

# When supply meets demand: Wage inequality in Portugal\*

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October 30, 2012

## Abstract

Wage inequality in Portugal increased over the last quarter of century. The period from 1982 to 1995 witnessed strong increases in both upper- and lower-tail inequality. A shortage of skills combined with skill-biased technological changes are at the core of this evolution. Since 1995, lower-tail inequality decreased, while upper-tail inequality increased at a slower rate. The supply of high-skilled workers more than doubled during this period, contributing significantly to the slowdown. Polarization of employment demand is the more credible explanation for the more recent evolution. As in other developed economies, for instance Germany and the United States, we show that institutions played a minor role in shaping changes in inequality.

*Keywords:* Inequality; Polarization; Supply; Demand; Institutions

*JEL Codes:* J3; D3; O3

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\*We thank Ferreira Machado and Ana Rute for helpful discussions. The paper benefited also from comments received at the 2009 Banco de Portugal's Labor Conference and AIEL 2009, Sassari, Italy. We are grateful to Lucena Vieira for the outstanding data handling of the *Quadros de Pessoal* dataset. Opinions expressed herein do not necessarily reflect the views of the *Banco de Portugal*. Any errors are of our responsibility.

# 1 Introduction

The debate over the level and trends in wage inequality in developed economies has evolved around a continental divide. Anglo-Saxon countries have higher and increasing inequality throughout the 80s and 90s (Card and Lemieux 2001, Autor, Katz and Kearney 2008), while, in Continental Europe, it is smaller and increased much less. Recently this view has been challenged with the reassessment of inequality developments for Germany in Dustmann, Ludsteck and Schönberg (2009), pointing to significant increased inequality throughout that period.

The main explanations for the rising wage inequality in the US in the 80s are the skill-biased technological change matched with a slower pace of expansion in the labor supply of the high-skilled. In the 90s, the wage distribution was shaped by the market polarization, resulting in falling inequality at the lower-tail of the income distribution and increasing inequality at the upper-tail. In Europe, the continuous rise in the supply of high-skilled individuals and labor market institutions that contribute to the compression of the wage distribution (minimum wage, wage-setting through collective bargaining, and unions) are frequently advanced as the main explanations for the lower level and more contained increase in inequality.

Portugal appears as an outfit for the institutional view. Indeed, Portugal shares the institutional features of Continental Europe, but has the inequality outcomes of Anglo-Saxonic countries. We reconcile the Portuguese outcome with the European experience in the context of the supply, demand, and institutions framework.

This paper visits the changes in the wage structure in Portugal between 1982 and 2006. Throughout the 80s and until the mid-90s, wage inequality increased steeply at both ends of the wage distribution. The subsequent period tells a different story, with wage inequality falling at the lower-tail and slowing down at the upper-tail. Supply and demand shifts explain most of these developments. The supply of skills remained quite low during the first period, but a large shift occurred during the 90s, with an increase in college graduates. The shifts in demand throughout this period favored the more skilled, but since 1995 we observe a polarization of the wage distribution, with both employment and wages increasing more in the lower- and upper-tail.

The institutional framework of the Portuguese labor market did not change much throughout this period. The basic regulations of collective bargaining, minimum wage, and fixed-term contracts were already in place before 1982. However, labor relationships went through signif-

icant changes. The starting years of our sample mark the end of the “revolutionary period” that started with the deposition of the Portuguese dictatorship in 1974. Indeed, 1982 marks the end of the last serious ideological confrontations in the Portuguese labor market, with general strikes and significant labor turmoil. After the deep 1983 economic crisis, labor confrontations subdued significantly and the number of days lost to strikes were reduced permanently. In 1986 there were 232 thousand workers involved in strikes, the majority of them in the publicly-owned transportation sector (52 percent), but this number fell to 29 thousand workers in 2007.

Using data from *Quadros de Pessoal* – a comprehensive employer-employee matched data set of private sector employment – we find a continuous increase in overall inequality from 1982 to 2006. This increase is stronger at the upper-tail of the distribution (90/50), especially until 1995. This can be explained by a slow increase in the supply of skills together with significant skill-biased shifts in demand. The skill-biased technological change explanation, common to most developed and open economies, fits with the rising college wage premium observed until the mid 90s. Afterwards, there is a strong shift in the supply of skills, but no strong sign of a deceleration in the demand for skills. These two developments led to a less sharper increase in the college/noncollege wage gap. Nevertheless, a more in-depth analysis shows that the increase in the wage gap was not common to all experience levels. Indeed, the wage gap decreased for less experienced individuals after 1995.

The evolution of inequality at the lower-tail of the wage distribution is more dichotomous across periods. There is a strong increase in 50/10 inequality in the first period, but since the late 90s the polarization of employment demand favored low-skill jobs, contributing to the compression of the wage distribution. The minimum wage may have also played a (minor) role in the reduction of 50/10 inequality, but only for female workers.

The results of the counterfactual analysis suggest that demand factors resulted in positive price effects in the initial period. The compositional change (larger supply of educated workers) in the second period resulted in negative price effects, countervailed by positive composition effects.

The importance of collective bargaining coverage to the evolution of wage inequality was also tested. The counterfactual analysis, which takes advantage of a significant drop in the coverage (7 percentage points from 2000 to 2006), indicates that its impact on the evolution of inequality during that period was negligible.

Previous studies of wage inequality in Portugal include Cardoso (1998), Machado and Mata

(2001), Martins and Pereira (2004), and Machado and Mata (2005). These studies cover only the first half of our sample and concentrate on the estimation of the college wage premium. Machado and Mata (2005) extends the analysis with counterfactual price and composition effects, using a quantile regression decomposition method. For the overlapping period, the wage premium estimates reported in these studies are in line with the ones we obtain here with a different methodology.

Overall, demand and supply conditions do a great job explaining shifts in the Portuguese wage distribution. The evolution of the demand for skills since 1995 is consistent with a trend of polarization of work. However, the strong increase of relative supply of skills for the cohorts born after the late 60s is associated with a reduction of the college wage premium. Institutions play a minor role; the minimum wage helps in explaining the time series variation in the 50/10 wage gap, but only for female, and collective bargaining instruments proved insufficient to compress the wage distribution.

## 2 Data

*Quadros de Pessoal* (QP) is an administrative dataset collected on an annual basis (reported to October of each year) by the Portuguese Ministry of Employment. Coverage is mandatory for firms with at least one salaried worker, except for civil servants, entities that employ non-permanent rural workers, and domestic workers. The QP is a source of information of great importance in the microeconomic analysis of employment in Portugal and has been extensively used (Cardoso 1998, Martins 2009).

The data is available from 1982 to 2006, with the exception of the years of 1990 and 2001. For the purpose of this study, we collect the monthly wage, hours worked, age, education, and occupation of workers. In 2006, the data cover nearly 3 million employees. This dataset has been used to study different aspects of the Portuguese labor market, among which wage inequality.

QP registers different wage components. We use the base wage measure, which corresponds to the monthly wage of regular working hours. Additionally, we consider a total wage measure that includes, besides the base wage, subsidies and premiums paid on a monthly basis (e.g. seniority and housing subsidies) and overtime pay. Finally, we also consider a measure of hourly wages. Details about the sample construction are deferred to the Appendix.

### 3 The Portuguese wage structure in the last 25 years

Figure 1 displays the basic wage structure changes in the Portuguese economy, plotting the log real wage change for male and female from 1982 to 2006. It illustrates the non-monotonic widening of the wage distribution over the past two decades and a half. A large increase in wage inequality, with the 90th percentile wages rising approximately by 50 log points relative to the 10th percentile and by close to 40 log points relative to the 50th percentile. For males, it remains flat below the 50th percentile and increases dramatically above the median, whereas for females it shows a small increase in the lower-tail of the distribution and a sizeable increase above the 60th percentile.

[FIGURE 1 HERE (see page 29)]

The two panels in Figure 2 decompose this evolution in two periods, 1982-1995 and 1995-2006. As it will be clear throughout the paper, despite the fact that no major shock occurred in the Portuguese economy to justify them, the two periods are a natural way to split the sample because of significant shifts in the skill supply.

The trends in inequality are quite different, both for males and females in the two periods. For males, the first period witnessed a strong increase in upper-tail inequality, and only a modest one in lower-tail. For females, lower-tail inequality remained constant, whereas there was a sizeable increase in upper-tail. In the second period, the increase in lower-tail inequality for females is negligible, and for males there was actually a reduction in inequality; low wage males clearly gained over median wages. In the upper-tail, the increase in inequality is stronger for males than for females, but yet quite modest in comparison with the previous period.

[FIGURE 2 HERE (see page 29)]

An alternative way to present these trends is shown in Figure 3, which displays the evolution of the standard deviation of log-wages and log-wage residuals. The standard deviation of log-wage residuals is obtained from OLS wage regressions estimated separately for each year. The control variables included were five education dummies, eight age categories, and all possible interactions between these two variables (see the Appendix for more details). For males the results show a continuous rise in inequality, although faster during the 1982-1995 period. Between 1995 and 2001 the observed and residual standard deviations flatten out, and resume

increasing afterwards. For females the results are similar, except that in the second period the increase is much smaller.

[FIGURE 3 HERE (see page 30)]

Age and education explain a smaller portion of the overall variance of log-wages for males than for females. The increase in inequality over this period occurred within age and education groups, as the residual inequality mimics pretty close the evolution of overall inequality, although with a small decoupling at the end of the period (in the final years, age and education explain a little more of the inequality level).

Finally, we consider the evolution of within-group inequality. Table 1 takes a first look at the evolution of wage dispersion among age and education groups for private sector workers. We use the 50/10 and 90/50 wage gaps and employment shares to identify price and quantity trends. Three main conclusions can be drawn from this table. First, as in other countries, wage dispersion fans out with age and education. This is true within all education and age groups. Secondly, there is an impressive shift in the supply of skills. The share of low-skill individuals (those with 6 or less years of schooling) decreased by 45 percentage points, while the share of high-skilled workers rose from 2.5 percent in 1982 to 12.9 percent in 2006. The age composition of the working population also changed during this period. The share of young workers decreased from 53.6 percent in 1982 to 45.5 in 2006, and among them the share of high-skilled increased from 2 percent to close to 18 percent. Finally, Table 1 highlights the changes in inequality over time. The lower-tail inequality decreased among the low- and medium-skill, and also for the high-skilled in the second period. The upper-tail inequality increased in all skill levels, but more clearly for those aged above 36 years. The rise in inequality was much stronger in the first period, especially among the high-skilled, while in the second period there was a decrease in lower-tail inequality, more pronounced for low- and medium-skill workers. This is preliminary evidence of the role of the supply and demand shifts observed during these 25 years, that may help in explaining the evolution of the Portuguese wage distribution. These shifts will be explored in a more structured way in the next sections.

