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WAGE INEQUALITY IN SPAIN: A REGIONAL PERSPECTIVE [*]

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ABSTRACT: This study examines wage inequality in the Spanish labour market from a regional perspective, drawing on stochastic dominance techniques. The main findings are, firstly, that wage inequality exhibits a significant regional heterogeneity and, secondly, that the reduction of wage inequality in the Spanish labour market in recent years is a general phenomenon. It is also observed that regional differences in workforce heterogeneity and the mix of jobs and workplaces and their returns are influential factors in the explanation of regional heterogeneity in the levels of wage inequality.

JEL Codes: J30, D31

Keywords: Wage inequality, stochastic dominance, Spain

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1. Introduction

The analysis of wage inequality and its determinants has received much attention in economic literature (Blau and Kahn, 1999 and Katz and Autor, 1999). However, in contrast with the abundance of international literature that has documented wage dispersion and its trends in other countries over the last few decades, research addressing these issues in Spain is not extensive. Two exceptions which can be highlighted are Jimeno et al. (2001) and Palacio and Simón (2004) who identify education, the type of contract and the profession of individuals and the different wage levels between companies as factors that have a significant impact on inequality levels in the Spanish labour market. From a time perspective, Izquierdo and Lacuesta (2006) sustain that in recent years wage inequality in Spain has been decreasing as a result of the opposing effects derived from changes in the composition of the workforce, which have had an increasing effect on inequality, and from modifications experienced by certain returns, which have tended to reduce inequality. Evidence obtained by Simón (2009) suggests that, from an international perspective, there are a series of significant unique features inherent in the Spanish wage structure, including the way in which the characteristics of the economic agents are remunerated in the Spanish labour market that generates, in relative terms, a significant reduction in wage inequality.

The aim of this study is to analyse wage inequality and its trends in Spain from a regional point of view. The study from this perspective is justified as wage determination in Spain incorporates an important territorial component, facilitated by certain specific institutional elements. As it is well known, the Spanish collective bargaining system is characterised by a very high coverage rate and by the presence of two levels of wage negotiation, the industry and company levels, the latter having a lower quantitative importance (see, for example, Banco de España, 2009). This system, characterised by a high coverage rate and by the predominance of industry-level agreements, is relatively common in other eurozone countries, which also possess bargaining systems with an intermediate level of centralisation (Du Caju et al., 2008). However, in contrast to these other countries, the majority of workers in Spain covered by collective bargaining are covered by industry-wide agreements which have a regional rather than national scope. No other country close to Spain (except for Germany) has a predominantly sectoral bargaining system which is developed fundamentally through industry-wide agreements with an infra-national scope.

Furthermore, the link that exists in practice between the minimum wages agreed in the industry-wide agreements and the actual wages received by the workers is highly significant (see, for example, Dolado et al. 1997). The unusual regional dimension of sectoral collective bargaining that exists in Spain plausibly facilitates the presence of differentiated regional mechanisms of wage determination. This circumstance is consistent with international evidence, in the sense that

collective wage bargaining is a labour institution that is highly influential in shaping the wage differences between regions that exist in each country (Vamvakidis, 2008), a fact that can be clearly seen in the specific labour market of Spain, where regional differences in real wages are very similar to those of the wage floors that are established by sectoral agreements on an infra-national scale (Simón et al, 2006).

The wage differences between regions in Spain are, in practice, highly significant, and large in size when compared with other European countries (García and Molina, 2002 and Serrano, 2002). Moreover, they are highly persistent over time, which is partially explained by the high degree of homogeneity between regions in terms of the wage increases established by industry-wide collective agreements (Alonso and Izquierdo, 1999). This pronounced persistence over time is practically incompatible with a wage adjustment capacity that is sufficient to respond to changes in economic conditions. Consequently, in the Spanish labour market there is only a limited dynamic association between the regional wage differences and unemployment rates and regional levels of productivity (Bentolila and Jimeno, 1998 and Bentolila and Dolado, 1991). Furthermore, the differences in wage levels between regions are only partially caused by competitive factors such as regional differences in prices or the composition of the workforce (López-Bazo and Motellón, 2009 and Simón et al., 2006). This circumstance, together with the low inter-territorial migratory flows and their low response to regional wage differences, are the main factors that explain the strongly defined regional segmentation of the Spanish labour market (Bentolila and Jimeno, 1998 and Bover and Velilla, 2005), which is evident in distinct and highly persistent differences in both employment rates and, especially, unemployment rates (Bande et al., 2008).

