important ways across studies and countries. Most of these studies were written before the recent crisis and the importance of wage rigidity in the recent period remains an open question.

In this paper, we use harmonized panel microdata from the period 1994-2010 covering 11 major countries of the Euro zone to examine the relationship between real wages and the business cycle before and after the Great recession.

In the first part of the paper, we estimate the relation between wages and the cycle using data from the pre-Crisis period. As in previous work, we find that aggregate real wage series are not cyclical. However, when we account for changes in the composition of workers over the cycle using

[2] A recent exception focusing is the study on the UK of Blundell, Crawford and Jin (2014). As unemployment in the UK did not increase as much as in continental Europe, they find little difference between aggregate wage series and series adjusting for composition effects.
[3] Figures from aggregate LFS data from Eurostat.
[4] See Anger (2011) for Germany, Peng and Siebert (2008) for Italy, Verdugo (2013) for France and Carneiro, Guimarães and Portugal (2012) for Portugal. For non-European countries, see also Shin (2012) for Korea, Devereux (2000) for the US and Devereux and Hart (2006) for the UK.

individual data, we find that most of this acyclicality reflects the effect of compositional changes of the labour force. We obtain statistically significant elasticities of real wages to unemployment increases comprised between −0.6 and −1.9 which are quite similar to the one obtained in the existing literature for the US or the UK.

We find evidence that the adjustment is heterogenous over the distribution of wages, with a much larger estimated elasticity for individuals at the bottom of the wage distribution than at the top. Consistent with the existing literature, the elasticity of job changers is found the double of the one of job stayers. On the other hand, we find little evidence that wages adjust additionally to regional specific unemployment shock, except in Spain. This last result implies that, within countries, the adjustment to a specific negative regional labour demand shock should occur through internal labour mobility and persistent unemployment differences.

A point particularly important for the Euro zone considering the current low inflation is whether this elasticity of real wages to the cycle varies with the inflation level. Low inflation could delay wage adjustment as firms might be less able to decrease nominal wages significantly. The data strongly confirm this hypothesis. We estimate elasticities superior to −1.5 when the inflation rate is superior to 2% while they are much smaller and statistically insignificant when the inflation rate is inferior to 1%.

In the second part of the paper, we examine whether the relationship between wages and the cycle has changed during the Great recession, using data from 2008 to 2010, the last year for which the data is available. A particularly interesting aspect of our dataset during that period is that for about half of the country in our sample (France, Finland, the Netherlands and Italy), wage data has been collected using administrative records.

We find few evidence of downward nominal wage rigidity in the strict sense during the Great Recession. A fraction of between 20 to 40% of full time employees experience negative nominal wage changes between two years and this proportion increased with the downturn. Even if nominal wage cuts were quite common, the existing evidence suggests that low inflation in 2009 delayed significantly wage adjustment. While negative nominal wage changes were less frequent in 2010, negative *real* wage change increased substantially relative to 2009 as the level of inflation increased.

Using standard decomposition techniques, we document how much the apparent rigidity of real wages in aggregate data has been substantially exaggerated by composition bias. Most of the increase or stagnation in real wages observed in the aggregate data can be explained by composition effects. When we control for changes in the composition and keep constant the distribution of education and experience to the pre-crisis period, we find that real wages responded significantly to the downturn in a way that is broadly similar to the one observed in previous cyclical episodes.

These results notwithstanding, three cave-at are in order. First, in spite of the fact that we use a harmonized panel data, information on income is in part not very homogenous during the Great recession, as some countries rely on administrative records and other from household survey. The fact that we observe systematic differences between the distribution of wage changes in register and survey countries suggest measurement errors play a significant role in explaining some cross-country differences in the distribution of wage changes. Second, even if the results indicate lower wage adjustment during recent periods or groups of countries, it is likely that there is significant heterogeneity across countries and periods that are difficult to assess precisely with the limited time dimension of our sample.

This paper proceeds as follows. In a first section, we discuss the existing evidence from the literature on the cyclicality of wages. In a second section, we describe our data sources and provide some descriptive statistics. In section three, we present the econometric model evaluating the cyclicality of real wages and provide estimates using individual level data from 11 Euro zone countries. In section four, we focus on the Great recession and document whether the evolution of wages has changed during this particular episode. The last section concludes.

Existing Evidence on the Cyclicality of Real Wages

A large empirical literature looked at the relation between wages and the cycle, most of the time approximating the cycle with the unemployment rate. Using mostly aggregate time series, the first strand of the literature found only modest cyclicality. In contrast, recent studies mentioned above highlighted that the adjustment of wages is masked by composition effects in aggregate data and found a much larger elasticity of real wages using microdata. As summarized by Martins, Solon and Thomas

(2012), a strong result of this literature is that the cyclical elasticity of real wages is comparable to that of employment.[5]

However, the response of real wages may differ across cycles and countries. In particular, during the Great recession, the role of downward rigidity in nominal wages has been widely debated. In an influential paper on the Euro area crisis, Schmitt-Grohé and Uribe (2013) underlined that available aggregate real wage data indicated little decline since the beginning of the Crisis. As a decline in real wages is the most efficient response to a negative external shock, such rigidity might explain a large share of the increase in unemployment in some countries.[6]

In practice, recent research using individual level data has conflicting view on the importance of downward nominal rigidities during that period. For the US, Elsby, Shin and Solon (2013) found little evidence that downward rigidity can explain the decline in hiring and the long duration of unemployment during the Great recession. In contrast, using regional price levels and wages, Beraja, Hurst and Ospina (2014) concludes that nominal wage rigidities played an important role in explaining regional unemployment increases.[7]

For Europe, much less evidence is available except for Germany and the UK which both experienced relatively moderate employment loss.[8] For Germany, Burda and Hunt (2011) argues that the behaviour of German labour market during the crisis can be explained in part by the ability of employers to reduce working time relatively flexibly. For the UK, Gregg, Machin and Fernandez-Salgàndo (2014) point to an increased sensitivity of real wages to local unemployment during the Great recession which represents a distinct break from the past.

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[5] Recent work using matched employer and employee data find also a substantial cyclicality of entry wages in particular jobs in specific firms (Martin et al. 2010), and also when controlling for firm heterogeneity (Carneiro at al. 2012).

[6] In addition, if real wages are rigid because of the existence of downward nominal wage stickiness, temporary higher inflation levels might facilitate real wages adjustments and help to restore competitiveness in countries of the periphery of the Euro zone.

[7] Using simulations from a DSGE model, Daly and Hobijn (2014) also conclude that downward nominal wage rigidities can explain the dynamics of wage and unemployment during the Great recession.

[8] An exception is the study of Carneiro et al. (2014) on Portugal during the Great recession. They point to a substantial role of downward nominal rigidities: they observe a strong increase in wage freeze explained in part by a large increase in the minimum wage in 2010.

Data and Descriptive Statistics

We combine two large nationally representative longitudinal microdata sets covering the same countries but different time period. The first dataset is the European Community Household Panel (ECHP), where information on real wages is available from 1994 to 2001.[9] The ECHP is a harmonised cross-national longitudinal survey focusing on household income and living conditions. We use information on net current monthly wage and salary earnings to estimate wages. We also construct an hourly wage rate using the reported number of hours worked at main job. We define full time workers as those that declare having a full time job.

Our second source of data is the European Union Statistics on Income and Living Conditions longitudinal panel (SILC) collected from 2004 to 2011 which contains retrospective information on total annual income over the period from 2003 to 2010. The SILC panel is the follow-up survey of the ECHP but its construction is nonetheless quite different.[10] First, in contrast to the ECHP, it uses a rotating panel where an individual is interrogated at most fourth time.[11] More importantly, the information on income available in the SILC is quite different than the one in the ECHP. No information on current monthly wages is reported but the data contains annual "*employee cash or near cash income*" in the year previous the survey.[12] The data also contains retrospective information for each month on whether an individual was working full or part time. As there is no distinction between income received from full time or part time work and no information on the exact number of annual hours, we exclude workers who declare having worked part time in a given month from the sample. We compute an adjusted annual wage as the ratio between total annual income and the number of month worked full time. As a robustness check, we also consider a sample of full-time full-year

[9] The ECHP panel has been used in many recent influential studies on wages: see e.g. Olivetti and Petrongolo (2008), Dickens et al. (2007) or Bellou and Kaymac (2012).
[10] The SILC panel is not based on a harmonized questionnaire as the ECHP but is constructed using a set of 'target variables' specified by EU regulations. Countries can choose relatively independently how to collect each variable. This implies that the SILC is potentially less homogenous than the ECHP. On the other hand, it can be released more rapidly and is considered more flexible. See the Data Appendix for additional details.
[11] An exception is France where an individual can be interrogated up to 9 times.
[12] An exception is Ireland which uses as a reference period the 12 month preceding the interview.

(FTFY) workers.[13] For these workers, we are more confident that annual wage variations reflect changes in the wage rate and not changes in the number of hours worked.

An important issue is that income data is collected differently across countries in the SILC. A first group collects information on income through a survey using household declarations. A second group which includes Finland, the Netherland, Italy, and, France after 2007 collect income data from administrative records.[14] The use of administrative data for these countries is a clear advantage of the SILC. Administrative data is considered as being much more accurate since it has been shown that many reported changes in wages in survey data reflect measurement error (Gottschak 2005).

