



**DEPARTMENT OF ECONOMICS FINANCE & ACCOUNTING**

**WORKING PAPERS SERIES  
N264/15**

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from Boom to Bust.**

**(Revised May 2016)**

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# The Changing Nature of Irish Wage Inequality from Boom to Bust<sup>\*</sup>

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May 2016

**Abstract:** The dramatic change in economic conditions in Ireland over the last 10 years provides an opportunity to examine the impact of large macroeconomic shocks on inequality. We analyse wage inequality in Ireland, from the height of an economic boom, through a very deep recession, to the start of a recovery. In keeping with previous work we find that the dispersion in wages increased towards the height of the boom, driven largely by rising returns to skill. However the economic crisis of 2008-2013 was accompanied by a significant reduction in wage dispersion. Although the improving characteristics of the workforce increased wages for all workers over this period, this was offset by falling returns to these skills. Only workers in the lowest decile were unaffected by declining returns, resulting in a reduction in wage inequality during the recession. Our analysis highlights the important role played by the national minimum wage in this process.

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<sup>\*</sup> We are grateful to Micheál Collins, Aéidin Doris, Olive Sweetman, participants at the 2016 Irish Economic Association Annual Conference, Galway and two anonymous referees for helpful comments on an earlier draft of this paper. We would like to thank the CSO for providing access to the RMF EU-SILC data and to the ISSDA for providing the QNHS microdata.

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## **1. Introduction**

A number of studies have examined the impact of the macroeconomic environment of a country on its level of inequality, looking in particular at whether inequality increases or declines during recessions (Heathcote et al. 2010, Bonhomme and Hospido 2012, Jenkins et al. 2013). The recent experience of the Irish economy provides a very useful setting for further examination of this issue. After a period of exceptional growth from 1994 to 2007, the Irish economy collapsed, with negative output growth from 2008 to 2010 and only very modest growth during the weak recovery of 2011 to 2013. The contrasting experience of the Irish economy over this period provides researchers with an ideal opportunity to track and examine the evolution of inequality as an economy moves from a boom to a severe recession, through to a subsequent recovery.

Any attempt to understand the changing nature of inequality during the Great Recession must account for the dramatic changes in the composition of the workforce that occurred during this period. To do this we use a decomposition technique developed by Machado and Mata (2005) to identify the separate contributions of changes in the composition of the workforce and changes in the returns to these characteristics to changes in wage inequality over the period from 2004 to 2013. Our work builds on earlier work by Voitchovsky et al. (2012) who adopted a similar approach when examining wage inequality in Ireland from 1994 to 2007. Extending the period of analysis to cover the time period from 2007 to 2013 allows us to assess the impact of the Great Recession on wage inequality in Ireland. Consistent with Voitchovsky et al. (2012) we show that wage inequality increased substantially during the boom, driven almost entirely by rising returns to skill. However, the pattern changed dramatically with the onset of the recession. Between 2007 and 2012 wage inequality fell significantly, so that by 2012 inequality had almost returned to its 2004 level.

This fall in inequality reflects stagnant or declining wages at all points in the distribution above the 10<sup>th</sup> percentile. The failure of wages to grow for these workers, despite substantial improvements in the skills of the workforce, reflects a significant decline in the returns to these skills during the recession.

The contrasting roles of returns and characteristics in explaining the evolution of wages in Ireland during the recession highlights the importance of controlling for compositional changes when examining wage trends (Solon et al. 1994, Doris et al. 2015). We find that the changing composition likely reflects a combination of factors including cohort effects, job loss and emigration. Furthermore, we find that the relative wage gains observed for the lowest paid reflects the force exerted on the bottom of the earnings distribution by the national minimum wage; the provision of a binding wage floor preventing large wage reductions for the lowest paid workers during the Great Recession.

Section 2 outlines the key features of the Irish macroeconomic environment over the period examined in our study and briefly reviews earlier work on wage inequality. Section 3 discusses the data used in our analysis and establishes the overall evolution of wage dispersion throughout the period of our analysis. Section 4 briefly describes the decomposition we use, along with the main findings of our analysis. Section 5 discusses our findings in more detail and Section 6 concludes.

## **2. The Great Recession**

The past decade saw the major world economies experience deep recessions, alongside a worldwide financial crisis. Ireland was one of the countries most affected by the economic downturn. Table 1 shows that prior to 2008 the Irish economy was thriving, with growth rates close to 6% and unemployment rates of only 4% (see also Whelan, 2013).

The Irish economy underwent a dramatic reversal with the onset of the Great Recession in 2008, with GDP contracting by 14% and unemployment rates rising to 14% by 2011. The effects of the global recession felt elsewhere were compounded in Ireland by the collapse of the construction sector following the bursting of a property bubble and a subsequent financial crisis in the banking sector. Few sectors of the economy were spared, though the construction sector experienced the largest declines, with employment in this sector falling by 60% between 2007 and 2011. By 2013 the Irish economy had bottomed out and was beginning to show signs of a weak recovery, though unemployment remained very high.

The Irish government responded to the crisis with a series of fiscal measures. These included the introduction of a new income levy, increases in the employee health levy and the abolition of the ceiling on pay related social insurance contributions. In addition there was a substantial cut in pay for public sector workers. Initially these pay cuts took the form of a new Pension Levy introduced in 2009 but were followed in 2010 by direct pay cuts of between 5% and 10%. An additional round of public sector pay cuts was implemented in 2013 affecting higher paid public sector workers; those earning more than €65,000 had their pay cut by between 5.5% and 10%, with the biggest cuts applying to those on higher pay.

A number of recent international studies have examined the impact of the macroeconomic environment on inequality. However, the evidence in this respect is quite mixed. Jenkins et al. (2013) examined the impact of the Great Recession on household incomes. They provided a general overview for 21 countries, with detailed analysis for a subset of 6 of these countries. Between 2007 and 2009 the changes in the distribution of household income in Germany, Sweden, and the UK were generally modest, whether measured in terms of real income levels, income inequality, or relative poverty rates. Italy and the USA were the two case study countries where increases in inequality were most

apparent. In keeping with this, Meyer and Sullivan (2013) found that income inequality increased in the U.S. during the Great Recession, however in contrast, consumption inequality fell.

Wage inequality increased in Germany following the economic downturn that accompanied the reunification of Germany in 1992/93 (Fuchs-Schundeln et al. 2010). However, wage inequality decreased in Germany during the Great Recession, driven predominantly by a decline in the exporter wage premium (Dauth et al. 2015).

Bonhomme and Hospido (2012) found a strong countercyclical pattern to male earnings inequality in Spain, with inequality increasing at the time of the 1993 recession, decreasing substantially during the 1997-2007 expansion, and increasing again during the recent recession. Likewise Newell and Socha (2007) reported that wage inequality increased in Poland following the economic downturn in the late 1990's. Looking over a longer period, Heathcote et al. (2010) found that those in the bottom of the earnings distribution tended to suffer the biggest losses during recessions in the United States.

Turning to Ireland, Callan et al. (2011) and Keane et al. (2012) documented the progressivity of the fiscal changes introduced in response to the crisis. Incomes for households in the lowest income groups fell by 4% to 5%, compared to a fall of almost 13% for those households with the highest incomes. Callan et al. (2014) examined income inequality from 2008-2013 and found that the largest falls in market income occurred in the bottom half of the income distribution. Much of this reflects the loss of earnings resulting from job losses which were most pronounced among the lower paid (Nolan and Voitchovsky, 2016). Callan et al. (2014) focused their analysis on the distribution of total household income and on the impact of changes in the tax benefit system on this distribution. They found that the relatively larger declines in market income for low income households were

moderated by changes in taxes and transfers, with the effect of transfers being especially important.

There have been fewer papers examining wage inequality, per se, in Ireland. Nolan et al. (2000) analysed the distribution of earnings for employees between 1987 and 1994. They found that the level of earnings inequality in Ireland at the time was high by OECD standards. Furthermore they reported a substantial increase in earnings inequality between 1987 and 1994, an increase they attribute to rising returns to skill. Voitchovsky et al. (2012) examined inequality in gross hourly wages for Irish workers from 1994 to 2007. They found that dispersion in hourly wages fell sharply to 2000 before increasing somewhat to 2007. However, their analysis did not extend to the Great Recession.