In contrast with previous studies on Spain which have exclusively analysed the presence of regional differences in wage levels, the objective of this study is to examine the regional differences in wage inequality. It is worth highlighting that very few references have been made to the regional dimension in the analysis of the distribution of wages other than average wages. These references are limited to Ahn et al, (2001), who identified the existence of significant regional differences in the degree of wage inequality and found that the relative size of the young population is a significant factor in explaining the phenomenon, and El-Attar and López-Bazo (2006), whose findings show that regional differences in both wage dispersion and wage distribution as a whole can be explained by a combination of regional differences in the endowments and relative returns of workforce and companies characteristics. The especial emphasis of this study on the analysis of the regional dimension of wage inequality will consequently contribute to improving general knowledge of this phenomenon and its determinants in Spain.

One noteworthy aspect of the research refers to the use of Lorenz inference-based stochastic dominance techniques. This methodology, as opposed to more common comparative

analyses, based on specific wage inequality measures, enables the non-ambiguous ranking of wage distributions according to their degree of inequality. This avoids the classic multiplicity of index numbers problem whereby the significance of the results of distribution inequality comparisons may vary depending on the specific inequality indexes used (Bishop and Formby, 1994). In contrast, the use of the empirical comparison of Lorenz stochastic dominance provides a clear way of examining whether significant differences in inequality levels exist in practice between Spanish regions, and the extent to which inequality experiences significant changes over time. In addition, it is worth highlighting that there are very few studies in international literature that have applied this methodology to the analysis of wage distributions: as far as we know, the only exception is Bishop et al. (1997) for the case of the United States.

This study attempts to provide answers to two basic questions. The first is to what extent there are significant differences between wage inequality levels in Spanish regions, and in the case where they exist, to identify their underlying factors. This analysis is related to previous studies carried out from an international comparative perspective addressing the reasons for the strong heterogeneity existing between countries in the level of wage inequality. The results of these studies suggest that the differences in workforce characteristics only explain a small proportion of international differences in inequality, indicating that the majority of these differences are associated with differences in the characteristics of job positions and companies (Blau and Kahn, 1996 and 2005 and Simón, 2010). The analysis of the factors that influence the regional differences in inequality levels is developed by using both the inference-based Lorenz stochastic dominance techniques together with the methodology proposed by Juhn et al. (1993). This technique enables the generation of counterfactual wage distributions under certain hypothetical scenarios, and its application facilitates a specific examination of whether the regional differences in wage inequality are due to Spanish regions being different in terms of the composition of their workforces and firms or, alternatively, to the presence of differentiated mechanisms for determining wages.

The second issue that is addressed is the extent to which all the Spanish regions share the same evolutionary trends of wage inequality than Spain as a whole. In this respect, it should be noted that although Spain exhibits an intermediate level of wage inequality compared with the other countries of the European Union (Simón, 2009 and 2010), more recently this inequality has started to diminish considerably. This circumstance contrasts with the general pattern of developed countries, where the most common trend has been an increase or maintenance of wage inequality, to the point where Spain is one of the very few developed countries in which wage inequality has decreased significantly in recent years (OCDE, 2007). Therefore, one of the specific points of interest of the study is to identify to what measure this trend in wage inequality observed

for the Spanish labour market as a whole is a phenomenon that extends to all the regions in general.

In short, the main findings of the research reveal that in practice there are significant variations between regions in terms of the wage inequality in the Spanish labour market, and that the overall process of wage inequality reduction which is being experienced in Spain is a phenomenon that extends to the majority of the regions. They also suggest that the regional differences existing in the characteristics of the workforce and companies constitute a highly significant determinant of the regional differences in wage inequality, although the presence of different mechanisms for determining wages also plays a relevant role.

The structure of the research is as follows. Following this introduction, the second section describes the data. Subsequently, the third section specifies the methodology used. The fourth section provides descriptive evidence and develops an empirical analysis of wage inequality in the Spanish regions. The study finishes with the conclusions.