[TABLE 1 HERE (see page 25)]

Hitherto, the results reported used the base wage. However, institutions and market forces may affect distinctly the evolution of different components of the total wage. To infer if our

measure of inequality, but in particular its evolution, changes with the wage definition, in Figure 4, we extend our analysis to measures of total wages (base wages + other regular monthly payments + overtime pay), hourly base wages, and hourly total wages.

[FIGURE 4 HERE (see page 30)]

From Figure 4, we take away three important facts:

1. Inequality is larger for measures of total wages than for measures of base wages. This is expected for two reasons. First, total wages are less subject to regulations (institutions). Second, given that not all individuals have the possibility, for instance, to work longer/extra hours, the spread of the distribution increases;
2. For the same measure of wages, hourly measures result in slightly larger levels of inequality, particularly at the upper-tail;
3. Despite these differences, the time profile of upper- and lower-tail inequality is rather similar across all wage measures; sharper increases in the early years and slowdown (even decrease) after the mid 90s. For instance, lower-tail inequality increased 4 log points from 1982 to 1995 if measured in base wages and 3 log points if measured in total wages. Over the same period, upper-tail inequality increased 24 log points if measured in base wages and 21 log points if measured in total wages.

Therefore, in the remaining analysis, which focuses on explaining the evolution of inequality rather than its level, we choose the base wages measure. Arguably, this measure ought to be more influenced by the institutional setting and, in this sense, it constitutes an harder testing ground for the hypothesis that the increase in inequality in Portugal is market-driven as in other economies (Autor et al. 2008, Dustmann et al. 2009). Furthermore, for statistical reasons, the choice of base wages avoids potential measurement errors in measures based on hours worked.

## 4 The sources of rising (and falling) inequality

The wage distribution in Portugal widened at the top, more strongly until the mid-90s. The returns to education are quite high in the Portuguese economy. However, there has been a huge increase in the supply of skills, namely of college graduates. In the US, Autor et al. (2008) show that the increase in the return to education is an important component of the rise in inequality.

The supply of skills in the Portuguese economy is characterized by a large shift in the rate of college graduates during the second half of the 90s. This large supply shift was matched, in part, with a shift in the demand for skills. However, this created a significant cohort effect that may have generated a reduction in the wage premium for education since the second half of the 90s. We analyze this issue by computing the college/noncollege gap by experience group.

Another important issue is the role of the minimum wage to inequality. The debate for the US is large, and the evidence mixed (Lemieux 2006, Autor et al. 2008). We follow this line of research and try to evaluate the role of the minimum wage in explaining wage inequality in Portugal.

#### 4.1 Sources of the rising college/noncollege wage premium

We follow Katz and Murphy (1992) and use a formal supply-demand framework that helps us understand the evolution of the returns to education during the last two decades and a half. The framework uses a two-level CES production function framework to explain the educational wage differentials by fluctuations in labor supply and smooth trends in relative demand growth.

In this setup aggregate production depends only on the quantities of skilled and unskilled workers. We take skilled workers as those with a college degree and unskilled workers as those without a college degree. The CES function stipulates an aggregate elasticity of substitution between the two types of labor, given by  $\sigma$ . Aggregate output can be written as:

$$Q_t = [\alpha_t (a_t N_{ct})^\rho + (1 - \alpha_t) (b_t N_{nt})^\rho]^{\frac{1}{\rho}}, \quad (1)$$

where  $N_{ct}$  and  $N_{nt}$  are the quantities employed of college equivalents and noncollege equivalents,  $a_t$  and  $b_t$  are the college and noncollege labor augmenting technological change,  $\alpha_t$  is a technology parameter and  $\rho$  is the production parameter. Skill-biased technological changes imply an increase in  $\frac{a_t}{b_t}$  or  $\alpha_t$ . The aggregate elasticity of substitution can be computed as  $\sigma = 1/(1 - \rho)$ .

Under the assumption that college and noncollege equivalents are paid their marginal products, we can use the expression for aggregate output to solve for the college wage differentials:

$$\ln \left( \frac{w_{ct}}{w_{nt}} \right) = \left( \frac{1}{\sigma} \right) \left[ D_t - \ln \left( \frac{N_{ct}}{N_{nt}} \right) \right], \quad (2)$$

where  $D_t$  indexes relative demand shifts favoring college graduates equivalents. The greater is  $\sigma$  the smaller the impact of shifts in relative supplies on relative wages and the greater must be



the fluctuations in demand shifts to explain the time series variation of relative wages for given time series variation of relative quantities.

Table 2 presents the estimates of a version of equation (2). To capture the demand shifts, we use a simple time trend,  $t$ , and a measure of the labor market conditions, the unemployment rate,  $UR_t$ . The model also includes the log real minimum wage,  $W_t^{min}$ , and the average unemployment insurance per unemployed,  $UI_t$ , specifically:

$$\ln\left(\frac{w_{ct}}{w_{ht}}\right) = \alpha_0 + \alpha_1 t + \alpha_2 \ln\left(\frac{N_{ct}}{N_{ht}}\right) + \alpha_3 W_t^{min} + \alpha_4 UR_t + \alpha_5 UI_t + \epsilon_t. \quad (3)$$

An important component of the rise in inequality in the US is the increase in the return to education. In European countries the pattern is somewhat different, either because the demand pressure on high-skill wages was not as strong as in the US or due to a stronger supply shift in college educated workers. The large dichotomy of supply shifts in the pre- and post-95 periods makes Portugal an interesting case. We focus on the wage differential between college and noncollege graduates.

[TABLE 2 HERE (see page 26)]

The top panel of Figure 5 presents college relative supply and wage premium series over 1984 to 2006 deviated from a linear trend. This figure reveals an acceleration in relative supply of college graduates since 1995. The opposite occurred during the 80s and early 90s. These fluctuations in the relative supply of college graduates, paired with a constant trend growth in relative college demand, do a great deal in explaining the evolution of the wage gap. Figure 5 shows that the wage gap increased over the 80s and early 90s (when relative supply was below trend levels) and decreased thereafter, again in an opposite move with relative supply.

[FIGURE 5 HERE (see page 31)]

The lower panel of Figure 5 uses the results in column (1) in Table 2 to predict the evolution of the college wage premium and compares it with the actual college wage differential. The model does an excellent job in predicting the growth of the wage differential since 1995, but it underestimates the college wage gap during the first half of the 90s. This fits with the evidence of a significant supply shift to explain the post-95 outcome. The slowdown in labor supply in the second half of the 80s lead the model to overpredict the wage gap and the subsequent

stabilization during the first half of the 90s implies an underestimation of the gap. For the first period, demand shifts were more important, and those are captured in the model through the trend (smooth) variable. These demand shifts generated in the first period a large price-effect.

The implied elasticity of substitution from columns (3) and (4) of Table 2 is around 1.7, slightly higher than the 1.6 estimates for the US in Autor et al. (2008), but only about one-third the estimates – of 5 – for Germany in Dustmann et al. (2009). There is evidence of a substantive responsiveness of wages to supply and demand shocks in Portugal. This result complements the micro economic evidence of strong wage cyclicality in the Portuguese economy obtained, among others, in Carneiro, Guimarães and Portugal (2009).

Table 2 considers also the possibility of a slowdown in demand shifts since 1995. In columns (2) and (5), we interact the time trend with a post-1995 dummy, which proves to be non-significant. The same conclusion holds for the impact of changes in labor market conditions, the minimum wage, and UI costs which seem to have at most a small effect on the wage gap.

## 4.2 The college/noncollege gap by experience group

As shown in Table 1, the evolution of wage inequality differed significantly across and within age/skill groups. The increase in inequality was concentrated in older workers, especially among the more educated. We take a closer look at this pattern in Figure 6 comparing the evolution of the college premium and college relative supply for younger and older workers. The college wage gap increased in a similar way for both groups until the first half of the 90s, but since 1995 the college premium jumped almost 30 log points for the more experienced and fell by almost 20 log points for young college graduates. If workers with the same education but different levels of experience are imperfect substitutes in production, we may expect these developments to be related with differences in the relative skill supplies in each experience-group (Card and Lemieux 2001). Consistent with this view, Figure 6 also shows a much more rapid increase in the supply of college graduates among the less experienced workers since 1995 (100 log points, which compares with 40 log points for the older group). The shifts in the relative supply of skills presented in Table 1 and Figure 6 show important differences among different age (and potential experience) cohorts. The intercohort shifts in the relative supply of higher educated workers is the result of the extraordinary increase in the rate of growth of educational attainment that characterizes the cohorts born after the late 60s.

[FIGURE 6 HERE (see page 32)]

We use the Katz and Murphy framework to take into account these different trends, and estimate a model for the college wage gap by experience group that includes the own experience group relative skill supplies. The basic models of education-related wage differentials ignore differences in the experience distribution of educational attainment. However, the introduction of imperfect substitutability between younger (less experienced) and older (more experienced) workers yields the prediction that an increase in the intercohort trend in educational attainment will lead to a relative fall in the college wage premium for younger workers that will make its way through the experience distribution as the cohort ages.

The Card and Lemieux (2001) model relaxes the hypothesis that different experience groups with the same education are perfect substitutes in production. It uses a production function similar to equation (1), but assumes that aggregate output depends on two CES subaggregates of college and noncollege labor, in which the elasticity of substitution is a function of the partial elasticity of substitution between different experience groups with the same level of education ( $\sigma_E$ ).

In the model, shifts in the experience-group-specific relative supply are expected to shift the experience profile of the college wage gap, with an effect that depends on the size of  $1/\sigma_E$ . The model estimated is:

$$\ln\left(\frac{w_{cjt}}{w_{njt}}\right) = \beta_1 \left[ \ln\left(\frac{N_{cjt}}{N_{njt}}\right) - \ln\left(\frac{N_{ct}}{N_{nt}}\right) \right] + \beta_2 \ln\left(\frac{N_{ct}}{N_{nt}}\right) + \beta_3 X_t + \gamma_j + \epsilon_{jt}, \quad (4)$$

where  $j$  indexes the experience groups, the  $\gamma_j$  are the experience group fixed effects and  $X_t$  include the same covariates as in Table 2. Under the assumptions of Card and Lemieux (2001), we can interpret  $-1/\beta_2$  as an estimate of  $\sigma$ , and  $-1/\beta_1$  as an estimate of  $\sigma_E$ .