To focus on workers with substantial attachment to the labour force, our final sample uses workers aged between 18 and 60, who are not self-employed and are working in the private sector.[15] We only retain observations with valid information on wages and exclude imputed observations. Following Elsby et al. (2013), to eliminate the influence of outliers, we trim the top and bottom 1% of wage observations within each country and years. In order to avoid panel error, we verify we have a true match by requiring that gender and age match across years for each individual. Finally, we compute real wages using the national HICP index obtained from the OECD website. In all our calculation, we use sampling weights to preserve the representativeness of the sample at each period.[16]

We focus initially on 11 large Euro zone countries available both in the ECHP and the SILC: Austria (AT), Belgium (BE), Germany (DE), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Netherland (NL), and Portugal (PT). A typical year contains about 25,000 individuals for the ECHP and 80,000 for the SILC for which we have at least two individual observations to estimate the first stage model. However, the coverage of the ECHP and the SILC

[13] Focusing on FTFY workers eliminate about 5% of the sample.
[14] In practice, Italy uses a so-called "multiple data collection strategy" where survey data is matched with administrative data for the whole sample. See Consolini and Donatiello (2013). For other countries, information on the income collection procedure for these countries are collected in Jäntti et al. (2013). In particular, see Burricand (2013) for France.
[15] We cannot exclude workers from the public sector in the SILC.
[16] Notice that risk of attrition differs between the two surveys. In the ECHP survey, that sample is not renewed over time so the representativeness is impaired at the end of the period. The fact that SILC uses a rotating panel of 4 years (9 years for France) limits the problems of attrition at the price of a lower longitudinal dimension.

sample varies over time. For the ECHP, data is available over the period 1994-2001 for all countries, with the exception of Austria and Finland for which the data is available during the period 1995-2002 and 1996-2001, respectively. For the SILC, there is no income data for Germany during the entire period. As a result, we cannot include Germany in our analysis of wages after 2001, and in particular during the Great recession.[17] Finally, data from Ireland and Greece is only available until 2008 and we have to exclude these countries from the analysis of wages during the Great recession.

Trends in Wages, Unemployment and Prices

We briefly document the evolution of aggregate macroeconomic indicators during our sample period of in Figure 1. Panel A documents the large differences in growth rate across countries, particularly during the 1990s. Ireland, Greece or Finland and to a lesser extent Spain and Portugal experienced much larger economic growth than other countries until the Great recession. Panel B documents the large variations in unemployment which occurred during the period: in particular, unemployment decreased spectacularly in Ireland or Spain until the Great recession. An important point is the remarkable heterogeneity of changes in unemployment rates across Euro zone countries during 2008-2010. Unemployment increases were particularly large in Spain or Portugal, and more moderate in countries such as France or Italy.

Even though the time dimension is somewhat limited, the figures suggest that we are able to pick up different cycles for each economy. In addition, while these countries have experienced common macroeconomic shocks, there are nonetheless significant differences in the cyclical behaviour of unemployment. For example, unemployment increased in Portugal from 1994-1996 while it decreased rapidly in Spain in those years. Similarly, in 2001-2003, unemployment increased in the Netherland but decreased in Italy. Finally, the third panel documents the substantial differences in inflation rates across countries. Inflation converged at the end of the 2000s but diverged somewhat during the Great recession.

[17] For SILC, the data includes 2004-2011, except for Germany where it only covers 2005-2006, France where it covers, 2004-2010 and Greece and Ireland for which the sample cover 2004-2009.

The evolution of aggregate real wages is documented in Figure 2 using real labour compensation per unit labour input. In the recent period, the most striking pattern is the substantial increase in real wages from 2008-2010 observed during the Great recession in France, Portugal, Spain, Italy, and Ireland while at the same time unemployment increased widely in these countries. In 2008-2009, in Spain, Ireland or Portugal, real wage increased by respectively 4%, 2.2% and 3.6%. Real wage growth was more moderate in 2009-2010, with most countries in our sample experiencing negative real wage change.

Wage Cyclicality in the Euro zone before the Great Recession

Econometric model

We start by estimating various models relating the response of real wages to the cycle. Following Solon et al. (1994) and much of the literature, we estimate the model in two steps.[18] A typical assumption is that *real* wages follow a standard log-earnings equation:

$$w_{ikt} = X_{it}\beta + \alpha_i + \gamma_{kt} + e_{ikt} \quad (1)$$

where log real wages w_{ikt} depend on observable individual characteristics which are varying over time X_{it}, in practice a linear and quadratic term of potential experience, a term constant over time α_i, which captures the effect of observable and unobservable characteristics on wages, such as education or ability, and an error term e_{ikt}.[19] The term γ_{kt} is a set of time by country fixed effects which, by definition, captures cyclical variations in average wages in country k conditional on the composition

[18] Using a two-step procedure allows to put equal weight on each country-year observation. Estimating the model in two steps also accounts for the potential correlations of the error term within country and year (see e.g. Card 1995). Conventional standard errors will be significantly downward biased if we introduce directly the unemployment rate at the individual level. In addition, the simple solution of using cluster standard errors at the country by year level might not be valid in some specifications where we have relatively few clusters as the consistency of the estimator depends on the number of clusters (Angrist and Pishke 2009, chapter 8).

[19] We follow the literature by treating the returns to observable and unobservable characteristics as constant over time. See Chay and Lee (2000) for a more general model allowing for changes in the returns to observed and unobserved characteristics over time.

of the labour force. This implies the parameters γ_{kt} comprise a real wage time series free of composition bias.

Using panel data, we can estimate the series γ_{kt} using the fixed effect estimator.[20] However, panel data is not always available and, even when it exist, it is often not rapidly released which prevent analysing recent periods. As a result, several recent papers proposed to control for composition effects using cross-section data.[21]

Without panel data, some assumptions must be made on α_i to estimate the model. Consider the linear projection of α_i on observable individual characteristics X_i such as education and sex, $\alpha_i = \beta_2 X_i + u_i$ where u_i is an error term orthogonal to X_i. Estimates of γ_{kt} using repeated cross-section will be consistent if $cov(u_i, \gamma_{kt}) = 0$, that is if the distribution of unobserved characteristics is uncorrelated with cyclical variations. This hypothesis will be invalid if, for example, individuals with lowest wages conditional on their observable characteristics are more likely to become unemployed. In the empirical work, we will assess how using each method affects the estimated elasticity of wages.

Once we have obtained the series γ_{kt} of average wages correcting for composition effects, the second and final step consist in estimating the correlation between that series with the national unemployment rate as proxies for changes in labour demand during the cycle. We estimate specifications of the form:

$$\Delta\hat{\gamma}_{kt} = \pi_t + \rho\Delta U_{kt} + u_{kt} \quad (2)$$

where ΔU_{kt} is the annual change in unemployment rate. The model controls non-parametrically for common shocks across-countries by including time fixed effects π_t. As a result, in such specification,

[20] Following Carneiro et al. (2012), we use the fixed-effect estimator instead of the first-difference estimator in order to avoid restricting the sample to only individuals working over two consecutive periods. In practice, using first-differences instead give broadly similar results.
[21] See e.g. Haefke, Sonntag and Van Rens (2013), Blundell, Crawford and Jin (2014) and Beraja et al. (2014).

the parameter ρ is identified from deviations in average unemployment changes and level across countries in a given year.

Results: Estimates of the Elasticity of Real Wages in the pre-Crisis period

Next, we present our estimates of the elasticity of real wages to changes in unemployment rate using longitudinal data from 1994-2001 in the ECHP and 2003-2007 in the SILC.[22] We do not include data for after 2008 in order to derive how much the evolution of wages during the current crisis differs with respect to previous episodes. In order to get an average across country, and because we have a short panel with at most 11 years per country, we first estimate our baseline model by pooling countries in the sample. We examine below whether the results differ in an important way across countries.

For comparison purposes, we first start with estimates of the model of equation (2) using uncorrected aggregate real wage data as a dependant variable. In Columns 1 and 2 of Table 1, we use changes in the real labour compensation from the national accounts obtained from the OECD website.[23] Consistent with previous studies using aggregate data, the results in Column 1 and 2 point to weak evidence of cyclicality. The estimated effects of unemployment are small and statistically insignificant.

In columns 3 and 4, we use as a dependant variable an uncorrected aggregate real wage series that we constructed using our micro-data. We find weak evidence of wage cyclicality, with elasticities between − 0.3 and −0.7 for unemployment change, measured quite imprecisely.

In columns 5 and 6, we present our baseline estimates of the two step model which controls for composition effects in the first step regression. The differences with respect to the previous column are striking: the estimated wage elasticity is about 2 to 3 times larger and is strongly statistically significant. We obtain an elasticity of −1.3 without time fixed effects and −1.1 when time fixed effects

[22] We use the 2004-2008 releases of SILC since it we use retrospective information on annual income in the previous year.

[23] To ensure comparability, we match the number of countries and years in the sample across regressions with the one of regressions using ECHP-SILC that we perform next.

are included, implying that a 1 p.p. increase of the unemployment rate is correlated with a decrease of between 1.3 and 1.1 p.p. of the average log real wage in the country.

To clearly document the underlying source of variations of these estimates, Figure 1 shows the "*Yulized residuals*" of the estimates of ρ_1 from the specification of the model reported in column 6.[24] The Figure indicates that no particular outlier seems to be driving the estimates. To derive formally the influence of a particular country, we have estimated the same models but excluding each country sequentially (see Appendix Table 1). We find that the results do not depend on the inclusion of a particular country in the sample: the largest change is obtained when excluding Ireland from the sample, with a parameter estimate of −0.705 (0.276) which is nonetheless strongly statistically significant.