2. Data

The information source from which the microdata have been retrieved for the research study is the *Encuesta de Estructura Salarial* (Wage Structure Survey; hereafter EES) for 1995 and 2002. The EES is a two-stage survey of wage earners based on their employers' social security contributions. One of the most relevant features of the EES is that it includes observations for individuals in each establishment, therefore providing what is known in economic literature as matched employer-employee microdata (reviews of the significant impact that the availability of this type of microdata has had on the understanding of how the labour market operates, and particularly with respect to wage determination, may be found in Hamermesh, 2008 and Abowd and Kramarz, 1999). The EES covers those employees that work in establishments with ten or more workers in the following branchs of activity: industry, construction, retail, hotel and restaurant trade, transport and communications, financial intermediation, property sale and rental activities and business services (and in the case of the 2002 wave, also health, education and other social activities). Although the EES possibly represents the most complete source of microeconomic data on wages in Spain, the fact that the its coverage of the labour market is not complete should be taken into account when interpreting the results of the empirical analysis.

In addition to information regarding wages, the EES contains diverse information with respect to the characteristics of the workers (sex, age, education and seniority) and their job positions and companies (occupation, type of contract, working hours, sector, size, type of collective agreement and region). The information contained in the EES also facilitates the calculation of variables relative to the composition of the workforce based on the series of observations for each establishment. Although these types of variables are subject to a certain

degree of measurement error as they are calculated from information of a sample, it should be noted that their use in econometric analysis is relatively frequent (see, for example, Bayard et al., 2003 and Card and De la Rica, 2006). Another point to take into consideration is that those observations corresponding to the over-65s and resident of Ceuta and Melilla have been eliminated, and, in the case of the 2002 wave of the EES, those observations relating to the sectors of activity that were not covered in the 1995 wave have also been eliminated in order to develop an empirical analysis for a homogeneous segment of the labour market. The final samples include a total of 155,889 observations for 1995 and 107,961 observations for 2002. The samples have a relatively large size and enable analyses to be developed broken down by region (the size of the regional samples in 1995 range from 3,238 observations for La Rioja to 22,640 for Madrid and in 2002 from 2,199 observations for La Rioja to 17,961 for Catalonia).

The wage concept used in the empirical analysis is the gross hourly wage. This wage has been calculated using the wage information corresponding to the month of October for each year, which was selected by the *Instituto Nacional de Estadística* (Spanish National Institute of Statistics) due to the fact that October is representative of the whole year in terms of wage payments. The wage per hour has the same definition for both 1995 and 2002, rendering it totally comparable between both periods, and it covers all types of payments made by companies, with the exception of overtime payments[1]. The wages of 1995, originally expressed in pesetas, have been converted into euros.

3. Methodology

3.1. Lorenz stochastic dominance and statistical inference

Traditionally, stochastic dominance techniques have been principal tools in comparative empirical research studies on income and economic wellbeing (see, for example, the analyses developed using these techniques in Bishop et al., 1991 and Ahamdanech and García, 2007, from an international comparative perspective, and Del Río and Ruiz-Castillo, 1996, for the specific case of Spain). However, their application in the comparative analysis of wage distributions has had a significantly more limited scope, despite the advantages inherent in adapting the technique to this field of study.

One of the most notable advantages of the Lorenz dominance for comparing relative wage inequality between regions (or, alternatively its evolution over time) is that this comparison is not based on specific measurements of wage distribution, but uses them all. There are also tools of statistical inference that can be used to avoid problems derived from sampling errors which arise

[1] The calculation of the hourly wage has been carried out for both 1995 and 2002 in the following way: [(basic monthly wage + monthly wage complements + extra annual payments calculated per month)]/[bargained annual working time/12].

when working with samples. Not considering these errors appropriately can frequently lead, in practice, to erroneous conclusions in comparative analyses of the stochastic dominance between distributions (Bishop et al., 1997).