The results are presented in Table 3. The first two columns present pooled estimates for the four experience groups allowing for group specific intercepts. These estimates point to significant effects of both own-group and aggregate supplies on the college wage gap by experience group. The aggregate elasticity in column (1) is close to 2, similar to the one obtained in Table 2. The implied partial elasticity of substitution between experience groups within the same education group is closer to 3. This is a smaller elasticity than reported in Autor et al. (2008) for the US (3.6) and the estimates by Card and Lemieux (2001) for the US, U.K., and Canada. The Portuguese labor market shows a great deal of wages sensitivity to supply conditions, even if somewhat lower than the more flexible Anglo-Saxon labor markets.

[TABLE 3 HERE (see page 26)]

These estimates allow us to conclude that the differences in own-group relative college supply growth can explain about half of the evolution of the college wage premium in the last couple of decades, and virtually all the evolution since 1995. In the latter period, the college wage premium decreased 15 log points for the less experienced and increased 14 log points for the group with 20-29 years of experience (see left panel of Figure 6). Over the same period the difference in own-group relative supply between the two groups was 79 log points (with a faster increase for the less experienced (see right panel of Figure 6). Thus, using the implied own-group inverse elasticity of column (1), we find that the quicker increase in college supply for the younger group explains 27 log points of the difference in wage gap, this is, 93 percent of the 29 log points difference in wage premium changes.

These results point to the potential importance of different sensitivities of the wage gap to own-group and aggregate supplies across experience groups. This is reported in the remaining columns of Table 3. The demand shifts are more important for prime-age individuals, those with experience between 10 and 29 years. The sensitivity of the wage gap to own-group supply decreases with experience; it is higher for younger individuals (3.9 for those with less than 10 years of experience and 1.8 for those with experience between 10 and 19 years). On the contrary, the sensitivity to aggregate supply increases with the experience level. The less sensitive are the youngest individuals; the elasticity is very low (less than 2) for the less experienced workers, and non-significant for those with 10-19 years of experience. Interestingly enough, the older workers' wage gap is not sensitive to changes in supply (either own-group or aggregate). The minimum wage and the unemployment rate do not play an important role in explaining the wage gap of any of the experience groups. Nonetheless, the coefficient of the minimum wage is larger for young and less experienced workers, an expected result given the larger incidence of the minimum wage among young workers.

The shifts in cohort-specific supply of highly educated workers, matched with a steady increase in relative demand for skills, provide a good explanation for the observed changes in education-related wage gaps. Indeed, the simple supply-demand framework used in this section can account for a great deal of the evolution of between-group inequality. The rise in the wage premium during the 80s and first half of the 90s and the slowdown observed since that date are associated with the differential rise in relative supply by experience groups. In particular, the reversal trend in the wage gap of less experienced college graduate workers is associated with

both a significant increase in own-group supply and a higher sensitivity of this group's wage gap to the aggregate supply of skills.

### 4.3 The role of the minimum wage

The minimum wage is usually considered an important feature of the wage-setting institutions in the Portuguese economy (Cardoso 1998). However, the impact of the minimum wage on wage inequality in Portugal remains pretty much unexplored. It affects directly a sizeable portion of salaried workers, but its impact is not fully described by the simple share of workers that earn its euro amount. Indeed, the change in the minimum wage may generate a “wave” effect on wage growth that goes well beyond the lower-tail of the wage distribution. This effect can be explained by a negative spillover of the minimum wage, as in Autor, Manning and Smith (2009).

The “wave” effect is displayed in Figure 7. Notice how the wage growth falls below the minimum wage increase (4.4 percent) in wage percentiles just above the minimum wage and starts recovering only above the 40th percentile for the total of salaried workers. This effect is sharper for the textile sector (which has a larger share of minimum wage earners), where the growth rate of wages falls until the 70th percentile.

[FIGURE 7 HERE (see page 32)]

The minimum wage should primarily affect inequality in the lower-tail of the wage distribution and among female workers, those with a higher incidence of minimum wage jobs. The exercise in Table 2, based on the college wage gap, was not designed to capture the impact of the minimum wage and its heterogeneity. To analyze the potentially differentiated impact in the upper- and lower-tail, we use again the Katz and Murphy framework and run simple OLS regressions of the 90/50 and 50/10 wage differentials on the log real minimum wage, a time trend and the other variables included in Table 2. The results are displayed in Table 4. They show a negative significant coefficient for the minimum wage, equal to -0.431, for female lower-tail inequality, and a smaller non-significant impact for males, -0.338. As expected, the coefficient is non-significant for both males and females in the 90/50 wage ratio regressions.

[TABLE 4 HERE (see page 27)]

We cannot commit, however, to a causal interpretation of these coefficients. This issue deserves further analysis, namely in line with the results of Autor et al. (2008), but they are,

nevertheless, indicative that there is some scope for a limited impact of the minimum wage in lower-tail inequality.

## 5 Inequality: the role of composition and prices

The evidence presented hitherto has made clear the significant changes in the composition of the Portuguese labor force, particularly in terms of its qualifications. Thus, it is possible that a fraction of the rise in inequality is attributable to composition effects; a larger share of more educated individuals, holding prices (wages) constant, would typically lead to higher inequality. One must not, however, play down price effects that come about through the standard impact of supply, demand, and institutional factors in relative prices.

Albeit in a partial equilibrium framework, we explore these effects by using the kernel re-weighting method developed by DiNardo, Fortin and Lemieux (1996), widely used in this literature.<sup>1</sup> The observed wage density at time  $t$ ,  $f(w|t)$ , can be decomposed into the product of the density of observable wages conditional on observable attributes  $x$  at time  $t$ ,  $g(w|x, T = t)$ , and the density of the same attributes,  $h(x|T = t)$ . Formally,

$$f(w|T = t) = \int g(w|x, T = t)h(x|T = t)dx \quad (5)$$

and similarly for time  $T = t'$ .

In order to compute the counterfactual wage distribution in year  $t$  that would have prevailed if the workforce attributes were the same as in year  $t'$ , one needs to re-weight the “price” function,  $g(w|x, T = t)$ , by the ratio of the “composition” functions,  $h(x|T = t')/h(x|T = t)$ . As shown by DiNardo et al. (1996), this ratio can be easily calculated by noting that  $h(x|T = t')/h(x|T = t) = \Pr(T = t'|x)/\Pr(T = t|x) \times (1 - \Pr(T = t'))/\Pr(T = t')$ . Notice that the reweighting function can be computed by using a dichotomous variable model – logit or probit – in the pooled data for years  $t$  and  $t'$ . In our case, the set of conditioning variables includes dummy variables for five levels of schooling and eight age groups, and all possible interaction terms between education and age dummies.

The same principle can be applied to decompose residual inequality; the price function  $g(w|x, T = t)$  is replaced with the residual price function  $g(\epsilon|x, T = t)$ . The residuals,  $\epsilon$ , are

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<sup>1</sup>Machado and Mata (2005) apply a counterfactual decomposition of price and quantities to changes in the wage distribution of the Portuguese economy. Their results for the 1986–1995 period are quite similar to the ones reported here.

obtained from a regression of log wages on the same set of attributes listed above.

A caveat *emtor* common in this literature is the partial equilibrium nature of the decomposition proposed, as it assumes that prices and quantities (characteristics) are independent. In the current setting, with large changes in the composition of qualifications and experience (age), this assumption of independence is likely to be violated. Nevertheless, we carry out the exercise as it is worth for comparison with other results in the literature, but the results should be interpreted carefully.

### **Price and composition effects: Estimates**

Figure 8 plots observed and counterfactual overall inequality. Table 5 complements this information with the rates of change (in log points) for particular years. The three counterfactual curves plotted hold prices constant at their 1982, 1995, and 2006 levels, while labor force composition is allowed to evolve as observed over the full sample, 1982 to 2006. Thus, in these figures, a vertical difference between the curves identifies the price effect at each year, i.e., the composition is held constant at that year's level while the prices change across counterfactual curves. Movements along each counterfactual curve identify composition effects.

[FIGURE 8 HERE (see page 33)]

[TABLE 5 HERE (see page 27)]

There are two distinct periods of inequality growth. Inequality grew at a faster pace from 1982 to 1995 than in the subsequent period, 1995-2006. In the upper-tail (90/50), overall male wage inequality grew by 24 log points in the first sub-period, and after 1995 grew 15.3 log points. But while the change of prices from 1982 to 1995 explain a substantial part of the observed increase in inequality, the same is not true afterwards. Indeed, the price changes from 1995 to 2006 yielded negative or tiny positive price effects. A tentative explanation for this change of pattern between periods rests on the substantive compositional changes that occurred. Thus, one might speculate that demand factors explain the positive and substantial price effect of the early period, while supply shifts counterbalanced the increase in demand to yield rather paltry price effects in the more recent period. All these effects are evident in Figure 8, where it is clear that the counterfactual curves for 1995 and 2006 are closer, resulting in smaller price effects (vertical distances), and the composition effects are also slightly bigger at the end of the period (moving along each counterfactual curve).

In the lower-tail (50/10), the first period is characterized by an increase in overall inequality of 8.5 log points, while between 1995 and 2006 this increase is almost wiped out,  $-6.5$  log points. The changes in prices from 1982 to 1995 explain again a substantial part of the increase in inequality. In the second period, the price changes would have resulted in even larger reductions in lower-tail male inequality. The composition effect must have cancelled out part of the price effect. Although not as pronounced as in the upper-tail, composition effects play a larger role in the later part of sample, which is consistent with the evidence gathered for the educational and age changes that characterized the Portuguese economy.

In Machado and Mata (2005), the contributions of increasing returns to education and of workforce composition have a similar contribution to the increase in wage inequality over the 1986–1995 period. In our case, we split the analysis by gender and obtain a larger price effect for men in upper- and lower-tail inequality, but a larger composition effect for women, over the same period. Thus, the results seem to be consistent in both methodologies.

[FIGURE 9 HERE (see page 34)]

The broad messages drawn for overall inequality carry over to residual inequality. Residual inequality slowed down in the final period, 1995–2006, at both ends of the distribution (see Figure 9 and Table 5). Price effects are more important in the early period, where they account for at least 62.5 percent of the raise in inequality. In the final period, composition effects play a larger role, and for lower-tail inequality a countervailing composition effect ends up cancelling the reduction in inequality implied by the price effect.

Keeping in mind the caveats raised, the results suggest that demand factors resulted in positive price effects in the initial period. The compositional change (larger supply of educated workers) in the second period resulted in negative price effects, countervailed by positive composition effects. Furthermore, these results are in line with the evidence obtained in the previous section.