Analyses of the behaviour of wages in Ireland during the Great Recession have tended to focus either on aggregate changes or on year on year wage changes. The Central Statistics Office (2010) used aggregate data from the Earnings Hours and Employment Costs Survey to study the change in the wage bill paid by employers in Ireland during the early part of the Great Recession. Between the third quarter of 2008 and the third quarter of 2009 the total wage bill of all employers fell by 7%. The majority of this reduction resulted from a decrease in employment levels in firms, with a smaller proportion due to a reduction in hours worked by employees. Walsh (2012) extended this analysis to cover the years from 2009 to 2011. He reported a 6% reduction in the wage bill of employers between 2009 and 2010 and a further reduction of 1% between 2010 and 2011. Once again, the majority of the reduction in the wage bill between 2009 and 2010 was as a result of a decrease in the number of employees.

Since the analysis in Walsh (2012) is based on the aggregate wage bill of employers it suffers from potential composition bias. Doris et al. (2015) used administrative longitudinal data to follow individual earnings for the entire employee population in Ireland between the years of 2005 and 2013. They found a significant degree of downward wage flexibility in the

pre-crisis period. They also observed a significant response in wage change behaviour with the onset of the crisis; the proportion of workers receiving earnings cuts more than trebled during the crisis. In addition these wage cuts were progressive, particularly in the public sector, where highest wage earners recorded earnings cuts of 12%. However, their analysis is limited by the lack of control variables for individual characteristics over time. While the use of longitudinal data allowed them to look at individual wage changes over time, the absence of detailed information on the characteristics of these individuals made it more difficult to analyse changes in inequality.

In this paper we extend the earlier analysis of wage inequality in Ireland by examining hourly wage dispersion from 2004 to 2013, a period covering the peak of the boom, the worst of the recession and the subsequent seeds of a recovery. We decompose changes in wage inequality into a component due to changes in the price of skill and a component due to changing characteristics of the workforce. In this way we assess the impact of the Great Recession on inequality in Ireland, taking into account any compositional changes that may have occurred during this period.

### **3. Data and Descriptive Statistics**

To carry out our analysis we use data from the Irish component of the EU Statistics on Income and Living Conditions (EU-SILC). The EU-SILC is an annual EU wide household survey, which is conducted in Ireland by the Central Statistics Office. The EU-SILC is a cross sectional dataset that provides information on the income and living conditions for a sample of households. The survey is conducted annually and the sizes of the Irish samples range from 5,000 to 6,000 households and from 11,000 to 14,000 individuals. The sampling frame and weighting procedures are designed to ensure the EU-SILC sample is representative



of the population. The EU-SILC commenced in Ireland in 2003. However in our analysis we make use of the RMF version of the data available from the CSO. These data contain a cleaned measure of hourly wages constructed by the CSO. These data are only available from 2004 onwards and the latest year for which we have access to the RMF data is 2013. Although we do not have data for the most recent years, the time period available to us nevertheless allows us to examine both the end of the boom period in Ireland, and almost all of the Recession period.

We follow Voitchovsky et al. (2012) and restrict our sample to all employees aged between 16 and 65 years of age, who work more than one hour and less than 100 hours a week and who report a gross wage above €1 an hour and below €100 an hour (in 2010 prices).<sup>1</sup> The analysis excludes those in full-time education at the time of the survey. In keeping with Voitchovsky et al. (2012) we focus on gross hourly earnings. This allows us to abstract from government induced changes in inequality arising from tax changes and instead focus on the labour market forces affecting inequality. Data on hourly wages are provided directly by the CSO in the RMF version of the data and are based on earnings received in the last pay cheque combined with hours worked. These data are subject to careful cleaning by the CSO, using administrative and other sources, prior to release of the RMF data.

The evolution of wage inequality from 2004 to 2013 is presented in Figure 1 and in more detail in Table 2. Two clear patterns emerge from the data. From 2004 to 2007 inequality increased, with the ratio of the top wage decile to the bottom decile rising from 3.62 to 4.04. Although wages at the bottom of the distribution increased by 5.6% over this

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<sup>1</sup> These restrictions are the same as those used by Voitchovsky et al. (2012) and allow us to directly compare our findings with this earlier work. However as a robustness check we repeated our analysis looking at workers aged 25-55 and working at least 15 hours a week. We also looked at workers working at most 39 hours a week to remove the effects of overtime. Our results, which are available from the authors upon request, are robust to all these changes in sample selection.

period, this was much smaller than the 12.4% increase in wages experienced by those at the top of the distribution.

The trend in inequality changed dramatically with the onset of the crisis in 2008. Between 2008 and 2012 earnings at the bottom of the distribution rose, albeit at a very modest 1% over this entire period. In contrast earnings at the top of the distribution fell by 4% over the same period. As a result, by 2012 inequality had almost returned to its 2004 level. There is suggestive evidence that inequality is starting to increase again as the economy begins its recovery. Real wages at the bottom of the distribution fell slightly from 2012 to 2013, while wages at the top of the distribution rose for the first time since 2009. However, it is too early to say from these data whether or not this is the start of a persistent trend associated with the recovery.

It is well known that compositional changes can have a significant impact on the wage structure (Solon et al. 1994). Since low paid workers lost their jobs in relatively large numbers during the Great Recession (Nolan and Voitchovsky 2016), the ensuing truncation of the wage distribution is likely to boost reported average wages of the remaining workers, mitigating any potential pro-cyclical pattern in average wages. The loss of these low paid workers from the sample of workers is also likely to affect the dispersion of wages among the remaining workers.

To examine the changes in the composition of the workforce in Ireland in more detail, Table 3 shows the educational distribution of workers in our sample from 2004 to 2013. What is particularly striking is the significant improvement in the education levels of the workforce during the recession. The proportion of workers with a third level education increased from 37% in 2007 to over 50% in 2013, a dramatic increase in such a short period. This was accompanied by a decline in the percentage of those with a primary education or

less, from 11% in 2007 to less than 5% in 2013.<sup>2</sup> In the next section we examine the impact of these, and other changes, on wage inequality in Ireland.<sup>3</sup>

#### 4. Decomposition and Results

To identify the contributions of changes in the returns to skill and changes in the distribution of these skills on inequality we use the decomposition developed Machado and Mata (2005). Machado and Mata's (2005) technique decomposes changes in the wage distribution into a component due to changes in the distribution of covariates (skills) and a component due to changes in the returns to these covariates. In this way the Machado and Mata's (2005) decomposition extends the Oaxaca (1973) approach for mean decomposition to the entire wage distribution.

The approach is based on quantile earnings regressions, specified as

$$Q_{\theta}(w|z) = z'\beta(\theta) \quad (1)$$

where  $\beta(\theta)$  is a vector of regression coefficients at the  $\theta^{th}$  quantile.

To perform the required distributional counterfactual analysis Machado and Mata exploit the probability integral transformation to derive the marginal distribution of wages consistent with the conditional distribution given in (1). The probability integral transformation theorem implies that if  $\theta_1, \theta_2, \dots, \theta_m$ , are drawn from a uniform(0,1) distribution then the corresponding  $m$  estimates of the conditional quantiles of wages at  $z=z^*$  for time  $t$ ,  $\{w_t^*(t) = z_t^*(t)'\beta^t(\theta_i)\}_{i=1}^m$ , represent a random sample from the estimated conditional distribution of wages given  $z^*$ . These conditional quantiles are the first stage in obtaining the unconditional marginal distribution, which is the ultimate distribution of interest. In order to estimate the marginal distribution consistent with these conditional

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<sup>2</sup> We consider the forces underlying these changes in Section 5.

<sup>3</sup> Summary statistics of all the variables used in our analysis by position in the earnings distribution are given in Table 4.

distributions one only needs to average the conditional distributions over the  $z$  values at time  $t$ . This can be done either analytically or via simulation.