The Lorenz dominance applied to the context of this study is based on the comparison of the Lorenz curves of two wage distributions. Let L_i^A be the coordinate of the Lorenz curve of wage distribution for region *A* in quantile *i*. According to the Lorenz method, wage distribution of region *A* dominates that of region B if $L_i^A \geq L_i^B$ for every *i* with at least a strict inequality. Thus, if wage distribution of region *A* Lorenz dominates that of region B the distribution of A is more egalitarian than that of *B*[2], taking into account that the whole distribution has been used for the comparison. In the case where the Lorenz curves of the two regions cross, there are no dominance relations in terms of inequality between their wage distributions[3]. It is important to point out that Lorenz dominance is not incompatible with the use of inequality indices, which provide complete rankings, rather it is complementary to them, enriching the examination of the phenomenon.

Notwithstanding, if the empirical analyses are based on sample data, the cuts in the curves may be due to sampling errors, and consequently they will not be statistically significant. However, certain hypothesis testing procedures can be found in the economic literature with respect to this question that are useful in determining whether the cuts in the curves are significant, which extends the ranking power of the technique described. Although a detailed analysis of the application of stochastic inference for the Lorenz dominance is presented in Appendix 1, it is important to highlight some aspects. Firstly, it is based on samples from which sampling statistics are generated whose asymptotic distributions are obtained. A hypothesis test is developed based on these distributions in order to analyse the statistical significance of the differences in the Lorenz curve coordinates. The sampling weights of the observations included in the survey are considered in the calculations for obtaining the comparative statistics between coordinates of the Lorenz curve, whose expressions are presented in Appendix 1.

3.2. The Juhn et al. (1993) technique

As indicated in the introduction, one of the basic objectives of this study is to examine the factors that influence the regional differences in levels of wage inequality. In order to analyse this question in more detail, in addition to the inferential techniques of statistical dominance, the methodology proposed by Juhn et al. (1993) has been used. This technique is based on the calculation of counterfactual wage distributions (more details of its application may be found in

[2] Atkinson (1970) includes a formal demonstration of how a Lorenz dominance of a distribution over another implies that the values of the indices usually used in economic literature for measuring inequality, such as the Gini index or the variation coefficient, are necessarily lower for the first distribution.

Appendix 1). Adapted to the specific context of this research study, this technique enables us to calculate the counterfactual wage distributions that each of the Spanish regions would have in the case where they differ from a reference wage distribution (that corresponding to Spain as a whole has been used), exclusively in the characteristics of the workers and companies or, alternatively, in the relative returns of these characteristics. Through the subsequent application of the stochastic dominance technique to the counterfactual wage distributions which are generated by this methodology, it is possible to analyse the reasons for the regional differences in wage inequality, and more specifically, whether these differences are due to the Spanish regions being different in terms of the composition of their workforce and companies, or alternatively in the way in which these factors are remunerated[4].

The explanatory variables included in the specification of the wage equations on which the technique proposed by Juhn et al. (1993) is based cover a wide spectrum of characteristics both in terms of the individuals and their job positions and companies[5]. The former comprise the gender of the individual; the maximum level of general education (distinguishing between eleven different levels); the years of potential experience in the labour market (measured as the age of the individual less the age when entering the labour market after finishing full time education) and its quadratic form and years of seniority in the current position and its quadratic form. The characteristics of the job positions considered are the type of contract (permanent or temporary); the type of working day (full time or part time) and occupation (distinguishing between fifty seven occupations)[6]. Finally, the attributes of the establishments are the sector (considering the divisions of the CNAE-93 classification); the type of collective agreement (industry-wide on a national level, industry-wide on a regional or provincial level, company agreement and other types of agreement); the size (five segments); the proportion of women; and the average number of years of education, seniority and experience, respectively of the establishment's workforce[7].

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[3] Note that the comparison is applicable immediately to the comparison of inequality of a region in two moments of time.

[4] One of the shortcomings of this technique is that it does not provide detailed information regarding the individual effect of each of the explanatory variables included in the equation, only of the overall effect of them all. This circumstance implies that it is not possible to differentiate between variables in accordance with criteria such as their evaluation from the point of view of equal opportunities and social justice (see Roemer, 1998).

[5] It is worth highlighting that the explanatory capacity of the wage equations is relatively high: the adjusted coefficients of determination of the regressions of equations (A.4) and (A.5) take values of around 0.55 for both years in the case of Spain and of between 0.44 and 0.66 for each of the Spanish regions. The detailed results of the estimates are not included in the study due to space constraints, but they are available from the authors on request.