## 6 Facts and explanations of polarization

The evolution of wage inequality in Portugal shows a strong increase in upper- and lower-tail inequalities until the mid-nineties. However, after that period the wage distribution polarizes, with a continuous increase in the upper half and a clear reversal in the lower half of the distribu-



tion. This polarization is observed in overall inequality, residual inequality and in educational wage gaps, a result also obtained for the US, Germany, and the UK.

What can account for this differentiated evolution at both ends of the wage distribution? We follow Goos and Manning (2007) and look for shifts in the employment structure consistent with the “polarization of work”, in which the increased demand for skills of the higher-educated workers is matched with a reduced demand for middle-educated workers, while the demand in occupations with low levels of education was left untouched.

These shifts in the demand for skills characterize the process of international division of labor, in which global outsourcing plays a relevant role. The Portuguese economy is particularly sensitive to this process, as it undertook a significant increase in the level of skills of younger cohorts. This makes the Portuguese experience interesting to study the “polarization of work”, as both demand and supply evolved in parallel directions since 1995.

The polarization of work is a demand side phenomenon, with rising relative demand for high- and low-skill occupations. Its implications are testable: if the changes in the wage distribution observed before and after 1995 are explained by demand shifts, then the employment changes by skill level and the corresponding wage changes should be positively associated in both periods. We apply a methodology similar to the one in Goos and Manning (2007) to our data, using both wages and educational levels to proxy for the occupational skill level.

Figure 10 presents the change in the shares in total employment from 1982 to 1994 and from 1996 to 2006 by occupation skill percentile, using both average wages and education level as proxies for the skill intensity.<sup>2</sup> It shows strikingly different patterns in the change in employment composition between periods. In the first period, there was a significant reduction in the share of employment in occupations with lower skill level and an increase for occupations with higher skill level. This is in sharp contrast with the post-1995 period, in which employment growth seems to have polarized. There is a strong employment growth in occupations with higher skill levels, a reduction in middle-skill jobs and rising employment in low-skill jobs.

[FIGURE 10 HERE (see page 35)]

This evolution of employment growth was matched with similar changes in the wage distribution, as shown in Figure 11. The real wage growth was monotone during the first period, although sharpest above the median, being negative below the 20th percentile. In the post-1995

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<sup>2</sup>In 1995, the occupational codes changed and the mapping of pre- and post-95 classifications is not perfect. For this reason, we use them separately, and exclude 1995 due to transition problems evident in the data.

period, wage growth follows a U-shaped pattern. It was stronger below the 30th percentile and above the 60th percentile. This means that labor market prices and quantities appear to covary positively in each of these two periods.

[FIGURE 11 HERE (see page 35)]

Overall, we take these observations as evidence that labor market demand shifts have favored low- and high-skill jobs relative to middle-skill jobs over the last 12 years, a pattern that is at odds with what we observe during the 80s and first half of the 90s in which shifts in demand seem to have been rising in skill.

## 7 What does collective bargaining do to wage inequality?

The role of unions in shaping wage and employment inequality has been extensively analyzed since the influential work of Freeman and Medoff (1984). Unions are believed to play a crucial role in reducing economic inequality. The impact of de-unionization on wage inequality was analyzed more recently in DiNardo et al. (1996) and Card and DiNardo (2002) for the US and in Dustmann et al. (2009) for Germany. These studies conclude that the decrease in union coverage is in general associated with an increase in wage inequality, particularly at the bottom of the wage distribution.

The Portuguese labor law grants unions the right to negotiate over a wide range of aspects of labor relations, including wages. Collective bargaining negotiations may occur at the industry or occupation level, and at the regional or national level. In addition, the Ministry of Employment can extend the coverage of an existing agreement to firms and workers of the same industry that did not participate in the bargaining process. These agreements define a set of wages for quite detailed occupation levels. There is evidence, however, that firms pay above these wages (Cardoso and Portugal 2005), giving them scope to differentiate among workers. The Portuguese wage setting system has some traits of a centralized one; however, it is characterized by an atomistic structure, from both the union and employer structures, with multiple agreements reached between firms and workers representatives.

QP data do not have information on the unionization of Portuguese workers, but there is information on the type of collective bargaining coverage for each worker (Table 6). The specific collective bargaining agreements foreseen in the law are: (i) collective agreement (*Acordo Colectivo de Trabalho, ACT*); (ii) collective contract (*Contrato Colectivo de Trabalho, CCT*);

(iii) firm-level agreement (*Acordo de Empresa, AE*); and, (iv) regulatory edict (*Portaria de Regulamentação de Trabalho, PRT*). In the period from 1982 to 2006, there are two distinct trends in collective bargaining coverage. Until 2000, the share of workers covered by some form of agreement was close to 97 percent. Between 2000 and 2006, it declined quite rapidly, by more than 7 percentage points.

It is natural to ask whether this fall in coverage had an impact on wage inequality. As we have seen, the early 2000s were characterized by falling wage inequality at the bottom and slight increase in inequality at the top of the wage distribution. We can use the DiNardo et al. (1996) framework and the information on collective bargaining coverage to construct a counterfactual that decomposes total variation in wage inequality into a price effect and a collective bargaining composition effect. As before, the decomposition assumes that the union wage-effect is independent of union coverage, and more generally that there are no spillovers from the unionized to the non-unionized firms and workers.

[TABLE 6 HERE (see page 28)]

In Table 7, we held constant the level of collective agreement coverage at its 2000 or 2006 values, and compute the change in inequality between 2000 and 2006 attributable to price effects. Formally, holding constant the collective bargaining at its 2000 level, the counterfactual wage distribution in 2006 is given as in DiNardo et al. (1996) by:

$$\begin{aligned} & f(w; t_w = 2006, t_{u|x} = 2000, t_x = 2006) \\ &= \int \int f(w|u, x, t_w = 2006) \psi_{u|x}(u, x) dF(U|x, t_{u|x} = 2006) dF(x|t_x = 2006), \end{aligned} \tag{6}$$

where  $u$  is the collective agreement indicator variable and  $x$  the other attributes considered above (age, education, and their interactions). The re-weighting function  $\psi$  is given by:

$$u \frac{\Pr(u = 1|x, t_{u|x} = 2000)}{\Pr(u = 1|x, t_{u|x} = 2006)} + (1 - u) \frac{\Pr(u = 0|x, t_{u|x} = 2000)}{\Pr(u = 1|x, t_{u|x} = 2006)}. \tag{7}$$

The results presented in Table 7 have the expected sign, but a rather small magnitude. The increase in male upper-tail inequality that would have happened if the level of collective bargaining had remained at its 2000 level is 6.8 log points, which compares with the observed overall inequality increase of 7.5 log points; the values for females are, in the same order, 7.7 and 6.2 log points, a slightly higher difference. Interestingly, the reduction of the importance of

collective bargaining has had almost no impact in lower-tail wage inequality; a decomposition of collective bargaining by education and age level shows that the majority of the reduction in coverage occurred among highly educated and young workers.

[TABLE 7 HERE (see page 28)]

The results for residual inequality are remarkably similar to those reported for overall inequality. Once we account for the productive characteristics, 95 percent of the increase in upper-tail male inequality is due to price effects, while in the case of overall inequality the value was 91 percent; in the case of females, 75 percent of the increase in upper-tail residual inequality arises from price effects, less than the 80 percent in overall inequality. The proportion of the price effects is even more similar between overall and residual lower-tail inequality.

In line with our results, Dustmann et al. (2009) report that 2004's German inequality would have decrease more if the unionization levels had remained at the higher levels of 1995. A similar result is found in DiNardo et al. (1996) for the US for the 1973 to 1988 period.

## 8 Conclusion

This paper challenges the view that the institutional settings common in Europe and shared by the Portuguese labor market prevented rises in wage inequality. In fact, we are able to explain most of the developments in overall and residual inequality in Portugal using the simple Katz and Murphy (1992) supply and demand framework.

The Portuguese labor market is an extraordinary setting to test the predictions from such a simple model. In the last two decades and a half, we can easily identify relative supply and demand shifts and interpret their impact on relative wages, while changes in the institutional setting have been quite modest. The relative supply of skills has a dichotomous evolution. First, from 1982 to 1995, the share of college graduates remained at very low levels. Later on, there is an impressive increase in the supply of skills, with the share of college graduates increasing by almost 8 percentage points. The demand shifts in the Portuguese economy are characteristics of a period of increasing economic integration, initially within the European Union and later globally.

These market forces resulted in increased wage inequality, both at the top and bottom of the wage distribution. The upper-tail inequality increase was much stronger during the first half of the period (until mid-90s) than afterwards. We interpret this slowdown, not as a reduction

in demand pressure, but as the result of an extraordinary increase in the supply of skills. Two results are particularly important to draw this conclusion. First, in the post-95 period, we observe a polarization of work – a demand phenomenon, characterized by relative employment and wage gains for low- and high-skill workers. Second, more skilled and younger cohorts experience a reduction of the college wage gap since the increase in high-skills was concentrated in this younger group. Older cohorts witnessed large increases in wage inequality.

The lower-tail inequality increased in the pre-95 period (especially in the 1987-1995 period) and declined (or at best remained stable) subsequently. The behavior of lower-tail wage changes is mainly explained by negative demand shocks during the first period and by the polarization of work, which benefited low-wage jobs (against middle-skilled jobs) and helped in reducing inequality after 1995. The wage setting institutions in the Portuguese economy play only a minor role in promoting wage compression. The minimum wage is shown to have a relevant impact in reducing lower-tail inequality for female workers.

The reduction in collective bargaining observed since 2000 accounts only for a negligible fraction of the increase in upper-tail inequality and did not influence at all the lower-tail developments described above.

We see these results as evidence that market forces are the main explanations for the changes in the wage distribution in Portugal. This is in accordance with the available evidence for other advanced countries, such as Germany, UK, and US.

## Appendix

### *Sample selection*

The selection criteria applied to our samples consisted in keeping all wage spells corresponding to full-time workers earning at least the minimum wage.

In 1983, the workers' age is available only for a third of the sample. Indeed, it seems to be missing 'not at random', impacting on 1983's wage equation estimates. To avoid losing one additional year of data, 1982, in the case of Figures 3, 8, and 9, we report interpolated values for 1983.

### *Education and Age*

The education variable distinguishes five groups. This number of categories aimed at capturing the changes in mandatory schooling that were in faced by workers in our sample. The five categories are: less than 4 years of schooling, more than 4 through 6 years of schooling, 9 years of schooling, 12 years of schooling, and college degree. Whenever necessary these categories are aggregated in broader groups.

