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The impact of EU integration on the Portuguese distribution of employees' earnings

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Abstract

This paper investigates the impact of Portugal's accession to the EU on employees' earnings inequality using data for the years 1985 and 1991 from the *Quadros de Pessoal* database. The distributions of earnings for the two years are compared using distinct empirical methodologies to better clarify the nature of inequality at the aggregate level: cardinal measures of inequality and the Lorenz stochastic dominance approach (Araar and Duclos, 2007); the Relative Distribution approach; and covariate (education) decomposition. Our results indicate that during the period under analysis the median and average earnings of employees increased, pointing to a sort of honeymoon effect of EU integration on Portuguese employees' earnings, but which was characterized by an increase in earnings inequality. Relative to 1985, in 1991 there were more employees with very low earnings but also more 1991 employees with high earnings and there were also more employees at the bottom end and at the top end of the earnings distribution. Moreover, the analysis of the relative earnings distribution by level of education reveals substantial differences for the top end of the distributions with the proportion of 1991 employees receiving the highest earnings higher than for the original 1985 cohort. These results deserve a deeper investigation since inequality may jeopardize future growth of the Portuguese economy. Similar analysis should also be carried out for recent and predictable future members of the EU.

Keywords: earnings inequality, education inequality, relative distribution, covariate decomposition
JEL classification: O12, D33

1. Introduction

The accession of Portugal to the European Union (EU) in 1986 resulted in several important and different shocks to the Portuguese economy, imposing, among others, a real positive and lasting effect on employees' earnings. This paper analyses the impact of the Portuguese accession to the EU on employees' earnings inequality using data for two years, 1985 and 1991, from the *Quadros de Pessoal* database, a rich Portuguese dataset with detailed and comprehensive information on workers and firms. The earnings distributions for the two years are compared using cardinal measures of inequality and the Lorenz stochastic dominance approach (Araar and Duclos (2007)). In order to inspect the overall differences of the two distributions and split the overall relative distribution into location and shape shift effects we apply the Relative Distribution approach (Handcock and Morris (1999)). Additionally, we use the technique of covariate decomposition to assess the importance of the distribution of education for the explanation of the evolution of the employees' earnings distribution over the sample period.

The analysis of income inequality has been at the top of the research agenda since the 1980's (see e.g. Silber (1999)), which resulted in the development of several new applied methodologies that allow us to inspect from a new perspective what has been known has the Portuguese economic miracle during the first years following its accession to the EU. For instance, recent literature on the relationship between inequality and economic growth[1] has challenged the prediction of the existence of a Kuznets (inverted-U) curve relating economic growth to income inequality. Although the evidence supports the Kuznets curve for developed countries during the 19th and part of the 20th centuries (see e.g. Williamson and Lindert (1980), Lindert (2000) and Margo (1999)), research based on data from the 1980's onwards reveals what is known by the 'Great U-Turn', corresponding to another spur of growth of inequality (Bennett and Bluestone (1988), Alderson and Nielsen (2002)). A similar pattern has been found for wages (Freeman and Katz (1995); Levy (1992)) in the USA and other developed countries (Gottschalk (1997)), and should thus also be investigated for countries such as Portugal.

As far as the Portuguese economy is concerned, Rodrigues (1996,1999,2007), analyzes at deep extent the main characteristics of inequality and poverty in the Portuguese economy during the 1990's. The author concluded that over the 1989-2000 period, when Portugal grew at considerable rates, especially during the last five years[2], the increase in real income resulted in a decrease of absolute poverty[3]. Nevertheless, this increase in income was not evenly spread throughout the period, since inequality rose strongly during the first half of the sample period, which calls for a deeper understanding of the behavior of the distributions of earnings in Portuguese economy.

The paper contributes to the literature on inequality in two important ways: (i) by applying distinct empirical methodologies that better clarify the nature of inequality at the aggregate level; and (ii) focusing on country specific data at the regional and sectoral level.

Our results indicate that during the period under analysis employees' median and average earnings registered a high growth rate, a consequence of the Portuguese EU integration in an area of higher earnings, what we have named the 'honeymoon effect" of Portuguese

[1] For interesting surveys on this subject see Aghion et al. (1999), Perotti (1994), Alesina and Perotti (1994), Bénabou (1996), and Deininger and Squire (1998).

[2] Real GDP per capita grew at an average annual growth rate of 2.8% during the whole period, 2.6% in 1989-1995 and 3.7% in 1995-2000.

[3] The poverty line is set at 6500 Euros a year.

integration. A deeper investigation of the distribution of earnings allowed us to conclude that this honeymoon effect was accompanied by an increase in earnings inequality. Relative to 1985, in 1991 there were more employees with very low earnings but also more 1991 employees with high earnings and there were also more employees at the bottom end and at the top end of the earnings distribution. Moreover, the analysis of the relative earnings distribution by level of education reveals substantial differences for the top end of the distributions with the proportion of 1991 employees receiving the highest earnings higher than for the original 1985 cohort. This characteristic is important since it may jeopardize future growth, as predicted by some endogenous growth theories that argue that in economies with a highly unequal initial wealth distribution and credit market imperfections, poorer individuals under-invest in human capital (see e.g. Alesina at al. (1999), Barro (2000)). Evidence from our research is also extremely important for other countries, especially the more recent and future EU member states.

The remainder of the paper is organized as follows. In section 2, we review the main macroeconomic indicators for the Portuguese economy over the period 1985-1991. Section 3, investigates the main characteristics of the evolution of Portuguese earnings at the overall level and for some parts of the relative distribution, also taking into account the location shift and the shape of the distribution in order to distinguish the respective impact on the evolution of earnings. In section 4, the relative distribution of earnings is modified in order to allow for education as a covariate, a major determinant of earnings. Finally, in section 5 we conclude.

2. The Portuguese macroeconomic performance over the period 1985-1991

The economic miracle experienced by Portugal in the first years after its accession to the EU, its causes and several dimensions, are already documented in some studies. For instance, Portugal (2005) claims that the participation of Portugal in the European exchange rate mechanism (ERM) from 1992 onwards encouraged the authorities to implement successful exchange rate and disinflation policies. Duarte and Simões (2002) investigate the sources of growth in the Portuguese economy and conclude that the high positive growth differential of the Portuguese economy is mainly explained by relatively low initial inputs availability.