[6] Although the 2002 wave of the EES incorporates information regarding the nationality of the individual, and whether the individual carries out a supervisory role, these variables are not included in the 1995 wave. Consequently, it was decided not to include them in the specification of the equation.

[7] While not being a exhaustive justification for using these explanatory variables, the majority of which constitute standards in economic literature, it should be pointed out that the inclusion of the proportion of women and the average years of education, seniority and experience in the establishment respond to the recent evidence available for Spain in the sense that a high presence of women significantly decreases relative wages of companies (Amuedo-

4. Empirical results

4.1. Descriptive evidence

Table 1 contains, for the whole of the period analysed, information of the Spanish regions regarding average wages and wage inequality (the latter is measured through the use of two inequality indices usually employed, the Gini index and the Theil index). By examining this evidence it can be clearly observed that the presence in the Spanish labour market of differences between regions in terms of wage structures is not limited to average wages, but extends to the levels of wage inequality. The regional variability in the levels of inequality of hourly wages is a phenomenon which seems to become more accentuated over time (the coefficient of variation of the regional values of both measurements of inequality experience significant increases: from 0.092 to 0.142 in the case of the Gini index and from 0.201 to 0.280 in the case of the Theil index). Furthermore, it is worth noting the strong temporal stability in regional wage determination, given the strong similarity in both years with respect to both regional differences in average wages (the correlation coefficient is 0.95) and those of inequality levels (the correlation coefficient of both measurements of inequality is higher than 0.75 and statistically significant at conventional levels). A final circumstance to highlight is the presence of a relationship, albeit more prominent in 2002, between the levels of average wages and wage inequality whereby both tend to be comparatively higher (lower) in the same regions.

In the specific case of wage inequality, the region with the largest inequality is systematically that of Madrid (where, by way of example, the Theil index in 1995 and 2005 takes values of 0.231 and 0.230, significantly higher than the values of this index for Spain as a whole, 0.184 and 0.167 respectively)[8]. On the contrary, the lowest levels of inequality are found in Navarra and La Rioja in 1995 (according to the Theil index and Gini values respectively), and in Cantabria (according to both indexes) in 2002. As it can be observed, while the regional rankings of inequality at each moment of time show a similar trend for both measurements of inequality (the Spearman rank correlation coefficient for regional values of both measurements takes values of 0.958 in 1995 and 0.970 in 2002), these rankings exhibit certain differences depending on the specific measurement of inequality. These results illustrate the problem of multiplicity of indices that frequently arises in comparative analyses when inequality measurements are used.

Dorantes and De la Rica, 2006), and that the endowment of the workforce as a whole of a company in practice has a high impact on the individual wages of all of the workers (Alcalá and Hernández, 2006).

[8] Elaborating on this point, it is worth highlighting that, according to the data of the European Wage Structure Survey, the wage inequality in Madrid in 2002 was only exceeded in the context of the EU-15 by the regions of London and Île de France when the NUTS1 territorial references are considered (Eurostat, 2005). Note that the European Wage Structure Survey contains equivalent information to that of the Wage Structure Survey conducted for Spain by the Spanish National Institute of Statistics and is wholly comparable between countries.

From a time perspective, it can also be confirmed that the significant reduction in wage inequality in the Spanish labour market in recent years seems to have a general nature, insofar as it extends to the majority of the Spanish regions. The only exceptions are Andalusia and Galicia where the values of the Theil index suggest that there could have been a rise in wage inequality. The regional orderings of inequality exhibit a significant stability over time (the Spearman Rank correlation coefficient has values of 0.730 and 0806 when the regional rankings of 1995 and 2002 are compared using the Gini index and the Theil index respectively). However, changes in the regional rankings of inequality may be observed over time, which indicates that the specific size of the reduction in inequality in some cases can represent significant regional differences.

Based on the above-mentioned descriptive evidence it can be established that the results of regional comparisons of inequality may be sensitive to the index used to measure it, and that the reduction in wage inequality in Spain, while having a general nature, exhibits a certain degree of regional heterogeneity in its intensity. These circumstances underline the advisability of using stochastic dominance techniques for analysing the relative levels of wage inequality in Spanish regions and their changes over time, given the advantages associated with their use. Therefore, in relation to the first point, these techniques provide an unambiguous ranking with respect to levels of inequality, enabling a record to be made of those cases in which regional differences of inequality are statistically significant. With regard to the second point, these techniques allow us to determine those specific Spanish regions that have experienced a significant reduction in wage inequality.