An important practical question is whether similar results could be obtained using more easily available cross-section data. Instead of using individual fixed effects, we include in the first step flexible controls for education and potential experience through the interaction between 8 cells of potential experience and 3 levels of education.[25] Results in columns 7 and 8 are in practice quite similar, the estimates being nonetheless slightly lower with elasticities between −1 and −0.8. Overall, this suggest that this method accounts relatively well for composition effects in our sample.

In Table 2, we estimate the robustness of the model using different groups of workers and periods. In column 1, we test how much our results change when the sample is restricted to full time full year workers. By focusing on these workers, we minimize measurement errors in labour supply at the price of selecting individuals with stronger labour markets attachments. With respect to the previous results, we find that the coefficients are barely affected. In columns 2 and 3, we assess

[24] The figure provides a graphical representation of the variations underlying the parameter estimate using the residuals of regression of $\Delta\gamma_{kt}$ on time fixed-effects on the y-axis and a separate regression of ΔU_{kt} on time fixed effects on the x-axis.

[25] We use a separate set of fixed effects for each country and each sample. The cells of potential experience are defined in the following way: less than 5 years, 6-10, 11-15, 16-20, 21-25, 26-30, 31-35, more than 36 year. Potential experience is defined using the declared year of entry in the labour market when available, and imputed when missing using respectively 21, 19 and 16 for individuals with tertiary, secondary and primary levels of education.

whether there exist important differences in wage cyclicality between men and women. We obtain a slightly larger cyclicality of wages for women, with a coefficient of −1.3 against −1 for men.

In column 4 and 5, we use hourly wages as a dependent variable in the first step regression which allows us to introduce part time workers in the sample. In doing so, we include the whole population of employees in the sample but introduce potentially more measurement errors in wages.[26] Because of the stronger prevalence of part time work for women, we estimate as previously separate models for men and women. We obtain quite similar coefficients for both groups suggesting an elasticity of −1.1.

In columns 6 and 7, we estimate separately the model with either the ECHP or the SILC. There are several reasons why the results might differ between these two samples: first, as discussed previously, the wage concept is different between the two surveys. Second the cyclicality might have changed between the two periods, particularly if the implementation of the Euro had a strong impact on wage evolutions in some countries.[27] However, for both periods, we obtain relatively strong and negative correlations. The coefficients are nonetheless substantially lower for the SILC with an elasticity of −1.8 for the ECHP and −1.2 for the SILC.

An important issue is that, even if the model is identified by using within-individual variations in wages, the composition of our sample is not constant over time since some individuals enter and exit the sample permanently. This might affect our estimates if the cyclicality of wages is heterogeneous and the share of workers with a different level of wage cyclicality endogenously varies over the cycle.[28] To assess the importance of this issue, column 8 shows estimates of the model using a balanced panel with the ECHP in the first step which keeps constant the composition of the sample

[26] See the Appendix for details on the construction of the hourly wage series.
[27] Measurement errors might also differ between ECHP and SILC (Moore et al. 2000).
[28] If the coefficients are heterogeneous, the regression estimates, under some additional assumptions, what Wooldridge (2005) calls the average partial effect.

over the estimation period.[29] With this sample, we obtain an elasticity of −1.4 which is substantially lower than the one of −1.9 obtained reported in column 6 but nonetheless statistically significant.[30]

In Table 3, we explore how the elasticity of wages varies across individuals with different skill levels. We estimate separate wage elasticity depending on the initial rank in the wage distribution of an individual when she is observed for the first time in the sample. We find significant differences in wage elasticity. In particular, the wage elasticity is much larger for those observed initially at the first decile (−2.8), the first quartile (−2) than for the last quartile or the last decile (−0.8).

Next, we distinguish the response of wages between those changing employer between two period and those remaining in the same job. The more important cyclicality of wages of jobs changers has been underlined in the empirical literature (see e.g. Devereux and Hart 20006) and might reflect the existence of implicit contracts insuring workers remaining with the same employer from excessive income fluctuations (Beaudry and DiNardo 1991). We estimate two separate series of corrected wage indexes for stayers and shifters using the following model:

$$w_{ikt} = X_{it}\beta + \alpha_i + \gamma_{kt}^{stay}\left(1 - S_{ikt}\right) + \gamma_{kt}^{shift} S_{ikt} + e_{ikt}$$

where S_{ikt} is an indicator variable equal to one when an individual has changed employer during the year. In the second step, we regress the estimates of γ^{stay} and γ^{shift} on the unemployment change and level. Results of these estimates are provided in Table 4. Consistent with the existing literature, job-changers exhibit a much higher level of cyclicality. While the estimated coefficient is close to −1 for stayers while it is −1.7 for shifter.

In Table 5, 6 and 7, we extend the model to test for various types of heterogeneity in the cyclical response of wages. In Table 5 and 6, we investigate whether we find a strong regional dimension in the adjustment of wages, following the tradition of Blanchflower and Oswlad (1995) and more recently Gregg et al. (2014). As the dispersion in unemployment is often large across regions,

[29] We focus on ECHP since SILC being a rotating panel, it is only possible to follow a fourth of the sample during at most four years.
[30] Previous work such as Solon et al. (1994) found relatively negligible differences between standard estimates and estimates obtained from a balanced sample.

and tends to widen during crisis periods, estimating whether wages additionally react to the dispersion of regional unemployment is important to understand how regional adjustments to asymmetric shocks occurs (Blanchard and Katz, 1992).[31] We estimate the following first-step model:

$$w_{ikt} = X_{it}\beta + \alpha_i + \gamma_{Rkt} + e_{ikt} \qquad (3)$$

where γ_{Rkt} varies across regions R within countries k. In the second step, we include in the regression both the national and regional unemployment rate.

As information on regions is not available for some countries in the sample, we rely on a restricted set of countries and have to exclude from the sample Germany, Ireland and the Netherlands.[32] For comparison, Column 1 shows the estimate of the baseline model using national variations on this restricted set of countries. Column 2 and 3 show estimates of models using either the national or regional unemployment rate: while the coefficient of the regional unemployment rate is statistically significant, we obtain a much larger coefficient using the national unemployment rate. When both rates are included in the model, as in Column 4, only the elasticity to the national level is economically and statistically significant. In column 5, we include time by year fixed-effects which absorb common national variations in wages. Using this specification, we find no effect of changes in the regional unemployment rate.

A potentially important issue is that our sample includes both large and small countries. The response to a regional shock may differ between the two as it might be easier to move from the South to the North in a small country like Belgium than in Italy. To capture existing differences, we perform a country-by-country estimate of the model including time fixed effects in Table 6. With the exception of Spain, we find little evidence of an additional adjustment to regional unemployment.

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[31] For example, in 2011 in Spain, the unemployment rate was 31% in Andalusia but only 13% in the Basque Country.

[32] Regional definitions in ECHP and SILC are aggregated to preserve confidentiality and they change in an important way between the two surveys. We have matched these definitions with data from the European LFS and calculated regional unemployment rates corresponding to the specific definitions available in the panel data. See appendix for details.

Overall, as in Gregg et al. (2014) for the UK, the evidence suggest that differences in regional unemployment rate do not seem to account much for cyclical wages variations once the effect national trends has been taken into account. This suggests that most of the adjustment to differences in unemployment rate across regions should occur through internal mobility, as found by Blanchard and Katz (1992) for the US.

Next, in Table 5, we test whether wages are more likely to be correlated with group specific unemployment rates than the overall unemployment rate. As the unemployment tend to increase much more rapidly for particular groups, such as young and low-educated workers, it is potentially important to know whether wages adjust proportionally to cell specific labour demand shock. We use wages from 24 cells defined by the interaction between 8 levels of experience and 3 levels of education that we relate to changes in the specific unemployment rate of the cell.[33] As previously for regions, we find that changes in cell-specific unemployment explain little of additional variations in wages. When combined with national rate as in column 3, or when the model includes country by time fixed effects as in column 4, the coefficient is quite small and statistically insignificant.

Inflation and real wage elasticity

Since 2013, inflation has been particularly low in the Euro zone. Variations of the inflation level might have important consequences on the adjustment of real wages which are not captured by the previous model where real wages are used as a dependent variable. In a low inflation environment, especially if inflation fluctuations are not anticipated (Elsby 2009), firms might find difficult to adjust real wages downward because it implies to decrease the nominal wage which is deemed to be particularly rigid (Tobin 1972).

The presence of downward nominal rigidities implies that the variable ΔU has a coefficient that varies with the aggregation inflation rate.[34] The coefficient should be smaller the lower the inflation rate and, as a consequence, the higher the fraction of individuals affected by downward

[33] We use the same first step model than in Eq (3) but where instead of being region, R denotes cells of education and experience.
[34] See Card and Hyslop (1997) for a formal proof.

rigidities. To evaluate the empirical relevance of this hypothesis, we extend our baseline model to allow for the elasticity to vary with the levels of inflation. During our sample period, as shown by Figure 1, variations in the rate of inflation have been quite large. In practice, the distribution of inflation in our sample is such that the first, second and third quartile are respectively 1% , 2% and 3%. We use these thresholds to estimate the following model:

$$\Delta\hat{\gamma}_{kt} = \pi_t + \rho_1 \Delta U_{kt} \times e_{\Delta IPC<1\%} + \rho_2 \Delta U_{kt} \times e_{\Delta IPC\in[1\%;2\%[} + \rho_3 \Delta U_{kt} \times e_{\Delta IPC\in[2\%;3\%[} + \rho_4 \Delta U_{kt} \times e_{\Delta IPC>3\%} + u_{kt}$$

where $e_{\Delta IPC\in[x,y]}$ is a dummy variable equals to one if the inflation rate is comprised in the indicated interval and zero instead. Each parameter ρ_k indicates how much the elasticity to unemployment rates varies with the inflation levels.