Given this approach, appropriate counterfactuals can be obtained by simply adjusting the distribution from which the characteristics are drawn, before combining the covariates and the returns. For instance it is straightforward to estimate what the distribution of wages in year 1 would have been if all characteristics had remained at the levels observed in year 0. To do this we begin by drawing a random vector  $\theta$ , of size  $m$ , from a  $U(0,1)$  distribution. Using the covariates for year 1 we estimate  $m$  conditional quantile regressions, with the quantiles corresponding to  $\theta$ . This provides  $m$  sets of year 1 returns, one for each quantile;  $\{\beta^1(\theta_i)\}_{i=1}^m$ . Finally we combine these point estimates with a random sample of  $m$ -draws from the rows of the covariate matrix in year 0. The corresponding estimates  $\{w_i^*(t) \equiv z_i^*(0)' \beta^1(\theta_i)\}_{i=1}^m$  provide  $m$  random draws from the counterfactual distribution of wages in year 1 with characteristics fixed at year 0 levels. Alternative counterfactuals can be simulated using the same procedure.<sup>4</sup>

Before looking at the decomposition results in detail, Table 5 reports the returns to characteristics by decile of the earnings distribution for 2004, 2007, 2008 and 2013. These are a key input into the wage decomposition procedure described above. The results are as expected with a male premium of 10% to 15%, a premium to being Irish of the order of 20% and an urban premium of the order of 10%. Of particular interest are the returns to education over this period. Our estimates show that the returns rise steadily with education. The OLS regressions in the last 4 columns of Table 5 show a mean return of tertiary education over primary education of the order of 50% to 70%.

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<sup>4</sup> Recent work by Firpo et al. (2009) establishes a procedure for estimating unconditional quantile regressions. While the regression results based on this approach differs from the quantile regressions reported in our paper (they are after all estimating different parameters), decomposition results based on either approach both rely on the unconditional marginal distribution of earnings.

Looking at the results at the individual quantiles we see that the return to tertiary education is substantially bigger the higher the conditional quantile. For example in 2004, the return to tertiary education at the 10<sup>th</sup> percentile was 50%, while the corresponding return at the 90<sup>th</sup> percentile was 87%. This pattern is consistent with international work in this area. Martins and Pereira (2004) examined data for 16 countries from the mid 1990s and found that the returns to schooling were higher for the more skilled individuals, conditional on their observable characteristics. They suggest a number of possible explanations including over-education, ability–schooling interactions, school quality effects or differences in the fields of study.

Given our interest in changes in inequality over this time, it is interesting to examine the change in returns to education over this period. The results in Table 5 show a fall in returns between 2004 and 2007 at the lowest decile but increasing returns at the higher decile. However, the period from 2008-2013 saw a substantial fall in returns to skill at both deciles. At the top decile only tertiary education records a statistically significant return over primary education by 2013, and even here the return is 63% compared to 82% in 2008.

To examine the role of changing returns and workforce composition on inequality over this period we implement the Machado and Mata decomposition outlined above.<sup>5,6</sup> The results are presented in Figures 2 and 3. Figure 2 examines the period from 2004 to 2007 corresponding to the peak of the boom, while Figure 3 looks at the period from of the Great Recession from 2007 to 2013. Looking at the boom period our results are in keeping with those of Voitchovsky et al. (2012). The solid line shows a general pattern of increasing wage growth throughout most of the distribution, resulting in a substantial increase in inequality

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<sup>5</sup> The procedure is implemented using the Stata code provided by Melley (2006). This procedure uses the same framework as Machado and Mata but evaluates the necessary integrals using summations rather than simulation. The two approaches are numerically identical as the number of random draws in Machado and Mata goes to infinity.

<sup>6</sup> In the analysis reported in the paper gender is captured by a gender dummy variable in the quantile regressions. We have also estimated the decomposition separately for men and women; our findings and conclusions are robust across genders.

during the boom. As with the earlier work our decomposition shows that this increase was driven almost entirely by rising returns to skill.<sup>7</sup> Although changing composition contributed to wage growth throughout the distribution, the magnitudes of these changes were small compared to the impact of rising returns. Throughout the wage distribution, changes in returns are estimated to account for approximately 80% of the observed wage changes. At the top of the distribution returns were estimated to have increased wages by almost 20%, compared to a 5% increase due to characteristics.

Figure 3 shows that this pattern changed dramatically with the onset of the recession. The pattern of wage changes between 2007 and 2013 resulted in a significant fall in inequality. This is driven by wage gains at the bottom of the distribution and stagnant or declining wages throughout the rest of the distribution. Wages declined across most of the distribution despite substantial improvements in the skills of the workforce. Indeed, our analysis reveals that the improvements in characteristics, by themselves, would have resulted in substantial wage gains, of the order of 8%, throughout much of the distribution. The failure of the improved characteristics to translate into wage gains over this period reflects the significant decline in returns to these skills that occurred during the recession. This decline in the returns to skill caused the wages of all but the lowest paid workers to decline over this period, a fact that may reflect the protective impact of the national minimum wage on the wages of the lowest paid. We examine the role of the minimum wage in explaining our findings in detail in Section 5.

The combination of changing returns and composition resulted in relative wage gains for the lowest paid workers and by extension lower inequality. Had the returns to skill not declined during the recession, we estimate that wages at the 10<sup>th</sup> percentile of the wage distribution would have increased by 1.5% during the recession rather than the observed

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<sup>7</sup> The shaded regions around the decomposition components correspond to bootstrapped 95% pointwise confidence intervals.

increase of 0.4%, while wages at the 90<sup>th</sup> percentile would have increased by 5.5% as opposed to the observed decline of 1.3%. Under the counterfactual of fixed returns to skill, inequality would have continued to rise during the economic crisis due to the changing composition of the workforce. In the next section of the paper we consider a number of alternative explanations for our findings in detail.

## **5. Discussion**

### **5a. Private Sector Analysis**

For comparison with Voitchovsky et al. (2012) the analysis in Section 4 included all workers, both in the public and private sectors. However, as noted in section 2, one of the responses of the Irish government to the Great Recession was a series of direct pay cuts for public sector workers in both 2010 and 2013. These pay cuts were deliberately progressive in nature, with the biggest pay cuts (up to 10%) applying to those with the highest salaries. These pay cuts, in and of themselves, would have had the effect of reducing inequality along the lines reported in section 2. To examine the extent to which our earlier findings are being driven by wage cuts in the public sector, we repeat the decomposition analysis, focusing only on private sector workers.<sup>8</sup> The results are given in Figure 4. The results presented here mirror those presented in Figure 3. For all but the lowest percentiles, wages showed little change between 2008 and 2013. However, this pattern is masking two offsetting forces. One would have expected wages at all percentiles to have risen in line with the significant improvement in the characteristics of the workforce over this period. The fact that wages were instead stagnant reflects the fall in returns to skill that occurred during the Great

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<sup>8</sup> Throughout our period of analysis the proportion of private sector workers in our sample ranges from 64% to 68%.

Recession. It is clear from this that the patterns identified earlier reflect labour market forces independent of direct government pay cuts to public sector workers.

#### 5b. Compositional Changes: Unemployment, Cohort Effects and Migration

In Table 3, we documented the dramatic fall in the proportion of the workforce with a primary education between 2008 and 2013 from 12% to 5% and the corresponding increase in the proportion with a third level education, from 38% to 53%. Given these changes and the role compositional changes play in determining the evolution of wages throughout this period, it is important to understand the forces behind these changes. In this section we focus on three factors that are potentially important in this respect; unemployment, cohort effects, and migration.

In equilibrium, employment of skilled labour relative to unskilled labour can increase as a result of either an increase in the relative demand for skilled labour (resulting in an increase in the return to skill) or an increase in the relative supply of skilled labour (resulting in a decrease in the return to skill). Demand for skilled labour can rise as firms turn to more educated workers during times of difficulties in search of efficiency gains or as a response to sectoral changes in the composition of output, while supply can increase due to factors relating to demographics or migration (see for example Katz and Murphy 1992, Autor et al. 1998)

To understand the contribution of these forces to changes in the composition of the workforce we begin by noting that the ratio of the proportion of highly educated workers to less educated workers can be written as

$$\frac{P_H}{P_L} = \frac{(1-UR_H) \#N_H}{(1-UR_L) \#N_L} \quad (2)$$

where  $P_j$  is the proportion of education group  $j$  in the workforce,  $UR_j$  is the unemployment rate for group  $j$ , and  $\#N_j$  is the number of education group  $j$  in the labour



force. In line with Katz and Murphy (1992) and Autor et al. (1998) we may interpret  $\frac{\#N_H}{\#N_L}$  as a measure of the relative supply of skilled to unskilled labour. Clearly an increase in the relative supply of skilled labour will increase the relative employment of this group. Abstracting from changes in the relative supply, equation (2) also shows that an increase in the unemployment rate for low educated workers will increase the proportion of high educated workers relative to low educated workers.<sup>9</sup>

Eurostat provides unemployment rates by education level for Ireland for the period from 2004 to 2013. These are reproduced in Table 6. The unemployment rate of adults with less than an upper secondary education increased from 7.8% in 2004 to 22.2% in 2013. For those with tertiary education the unemployment rate increased from 2.3% to 7.3%. The large rise in unemployment among the less educated largely reflects the collapse of the construction sector, a sector with relatively low levels of education.<sup>10</sup> CSO data show employment in the relatively low skilled construction sector fell from 225,100 in 2005 to 103,300 in 2012. These unemployment data are consistent with recent work by Nolan and Voitchovsky (2016) who used the EU-SILC data to examine job loss by wage level during the Great Recession. They found that the probability that an employee remains in employment from one year to the next, is positively related to their monthly earnings during both the boom and the recession. However, the wage gradient is much more pronounced during the Great Recession.