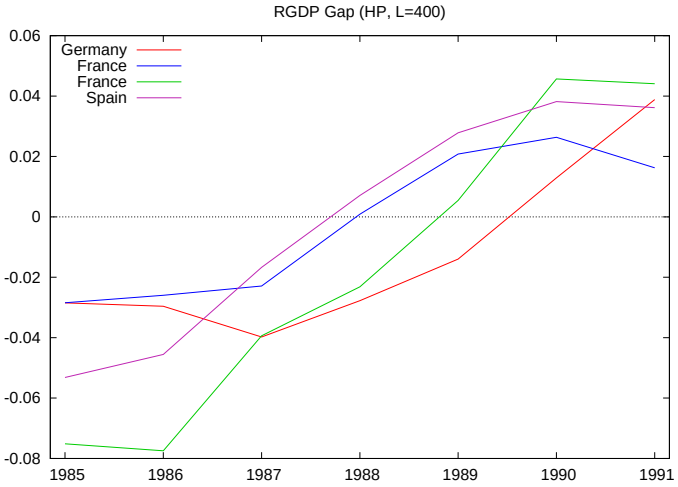
Table 1 contains comparative information concerning some main macroeconomic indicators over the period 1985-1991 between Portugal, France, Germany and Spain. The information in Table 1 confirms the extraordinary macroeconomic performance of the Portuguese economy between 1985 and 1991, especially when compared to that of Spain that joined the EU in the same year as Portugal. Portugal presents the highest output, total and per person employed, growth rate, and the lowest unemployment rate. However, the Portuguese inflation indicator, the growth rate of the Consumer price index (CPI), performs badly when compared to that of the other three countries.

Table 1. Main Macroeconomic Indicators, 1985-1991

	Real GDP per person employed	Real GDP	Consumer Price Index	Average unemployment rate (%)
	Annual average growth rate (%)			
Portugal	4.3	5.7	11.3	6.4
France	2.0	2.9	3.1	9.2
Germany	2.2	3.6	1.7	7.4
Spain	1.0	4.2	6.4	15.4

A number of factors, among which the economic policies followed, were behind this Portuguese economic miracle. This was a period when economic optimism prevailed due to European Integration and several liberalization reforms took place, covering privatizations, investment, prices, development of the capital market and international flows of capitals. At the same time, institutional reforms were implemented to back up these policies, such as anti-inflationary policies and new wage bargaining practices (namely wage indexation to expected inflation, beginning in 1993). Portugal also benefited in an important way from the European Community net transfer funds. The relevant figures as a percentage of GDP are: 1.4%; in 1988 and 1989; 1.2%; in 1990; and, 1.5% in 1991. Additionally, the Portuguese most important European trade partners exhibited synchronized business cycles with the Portuguese economy (see Figure 1 below) during this period.

Figure1. Real Output Gap in Portugal, France, Germany and Spain, 1985-1991



We investigate in the next section whether this impressive macroeconomic performance was also accompanied by a good performance at the level of employees' earnings.

3. The Portuguese earnings distribution over the period 1985-1991: a relative distribution analysis[4]

In this section we apply the relative distribution (RD) analysis proposed by Handcock and Morris (1999) to study two employees' earnings distributions, one for the year 1985 and the other for the year 1991[5]. The data is drawn from the *Quadros de Pessoal* database, a rich Portuguese dataset with detailed and comprehensive information on workers and firms, which is the result of an annual compulsory survey conducted by the *Ministério do Trabalho e da Solidariedade Social (MTSS)* where firms are required to provide information about their workers on items such as monthly compensation, highest schooling level attained, age, and monthly hours worked. We measure earnings as average full earnings of the employees that performed complete working hours during the month of October of the corresponding year. In the year 1985, we have information for a total of 1426264 employees; and in the year 1991, for 1769520 employees, across regions (308 concelhos) and economic sectors (seventeen NACE at 1 digit[6]). Earnings values were then deflated by the harmonized consumer price index (HCPI)[7] for Portugal.

Before applying the RD approach, to get an initial grasp on the evolution of earnings, we computed several more usual measures of relative inequality for the above described weighted distributions of earnings, namely the Lorenz curve (Lorenz, 1905) and also measures of relative inequality (Fields (2001)) that are strongly Lorenz-consistent: the Gini coefficient (Xu, 2004); Theil's entropy measure (Theil, 1967) and Atkinson's measure[8] (Atkinson, 1970). Table 2 presents these cardinal inequality measures and also two moments for the distribution of employees' earnings.

From the inspection of table 2 it is possible to conclude that, between 1985 and 1991: (i) all three inequality measures have risen; (ii) the average annual growth rate of median earnings was 3.9% (with total growth for the period equal to 25.9%); and (iii) the average annual growth rate of average earnings was 4.6% (with total growth for the period equal to 31%). Additionally, median and average earnings values indicate a heavy right tail for both distributions.

Table 2. Characterization of the Distribution of Earnings, 1985 and 1991

	Gini	Atkinson	Theil	Median (€)	Average (€)
1985	0.225	0.042	0.089	662.1	739.8
1991	0.256	0.052	0.112	833.9	970.1

Plotting the two earnings distributions (see Figure 2), it is also possible to conclude that from 1985 until 1991 earnings became less concentrated around the interval 200-700 euros and there was a rise in the frequency of earnings higher than 800€ in the year 1991.

[4] The following packages were used in the empirical analysis: Zeileis (2009) and Handcock (2009) for R and Jann (2008) for Stata.

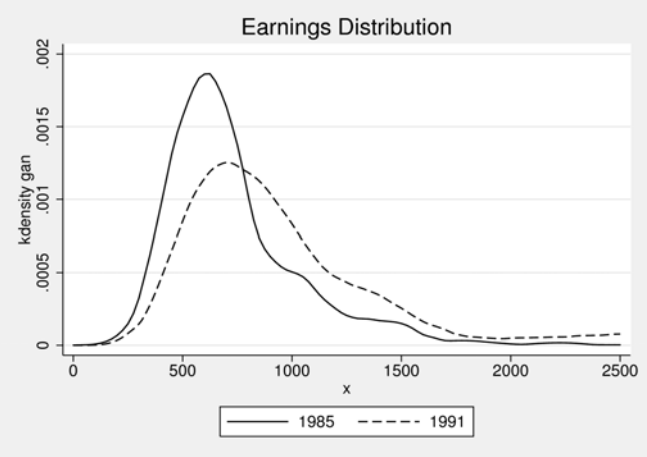
[5] This type of analysis is usually conducted based on the computation of summary statistics for the distributions, such as moments or empirical inequality indexes.

[6] NACE stands for National Acitivity Classifications of EU member states.

[7] Base year 2000.