Consistent with the theory, results in Column 1 in Table 4 point to a sizable increase in the response of wages between a low and high inflation regime. The elasticity is close to −0.6 and measured imprecisely when inflation is inferior to 1%, while it is close to −1.4 and statistically significant when inflation is superior to 1%. In Column 2, as a robustness check, we exclude Spain, Italy, Greece and Portugal from the sample as these countries experienced a particularly large inflation level during the 1990s. We find quite similar results with an increased in the measured wage elasticity with the inflation rate.

Heterogeneity in Wage Elasticity across countries

Until here, we have estimated the model by pooling all countries in our sample. Obviously, the hypothesis of similar wage elasticity across countries over this period is quite strong and there may exist important cross-country differences the cyclicality of wages which are potentially related to differences in labour market institutions. To explore this issue, we divide our sample in two and estimate a separate effect for countries from the South of Europe which, according to OECD (2013), have more rigid labour market institutions during the period. This group includes Spain, Portugal, Italy, Greece, and France. As expected, results in Table 9 indicate that countries with more rigid institutions have a lower level of wage elasticity. We obtain elasticities of between −0.6 and −0.9 for rigid countries, while the coefficient is multiplied by 2 and is close to −1.8 for countries which are deemed as less rigid.

In Table 9, we estimate a separate country by country elasticity. For most countries, with the exception of Belgium and France, we find a negative coefficient, which is sometime quite large as for Austria and Ireland. The coefficient is close to zero for Germany.

Obviously, these results must be interpreted with caution. Given the limited time dimension of our sample, our ability to test convincingly for heterogeneity across countries is somewhat limited and as the results are heavily dependent of a particular observation. In addition, as discussed below, country specific studies on France by Verdugo (2013) and on Germany by Anger (2011) which use different data and a substantially longer period of time found a substantial cyclicality of real wages.

Discussion

Evidence from panel microdata of individual from 11 Euro zone countries shows that real wages have been quite pro-cyclical from 1994-2008. Our finding that composition effects have an important impact on wage cyclicality confirm an important conclusion that has emerged in previous work using longitudinal microdata. Our estimated elasticities are remarkably in line with existing estimates from this literature.[35] The literature reports elasticities between −0.7 to −1.7 for the US (Solon et al. 1994) and −1.7 to −2.0 for the UK (Devereux and Hart, 2006). For Euro zone countries, Anger (2011) reports elasticities from -0.8 to -1.7 for Germany, Verdugo (2013) finds −1.5 for France, Carneiro et al. (2012) find −1.6 to −2.5 for Portugal, Peng and Siebert (2008) find −1.4 to −3 for Italy, and de la Roca (2014) found −0.4 for Spain.

Obviously our results are limited by the fact that impossible to extend our analysis on earlier periods. In addition, because of sample limitations, it is not possible to estimate credibly a separate elasticity across countries.

[35] Most papers use a model similar to the one of Eq. (1) but there are sometimes important differences in the sample construction and the unemployment measure used to estimate the model which must be taken into account to interpret the results. See Anger (2011) for a discussion.

Wage adjustments during the Great Recession

Having established the cyclicality of wages in our sample of Euro zone countries before 2008, we next investigate how much the evolution of real wages differed during the Great recession.

Distribution of nominal wage changes during the Great Recession

We start by presenting visual evidence from the distribution of individual wage growth before and during the Great recession. Figure 4 present a series of histograms representing the distribution of year-to-year changes in nominal wages in the SILC sample during the first year of the crisis, in 2009, and just before the crisis, in in 2008.[36] For Portugal, as there was an important change in data collection procedure in 2008 which makes 2008-2009 changes unreliable, we use instead changes from the 2010-2009 period as a comparison.[37] Following Card and Hyslop (1997), the inflation rate of both periods is drawn using a vertical line, with a solid line for 2008 and a dashed line for 2009. The first panel represents the groups of countries for which data is collected using administrative records while countries in the second panel rely on information on income from household surveys.

As in Dickens et al. (2007), we find that these distributions have a number of characteristics in common but across countries also notable differences. Four features stand out. First, as highlighted in the previous literature, nominal wage decreases are not rare in both years. Depending on country and year, roughly 20-40% of workers experience nominal-wage cuts which are strong evidence that nominal wages are not sticky for a large proportion of the workforce. In particular, wage data from France, Italy, Netherland and Finland, all collected from administrative records show a surprisingly high frequency of nominal wage reductions.

Second, measured year-to-year changes in individual wages have clearly responded to the Great recession: for most countries, the distribution of annual wage changes has clearly shifted to the left in 2009. To capture more systematically how the distribution varies over the cycle, we report in

[36] For scale reasons, the real wage changes have been censored at +-0.4 and the masses at the upper and lower extremes represent cumulative fractions.

[37] Starting in 2008, most wages in Portugal were collected net of social contribution while there were collected gross. As an imputation procedure was used to convert

Table 11 the share of negative nominal and real wage changes from 2003 to 2010. For most countries, the share of workers with negative nominal wage change has substantially increased in 2009 and 2010 with respect to 2008. While nominal wage changes are quite frequent, inflation nonetheless appears to play an important role in real wage adjustments. A simple comparison between nominal and real wage changes illustrates the strong effect of inflation. While the share of workers with negative wage changes decreased from 2009 to 2010 by 3 points in France, the share of workers with negative real wage growth increased by about 11 points as inflation increased dramatically in 2010 with respect to 2009.

Third, there are systematic variations in these distributions between countries using administrative records and countries using survey data. Large negative variations superior to −0.1 are quite rare in countries using administrative data (less than 10% in France, Finland and Italy and 4% in the Netherlands) but are observed more frequently in survey data countries (about 20% in Spain and Austria). This suggests that to a large extend, some systematic cross-country differences in the distribution of wage changes are correlated with collection method of the data.

Fourth, evidence for the existence of a spike at zero before and during the Great recession is mixed. A spike is visually discernible in Spain and to a lesser extent in Austria with respectively 8%, and 3% of wage freeze on average over the 2004-2010 period. In contrast, in countries using payroll data, less than 1% of individuals have an identical wage during two subsequent years.

Wage Cyclicality during the Great Recession

The strong response of individual wage documented above implies that composition effects might have been important in explaining the behaviour of the average wage during the Great recession. To assess this issue more formally, we estimate how much the average wage would have declined during the Great recession had the characteristics of workers in the labour force remained constant during the recession. To estimate this counterfactual, we use the following simple decomposition:

$$w_t - w_{t'} = \left[w_t - w_t(Z_{t'}) \right] + \left[w_t(Z_{t'}) - w_{t'} \right]$$

where w_t is the average wage observed in year t and $w_t(Z_{t'})$ is the counterfactual wage that would have been observed in t has the distribution of characteristics $Z = (X, \alpha)$ of employees remained the one of period t'. The first term between the brackets on the left side captures *composition effects* as it can be interpreted as the change in average wage that would be observed in period t had the composition of the labour force with respect to characteristics Z been similar to the one of period t'. The second term in the brackets captures *price effects* and reflects changes in average labour price between t and t' that would have been observed had the distribution of characteristics X remained similar to the one of period t' during both periods.

The counterfactual average wage $w_t(Z_{t'})$ is unobserved and must be calculated. We use the reweighting approach proposed by DiNardo et al. (1996). As in our 'cross-sectional' estimates in the previous section, we calculate weights for 24 groups of education and experience interacted with sex such that the reweighted distribution in a given year is equal to the one of the reference year. The "counterfactual" average wage is then simply obtained by using these weights.[38]

Table 12 shows the results of the decomposition using the composition of the labour force using 2008 as a reference for the distribution of education and experience. As expected, composition effects are large and tend to be positive across all countries, except in Austria where unemployment did not change much during the Great recession. Figure 5 shows more formally the relationship between each element of the decomposition with the unemployment change. While changes in observed average wages are weakly correlated with unemployment, composition adjusted wage changes across countries are strongly proportional to unemployment change. Interestingly, the cross-country correlation is −0.55 (0.22) which is consistent with the lowest elasticities estimated in the previous section.

[38] Notice that, by definition, we only achieve a partial correction of composition biases by using reweighting techniques. The interpretation of the 'price effect' in our decomposition as reflecting purely changes in prices is valid under the conditional independence assumption that the distribution of other unobserved factors within groups has not changed over time (Fortin, Lemieux and Firpo 2011).

In Figure 6, we document how wages have changed at different part of the distribution. If anything, we find a stronger effect on the lower part of the distribution than on the upper part. Notice however the estimated large increases of P10 in Portugal which reflects the implementation of a large minimum wage increase in 2010 (see Portugal et al. 2014 for a discussion). Table 13 shows we tend to find lower levels of adjustment for full-time full-year workers. Changes in wages seem also substantially larger for male than female.