We can combine the unemployment rates in table 6 with equation (2) to get an indication of the contribution of unemployment to the changes in the composition of the workforce reported earlier. Using Quarterly National Household Survey (QNHS) microdata

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<sup>9</sup> Murphy and Welch (1992) use innovations to the aggregate unemployment rate as a proxy for relative labour demand shifts in their analysis of inequality in the U.S..

<sup>10</sup> Analysis of Quarterly National Household Survey (QNHS) microdata shows that in 2005 38.6% of workers in the construction sector had less than an upper secondary education. The corresponding figure across all sectors was 28.36%.

for 2004 we estimate  $\frac{\#N_H}{\#N_L} = 1.02$ , where  $\#N_H$  is the number of those in the labour force with tertiary education and  $\#N_L$  is the number in the labour force with lower secondary education or less. For convenience we set this ratio equal to 1. Using equation (2) we can then estimate the ratio of the proportion of high educated workers to low educated workers in 2004 as  $\frac{(1-UR_H)}{(1-UR_L)} = \frac{(1-.023)}{(1-.078)} = 1.06$ . This estimate is close to the actual observed ratio of 1.03 obtained from Table 3.

To examine the impact of changing unemployment rates we keep the labour force ratio fixed at 1 and adjust the unemployment rates using the Eurostat data.<sup>11</sup> Doing this gives an estimated ratio of the proportion of high educated workers to low educated workers in 2013 as  $\frac{(1-UR_H)}{(1-UR_L)} = \frac{(1-.073)}{(1-.222)} = 1.19$ . As expected, changes in the patterns of unemployment across education can account for some of the observed change in the educational profile of workers. However, the estimated 2013 ratio of 1.19 is still substantially smaller than the actual reported ratio from Table 3, which equals 3.3.

An alternative way of examining the impact of unemployment on the composition of the workforce is to consider the education distribution of all those of working age, irrespective of employment status. If the compositional changes in the workforce are driven by low educated workers losing their jobs, we would expect the compositional changes to be more muted when we consider all those of working age. Comparing the working age population with the workforce we find, as expected, that the education level of the working age population is lower than that of the working population. For example, in 2013 4.9% of the workforce had a primary education level or less; the corresponding figure for the working

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<sup>11</sup> This simple analysis ignores the fact that the relative unemployment rates may change because of changes to the denominator (relative supplies) rather than the numerator (unemployment levels).

age population as a whole was over twice as high at 11.8%.<sup>12</sup> Conversely the percentage of the working age population with a third level degree is 42% but over 53% in the workforce.

Of greater interest to us however is how these distributions changed over time. From 2008 to 2013 the share of the working age population with a primary education or less decreased by 44% (from .21 to .12), compared to a decline of over 55% (from .11 to .05) in the workforce. Consistent with the analysis in the previous paragraph, we find that part of the decline in the educational composition of our working sample reflects disproportionate job losses among lower educated workers. Nevertheless a significant improvement in the educational composition of the sample is still evident, even when we consider all those of working age.<sup>13</sup> As earlier, the evidence implies that that differences in unemployment rates across education levels, explains part, but not all of the compositional changes we observe.

The above analysis shows that a complete understanding of the change in the composition of the workforce between 2004 and 2013 must take account of changes in relative supply  $\frac{\#N_H}{\#N_L}$ . Analysis of QNHS micro data show that this ratio increased from 1.02 in 2004 to 2.55 in 2013. In the remainder of this section we consider two possible factors contributing to changes in  $\frac{\#N_H}{\#N_L}$ ; cohort effects and migration.

Even in normal economic circumstances one would expect the educational composition of workers to improve over time due to cohort effects; older less educated cohorts leave the sample due to retirement and are replaced by younger more educated entrants to the labour force (Card and Lemieux, 2001, Centeno and Novo, 2014). Indeed

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<sup>12</sup> We have checked the reliability of these figures by comparing the EUSILC education data to the education distribution obtained from the QNHS micro data files. The QNHS has the advantage of much larger sample sizes than the EUSILC, though the absence of detailed wage data means that it cannot be used for the detailed decomposition. The proportion of those of working age in the QNHS with a primary degree or less in 2013 was 10.23%, while the proportion of the QNHS workforce with a primary degree or less was 4.39% These are very similar to the figures reported in the text for the EUSILC data.

<sup>13</sup> This is consistent with data from OECD (2014) that reports the percentage of those aged 25-64 with a tertiary education increased from 29% to 40% in Ireland between 2005 and 2012, while the percentage of those with less than upper secondary decreased from 35% to 25%.

Nolan et al. (2000) drew attention to a marked improvement in the education profile of employees during their earlier time period (1987-1994), an increase they attributed to cohort effects.

To examine the role of cohort effects in explaining our compositional changes, we focus on a particular pseudo-cohort of workers over the period 2004-2013. That is, rather than follow the entire sample we look at changes in the composition of workers born in 1959-1969 and follow this cohort throughout 2004-2013. The results are given in Table 7. Since we are following a pseudo-cohort these results are free of cohort effects; by construction older less educated workers are not being replaced by younger more educated workers in this pseudo-cohort sample. The results in Table 7 show that focusing on a specific cohort reduces the compositional changes somewhat. The percentage of those with an upper secondary education or less falls from 58% to 43%, compared to a fall from 58% to 38% for all workers. Likewise the rise in the percentage of those with a tertiary education is somewhat more muted for this sample. For the pseudo-cohort the percentage with a tertiary education increased from 32% to 49%, while for all workers the percentage increased from 32% to 53%. From this it would seem that cohort effects may explain some of the compositional effects we observe. However, even when cohort effects are removed from our analysis, it is evident that compositional changes in the workforce are still evident.

A final possible explanation for the observed rise in  $\frac{\#N_H}{\#N_L}$ , which in turns feeds into the changing educational composition of the workforce, is the selective nature of emigration observed in Ireland during the Great Recession. The CSO<sup>14</sup> provide data on migration patterns in Ireland during this period. These data show that Ireland was a net recipient of migrants from 1996 to 2009. Net inward migration was over 25,000 each year from 2000 to 2008, reaching a high of 104,800 in 2007. However, this changed dramatically with the

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<sup>14</sup> <http://www.cso.ie/en/releasesandpublications/er/pme/populationandmigrationestimatesapril2014/>

beginning of the Recession. Net migration was close to zero in 2009 and for each year from 2010 to 2013 Ireland experienced net outward migration of over 25,000 individuals. Furthermore many of those leaving the country were working prior to leaving. In 2009 almost 60% of people who emigrated from Ireland had been in work the previous year, while the corresponding number for 2013 was 44.4%.