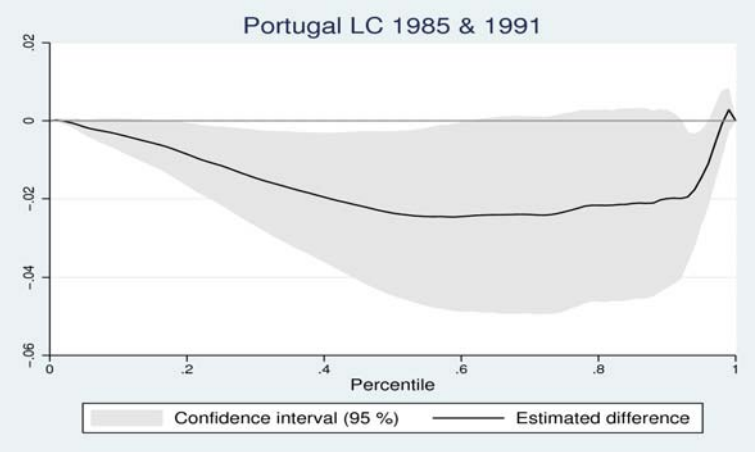
[8] We considered the coefficient of risk aversion to inequality equal to 0.5.

Figure 2: Earnings Density



The inequality measures (see Table 2) point to an increase in overall inequality over the period, suggesting Lorenz dominance[9] of the 1991 Lorenz curve (LC) over the 1985 curve. This hypothesis is also confirmed by applying the stochastic dominance approach (Davidson (2008)). To compute de confidence intervals (CI) of the estimated Lorenz difference curve[10] we use an asymptotic approach taking into account the information about the data of the two curves. Figure 3 contains the estimated Lorenz difference curve with the gray area corresponding to the confidence interval at 95% level of significance. Since the estimated Lorenz difference curve lies on the 4th quadrant and the upper CI slightly cuts the horizontal axis these facts indicate that the 1991 LC is dominated by the 1985 LC curve. We can thus conclude for an increase in inequality between the two years.

Figure 3: Earnings Lorenz difference curve (1985 LC – 1991 LC)



To get a deeper understanding of the characteristics and behavior of the Portuguese earnings distribution over the period 1985-1991, we apply the RD analysis (see Handcock and Morris (1999)). The RD analysis is a non-parametric approach specially suited to the investigation of the differences between distributions. One major advantage of this methodology is that the results are independent of monotonic transformations of the variables

[9] Applying the methodology in Araar and Duclos (2007).
[10] That corresponds to the difference between the 1985 LC and the 1991 LC (1985 LC – 1991 LC).

under study, implying for instance that we can study the distribution of earnings or the distribution of the log of earnings.

The reference data is the one generated in 1985, represented by Y_0. $F_0(y)$ thus represents the cumulative distribution function (CDF) of Y_0 and $f_0(y)$ represents the respective density function (PDF). This data will then be compared with data for 1991, represented by Y, based on the different functions: CDF or $F(y)$ and PDF or $f(y)$.

The relative distribution of Y to Y_0 is the distribution of the random variable $R=F_0(Y)$ where R is simply the grade transformation of Y into Y_0 (Cwik and Mielniczuk(1989)). With this transformation R measures the relative rank of Y compared to Y_0. The CDF of R is defined by

$$G(r)=F(F_0^{-1}(r))=F(Q_0(r)) \quad (1)$$

where r represents relative data, i.e. the proportion of values, with $0 \leq r \leq 1$ and $Q_0(r)$ the quantile function of F_0.

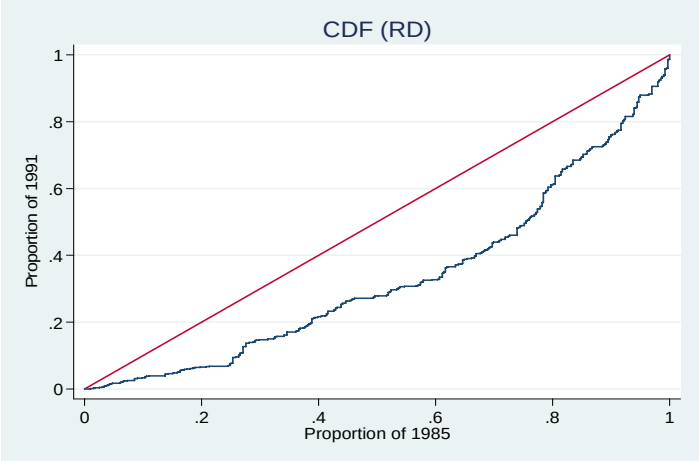
The PDF of R corresponds to the first derivative of G(r), given by

$$g(r) = \frac{f\left(F_0^{-1}(r)\right)}{f_0\left(F_0^{-1}(r)\right)} \quad (2)$$

Since f and f_0 are density functions, the PDF of R is also a density ratio. The CDF and PDF can be given a straightforward interpretation: the relative CDF, $G(r)$, corresponds to the proportion of 1991 earnings that is below the level of proportion r of 1985 earnings; and, the relative PDF is the ratio of the frequency of 1991 earnings to the frequency of the 1985 earnings at the r^{th} quantile of the 1985 earnings distribution. If the 1985 and 1991 earnings distributions are identical then the relative distribution is uniform along the interval [0,1]. When the PDF of R is greater than 1 there is a greater frequency of observations in the 1991 earnings distribution. In terms of the CDF if, for instance, for the median of 1985 earnings ($r=0.5$) we get a value 0.3 this means that only 30% of 1991 employees earn less than the 1985 median earnings. If the CDF coincides with the bisector the two distributions, 1985 and 1991, are equal. The confidence intervals for the PDF are obtained using a normal approximation to produce the distribution of the estimates.

The CDF plotted in Figure 4 gives us a clear picture of what happened in terms of the evolution of earnings for different parts of the distribution. For the median of the 1985 earnings distribution ($r=0.50$) we get a value for $G(r)$ of 0.278 implying that only 27.8% of the employees in 1991 earn less than the 1985 median of earnings. The corresponding values associated with the 1st ($r=0.25$) and 3rd quartiles ($r=0.75$) of the 1991 distribution are, respectively, 7.7% and 50%. We thus conclude that, for the year 1991, there was a smaller proportion of employees earning less or the same as the corresponding proportion of employees in 1985.

Figure 4. Relative Cumulative Distribution Function



In order to clarify the changes occurred in earnings inequality during the 1985-1991 period we deal with possible differences in the shape of the distributions by testing for relative polarization (RP) (see Table 3). The median relative polarization (MRP) [11] of Y relative to Y_0 is given by $MRP = 4 \cdot \int_1^1 | r - \frac{1}{2} | \cdot g_0^A(r) \cdot dr - 1$. The density function of R_0^A is g_0^A with $R_0^A = F_0(Y_A)$ the relative distribution of Y_A to Y_0. Y_A is the median-shifted version of Y. The MRP represents the mean absolute deviation from the median of the location-matched relative distribution and has values between -1 and 1. A zero value for RP corresponds to no differences in the shape of the distribution. A positive value corresponds to an increase in the tails of the distribution, which is equivalent to more polarization, while a negative value indicates convergence towards the center.