The age variable considers eight age groups: less than 25 years old; 25-29; 30-34; 35-39; 40-44; 45-49; 50-54; and more than 54 years old.

### *Relative supply measures*

We calculate the quantities supplied of college and noncollege graduates using the QP samples. We construct a labor quantity sample measured in efficiency units for all workers with 0 to 39 years of potential experience. These workers are split into 400 gender  $\times$  education  $\times$  potential experience cells. Experience groups are single-year categories of 0 to 39 years; education groups are the same as above. The quantity data are merged with price data containing mean real wage by year, gender, potential experience, and education. To compute the efficiency units, we use mean real wage by year, gender, education, and age.

### *Education wage differentials*

The data are sorted into gender-education-potential experience groups, based on a breakdown of the data into two gender, five education, and four potential experience categories (0-9, 10-19, 20-29, and 30 or more years). Log monthly base wages of full-time workers are regressed in each year separately by gender on the dummy variables for four education categories, a quartic in experience and interactions of the experience quartic with the education dummies. The

composition adjusted mean log wage for each of the forty groups in a given year is the predicted log wage from these regressions evaluated at the relevant experience level (5, 15, 25 and 35 years for each of the four experience groups). Mean log wages for broader groups in each year represent weighted averages of the relevant cell means using a fixed set of weights, equal to the mean share of total employment by each group over 1982 through 2006.

## References

- Autor, D. H., Katz, L. F. and Kearney, M. S. (2008), ‘Trends in U.S. wage inequality: Revising the revisionists’, *Review of Economics and Statistics* **90**(2), 300–323.
- Autor, D., Manning, A. and Smith, C. L. (2009), The role of the minimum wage in the evolution of the U.S. wage inequality over three decades: A modest re-assessment, Working paper, MIT.
- Card, D. and DiNardo, J. (2002), ‘Skill-biased technological change and rising wage inequality: Some problems and puzzles’, *Journal of Labor Economics* **20**(4), 733–783.
- Card, D. and Lemieux, T. (2001), ‘Can falling supply explain the rising return to college for younger men? A cohort-based analysis’, *Quarterly Journal of Economics* **116**(2), 705–746.
- Cardoso, A. (1998), ‘Earnings inequality in Portugal: High and rising?’, *Review of Income and Wealth* **44**(3), 325–343.
- Cardoso, A. and Portugal, P. (2005), ‘Contractual wages and the wage cushion under different bargaining settings’, *Journal of Labor Economics* **23**(4), 875–902.
- Carneiro, A., Guimarães, P. and Portugal, J. (2009), Real wages and the business cycle: Accounting for worker and firm heterogeneity, Discussion Paper 4174, IZA.
- DiNardo, J., Fortin, N. and Lemieux, T. (1996), ‘Labor market institutions and the distribution of wages, 1973-1992: A semiparametric approach’, *Econometrica: Journal of the Econometric Society* pp. 1001–1044.
- Dustmann, C., Ludsteck, J. and Schönberg, U. (2009), ‘Revisiting the German wage structure’, *Quarterly Journal of Economics* **124**(2), 843–881.
- Freeman, R. and Medoff, J. (1984), *What do unions do?*, Basic Books, New York.

- Goos, M. and Manning, A. (2007), ‘Lousy and lovely jobs: The rising polarization of work in Britain’, *The Review of Economics and Statistics* **89**(1), 118–133.
- Katz, L. and Murphy, K. (1992), ‘Changes in relative wages, 1963-1987: Supply and demand factors’, *The Quarterly Journal of Economics* pp. 35–78.
- Lemieux, T. (2006), ‘Increasing residual wage inequality: Composition effects, noisy data, or rising demand for skill?’, *The American Economic Review* **96**(3), 461–498.
- Machado, J. and Mata, J. (2001), ‘Earning functions in Portugal 1982–1994: Evidence from quantile regressions’, *Empirical Economics* **26**(1), 115–134.
- Machado, J. and Mata, J. (2005), ‘Counterfactual decomposition of changes in wage distributions using quantile regression’, *Journal of Applied Econometrics* **20**(4), 445–465.
- Martins, P. (2009), ‘Dismissals for cause: The difference that just eight paragraphs can make’, *Journal of Labor Economics* **27**(2), 257–279.
- Martins, P. and Pereira, P. (2004), ‘Does education reduce wage inequality? Quantile regression evidence from 16 countries’, *Labour Economics* **11**(3), 355–371.



Table 1: Within-group wage dispersion by age and education

		Within-group wage dispersion			Worker share		
		1982	1995	2006	1982	1995	2006
Low skill							
Age < 36	50/10	0.260	0.217	0.185	0.334	0.158	0.037
	90/50	0.389	0.422	0.459			
Age 36-45	50/10	0.403	0.341	0.247	0.160	0.132	0.068
	90/50	0.453	0.616	0.508			
Age > 45	50/10	0.378	0.434	0.321	0.193	0.153	0.130
	90/50	0.488	0.666	0.717			
All	50/10	0.332	0.358	0.265	0.688	0.442	0.235
	90/50	0.448	0.639	0.664			
Medium skill							
Age < 36	50/10	0.466	0.391	0.305	0.190	0.340	0.338
	90/50	0.547	0.771	0.686			
Age 36-45	50/10	0.562	0.785	0.429	0.058	0.101	0.183
	90/50	0.538	0.780	1.083			
Age > 45	50/10	0.618	1.003	0.643	0.040	0.065	0.115
	90/50	0.749	0.784	1.255			
All	50/10	0.550	0.528	0.400	0.287	0.506	0.636
	90/50	0.723	1.100	1.046			
High skill							
Age < 36	50/10	0.639	0.983	0.756	0.012	0.028	0.080
	90/50	0.639	0.920	0.927			
Age 36-45	50/10	0.764	1.220	1.213	0.007	0.014	0.031
	90/50	0.610	0.877	1.174			
Age > 45	50/10	2.159	2.308	2.797	0.005	0.010	0.018
	90/50	0.633	1.000	1.233			
All	50/10	0.850	1.194	1.000	0.025	0.051	0.129
	90/50	0.784	1.082	1.380			

Notes: See note to Figure 1 in p.29. Low skill - 6 or less years of schooling; Medium skill - 9 to 12 years of schooling; High skill - college degree.

Table 2: Regression models for the college/noncollege log wage gap

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
College/Noncollege relative supply	-0.724 <i>0.154</i>	-0.678 <i>0.165</i>	-0.769 <i>0.162</i>	-0.605 <i>0.193</i>	-0.587 <i>0.200</i>	-0.616 <i>0.198</i>	
Log real minimum wage			-0.433 <i>0.461</i>	-0.719 <i>0.488</i>	-0.691 <i>0.502</i>	-0.626 <i>0.521</i>	-0.704 <i>0.646</i>
Unemployment rate				-0.014 <i>0.010</i>	-0.013 <i>0.010</i>	-0.012 <i>0.010</i>	-0.031 <i>0.010</i>
Log unemp. insurance per unemp'ed						0.042 <i>0.068</i>	0.021 <i>0.085</i>
Time	0.032 <i>0.003</i>	0.034 <i>0.004</i>	0.037 <i>0.006</i>	0.035 <i>0.006</i>	0.037 <i>0.006</i>	0.034 <i>0.007</i>	0.021 <i>0.006</i>
Time*1995		-0.002 <i>0.002</i>			-0.001 <i>0.002</i>		
Constant	-0.269 <i>0.191</i>	-0.229 <i>0.199</i>	1.272 <i>1.65</i>	2.611 <i>1.847</i>	2.508 <i>1.897</i>	1.992 <i>2.143</i>	3.274 <i>2.611</i>
No. of observations	21	21	21	21	21	21	21
$R^2$	0.919	0.923	0.924	0.933	0.934	0.934	0.892

Notes: Standard errors in *italic*. Each column presents an OLS regression of the fixed-weighted college wage premium on the indicated variables. The minimum wage is deflated by the consumers price index. The sources for labor supply and wages are the *Quadros de Pessoal*, 1984-2006.

Table 3: Regression models for the college/noncollege log wage gap by experience group

	All groups		Potential experience groups							
	(1)	(2)	0-9 years (3)	10-19 years (4)	10-19 years (5)	20-29 years (6)	20-29 years (7)	30-39 years (8)	30-39 years (9)	30-39 years (10)
Own minus aggregate supply	-0.338 <i>0.044</i>	-0.331 <i>0.040</i>	-0.260 <i>0.124</i>	-0.234 <i>0.134</i>	-0.569 <i>0.083</i>	-0.612 <i>0.098</i>	0.037 <i>0.095</i>	0.017 <i>0.099</i>	0.325 <i>0.230</i>	0.284 <i>0.258</i>
Aggregate supply	-0.485 <i>0.108</i>	-0.373 <i>0.137</i>	-0.581 <i>0.315</i>	-0.469 <i>0.354</i>	-0.150 <i>0.142</i>	-0.159 <i>0.147</i>	-0.473 <i>0.208</i>	-0.362 <i>0.234</i>	-0.208 <i>0.135</i>	-0.163 <i>0.181</i>
Log real minimum wage		-0.302 <i>0.339</i>	-0.271 <i>0.507</i>			-0.081 <i>0.273</i>		-0.174 <i>0.462</i>		-0.151 <i>0.387</i>
Unemployment rate		-0.010 <i>0.006</i>	-0.014 <i>0.009</i>			0.005 <i>0.005</i>		-0.012 <i>0.009</i>		-0.003 <i>0.007</i>
Time	0.038 <i>0.003</i>	0.038 <i>0.004</i>	0.030 <i>0.004</i>	0.029 <i>0.007</i>	0.038 <i>0.002</i>	0.040 <i>0.003</i>	0.036 <i>0.006</i>	0.035 <i>0.008</i>	0.026 <i>0.003</i>	0.027 <i>0.004</i>
Constant	-0.156 <i>0.132</i>	1.157 <i>1.285</i>	-0.149 <i>0.345</i>	1.083 <i>1.811</i>	-0.064 <i>0.113</i>	0.149 <i>1.031</i>	0.190 <i>0.368</i>	1.009 <i>1.696</i>	1.085 <i>0.342</i>	1.639 <i>1.397</i>
No. of observations	84	84	21	21	21	21	21	21	21	21
$R^2$	0.941	0.943	0.865	0.934	0.983	0.984	0.974	0.977	0.981	0.981

Notes: Standard errors in *italic*. Each column presents an OLS regression of the fixed-weighted college wage premium on the indicated variables. The college/noncollege wage premium is calculated at the mid-point of each potential experience group. The minimum wage is deflated by the consumer price index. Columns (1) and (2) also include dummy variables for the four potential experience groups used in the Table. The sources for labor supply and wages is the *Quadros de Pessoal*, 1984-2006.