In Table 14, we investigate whether we find a substantial regional adjustment to changes in wages. Consistent with the results from the previous section, we find no effect of regional unemployment once the effect of national unemployment rates have been taken into account. In addition, separate estimates for France, Spain and Italy show very little regional dimension.

Overall, the results in this section suggest that wage adjustment during the Great recession in these countries has been substantial. As composition effects were largely proportional to unemployment changes, they obscured cross-country differences in wage adjustment in an important way, making variations in the aggregate data difficult to interpret.

Discussion

Using individual level data for the Euro zone before and during the Great Recession, we have investigated the relationship between real wages and change in unemployment rate. We found that composition effects hide the significant correlation between real wage changes at the individual level and the business cycle. With individual level data, we estimate that the elasticity with respect to unemployment rate between −0.7 and −1.9. We also find a substantially larger elasticity for those job changers and for workers at the bottom of the wage distribution. The estimated elasticity is diminished in period of low inflation compared with periods of high inflation. Finally, we do not find evidence of an additional correlation of wages to regional-specific changes in unemployment or a cell-specific unemployment.

Consistent with these findings, we find that composition effects have been large during the Great recession and potentially explain most of the stagnation or increases in average wage observed in aggregate data from 2008 to 2010 in countries most affected by an unemployment increase. At

constant composition of the labour force in terms of education and experience, the data indicates much larger wage adjustments during the downturn in countries most affected by the crisis. Indeed, we find composition effects during the Great recession to be strongly proportional to the unemployment increase.

The results in this paper have several implications. First, our results confirm that the evolution of the aggregate real wage series is partially misleading. International comparisons in wage adjustment must be interpreted with caution when there are simultaneously large differences in unemployment change across countries.

Second, the difficulties related to the interpretation of changes in aggregate wage data over time and across countries suggest that the availability of a wage index taking into account composition effects would have a substantial payoff. Obviously, for such index to be useful for policy making, it would have to be available in a reasonable delay and be sufficiently homogenous across countries. Results from this paper show that simple reweighting techniques controlling for composition effects using observable characteristics of the labour form in term of education and experience would be quite useful.

Finally, the fact that wage adjustment where particularly slow during low inflation period confirms previous evidence that adjustment are more difficult to make during periods of low inflation. These results confirm it is important for the Euro Zone to avoid deflationary low inflation during periods in which wages have to be adjusted significantly.

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Table 1: Real Wage Elasticity: Aggregate versus Individual level Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Specification	Real aggregate Labour Compensation		No individual fixed-effects		Include indiv. fixed-effects		Cross-section methodology	
ΔU_t	-0.188	-0.034	-0.705	-0.382	-1.321***	-1.141***	-1.081***	-0.797**
	(0.236)	(0.270)	(0.969)	(0.922)	(0.334)	(0.329)	(0.387)	(0.393)
Sample	National Accounts		ECHP / SILC					
Time period	1994-2001 // 2003-2008							
Time FE	No	Yes	No	Yes	No	Yes	No	Yes
Individual FE (First Step)	na	na	No	No	Yes	Yes	No	No
N	101	101	101	101	101	101	101	101

Notes: The table presents estimates of the relationship between annual changes in log real wages and changes in the unemployment rate. Columns 1 and 2 use data from national accounts to calculate wages while other columns use data from the ECHP and the SILC panels. See text for details. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 2: Differences in Wage Elasticity for various sample definitions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Full-time Full-year workers	Men	Women	Hourly wage: men	Hourly wage: women	ECHP	SILC	ECHP: Balanced Sample
ΔU_t	-1.091***	-1.023***	-1.336***	-1.100***	-1.175***	-1.846***	-1.182**	-1.423***
	(0.334)	(0.330)	(0.376)	(0.335)	(0.402)	(0.388)	(0.577)	(0.348)
Time period	1994-2001 // 2003-2008					1994-2001	2003-08	1994-01
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	101	101	101	101	101	59	42	59

Notes: The table presents estimates of the relationship between annual changes in log real wages and changes in the unemployment rate. Column 1 estimates the model using full-time full year workers. Column 2 and 3 use respectively men and women full time workers. Column 4 and 5 use hourly wages including full and part time workers for respectively men and women. Column 6 estimates the model using only with data from the ECHP. Column 7 uses only data from the SILC. In Column 7, the model is estimated using the ECHP with a balanced sample. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 3: Wage Elasticity across the Wage Distribution

	(1)	(2)	(3)	(4)	(5)	(6)
	P10	Q1	Q2	Q3	Q4	P90
ΔU_t	-1.977**	-1.746***	-1.034***	-0.842**	-0.719	-0.843
	(0.854)	(0.515)	(0.326)	(0.356)	(0.438)	(0.578)
Sample	ECHP-SILC					
Time period	1994-2001					
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
N	101	101	101	101	101	101

Notes: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the unemployment rate. Each column estimates a different model for individuals defined by their location in the wage distribution of their country the year they are observed for the first time in the sample. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 4: Wage Elasticity of Job Stayers and Job Changers

	(1)	(2)	(3)	(4)	(5)	(6)
	Without Time Fixed-Effects			*Including Time Fixed-Effects*		
	All workers	Stayers	Changers	All workers	Stayers	Changers
ΔU_t	-1.321***	-1.148***	-1.818***	-1.141***	-1.021***	-1.693**
	(0.334)	(0.294)	(0.648)	(0.329)	(0.285)	(0.692)
Time period	1994-2001 // 2003-2008					
Time FE	No	No	No	Yes	Yes	Yes
N	101	101	101	101	101	101

Notes: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the unemployment rate. Column 1 and 4 estimate the model the whole population. Columns 2 and 5 report the effect for those who remained with the same employer. Columns 3 and 6 report the effect for those who changed employers. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 5: Effect of Regional Unemployment

	(1)	(2)	(3)	(4)	(5)
	National Level	Regional regressions			
ΔU_t	-0.780***	-0.773**		-0.665**	
	(0.282)	(0.317)		(0.287)	
regional ΔU_{Rt}			-0.228*	-0.090	-0.021
			(0.135)	(0.116)	(0.089)
N	77	574	574	574	574
Time FE	Yes	Yes	Yes	Yes	Yes
Time x Country FE	No	No	No	No	Yes

Notes: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national and regional unemployment rate. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 6: Regional Unemployment Elasticity per Country

	AT	BE	ES	FI	FR	GR	IT	PT
regional ΔU_{Rt}	-0.077	0.183***	-0.391**	0.511	-0.056	-0.144	0.173	0.147
	(0.231)	(0.048)	(0.153)	(0.414)	(0.179)	(0.704)	(0.196)	(0.288)
N	29	35	124	38	165	34	101	48
Time x Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national and regional unemployment rate. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 7: Effect of Cell-Specific Unemployment Rate

	(1)	(2)	(3)	(4)
ΔU_t	-2.050***		-1.763***	
	(0.267)		(0.334)	
Cell-specific ΔU_{Ct}		-0.521***	-0.290	-0.224
		(0.186)	(0.207)	(0.157)
N	2273	2273	2273	2273
Time x Country FE	No	No	No	Yes

Notes: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national and cell-specific unemployment rate. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 8: Wage Elasticity and the Inflation rate

	(1)	(2)
ΔU_{kt}	-0.619	-0.294
x Inflation < 1 %	(1.867)	(2.058)
ΔU_{kt}	-0.918*	-0.595
x Inflation $\in [1,2]$	(0.465)	(0.556)
ΔU_{kt}	-1.035*	-1.342**
x Inflation $\in [2,3]$	(0.465)	(0.624)
ΔU_{kt}	-1.428*	
x Inflation > 3%	(0.605)	
N	101	
Sample	ECHP+SILC	
Time period	1994-2001 // 2003-2008	
Countries	All	GR, ES and IT excluded
Time FE	Yes	Yes

Note: The table presents estimates of the relationship between annual changes in log real wages and changes in the national unemployment rate of full time workers interacted with the inflation level. In column 2, countries with the largest average inflation level over the period, which are Greece, Spain and Italy, are excluded from the sample. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 9: Rigid vs Less Rigid Countries

	(1)	(2)
ΔU_t x Rigid	-0.734**	-0.572*
	(0.320)	(0.326)
ΔU_t x (Non Rigid)	-1.920***	-1.793***
	(0.478)	(0.473)
N	101	101
Time FE	No	Yes

Note: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national unemployment rate interacted with whether the country has more rigid labour market institutions. Rigid countries are Spain, Portugal, Italy, Greece, and France. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 10: Country Specific Elasticity

	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
ΔU_t	-4.020	0.513	-0.089	-0.903**	-1.476**	0.210	-0.363	-3.052***	-0.481	-1.412**	-0.859*
	(2.511)	(0.521)	(0.874)	(0.369)	(0.749)	(0.883)	(0.707)	(0.496)	(1.185)	(0.684)	(0.494)
N	9	11	6	10	9	9	8	8	11	10	10

Note: The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national unemployment rate estimated separately for each country. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Table 11: Percentage of workers with negative real or nominal annual log wage change