Table 3. Relative Polarization (RP) for Earnings

	Coefficient	**Bootstrap S.E.**	**95% CI (Normal-based)**	
Median RP	0.246	0.053	0.140	0.351
Lower RP	0.265	0.074	0.116	0.414
Upper RP	0.226	0.067	0.091	0.361

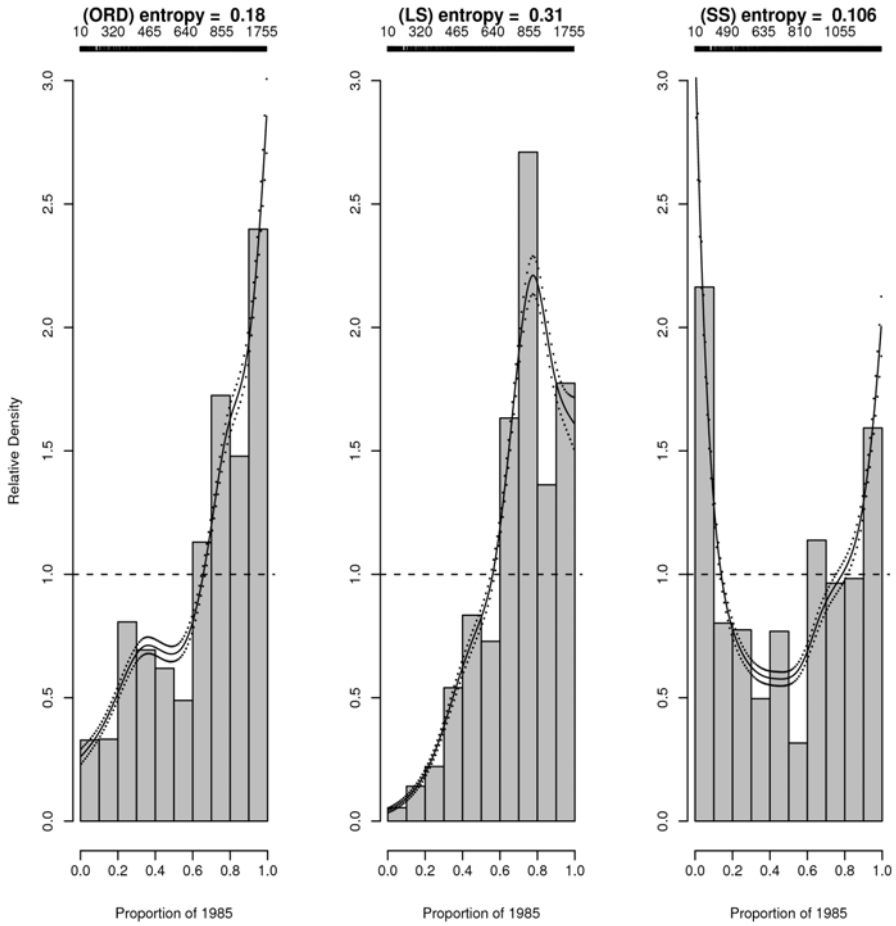
The estimated RP values presented in Table 3 confirm the increase in inequality during the period with the standard errors calculated after 50 replications presenting very small values compared to the estimated coefficients and all the estimated coefficients presenting low significance probability levels. For instance, when we compare the 1991 distribution with the 1985 distribution, we get a median RP of 24.6%[12] meaning that this percentage of employees moved from the centre of the distribution to the upper and lower quartiles over the sample period. The same interpretation applies to the values of the lower and upper RP. These results confirm the idea that inequality increased over the period 1985-1991 due to polarization, allowing us to get a better understanding of the underlying changes.

Additionally, we extended our investigation of the changes in the earnings distribution that occurred during the period under analysis in order to account for changes due to the

[11] Handcock and Morris (1999), pp. 69-73.
[12] Ranging from 14% to 35.1% at the 95% confidence level.

location shift (LS) and due to the shape shift (SS). The relative distribution can be decomposed into a location and a shape component. Suppose we represent by Y_{0L} a variable that describes the 1985 distribution location-adjusted, i.e. we transform it in such a way that it has the same median as the 1991 earnings distribution. This new variable corresponds to a counterfactual distribution with the location of the 1991 distribution and the shape of the 1985 distribution. We have now three distributions, Y_0, Y and Y_{0L}, based on which we can construct two relative distributions that represent the effects of changes in location and shape. The RD that represents the location is the RD of Y_{0L} to Y_0 and the RD that represents the shape shift is the RD of Y to Y_{0L}. Figure 5 plots the RD for the overall distribution (ORD), the RD for the location shift (LS), and the RD for the shape shift (SS).

Figure 5. Location Shape Decomposition for the ORD



From the inspection of Figure 5, we can observe that, for instance, in what concerns the ORD for percentile 19% of the 1985 cohort, the relative density value is 0.5 meaning that half of the 1991 employees received the level of 1985 earnings associated with percentile 19%. For percentiles equal or higher than 66% of the 1985 cohort, the relative density value is higher than one, which means that the proportion of 1991 employees that received the level of earnings corresponding to the 1985 66% percentile is greater than that of 1985. The difference in average earnings over the period was due to an increase in top earnings, i.e. it can be explained by the differences at the top end of the distribution. For instance, the relative density at the 97.5% percentile of the 1985 cohort is 2.6, which means that, at the top end of the distribution, the proportion of 1991 employees with the corresponding earnings is almost

three times than the corresponding 1985 employees. We can thus conclude that the proportion of employees at the bottom end of the earnings distribution in 1991 is lower than that of 1985, and the contrary applies to the top end of the earnings distribution.

The LS relative density curve plotted in Figure 5 represents the effect of the median shift in earnings between the two years in terms of the relative density, under the assumption of no change in the shape of the distribution. LS entropy[13] value is 0.31, almost three times the one associated with de SS curve, which corresponds to an important effect of the location shift associated to the 1991 earnings distribution. At percentile 50% for the 1985 cohort, the proportion of 1991 employees that received the level of 1985 earnings associated with this percentile is 84%, which illustrates the strong location shift mentioned above. The bottom deciles are very small compared to those of the ORD and, on the contrary, the deciles 0.7 to 0.8 are substantially higher. For an invariant distribution shape, we can again conclude that we there were fewer 1991 employees with very low earnings and more 1991 employees with high/top earnings.