These migration trends, while large, would not affect the relative supply of skilled and unskilled workers if the net migration were balanced, in the sense that it had the migration flows had the same skill composition as the existing workforce (Borjas et al. 1997). However, differences in either the education level of migrants versus stayers or of emigrants versus immigrants, may have a large impact on the educational composition of the Irish labour force. Since 2009 the CSO report migration by education level. Between 2009 and 2013 the proportion of emigrants with a third level education increased from 35% to 42%, while the proportion with a secondary education or less was relatively unchanged (45.3% versus 45.8%).<sup>15</sup> In addition to changes in the profile of emigrants from Ireland however, there were also large changes in the education profile of immigrants into Ireland. The proportion of immigrants into Ireland with a third level education rose from 47% to 58% between 2009 and 2013. As with emigrants, there was little change in the percentage of immigrants with a secondary degree or less, this percentage falling from 31.7% to 31.3%. The net result of these changes in migration patterns is that between 2009 and 2013 net outward migration of those with a secondary school level of education or less increased by 74,600, while net outward migration of those with a third level degree increased by 35,700. Although migration affected workers of all education levels these data suggest that net migration was larger among the lowest educated. The CSO reports that the size of the total labour force in Ireland in 2009 was equal to 2.26m. Based on data from the QNHS micro data for the second quarter of 2009

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<sup>15</sup> Unfortunately the CSO data do not provide a finer breakdown by lower levels of education.

we estimate that the number of those in the labour force with a secondary education or less was 1.10m, while the number with a third level education or higher was 856,314. Combining the labour force data with the migration data we see that recent Irish migration patterns were unbalanced, in the sense that the less educated were over represented in migration flows relative to their position in the labour force. Migration therefore increased the relative supply of skilled labour remaining in the Irish labour force and in doing so contributed to the compositional changes noted earlier. However, the baseline figures clearly show that the changes in net migration patterns, by themselves, are likely to account for only a small part of the compositional changes reported in Section 3.

Having looked at a range of possible explanations for the dramatic improvement in the educational composition of the workforce reported earlier we conclude that these changes are not due to any one single dominant factor but rather represent a combination of forces, including cohort effects, increased unemployment concentrated among the less educated and selective patterns of net migration.

#### 5c: Minimum Wage.

Finally in this section we consider the role of institutions and in particular the national minimum wage in helping understand our findings. Ireland introduced a National Minimum wage on April 1<sup>st</sup> 2000. The rate was set at €5.58, which at the time corresponded to approximately 60% of median earnings. The rate has been increased a number of times since then, most recently on January 1<sup>st</sup> 2016 and the adult rate currently stands at €9.15.<sup>16</sup> By its very nature the minimum wage sets a floor below which the hourly wage paid by employers

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<sup>16</sup> For more details on the Irish National Minimum Wage see Low Pay Commission (2015).

can not fall. By truncating the wage distribution from the left, one would automatically expect an effective minimum wage to reduce inequality, absent very large spillover effects.

A number of international studies have looked at the role of the minimum wage in determining inequality. Lee (1999) concluded that more than the entire rise in the 50/10 earnings differential in the U.S. between 1979 and 1988 was due to the falling federal minimum wage. A recent reexamination of this work by Autor et al. (2016), exploiting two additional decades of data, also found that the minimum wage reduced inequality but that the net effects were less than half as large as previously claimed. Dolton et al. (2012), found that wage inequality in the U.K. was lower in regions where the National Minimum Wage had its biggest effect, while Lindley and Machin (2013) found that the introduction of the National Minimum Wage in the U.K. had a compressing effect on lower tail wage inequality.

A key determinant of the impact of the minimum wage on inequality is its bite, both in terms of compliance and where in the wage distribution it is located. The evidence to date suggests that compliance with the Irish Minimum Wage is high (Low Pay Commission, 2015). Further evidence in support of this is provided in Figure 5. Figure 5 shows the density of nominal hourly wages, both in 2004, when the minimum wage was €7.00, and in 2013, by which time the minimum had increased to €8.65. In both years we see that the legislated minimum wage effectively truncates the wage distribution to the left.<sup>17</sup>

To examine the implications of the minimum wage for our analysis we first determine the effective percentile of the wage distribution corresponding to the legislated wage. We focus on 2008 and 2013. In 2008, the minimum wage of €8.65 corresponded to the 6.5<sup>th</sup> percentile of the wage distribution for our sample, while in 2013 it corresponded to the 5.9<sup>th</sup> percentile. When measuring the bite of the minimum wage using survey data some studies allow for measurement error by expressing the effective minimum wage as an interval around

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<sup>17</sup> Some of the mass in the wage distribution below the minimum wage reflects sub-minimum wages for young workers or those on training schemes.

the legislated wage. For example, in his analysis of minimum wage workers in Ireland in 2015, Collins (2015) classifies those earning between €8.22 and €9.08 (+/- 5% from €8.65) as minimum wage workers. Using Collins's (2015) upper bound we find that the minimum wage corresponds to the 9<sup>th</sup> percentile of the wage distribution in both 2008 and 2013. From both the bite and location of the minimum wage it is evident that the minimum wage potentially exerts a very strong influence on wages in the bottom decile of the wage distribution.

To see this more clearly Figure 6 plots the evolution of the 10<sup>th</sup> percentile wage, the minimum wage and the 90<sup>th</sup> percentile wage for our sample from 2004 to 2013. The influence of the minimum wage on the wages of the bottom decile is clear. Wage growth at the 10<sup>th</sup> percentile tracks growth in the minimum wage very closely throughout the entire period. This is in contrast to the 90<sup>th</sup> percentile wage. During the boom the 90<sup>th</sup> percentile wage grew much faster than either the 10<sup>th</sup> percentile wage or the minimum wage, resulting in the increase in boom-time inequality noted previously. However, during the Great Recession, while both the 90<sup>th</sup> percentile wage and the 10<sup>th</sup> percentile wage declined, the fall in the 90<sup>th</sup> percentile wage was substantially larger. This reflects the influence of the minimum wage on the bottom decile. Although the legislated minimum wage was constant during the recession<sup>18</sup> it seems to have provided an effective floor for the bottom of the wage distribution, preventing falls of the magnitude seen at the top of the distribution. The reduction in wage inequality shown earlier arose because workers in the bottom decile did not suffer the fall in wages and returns experienced at all other points of the distribution. The results here suggest that the national minimum wage, and in particular the provision of an effective wage floor during the Recession, played a key role in this process.<sup>19</sup>

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<sup>18</sup> The minimum wage was reduced by €1 in January 2011 but this cut was reversed in July of the same year.

<sup>19</sup> This analysis abstracts from any potential effects the minimum wage may have on the employment or hours of low skilled workers. For an overview of the literature in this respect see Low Pay Commission (2015).



## 6. Conclusions

Although the economic downturn beginning in 2007 reflected a global recession that affected many countries, the combination of falling global output, a housing bubble and a financial crisis meant that Ireland was one of the countries most affected by the Great Recession. The collapse in output and spiraling unemployment rates during the Great Recession in Ireland provides a rare opportunity to study the response of wage inequality to dramatic changes in economic conditions. To do this we examine how wage inequality in Ireland changed as we moved from the height of the boom through the Great Recession.

We find a strong cyclical pattern to wage inequality in Ireland, with inequality rising during the boom and falling during the Great Recession. Like previous work we find that the rise in inequality during the boom was largely driven by a rise in the returns to skill, reflective of the tightness of the labour market at that time. Any consideration of the subsequent change in wage structure during the Great Recession must account for the large changes in the composition of the labour force that occurred during this period. We find that the education levels of the workforce improved significantly during the crisis, with the proportion of the workforce with tertiary education increasing from approximately 35% to over 50%. Further analysis suggests that the improvement in the skills of the workforce during the Recession reflected a combination of factors such as cohort effects, emigration and unemployment.

Despite the improvement in education of the remaining workforce over this time, wages were stagnant or declined slightly throughout most of the wage distribution. This reflects a decline in the returns to skill during the recession. Only those workers in the bottom decile of the earnings distribution did not experience a fall in returns to skill during the recession. Our analysis highlights the important role played by the national minimum wage in protecting the wages of the least skilled workers and in doing so reducing inequality. This

may be especially true during deep recessions, when the forces leading to wage reductions for many workers may be particularly strong. The relative strength of the minimum wage and the role it plays in protecting wages at the bottom of the distribution must be borne in mind when interpreting cross-country differences in the cyclicity of wage inequality.