	A. Countries using administrative data											
	FI		**FR**		**IT**		**NL**					
	Nominal Wage Cut	Real Wage Cut	Nominal	Real	Nominal	Real	Nominal	Real				
2004	0.22	0.22	0.31	0.50	0.35	0.46						
2005	0.24	0.27	0.27	0.40	0.32	0.44	0.18	0.23				
2006	0.26	0.31	0.28	0.42	0.23	0.35	0.23	0.31				
2007	0.21	0.27	0.27	0.37	0.41	0.53	0.15	0.18				
2008	0.19	0.34	0.21	0.41	0.30	0.49	0.21	0.30				
2009	0.33	0.38	0.32	0.32	0.40	0.45	0.21	0.26				
2010	0.26	0.35	0.29	0.43	0.36	0.46	0.24	0.31				
	B. Countries using survey data											
	AT		**BE**		**ES**		**GR**		**IE**		**PT**	
	Nominal	Real	Nominal	Real	Nominal	Real	Nominal	Real	Nom.	Real	Nom.	Real
2004	0.41	0.45	0.35	0.44	0.37	0.50	0.30	0.44	0.32	0.40		
2005	0.42	0.46	0.29	0.40	0.37	0.49	0.19	0.46	0.28	0.36	0.12	0.27
2006	0.36	0.47	0.33	0.46	0.33	0.49	0.25	0.43	0.25	0.35	0.26	0.34
2007	0.38	0.45	0.33	0.42	0.29	0.41	0.11	0.40	0.29	0.40	0.33	0.41
2008	0.34	0.46	0.25	0.43	0.31	0.50	0.17	0.54			0.30	0.45
2009	0.38	0.38	0.34	0.33	0.39	0.37					na	na
2010	0.35	0.45	0.35	0.47	0.42	0.59					0.49	0.56

Note: For each country, the table shows the share of full time workers with a negative real or nominal log wage change.

Table 12: Decomposition of real average log wage changes, 2008-2009 and 2008-2010

	2008-2009		
	Observed change	Composition Effects	Adjusted change, 2008 Xs
AT	-0.37	-0.12	-0.26
BE	1.94	0.58	1.36
ES	-0.03	1.65	-1.67
FI	0.38	0.04	0.33
FR	-0.30	0.62	-0.92
IT	-3.76	0.67	-4.44
NL	-0.11	0.47	-0.58
	2009-2010		
	Observed change	Composition Effects	Adjusted, 2009 Xs
AT	1.45	-0.34	1.79
BE	-2.46	1.01	-3.47
ES	-0.66	2.20	-2.86
FI	1.19	1.00	0.19
FR	0.26	1.15	-0.89
IT	3.86	2.16	1.70
NL	1.49	2.16	-0.67
PT	-2.17	0.40	-2.57
	2008-2010		
	Observed	Composition	Adjusted, 2008 Xs
AT	1.08	-0.46	1.54
BE	-0.52	1.75	-2.27
ES	-0.69	4.12	-4.81
FI	1.56	1.49	0.07
FR	-0.04	1.66	-1.70
IT	0.10	2.92	-2.82
NL	1.38	2.67	-1.29

Note: DFL decomposition method keeping constant the distribution of education and experience across 24 cells. The third columns shows the counterfactual log wage change estimated using the DFL reweighting technique by keeping the distribution of education and experience constant across 24 groups using the 2008 distribution. See text for details.

Table 13: Composition Adjusted Real Wage Changes in 2008-2010 for different sample definitions

	FTFY	Men	Women	Hourly Wages Men	Hourly Wages Women
AT	4.74%	1.76%	1.13%	4.79%	4.61%
BE	0.28%	-1.67%	-3.33%	-0.95%	0.62%
ES	-2.66%	-5.00%	-4.20%	-1.52%	-4.44%
FI	2.32%	-1.57%	1.72%	0.85%	2.55%
FR	0.72%	-2.75%	-0.25%	0.49%	2.23%
IT	-2.15%	-3.47%	-1.80%	-4.98%	-6.10%
NL	-0.22%	-1.60%	-0.26%	0.84%	9.18%
PT	-1.69%	-2.33%	-2.89%	-2.09%	-3.56%

Note: Each column shows the composition adjusted change in log real wages for a different subgroup of the population. The composition adjusted wage change has been obtained using the DFL reweighting technique by keeping the distribution of education and experience constant across 24 groups using the 2008 distribution.

Table 14: Regional wage adjustments during the Great Recession, 2008-2010

	Pooled Estimates: *AT, BE, ES, FI, FR, IT*			Country specific Estimates		
				FR	SP	IT
ΔU_t	-0.405**		-0.733***			
	(0.160)		(0.248)			
regional ΔU_{Rt}		-0.127	0.399*	0.256	0.482	-1.747
		(0.154)	(0.232)	(0.466)	(0.299)	(2.327)
N	105	105	105	44	36	8
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: : The table presents estimates of the relationship between annual changes in log real wages of full time workers and changes in the national and regional unemployment rate. Robust standard errors are in parenthesis. Statistically significant * at the .10 level; ** at the .05 level; *** at the .01 level.

Figure 1: Real GDP, Unemployment Rate and HICP over our sample period
(Source: OECD)