Finally, the SS relative density curve plotted in Figure 5 represents the effect of the shape shift in the earnings distribution between the two years, with the exclusion of the median effects in the relative density function. If we look at the deciles 10% - 65% (and at deciles 76.5% - 87.5%), we conclude that considerably more than a half of the distribution located at the middle represents a proportion of 1991 employees less than 1985 employees. Moreover, we observe high values at the bottom end, 2.73 (percentile 1.5%), and at the top end, 2.0 (percentile 99.5%) of the SS curve, which imply large differences at low and high percentiles - there were relatively more 1991 employees at the bottom end and at the top end of the distribution.

4. Education and the evolution of the Portuguese earnings distribution over the period 1985-1991

The previous analysis concentrated on the examination of the distributions of earnings for the two years, 1985 and 1991. We can also admit that the two series differ as a result of the presence of a variable *Z*, known as a covariate, which we will consider to be the level of education of employees measured as the number of years of schooling corresponding to the highest completed level of education by the employees. We can adjust the relative distribution of earnings for the changing distribution of education. We thus consider (Y_0, Z_0) as our reference data, corresponding to the 1985 employees' earnings, and (Y, Z) as our comparison data, corresponding to the 1991 employees' earnings. Following closely Handcock and Morris (1999), we build a virtual population for the reference data with the same covariate as the comparison data, i.e. we analyze what would the 1985 earnings have looked like if the 1985 employees had the same years of education as the 1991 employees.

We represent the marginal density of Y_0 by,

$$f_0(y) = f_{Y_0}(y) = \int f_{Y_0|Z_0}(y \mid z) \cdot f_{Z_0}(z) \cdot dz \qquad (3)$$

If Y_A is the expression of Y_0 for the virtual reference distribution, its density distribution can take the form,

[13] In the sense of the Kullback–Leiber definition of divergence. It represents the information that results for discriminating the distribution of a variable from an uniform distribution (Handcock and Morris (1998)).

$$f_A(y) = \int f_{Y_0|Z_0}(y \mid z) \cdot f_Z(z) \cdot dz \tag{4}$$

where Y_A is a random variable describing Y_0 composition-adjusted to Z, which can be also expressed as,

$$f_A(y) = \int g_Z(r) \cdot f_{Y_0|Z_0}(y \mid Q_{Z_0}(r)) \cdot dr \tag{5}$$

where $g_Z(r)$ is the relative density of Z to Z_0 and $Q_{Z_0}(r)$ is the quantile function of Z_0.

With the composition-adjusted response distribution, the overall relative distribution can be decomposed into a component that represents the effect of changes in the marginal distribution of the covariate (composition effect) and a component that represents the residual changes.

In terms of density ratios we have:

$$\frac{f(y_r)}{f_0(y_r)} = \frac{f_A(y_r)}{f_0(y_r)} \cdot \frac{f(y_r)}{f_A(y_r)} \tag{6}$$

where the overall relative density is equal to the product of the density ratio for the composition effect by the density ratio for the residual effect.

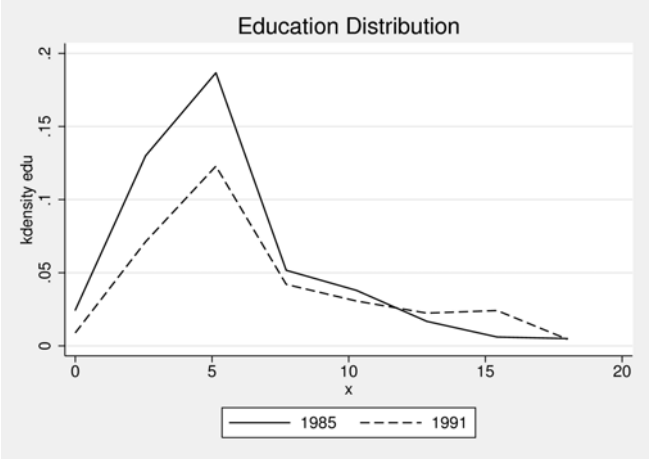
We begin our analysis with the study of the relative distribution of education for the two years, 1985 and 1991, followed by the evaluation of the two distributional impacts. The first impact is a compositional shift and quantifies the impact of changes in the levels of education upon the distribution of earnings. The second impact corresponds to the change of the relation between the response and the covariate variable. Even under the assumption of no change in the composition of the education of employees, the conditional distribution of earnings by education level has changed from 1985 to 1991, the aim of the analysis of the second impact. Empirically these impacts are obtained by counterfactual computations. We consider that the reference population of employees has the same covariate composition as the comparison population, so that we can build the distribution of earnings neglecting changes on education levels. Finally, the residual differences in the relative distribution will be interpreted as resulting from a change in the covariate-response relation.

In Table 4 we present some summary inequality and location measures for the distribution of years of education. Figure 6 contains the respective education density curves for the years 1985 and 1991. Based on the information of the Gini coefficient and the Atkinson index presented in Table 4 we conclude that education inequality is higher in 1991 relative to 1985, but the opposite conclusion applies when we use the information from the Theil coefficient. The location values registered an increase with an average annual growth rate of the median of 6.9% (total growth for the period equal to 50%), a quite impressive figure. From the inspection of Figure 6 it is possible to observe important differences for the lowest and highest levels of education, "≤4", and >12, respectively.

Table 4. Characterization of the distribution of education, 1985 and 1991

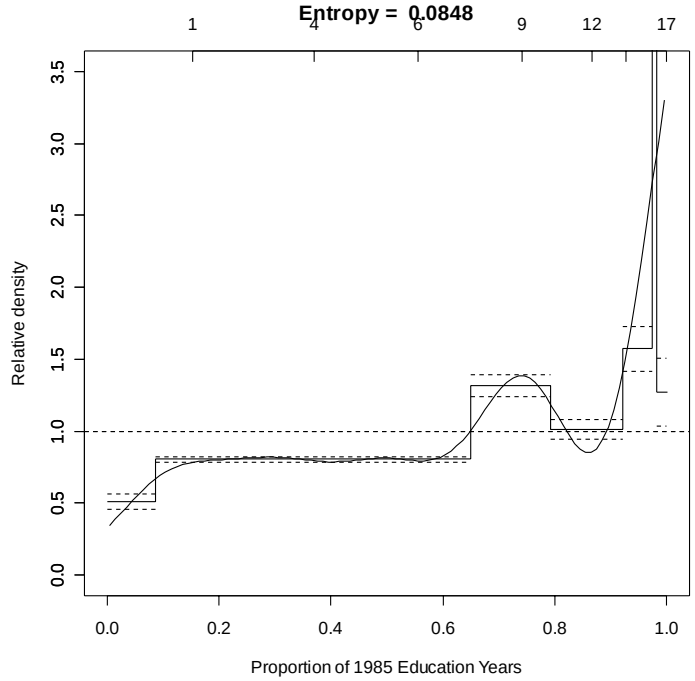
	Gini	Atkinson	Theil	Median	Average
1985	0.280	0.076	0.152	4	5.410
1991	0.304	0.079	0.159	6	6.720

Figure 6. Education Densities



In Figure 7 we plot the relative distribution for education. The education RD shows a 20% reduction in 1991 in employees with average years of schooling not higher than 7 years, and a 32% increase of 1991 employees with 7 to 10 years of schooling. It is also possible to observe a disproportionately high concentration on the top level of education in 1991, relative to 1985.