Table 4: Regression models for the 90/50 ad 50/10 wage ratios

	Male		Female	
	90/50	50/10	90/50	50/10
College/Noncollege relative supply	-0.056 <i>0.068</i>	-0.452 <i>0.099</i>	-0.453 <i>0.116</i>	-0.055 <i>0.043</i>
Log real minimum wage	-0.064 <i>0.171</i>	-0.338 <i>0.25</i>	-0.251 <i>0.276</i>	-0.431 <i>0.111</i>
Unemployment rate	-0.001 <i>0.003</i>	-0.004 <i>0.004</i>	0.002 <i>0.006</i>	0.003 <i>0.001</i>
Time	0.017 <i>0.002</i>	0.017 <i>0.003</i>	0.027 <i>0.004</i>	0.008 <i>0.001</i>
Constant	0.706 <i>0.645</i>	1.044 <i>0.948</i>	0.881 <i>1.109</i>	1.681 <i>0.418</i>
No. of observations	21	21	21	21
$R^2$	0.989	0.827	0.968	0.932

Notes: See notes of Table 2.

Table 5: Observed and composition-constant changes in overall and residual inequality, log points  $\times 100$

	Overall Inequality			Residual Inequality		
	1982-1995	1995-2006	1982-2006	1982-1995	1995-2006	1982-2006
	$\Delta 90/50$					
	Males					
Observed	24.0	15.3	39.2	10.8	9.9	20.7
1982's composition	15.5	-3.4	12.1	9.0	3.4	12.4
1995's composition	13.9	-3.0	10.9	8.5	4.0	12.5
2006's composition	20.0	3.0	23.0	10.0	5.5	15.5
	Females					
Observed	25.7	9.3	35.0	10.3	4.2	14.5
1982's composition	5.0	-16.1	-11.1	4.1	-5.0	-0.9
1995's composition	21.5	-21.6	-0.1	6.7	-6.9	-0.2
2006's composition	34.7	0.4	35.0	12.5	-4.8	7.8
	$\Delta 50/10$					
	Males					
Observed	8.5	-6.5	2.0	7.2	-0.3	6.9
1982's composition	3.4	-8.2	-4.8	4.5	-6.7	-2.2
1995's composition	6.9	-10.5	-3.6	5.4	-6.7	-1.3
2006's composition	8.2	-14.2	-6.0	8.0	-6.8	1.1
	Females					
Observed	5.6	3.4	8.9	7.3	3.7	11.0
1982's composition	-1.4	-3.4	-4.9	0.8	-4.9	-4.1
1995's composition	-6.3	-6.6	-12.9	3.0	-7.1	-4.1
2006's composition	-3.8	-16.2	-19.9	6.9	-10.2	-3.2

Table 6: Collective agreement: Proportion of workers covered

year	All IRC	By type:				No IRC
		ACT	CCT	PRT	AE	
1982-1986	.97	.067	.79	.031	.088	.028
1987-1991	.98	.043	.81	.048	.086	.018
1992-1996	.98	.039	.82	.057	.064	.018
1997-1999	.96	.035	.83	.048	.045	.038
2000	.97	.036	.84	.045	.042	.032
2002	.95	.037	.83	.048	.037	.050
2003	.95	.036	.82	.060	.035	.052
2004	.93	.033	.80	.060	.038	.071
2005	.91	.030	.78	.060	.035	.090
2006	.90	.031	.78	.061	.032	.101

Notes: Before 2000, the reported values are averages of the corresponding periods. **IRC** – Collective agreement instruments; **ACT** – Collective agreement (signed by unions and a group of firms); **CCT** – Collective contract (signed by unions and employers associations); **AE** – Firm-level agreement; **PRT** – Regulatory edict issued unilaterally by the Ministry of Employment to specific sectors/regions where there is no collective negotiation.

Table 7: Counterfactual analysis: Collective bargaining, log points  $\times 100$

	Overall inequality 2000-2006	Residual inequality 2000-2006
	$\Delta 90/50$	
	Males	
Observed	7.46	5.00
2000's composition	6.77	4.75
2006's composition	6.54	4.91
	Females	
Observed	7.74	2.49
2000's composition	6.16	1.85
2006's composition	6.32	1.40
	$\Delta 50/10$	
	Males	
Observed	-3.56	-0.54
2000's composition	-3.80	-0.53
2006's composition	-3.42	-0.32
	Females	
Observed	4.57	5.76
2000's composition	4.57	5.95
2006's composition	3.82	5.73

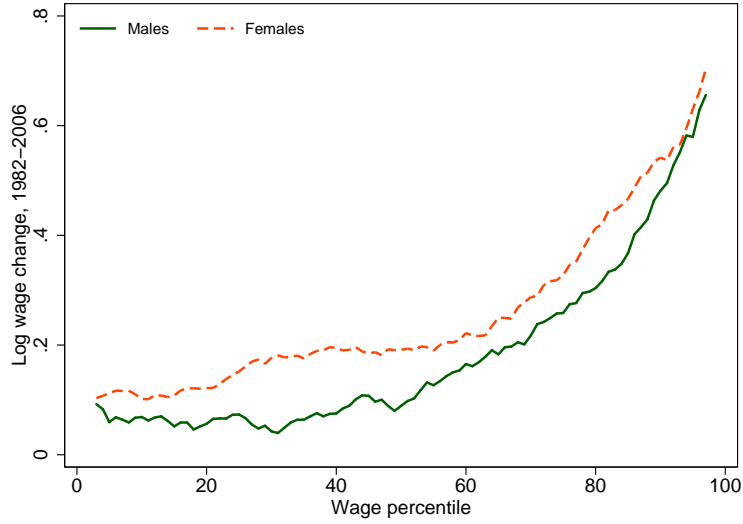


Figure 1: Log wage distribution percentile changes, 1982-2006 (M/F). Source: Quadros de Pessoa data for 1982 and 2006, full-time workers aged 16 to 65 with 0 to 39 years of potential experience. Full-time workers are those who worked 35-plus hours per week and earned at least the minimum wage. Calculations were deflated using the Consumer Price Index.

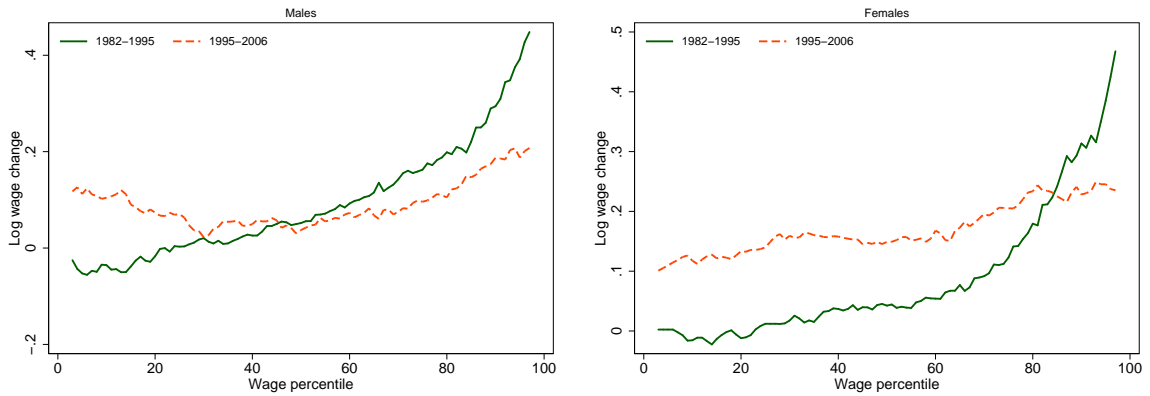


Figure 2: Log wage distribution percentile changes, Males (left panel), Females (right panel); 1982-1995 and 1995-2006. See also notes to Figure 1.



Figure 3: The evolution of the standard deviation of log-wages and log-wage residuals (M/F). Regressions control for five education categories, eight age categories, and all possible interactions between these two variables.

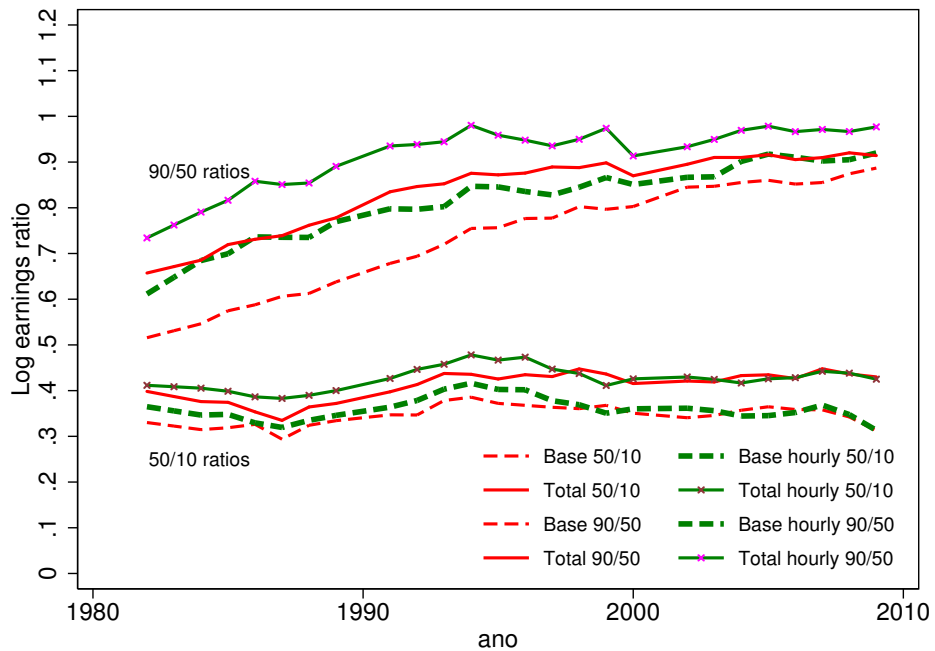


Figure 4: Log wage ratios 90/50 and 50/10 based on different measures of wages: base wages, total wages and hourly base and total wages. See text for wage definitions.