4.2. Lorenz dominance

The first question that this study attempts to address is the extent to which significant and persistent wage differences exist between the wage inequality levels of Spanish regions. In order to explain this question, tables 2 and 3 include the results derived from applying the contrasts of Lorenz stochastic dominance to the bilateral comparisons of wage distributions of the Spanish regions for each of the years analysed (the first column of each table corresponds to the comparison with the wage distribution for Spain as a whole). In order to facilitate the interpretation of the results, it is worth pointing out that if a region exercises Lorenz dominance in a positive (negative) sense over another, this implies that the first has a lower (higher) wage inequality. Furthermore, this dominance is strong if statistically significant differences of the same sign are detected in the coordinates of the two Lorenz curves in the comparisons developed for all the deciles of the distributions. The dominance is weak if there is some statistically significant difference in one of them, but there is at least one decile for which the null hypothesis of the equality of the coordinates of the two Lorenz curves cannot be rejected. Finally, there is no

dominance of one distribution over another if the results of the comparisons reveal differences with opposite signs in different deciles.

Figures 1 and 2 contain the Hesse diagrams for the regional wage distributions (together with that of Spain as a whole) for 1995 and 2002 respectively. These diagrams represent a ranking of the distributions in accordance with their inequality, whereby those territories that occupy a higher position have a lower wage inequality. The presence of a continuous line between the boxes of two territories corresponds to a situation in which, according to the stochastic dominance comparisons, the territory with a higher position Lorenz dominates the other (either weak or strong dominance) and therefore, has a lower wage inequality. Furthermore, with a continuous line all of the dominances that are transmitted flowing down from the lines that intersect it are taken into account. A discontinuous line implies that there is dominance between the two territories that it connects, but intersection with other lines does not imply dominance. Finally, table 4 illustrates an indicator with which the position of each region in the Hesse diagram is determined, and which corresponds to the number of dominances of the region of reference over the rest of the regions less the number of dominances of the other regions over the region of reference.

The Hesse diagrams reveal that, in practice, there are many Lorenz dominances between regions, a circumstance that confirms that the levels of wage inequality of Spanish regions are not similar and exhibit considerable differences. Likewise, irrespective of the year of reference, regions such as Catalonia, Galicia and Madrid reveal a trend of comparatively high inequality levels while, on the contrary, La Rioja or Navarra possess a comparatively low wage inequality. These results are consistent, in turn, with the values of the synthetic rank position indicators for each region in the diagrams (table 4). Focusing on the comparison with Spain as a whole, one result worth mentioning is that it can be concluded that Madrid is the only Spanish region that has levels of wage inequality that are higher than the national average, with the opposite scenario applying to the majority of the other regions. This finding suggests that the wage inequality existing in Spain as a whole is highly influenced by the specific case of Madrid, which can be plausibly explained, among other circumstances, by its high relative demographic weight.

The detailed results of the stochastic dominance comparisons included in tables 2 and 3 confirm that the differences in inequality existing between Spanish regions and the national average (first column of the tables) are evident in a high proportion of cases (including that of the comparison of Madrid with Spain) in the form of strong dominance of one distribution over another, being statistically significant at 1%. Nevertheless, it should be noted that the number of dominances in the comparisons between regions is much higher, especially in the case of strong dominances, in 2002 (for which 51 bilateral comparisons reveal weak dominances; 54 strong dominances with a level of significance of at least 10% and 21 comparisons no dominances) than

in 1995 (for which 59 of the 136 bilateral comparisons reveal weak dominances; 39 strong dominance and no dominances are found in 38 comparisons). This result confirms that the differences between regions in terms of wage inequality levels tend to become more intense over time.

In some regions significant changes in relative levels of wage inequality are detected. Aragon, for example, in 1995 was among the regions with the lowest levels of inequality and in 2002 it had become one of the regions with highest inequality. From having an intermediate level of inequality, Cantabria and Extremadura became regions with some of the lowest levels of inequality and the Canary Islands became a region with an intermediate level of inequality in 2002 after having a comparatively high level in 1995. The rank position indicators of the regions in the Hesse diagrams for both years reveal however, a positive and statistically significant correlation (also taking into consideration Spain in the comparison, the Spearman Rank correlation coefficient takes a value of 0.76, being statistically significant at 1%), which suggests that on the whole there is relatively stable ranking of the Spanish regions in accordance with their levels of inequality.