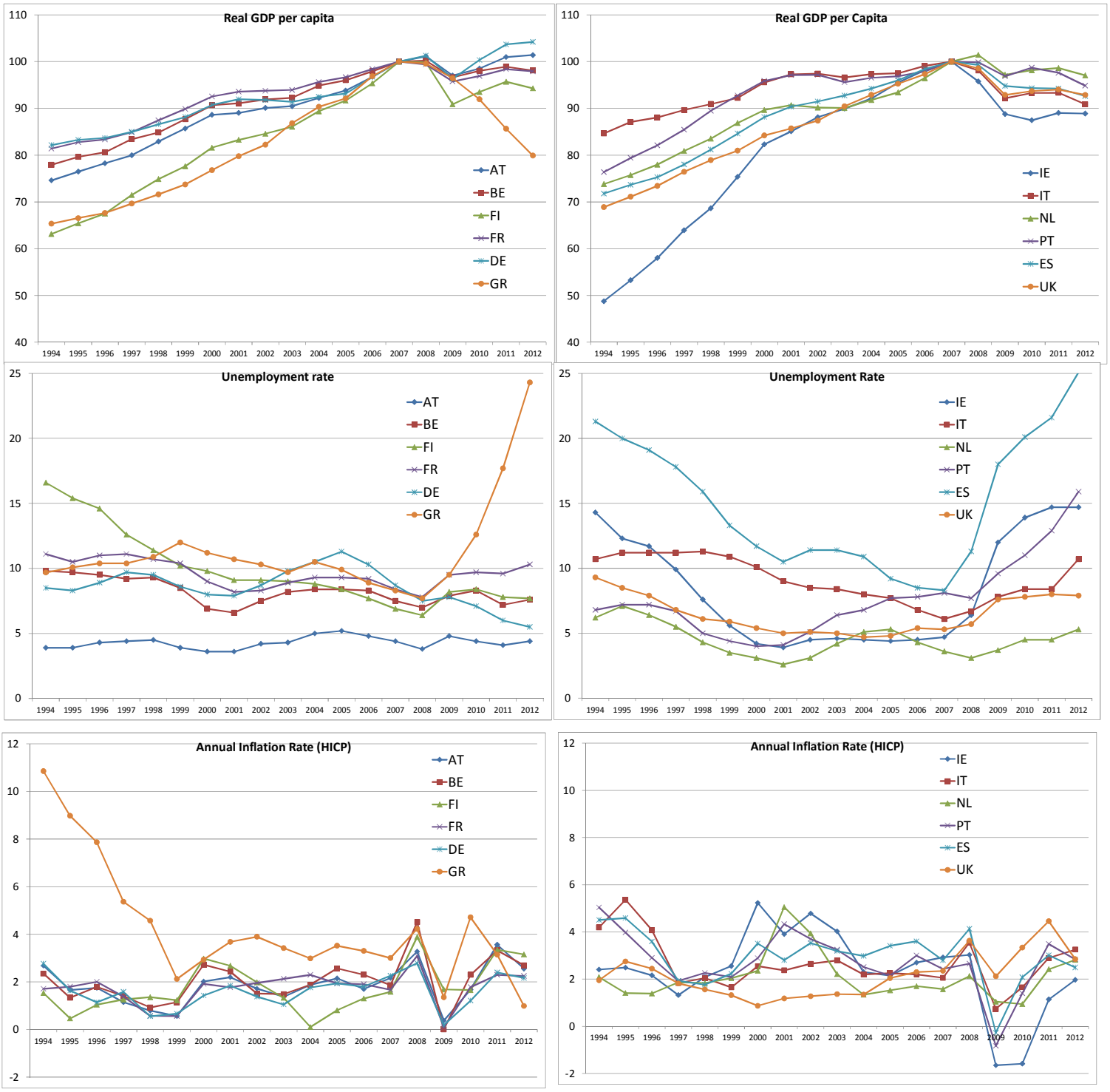
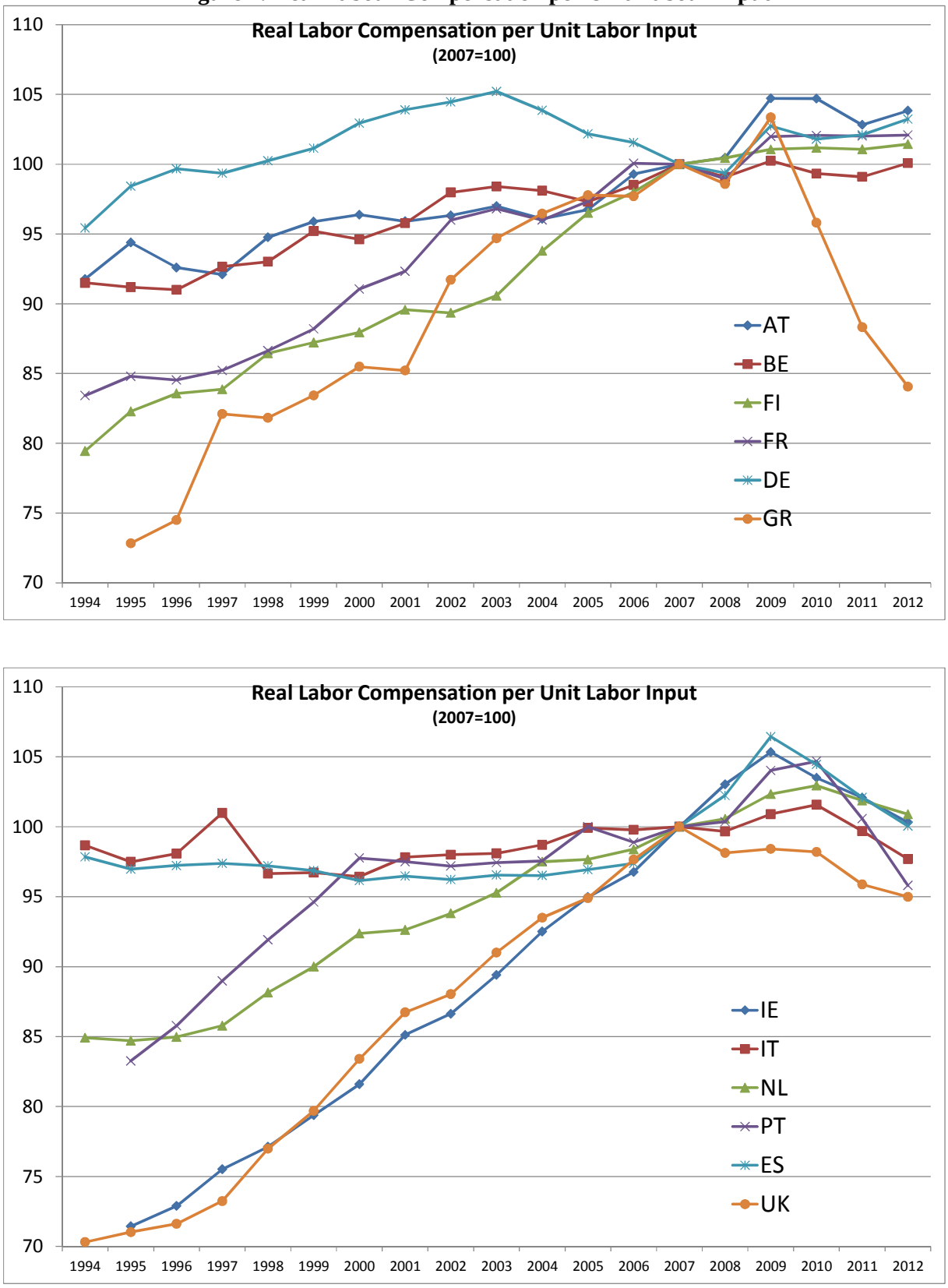
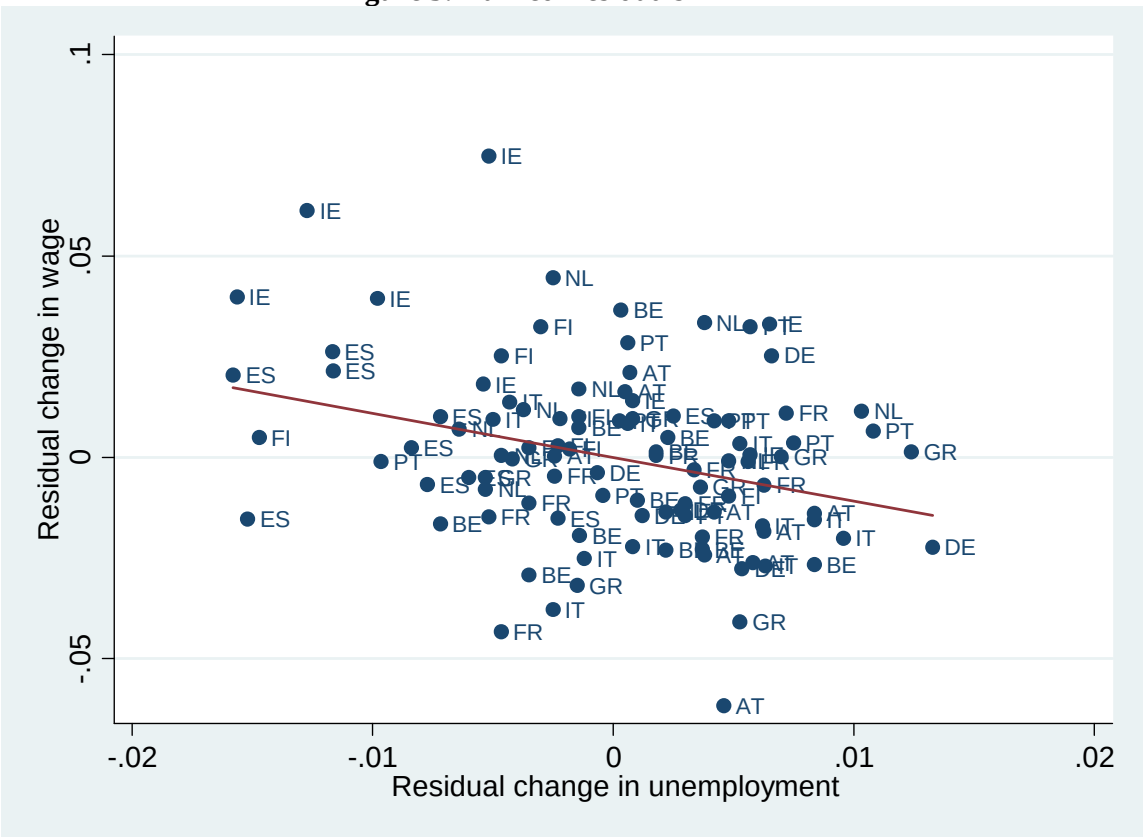


Figure 2: Real Labour Compensation per Unit Labour Input



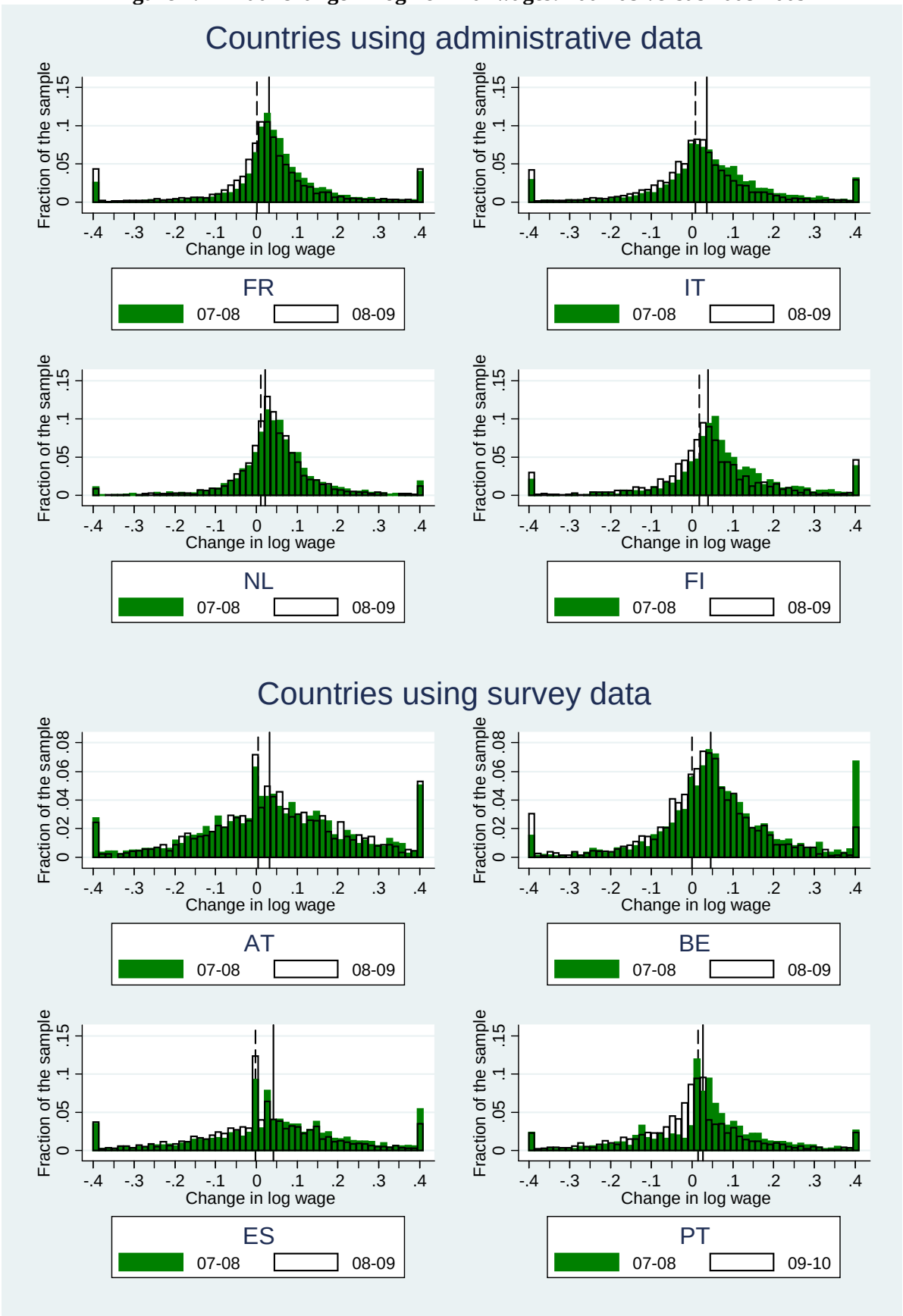
Source: OECD.