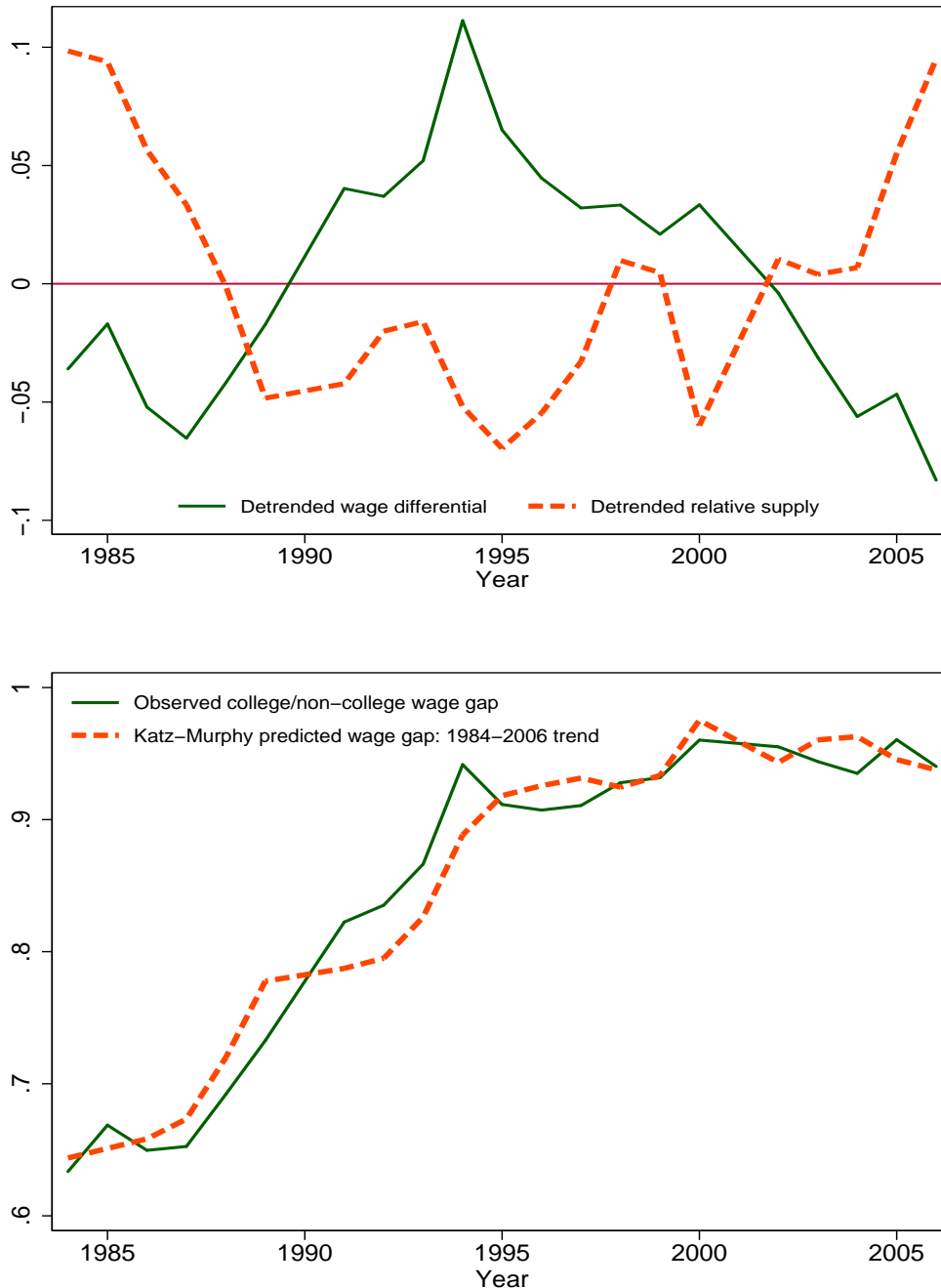


Figure 5: *Top panel:* College/noncollege relative supply and wage differential. The composition adjusted college wage premium is calculated using QP data, sorted into gender-education-potential experience groups. We have two gender, five education and four potential experience groups. Mean log wages for broader groups in each year represent weighted averages of the relevant cell means using a fixed set of weights equal to the mean share of total employment by each group over 1984-2006. The detrended supply and wage series are the residuals from separate OLS regressions of the relative supply and relative wage measures on a constant and a linear trend. *Bottom panel:* Prediction for the college/noncollege wage gap. The predicted wage gap is the fitted values from an OLS regression of the college/noncollege wage gap for the years 1984 to 2006 on a constant and the college/noncollege relative supply measure (Column (1) of Table 2). The college/noncollege log relative supply index is the logarithm of the ratio of college-equivalent to noncollege equivalent labor supply in efficiency units in each year.

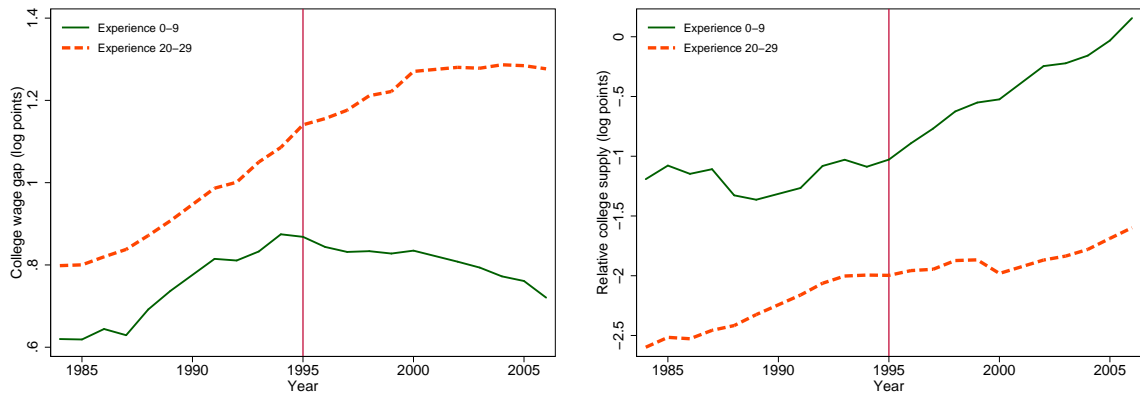


Figure 6: *Left panel:* Composition-adjusted log relative college/noncollege wage gap by potential experience. *Right panel:* Composition-adjusted log relative college/noncollege supply by potential experience. See notes to Figure 5 in p. 31 for the details on the construction of supply and wage measures.

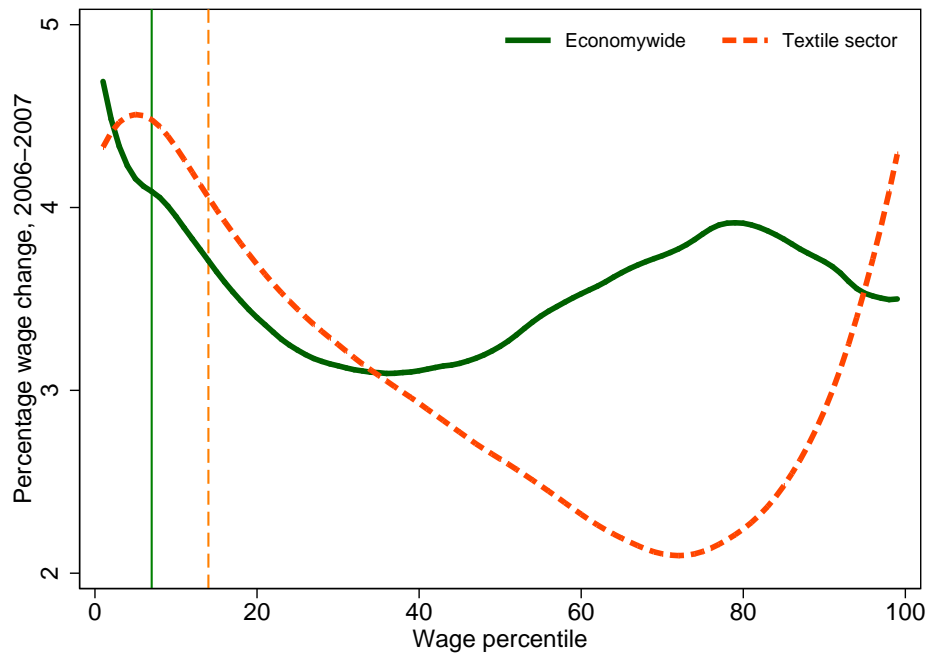


Figure 7: Wage growth rates by wage percentiles for the total of the economy and the textile sector. Source: Social Security, 2006-2007. The percentiles were computed separately for each curve (all workers; only textile).