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Figure 1: Indexed Real Hourly Wages by Percentile, 2004-2013

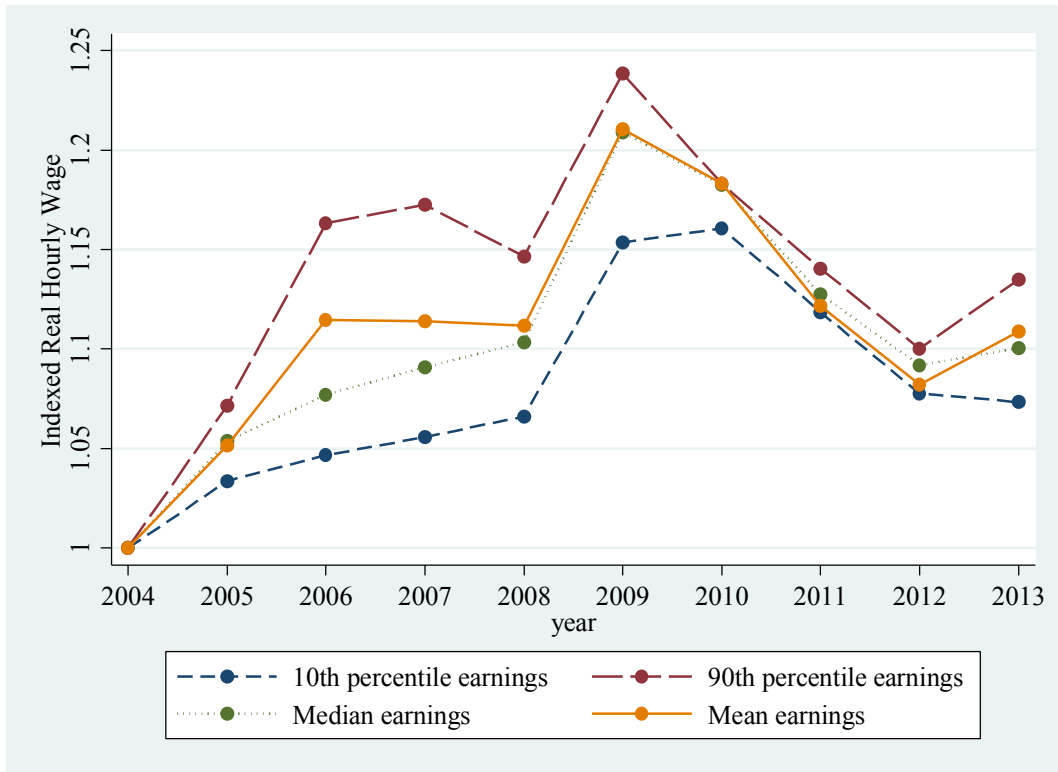


Figure 2: Decomposition of Hourly Earnings Changes for all Workers, 2004-2007

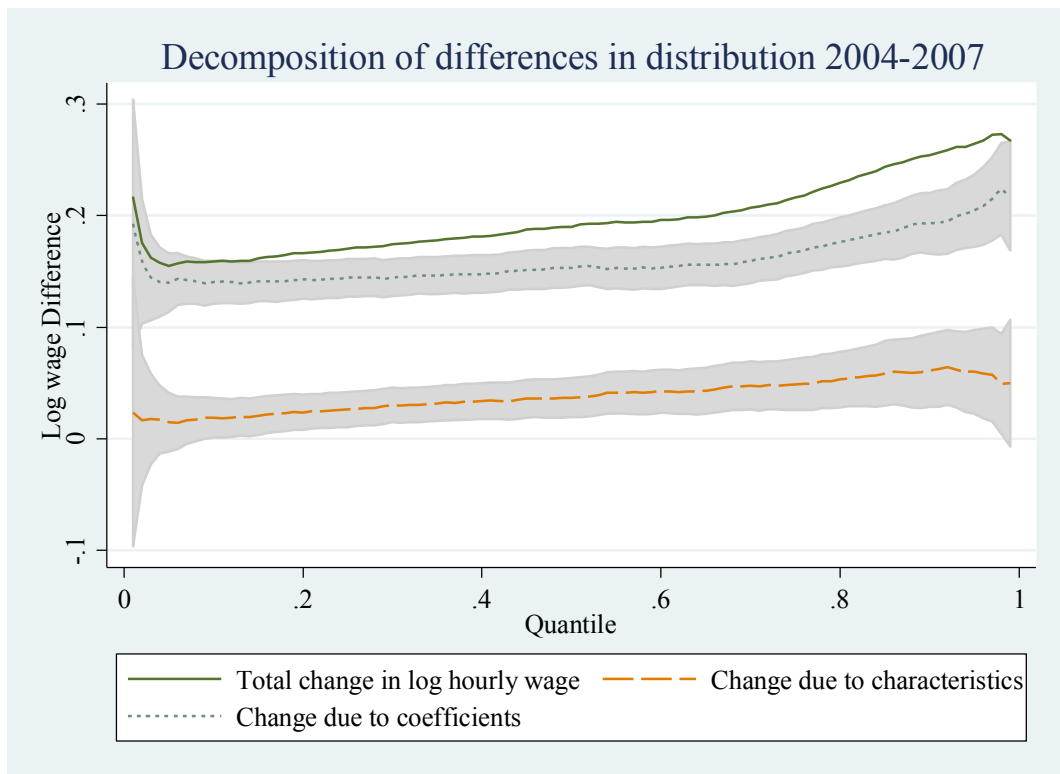


Figure 3: Decomposition of Hourly Earnings Changes for all workers, 2008-2013

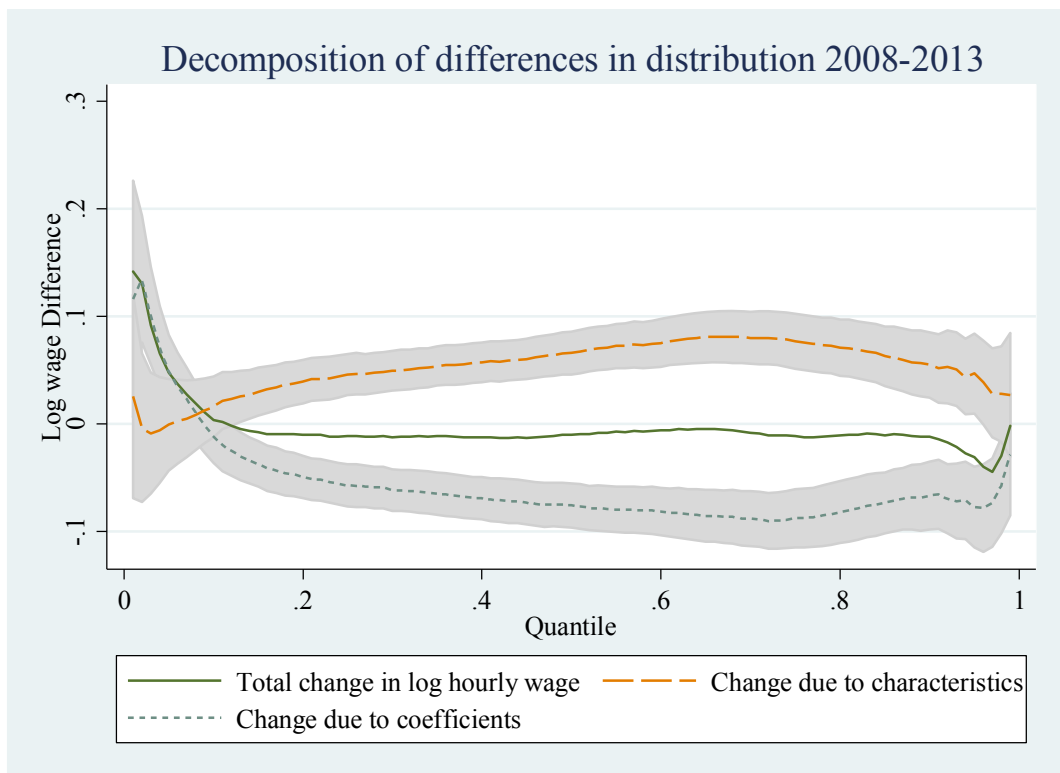


Figure 4: Decomposition of Hourly Earnings Change for Private Sector Workers, 2008-2013