Figure 3: Yulized Residuals



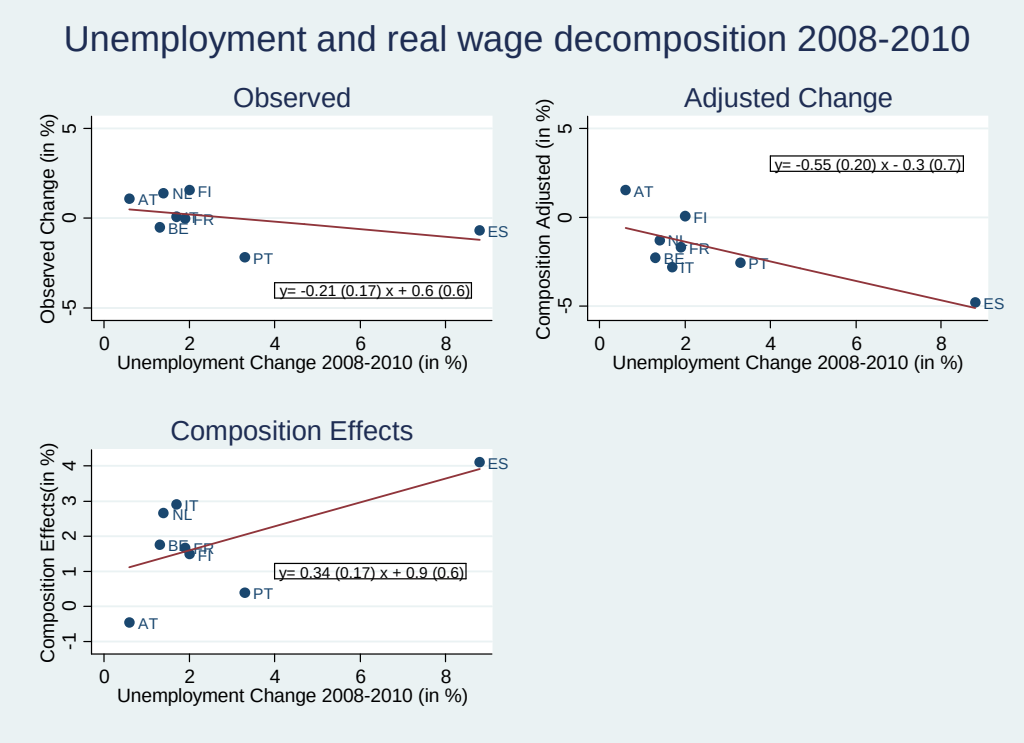
Note: The figure shows the residuals of the regression of real change in wage on year fixed effects on the residuals of a regression of changes in unemployment rate on year fixed effects.

Figure 4: Annual change in log nominal wages: 2007-08 versus 2008-2009



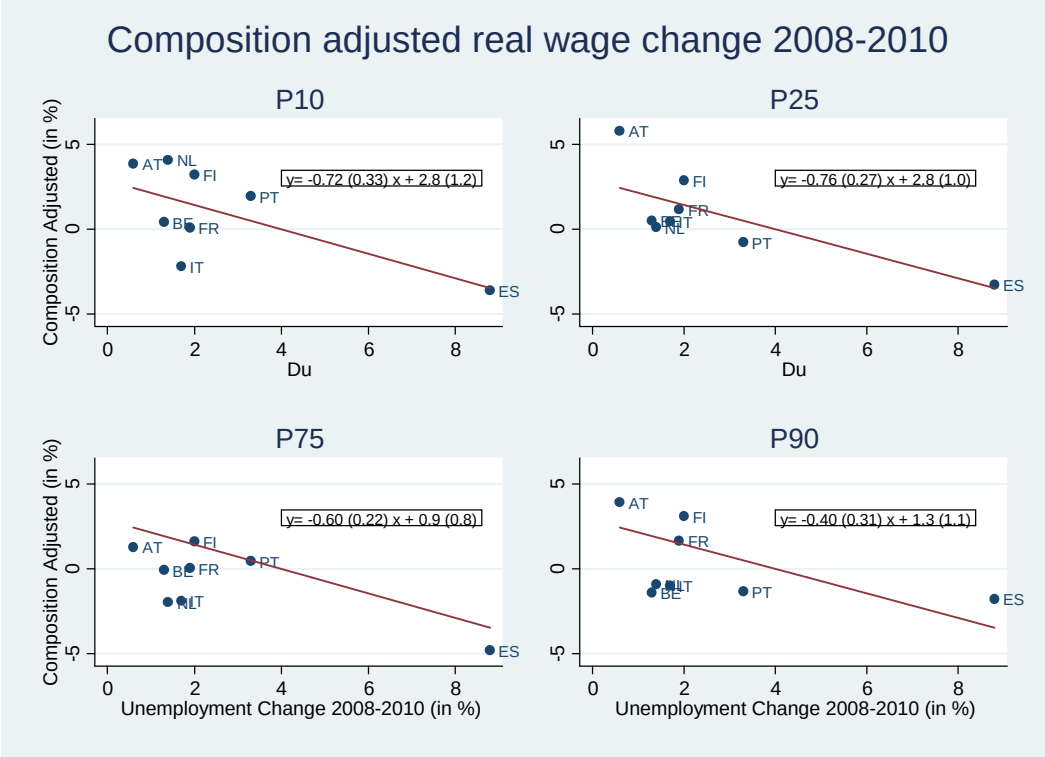
Note: The figure presents the distribution of annual changes in wage in 2008 and in 2009. The continuous and dotted line represents respectively the inflation level in 2008 and 2009. Bin width is 1.5 log points.

Figure 5: Unemployment Change and Composition Effects in 2008-2010



Note: The figure shows the relationship between changes the decomposition of changes in wages using the DFL reweighting technique and changes in unemployment rates across countries.

Figure 6: Composition adjusted change for different part of the distribution



Note: The figure shows the relationship between composition adjusted changes in wages at the first decile (P10), first quartile (P25), the third quartile (P75), and the ninth decile (P90) of the wage distribution and changes in unemployment rates across countries.

Data Appendix

ECHP: We use information on net current monthly wage and salary earnings (*pi211m*) to estimate wages. We construct an hourly wage rate where the number of hours is obtained using the number of hours per week worked at main job (*pe005a*). We define full time workers are those that declare having a full time job (*pe005c*), working full time, and are not self-employed (*pe001*) and are working in the private sector (*pe009*). We identify job changer by using information on the date of start of current job (*pe011*).

SILC: We measure income using "*employee cash or near cash income*" in the year previous the survey (*py010n*) (except Ireland which uses as a reference period the 12 month preceding the interview). We measure working time using retrospective information for each month on whether an individual was working full or part time (*pl210a-pl210f*). Job shifters are identified using information on change of job since last year (*pl160*). Hourly wages are calculated using information on the number of hours usually worked per week in main job (*pl060*).

Cells of education and potential experience: We use three levels of education: recognised third level education, second stage of secondary level education, less than second stage of secondary education. Potential experience is defined using the difference between age and the declared age of entry in the labour force. When age of entry is missing, we impute 21, 19 and 16 for those with respectively third, second and less than second level of education.

Aggregate data: Wages are deflated using the IPCH index obtained from the OECD website. For Germany, Greece and Ireland, for which IPCH is not available before 1994, we supplement the series using the national price index for this period.

Regional and cell specific unemployment: We match regional information from the ECHP and the SILC with data from regional unemployment. As regional definitions vary in the ECHP and the SILC and we are unaware of a published regional unemployment rates corresponding to these regions, we use microdata from the LFS available from Eurostat to construct unemployment rates at the regional level that correspond to the one in the ECHP and the SILC. By definition, we have to limit our analysis to countries and periods for which information on regions is available. In the SILC, these countries and their respective number of regions are: AT(3 regions), BE (3), ES(19), FI(4), FR(22), GR(4), IT(5). In the ECHP, these countries and their respective number of regions are: AT(3 regions), BE (3), ES(7), FI(5), FR(8), GR(4), IT(11), PT(7).

Appendix Tables:

Table A1: Sensitivity of the results to the exclusion of a particular country

	Country excluded from the sample :										
	AT	BE	DE	ES	FI	FR	GR	IE	IT	NL	PT
dchom	-0.974***	-1.159***	-1.132***	-1.302***	-1.120***	-1.290***	-1.204***	-0.705**	-1.080***	-1.224***	-1.357***
	(0.333)	(0.336)	(0.336)	(0.424)	(0.359)	(0.338)	(0.342)	(0.276)	(0.350)	(0.334)	(0.343)
N	92	90	95	91	92	92	93	93	90	91	91

Note: Each column of the table shows regression results of the baseline model reported in column 6 table 1 but in which the indicated country has been excluded from the sample. Robust standard errors are in parenthesis.