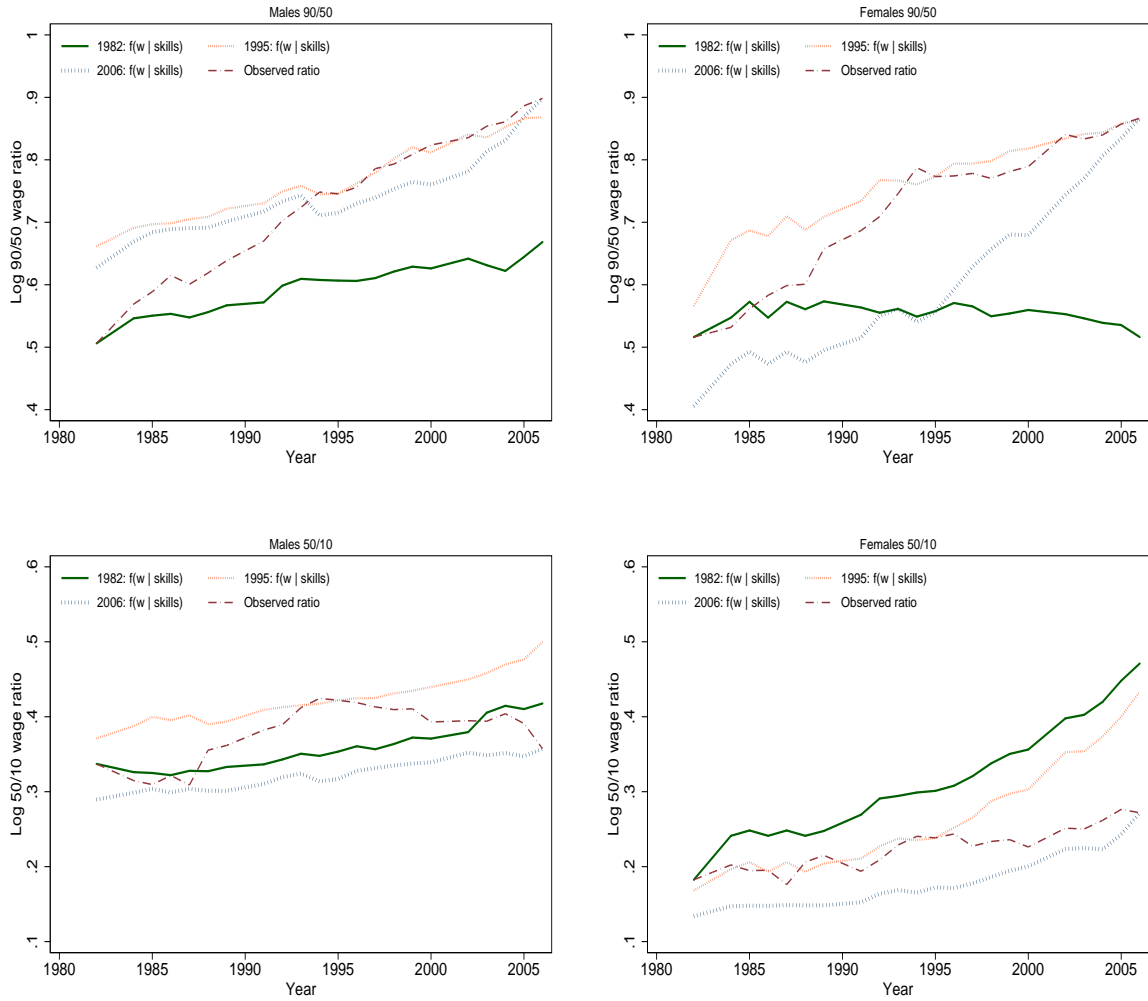


Figure 8: Actual and counterfactual 90/50 and 50/10 overall wage inequality, QP 1982-2006. The series labeled “Observed ratio” present the actual log difference between the percentiles in the data. The series labeled “Year:  $f(w - \text{skills})$ ” corresponds to the log difference of the percentiles of a reweighted (counterfactual) distribution of year “Year” where the weights are proportional to the distribution of skills (age, schooling, and interactions) in each year depicted in the  $x$ -axis and the distribution of skills in year “Year”. See text for additional details.

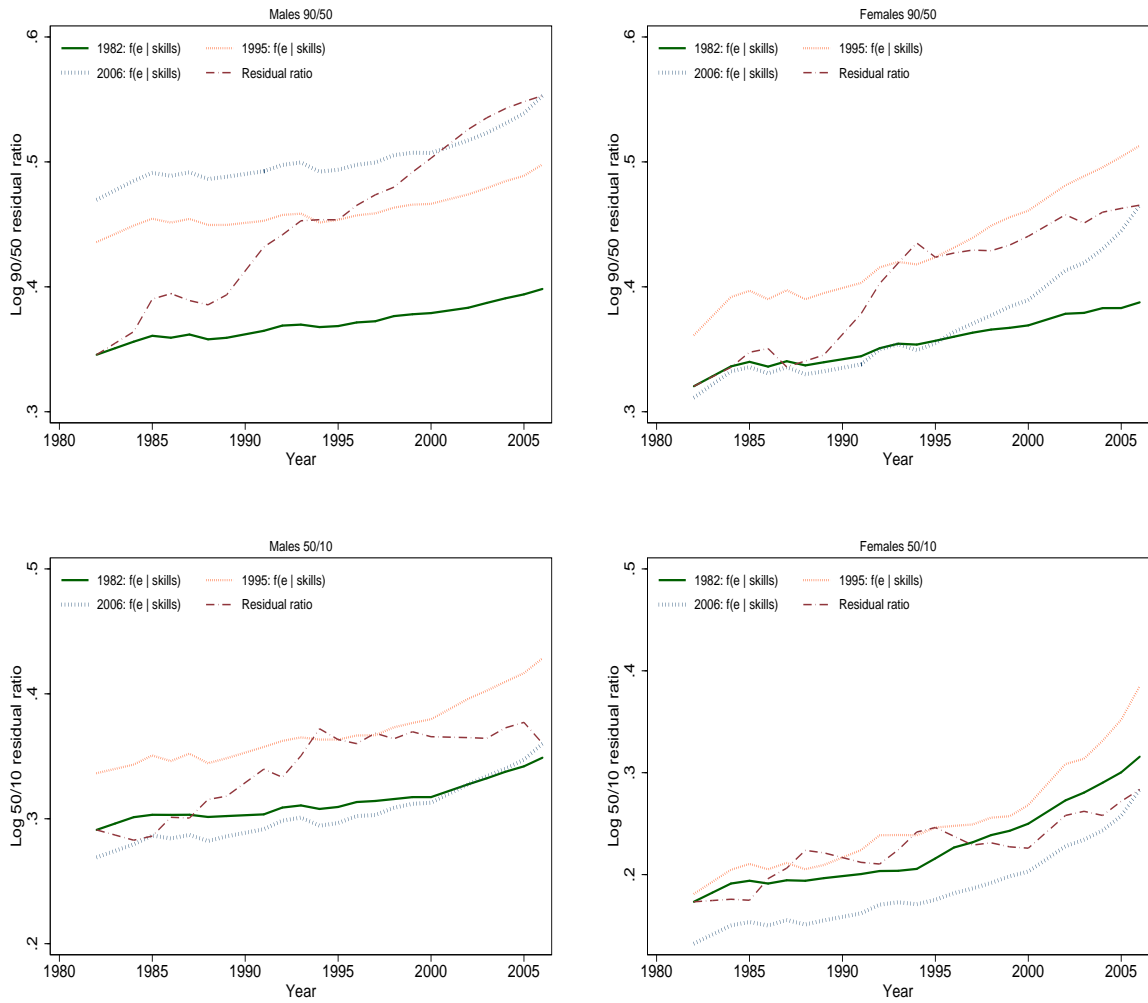


Figure 9: Actual and counterfactual 90/50 and 50/10 residual wage inequality, QP 1982-2006. The series labeled “Observed ratio” correspond to the difference between the percentiles of the residual distribution of an OLS regression of log wages on 8 age dummies, 5 education levels dummies, and all corresponding interaction terms. For the meaning of the remaining series see notes to Figure 8.

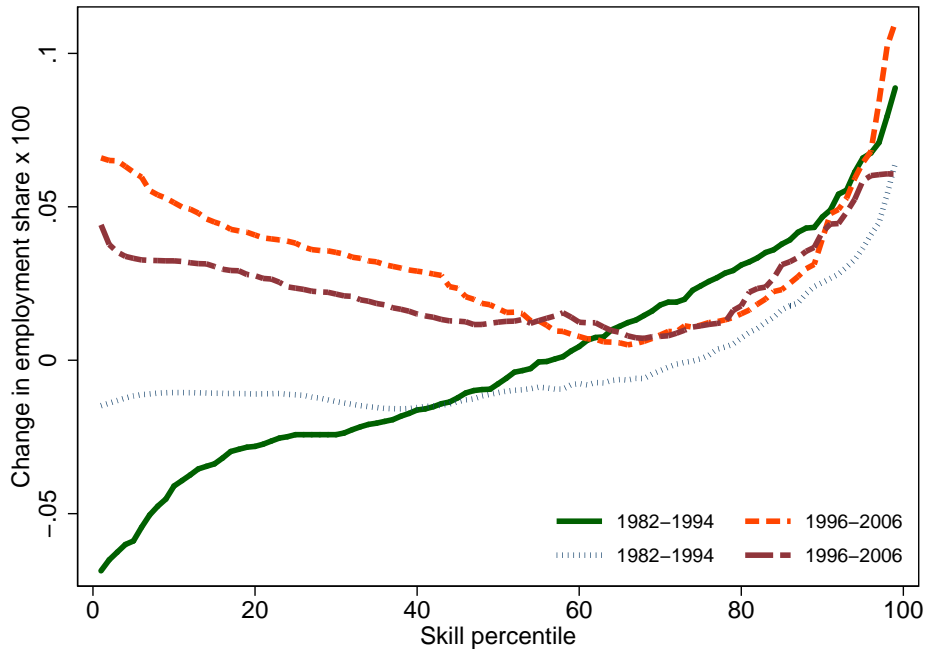


Figure 10: Change in occupation's employment shares by occupational skill percentile. The figure plots log changes in employment shares by 1982 and 1996 occupational skill percentile rank using a locally weighted smoothing regression (with bandwidth 0.8). We consider two measures of occupational skill: (i) the employment-weighted percentile rank of the occupation's mean years of education and (ii) the employment-weighted percentile rank of the occupation's mean wages.

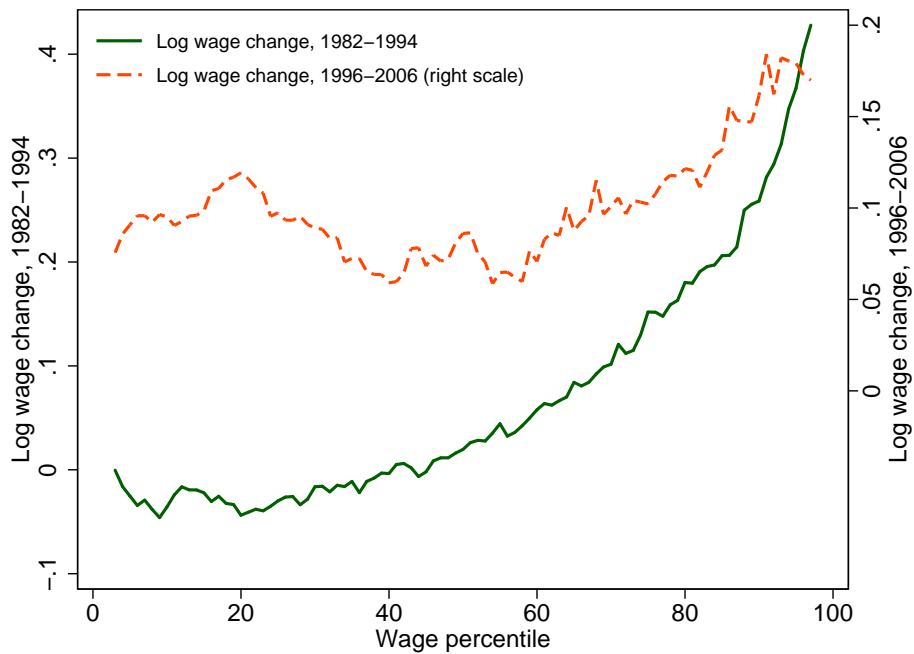


Figure 11: Change in real wages, by wage percentile. See notes to Figure 1.