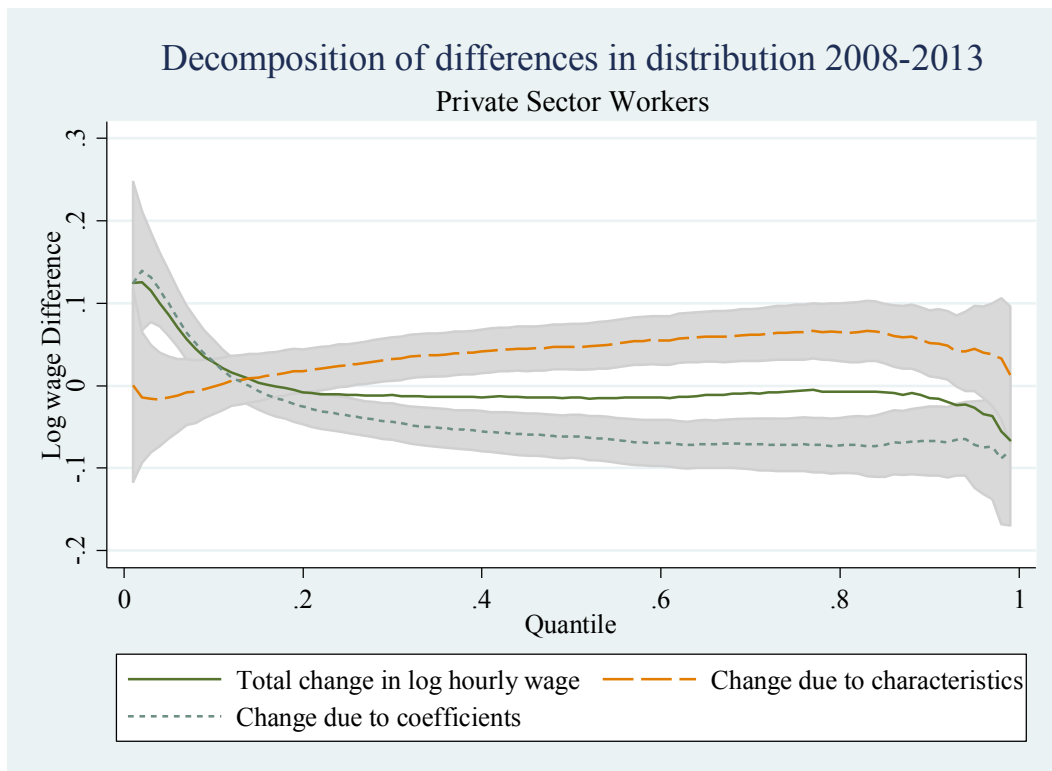




Figure 5: Nominal Hourly Wage Distribution 2004 and 2013, and the Respective National Minimum Wages.

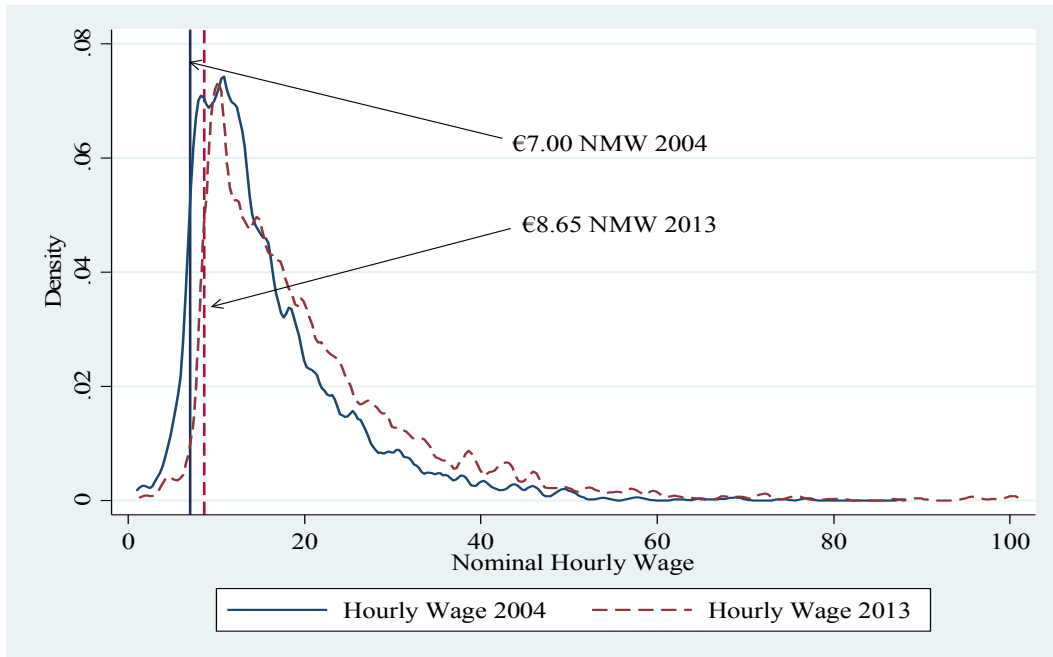


Figure 6: Indexed Nominal Hourly Wages by Percentile & Indexed National Minimum Wage, 2004-2013

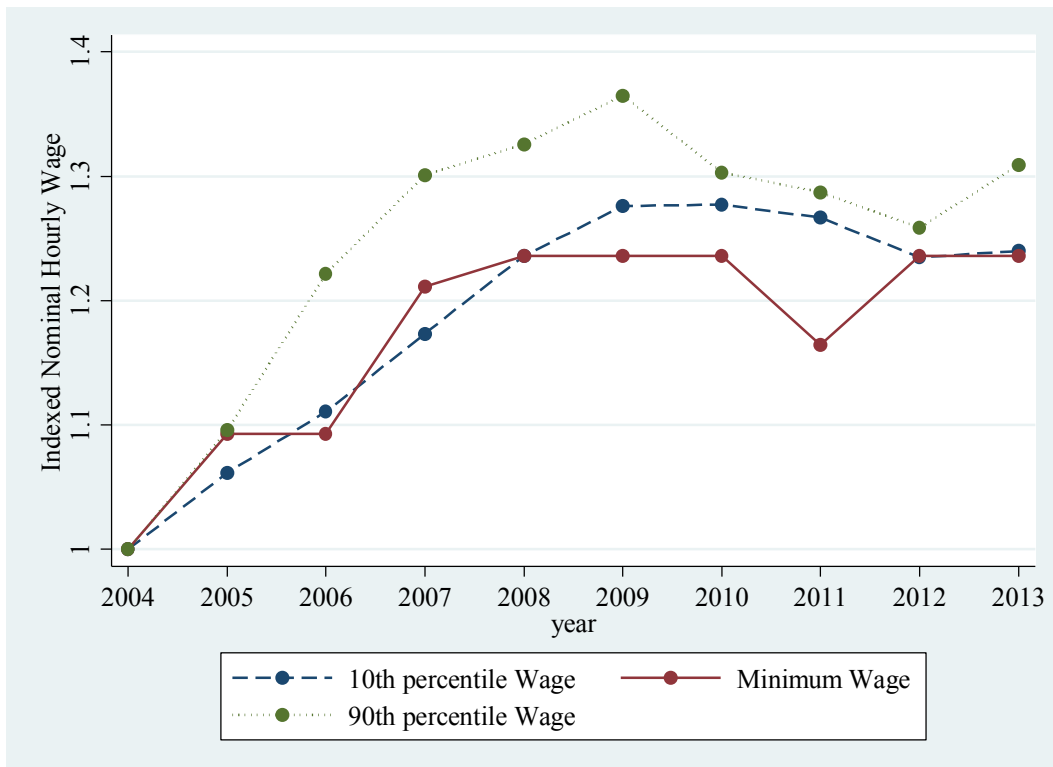


Table 1: GDP Growth Rate and Total Unemployment Rate:  
Ireland 2004-2013

	<b>GDP Growth (annual %)</b>	<b>Unemployment Rate 1<sup>st</sup> Quarter each year</b>
<b>2004</b>	4.4	4.6
<b>2005</b>	6.3	4.2
<b>2006</b>	6.3	4.5
<b>2007</b>	5.5	4.6
<b>2008</b>	-2.2	5.0
<b>2009</b>	-5.6	10.3
<b>2010</b>	0.4	13.1
<b>2011</b>	2.6	14.4
<b>2012</b>	0.2	15.0
<b>2013</b>	1.4	13.7

Source: GDP Growth (OECD), Unemployment Rate (CSO)

Table 2: Hourly Earnings, 2004-2013 (2010 Prices)