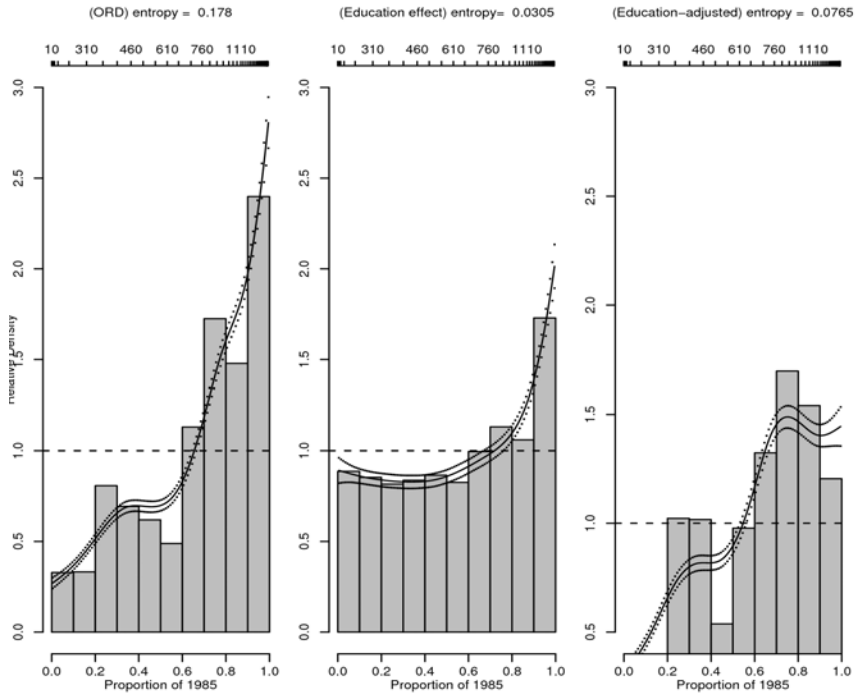
Figure 7. Relative Distribution for Education 1991-1985



In Figure 8 we plot three different relative distributions of earnings: the overall relative distribution of earnings (which is the same as the one plotted in Figure 5), the education effect relative distribution of earnings, and the education-adjusted relative distribution of earnings. As can be seen from the inspection of the education composition effect curve, differences in education composition from 1985 to 1991 had a small impact on the relative distribution of earnings (a conclusion supported by the low level of entropy, 0.03). The fact that in 1991 there were more employees with higher levels of education produced considerable effects in some parts of the distribution. For instance, above percentile 72.5% of the 1985 cohort, the

relative density is greater than one, with a value of 2 at the top of the relative distribution. This means that the number of employees with the highest level of earnings [14] is the double in 1991 relative to 1985. Below percentile 72.5% of the 1985 cohort, 1991 employees receive lower earnings than 1985 employees.

Figure 8. Education Covariate Decomposition of Earnings



The conditional distribution of earnings by years of education would change even if there were no changes in the distribution of employees by years of schooling, and thus the overall relative distribution would also change. This aspect is represented in Figure 8 by the education-adjusted relative distribution of earnings. Until percentile 55% of the 1985 cohort, the 1991 distribution has values below those of 1985. Above that, more specifically for percentiles 67.5% to 72.5% and again near the top end of the 1985 distribution, the values of the relative distribution are 40% to 50% higher. The entropy value for this case is 50% of the overall entropy value and 2.5 times higher than the one associated with the education effect. This result points to an increase in the returns to education over the period 1985-1991, which is in accordance with the literature (see e.g. Budria and Nunes (2005), Portugal (2004) and Hartog et al. (1999)).

In Table 5 we present the results of the relative polarization analysis for the education effect relative distribution of earnings and the education/composition-adjusted relative distribution earnings regarding the median (MRP). As can be observed in Table 5, MRP for the education-composition effect is negligible. On the contrary, for the composition-adjusted effect, polarization increased 20%.

[14] Corresponding to seventeen years of schooling.

Table 5. Median Relative Polarization for Education Composition

	Estimate	p-value	95% CI (Normal-based)	
Education-composition effect	0.072	0.000	0.042	0.103
Composition-adjusted effect	0.196	0.000	0.167	0.225

A more accurate description of what happened due to changes in the levels of education can be observed through the inspection of earnings distribution and the relative distributions associated with the different levels of the covariate variable, years of schooling. The levels of education considered are: "≤4", corresponding to years of schooling in the interval [0, 4]; "4<edu≤9" corresponding to years of schooling in the interval]4, 9]; "12" representing exactly 12 years of schooling; and ">12" corresponding to more than 12 years of schooling.

In Figure 9 we plot the earnings (gan) distributions for each level of education. It is possible to identify in Figure 9 a change in the shape of the distributions, less important for earnings "4<edu≤9" level of education (Figure 9.2). In what concerns the location, with the exception of earnings for "≤4" and "4<edu≤9" levels of education (Figures 9.1 and 9.2), there was a clear shift to the left from 1985 to 1991. There is also clear evidence that in Portugal the earnings of the more educated employees (">12") increased during this period, a conclusion based on the shift to the right of the respective densities (Figure 9.4).