<b>Year</b>	<b>Bottom Decile</b>	<b>Bottom Quartile</b>	<b>Median</b>	<b>Top Quartile</b>	<b>Top Decile</b>	<b>Mean</b>	<b>Top Decile/ Bottom Decile</b>
<b>2004</b>	8.26	10.64	14.48	21.04	30.08	17.37	3.64
<b>2005</b>	8.54	11.00	15.26	22.36	32.23	18.27	3.78
<b>2006</b>	8.65	11.24	15.60	23.55	34.99	19.37	4.05
<b>2007</b>	8.72	11.16	15.80	23.65	35.27	19.35	4.04
<b>2008</b>	8.81	11.14	15.98	23.79	34.48	19.32	3.92
<b>2009</b>	9.53	12.18	17.51	26.12	37.25	21.03	3.91
<b>2010</b>	9.59	12.12	17.12	25.38	35.59	20.56	3.71
<b>2011</b>	9.24	11.30	16.33	24.11	34.30	19.49	3.71
<b>2012</b>	8.90	10.76	15.81	23.18	33.10	18.80	3.72
<b>2013</b>	8.87	11.03	15.93	23.51	34.13	19.27	3.85

Table 3: Distribution of Education in the working population, 2004-2013 (proportion)

	<b>Primary</b>	<b>Lower Secondary</b>	<b>Upper Secondary</b>	<b>Post Leaving Cert</b>	<b>Third Level</b>
<b>2004</b>	.12	.19	.27	.10	.32
<b>2005</b>	.13	.18	.26	.10	.33
<b>2006</b>	.12	.18	.25	.10	.36
<b>2007</b>	.11	.18	.25	.09	.37
<b>2008</b>	.11	.17	.24	.10	.38
<b>2009</b>	.08	.14	.24	.09	.43
<b>2010</b>	.08	.13	.23	.08	.46
<b>2011</b>	.07	.12	.21	.07	.51
<b>2012</b>	.06	.12	.23	.07	.51
<b>2013</b>	.05	.11	.22	.07	.53

Table 4: Characteristics of the Workforce

	<b>2004 P10</b>	<b>2008 P10</b>	<b>2013 P10</b>	<b>2004 P90</b>	<b>2008 P90</b>	<b>2013 P90</b>	<b>Mean 2004</b>	<b>Mean 2008</b>	<b>Mean 2013</b>
<b>Male</b>	.375	.376	.371	.570	.547	.543	.510	.488	.473
<b>Experience</b>	19.25	20.57	19.44	25.28	26.74	24.34	21.66	24.03	21.82
<b>Primary Education</b>	.203	.172	.086	.011	.028	.003	.118	.112	.050
<b>Lower Secondary Education</b>	.302	.245	.133	.039	.022	.010	.192	.170	.107
<b>Upper Secondary Education</b>	.305	.320	.265	.110	.085	.066	.273	.242	.221
<b>Post Leaving Certificate Qualification (PLC)</b>	.073	.088	.123	.042	.035	.003	.096	.097	.073
<b>Third Level Education</b>	.117	.176	.368	.798	.830	.914	.322	.379	.531
<b>Irish</b>	.919	.843	.699	.963	.978	.950	.950	.922	.852
<b>Urban</b>	.630	.655	.619	.782	.758	.715	.706	.686	.644
<b>Border, Midlands and Western Region (BMW)</b>	.326	.276	.275	.131	.123	.166	.205	.198	.244

Table 5: Regression Results 2004, 2007, 2008 & 2013  
(standard errors in parentheses)

	2004 P10	2007 P10	2008 P10	2013 P10	2004 P90	2007 P90	2008 P90	2013 P90	OLS 2004	OLS 2007	OLS 2008	OLS 2013
<b>Male</b>	.132 (.022)	.120 (.031)	.161 (.027)	.093 (.023)	.148 (.022)	.149 (.028)	.151 (.018)	.098 (.041)	.172 (.014)	.153 (.015)	.157 (.016)	.081 (.017)
<b>Exp</b>	.028 (.003)	.026 (.004)	.032 (.005)	.021 (.003)	.042 (.004)	.040 (.004)	.049 (.005)	.040 (.004)	.037 (.002)	.038 (.002)	.042 (.002)	.034 (.003)
<b>Exp<sup>2</sup></b>	-.001 (.000)	-.0004 (.000)	-.001 (.000)	-.0004 (.000)	-.0006 (.000)	-.0006 (.000)	-.0007 (.000)	-.0006 (.000)	-.001 (.000)	-.0006 (.000)	.007 (.000)	-.005 (.000)
<b>Lower Sec.</b>	.067 (.039)	.054 (.039)	.034 (.040)	-.011 (.030)	.156 (.036)	.182 (.068)	.057 (.059)	-.138 (.104)	.132 (.027)	.087 (.030)	.058 (.031)	-.022 (.041)
<b>Upper Sec.</b>	.201 (.036)	.172 (.048)	.108 (.048)	.077 (.026)	.316 (.038)	.338 (.082)	.248 (.074)	.046 (.102)	.329 (.027)	.258 (.029)	.210 (.031)	.110 (.038)
<b>PLC</b>	.238 (.039)	.211 (.053)	.226 (.056)	.070 (.031)	.404 (.032)	.399 (.080)	.298 (.089)	-.052 (.106)	.368 (.032)	.329 (.035)	.265 (.037)	.078 (.045)
<b>Third Level</b>	.501 (.033)	.450 (.053)	.471 (.052)	.266 (.037)	.874 (.036)	.918 (.065)	.824 (.065)	.632 (.098)	.750 (.026)	.724 (.029)	.676 (.030)	.525 (.036)
<b>Irish</b>	.260 (.054)	.251 (.058)	.350 (.079)	.221 (.031)	.108 (.055)	.244 (.039)	.265 (.057)	.259 (.031)	.161 (.032)	.294 (.029)	.340 (.030)	.280 (.024)
<b>Urban</b>	.097 (.038)	.082 (.030)	.040 (.024)	.029 (.021)	.047 (.034)	.078 (.035)	-.018 (.026)	.048 (.029)	.089 (.016)	.069 (.017)	.047 (.018)	.068 (.018)
<b>BMW Region</b>	-.115 (.036)	-.060 (.033)	-.037 (.030)	-.047 (.023)	-.079 (.027)	-.073 (.027)	-.113 (.036)	-.078 (.031)	-.089 (.018)	-.089 (.019)	-.075 (.020)	-.075 (.020)
<b>Constant</b>	1.21 (.077)	1.39 (.112)	1.33 (.124)	1.68 (.070)	1.96 (.061)	1.98 (.105)	2.06 (.072)	2.29 (.121)	1.50 (.045)	1.59 (.045)	1.60 (.047)	1.83 (.048)

As in Table 4, BMW refers to the Borders, Midlands and Western Region of Ireland and PLC refers to Post Leaving Certificate Education.

Table 6: Unemployment Rates of those Aged 15-64 by Education:  
Ireland 2004-2013

	<b>Unemployment Rate: Lower Secondary Education or Less (%)</b>	<b>Unemployment Rate: Third Level Education or More (%)</b>
<b>2004</b>	7.8	2.3
<b>2005</b>	7.4	2.5
<b>2006</b>	7.0	2.7
<b>2007</b>	7.8	2.8
<b>2008</b>	10.5	3.8
<b>2009</b>	18.1	7.2
<b>2010</b>	22.2	7.9
<b>2011</b>	24.4	7.9
<b>2012</b>	25.9	7.6
<b>2013</b>	22.2	7.3

Source: Eurostat

Table 7: Distribution of Education among Workers for the cohort born between 1959 and  
1969 (aged 35-45 in 2004)

	<b>Primary</b>	<b>Lower Secondary</b>	<b>Upper Secondary</b>	<b>Post Leaving Cert</b>	<b>Third Level</b>	<b>Average Age</b>
<b>2004</b>	.08	.22	.28	.10	.32	40.2
<b>2005</b>	.09	.20	.28	.10	.34	41.2
<b>2006</b>	.08	.19	.24	.12	.37	42.2
<b>2007</b>	.07	.19	.24	.11	.39	43.3
<b>2008</b>	.07	.18	.25	.12	.39	44.0
<b>2009</b>	.07	.15	.24	.10	.43	45.2
<b>2010</b>	.06	.15	.25	.09	.43	46.1
<b>2011</b>	.05	.15	.23	.07	.48	46.9
<b>2012</b>	.06	.15	.24	.06	.48	47.7
<b>2013</b>	.06	.16	.21	.06	.49	48.8