Figures 9.1 to 9.4 Levels of Education Densities

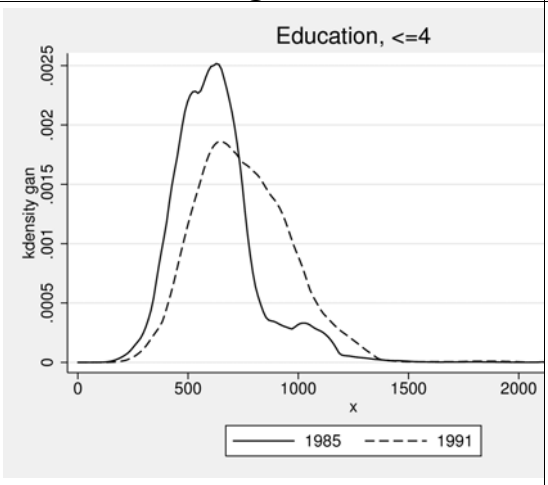


Fig. 9.1

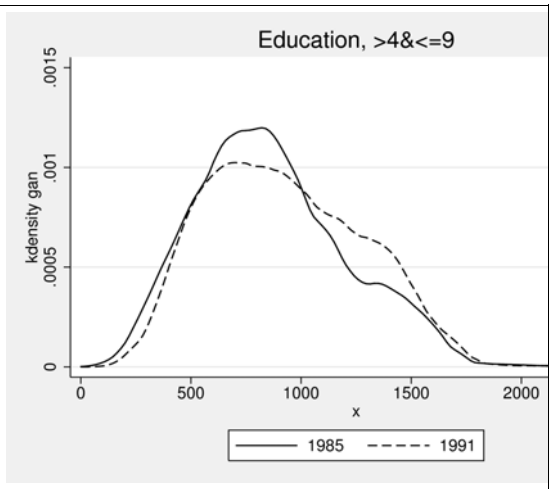


Fig. 9.2

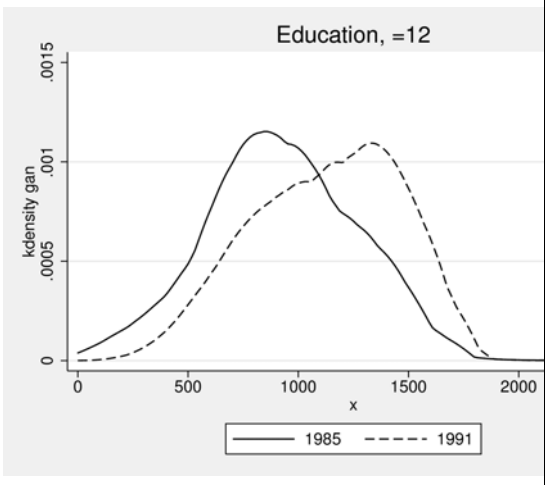


Fig. 9.3

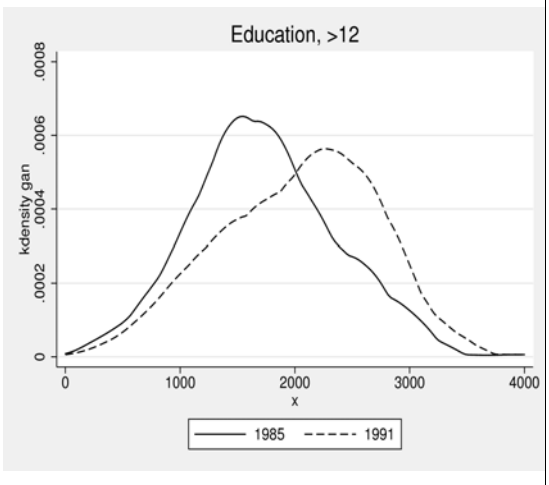
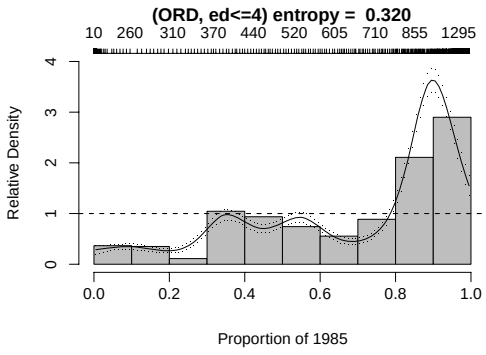


Fig. 9.4

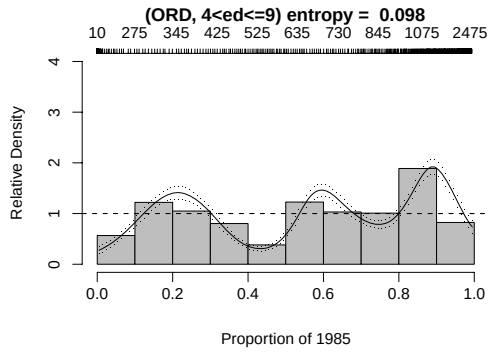
Figure 10 and that contains the relative distributions by level of education confirm the above results. The low level of entropy coefficient (0.02) associated with years of schooling between 4 and 9 years confirms the small overall divergence between the 1985 and 1991 distributions. For the first level of education, ("≤4"), up to the 72% percentile of the 1985 cohort, the 1991 proportion of employees with the corresponding earnings is lower than in 1985, implying that fewer employees are receiving low-earnings. The relative difference is substantial at the top end of the distribution, reaching a maximum of 3.06 at percentile 99.5%, implying that a greater proportion of 1991 employees earn the highest earnings (for this level of education). According to Figure 10, the distribution of earnings has not changed much for the employees with the level of education "4<edu≤9", although in some parts of the distribution there are considerable differences.

From the inspection of Figures 10.1 to 10.4 and the corresponding entropy values it is possible to observe that the differences in the earnings distributions for each year are higher for the first and third ("=12") levels of education. For the third level of education (Figure 10.3), until percentile 67% of the 1985 cohort, fewer 1991 employees are negatively affected in terms of earnings. The most substantial differences are located again at the top end, percentiles 96.5% to 99.5%, that present a relative value higher than 3, i.e. three times more 1991 employees have the top earnings for this level of education. The differences for the most educated employees, (">12"), (Figure 10.4), between 1985 and 1991 are less important than for the first and third levels of education, but are still important. After percentile 65.5% of the reference distribution, the relative density value is higher than one, reaching a maximum value of 2.3 at the top end of the 1985 distribution. In conclusion, with the exception of the second level of education, the proportion of 1991 employees receiving the highest earnings is greater than for the original cohort.

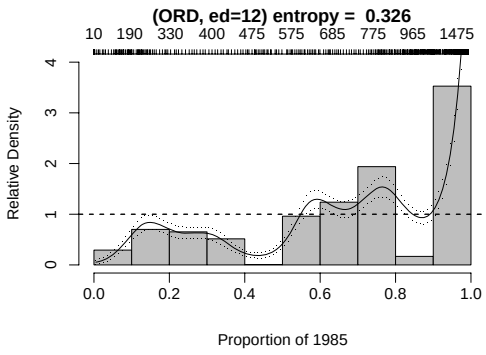
Figure 10. ORD with levels of education as covariate



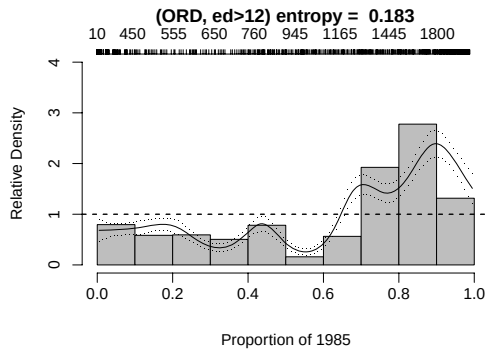
10.1 ORD with covariate "edu≤4"



10.2 ORD with covariate "4<edu≤9"



10.3 ORD with covariate "edu=12"



10.4 ORD with covariate "12<edu"

Table 6 contains a summary of the polarization measures associated with the relative earnings distribution for the different levels of education. Notice that the upper RP for the levels of education "=12" and ">12" is negative, which implies that there was convergence towards the median. However, for these two levels of education the CI is sufficiently wide not making possible a clear interpretation of the results. Additionally, the standard errors (S.E.) are also quite high so that we can't reject the nullity of any movement in terms of polarization for the last two levels of education. For the first level of education ("≤4") there is polarization of 16%, corresponding to an increase in the tail of the distribution, and a value of 24% for the distribution above its median (upper RP). For the second level of education ("4<edu≤"), there is a polarization of 24%, more or less equally distributed in terms of values above and below the median. The results thus confirm the growth in earnings inequality due to an increase in the tails of the distributions for these two levels of education and by figures of considerable importance.

Table 6. Relative Polarization for earnings by level of education

	Coefficient	**Bootstrap S.E.**	**95% CI (Normal-based)**	
Level of education: "≤4"				
Median RP	.1654987	.0757557	.0132618	.3177355
Lower RP	.0921373	.1442686	-.1977813	.3820559
Upper RP	.23886	.1234109	-.0091435	.4868636
Level of education: "4<edu≤9"				
Median RP	.2457626	.0497472	.1457919	.3457333
Lower RP	.265137	.0748555	.1147091	.4155648
Upper RP	.2263882	.0604085	.1049928	.3477837
Level of education: "=12"				
Median RP	.0627228	.1519906	-.2427138	.3681594
Lower RP	.4012125	.1611833	.0773025	.7251225
Upper RP	-.2757669	.2750156	-.8284314	.2768976
Level of education: ">12"				
Median RP	.1104747	.141691	-.174264	.3952133
Lower RP	.3289205	.1562023	.0150203	.6428208
Upper RP	-.1079712	.2818873	-.674445	.4585026

5. Conclusion

This study analyzed the impact of Portugal's accession to the EU on employees' earnings inequality using data for the years 1985 and 1991. The period under analysis corresponds to a sort of 'honeymoon' effect of the Portuguese accession to the EU in terms of employees' earnings since these rose considerably between 1985 and 1991. Our main purpose was to investigate in more detail the characteristics and evolution of the distribution of earnings over the 1985-1991 period by using a recent, nonparametric, full information methodology, known

as Relative Distribution analysis and emphasizing the influence of education on the distribution of earnings. This methodology performs better than the usual empirical summary measures of inequality, or even parametric methods, allowing for a better characterization of overall differences in the distributions of earnings for the two years under analysis. In particular, the Relative Distribution methodology is especially appropriate when inequality is associated with polarization rather than median shifts (Nielsen et al. (2005)) and, frequently, we witness a rise in polarization associated with a rise in incomes. The RD methodology makes it possible to identify quite different patterns of the distribution, even in the case of identical evolution patterns (Morris et al. (1994)).

The different methodologies (usual inequality summary measures; stochastic dominance Lorenz curve; inspection of the CDF for the relative distribution) allowed us to conclude for an increase in earnings inequality during the period under analysis. Additionally, relative polarization analysis found evidence of an increase in polarization: from 1985 to 1991, 25% of employees moved from the center to the upper and lower quartiles. Based on the inspection of the overall relative distribution (ORD) we confirmed that there are less employees at the bottom end of the distribution earnings in 1991 than in 1985 and the opposite applies to the top end of the earnings distribution. The decomposition of the evolution into location (LS) and shape (SS) shift effects revealed fewer 1991 employees with very low earnings and more 1991 employees with high earnings., and also that there were more 1991 employees at the bottom end and at the top end of the distribution.

To gain further insights about the evolution of the distribution of earnings we added a covariate variable to the relative distribution corresponding to the level of education of employees. The relative distribution for education shows: (i) a 20% reduction in the 1991 number of employees with less than 7 average years of schooling; (ii) a 32% rise in the 1991 number of employees with 7 to 10 average years of schooling; and, (ii) a disproportionately high concentration on the top level of education in 1991, compared to 1985. The analysis of a composition education effect, confirms that the change in the composition from 1985 to 1991 had a small impact on the relative distribution of earnings. Nevertheless, the number of 1991 employees with the highest level of education doubled relative to 1985 employees and, below percentile 72.5% of the 1985 cohort, 1991 employees received fewer earnings than 1985 employees. The education-adjusted relative earnings distribution thus seems to endorse the previous findings in the literature that returns to education have increased in Portugal over the period 1985-1991. Additionally, there is also evidence of an increase in polarization (20%) for the latter distribution. Moreover, the analysis of the relative earnings distribution by level of education reveals substantial differences for the top end of the distributions (except for employees with between 4 and 9 years of schooling) with the proportion of 1991 employees receiving the highest earnings higher than for the original 1985 cohort.

Other promising parametric methodologies that extend the Blinder-Oaxaca methodology (Blinder (1973) and Oaxaca (1973))[15] have been proposed recently. For instance, Machado and Mata (2005) apply a methodology based on the estimation of marginal wage distributions consistent with a conditional distribution estimated by quantile regression for the period 1986-1995. The data used is also drawn from *Quadros de Pessoal* database but the authors use samples of 5000 employees, while this study uses all the information for employees, and this is why we believe that the RD methodology is appropriate in this context[16]. Machado and Mata (2005) consider several covariates for the explanation of wages - sex, education, age and

[15] See Deutsch and Silber (2007)

[16] Another difference between this study and Machado and Mata (2005) relates to the variable analyzes. Machado and Mata (2005) use hourly wages while we use total monthly earnings.

tenure - and conclude that the only covariate with an unequivocal contribution to the wage distribution is education[17].

Future research should focus on the analysis of the consequences of the evolution of the distribution of employees' earnings for Portuguese external competitiveness and economic growth. For instance, the increase in the rate of return to education that is the most likely cause for the polarization around the highest earnings that we found in this study, was with certainty detrimental to the external competiveness of the Portuguese economy. In fact, according to data from the AMECO database, during the period under analysis the Portuguese real effective exchange rate based on unit labor costs appreciated 26.4%. As for the growth performance of the Portuguese economy, it is worth to investigate whether this rise in inequality has constituted a stimulus for growth, as predicted by classical theories on the subject, or on the contrary has had a negative impact in accordance with recent endogenous growth theories.

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[17] Machado and Mata (2005), pp. 458, 461 and Table II.

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