Overall, the findings reveal that there are significant and persistent wage differences between the wage inequality levels of Spanish regions, and that these differences tend to become more pronounced over time. The next step in the analysis is concerned with identifying the factors that underlie these differences and more specifically, the extent to which they are caused by inter-regional differences in terms of the characteristics of the workers and companies or, alternatively by inter-regional differences in the relative returns of these factors.

Tables A.1 to A.4 of Appendix 2 show the results of applying stochastic dominance techniques to the analysis of the Lorenz dominance between the regional wage distributions corresponding to the two types of counterfactual wages generated with the technique proposed by Juhn et al. (1993). These tables also include the results of the bilateral comparisons of the counterfactual distributions between all the regions and those of the comparison of each of them with that of Spain as a whole (note that the latter case is equivalent to the comparison with the wage distribution observed for Spain, given that this is the reference taken in the generation of counterfactual wages).

The hypothetical wages 1, as referred to herein, have been obtained for each region from the equation (A.6), which implies the application of the returns of the characteristics and the effect of the unobservable factors of Spain on the characteristics of the individuals and companies in each region. The differences between regions in terms of the distributions of hypothetical wages 1 therefore are exclusively due to their differences in characteristics, so the results of the comparisons in this case are indicative of the effect of this factor in the generation of regional differences in wage inequality. In relation to this point, the existence of a highly significant number

of dominances between counterfactual distributions is evident: the results for 1995 and 2002 give values of 115 and 108 respectively of the 136 possible bilateral comparisons between regions (although the number of strong dominances decreases considerably between the two years, from 35 to 7: tables A.1 and A.3). Expanding on this point, the majority of the regions reveal characteristics that differ from those of Spain as a whole to the point where this difference on its own generates a wage inequality that is different from the national average (being higher in seven and ten cases in 1995 and 2002 respectively, and lower in eight and five: see the first column of both tables). This evidence suggests that as a whole, the regional differences in characteristics represent a significant cause of the differences between regions in wage inequality.

The hypothetical wages 2 have been obtained from the equation (A.7), establishing only the effect of the unobservable factors with that existing in Spain. The differences of these wages with respect to the hypothetical wages 1 are exclusively due, therefore, to the substitution of relative returns in Spain as a whole by the relative returns of each region. Consequently, the comparison of the dominance results obtained with both types of counterfactual wages reveals the effect that the regional differences have on the mechanisms for determining wages in the generation of wage inequalities between regions. In practice, the number of dominances is very similar in both cases. In 1995, a total of 115 (of which 35 are strong) for hypothetical wages 1 and 106 (32 strong) for hypothetical wages 2; and in 2002 a total of 108 (7 strong) as opposed to 107 (17 strong). However, for a highly significant number of regional comparisons the results change; 64 in 1995 and 74 in 2002 (consequently it remains at 72 and 62). Moreover, in the specific case of comparisons with Spain as a whole, the direction of dominance changes for eight regions. This circumstance can be observed in the Hesse diagrams for both types of counterfactual wage[9]. These different types of wage reveal pronounced differences, which are logically translated into significant differences between the rank position indicators of the regions, especially in 2002 (table 4)[10].

In order to further analyse the effect that the regional differences have on relative returns in generating wage inequalities between regions, table 5 contains for each of the years analysed the results derived from applying the stochastic dominance techniques to the Lorenz dominance analysis in the bilateral comparisons for each region between the wage distributions corresponding to the hypothetical wages 1 and 2. The differences between the two distributions are caused exclusively by the differences existing between the region and Spain as a whole in terms of the effect of relative returns, whereby a positive (negative) dominance of the first over the second

[9] For reasons of space, these diagrams have not been included in the study. They are available from the authors on request.

[10] Therefore, in both years there is a positive correlation, 0.52 and 0.22, respectively, but the values are far from the unit value of 1 (and statistically significant only in the first case, at 5%).

indicates that the relative returns of Spain generate a lower (higher) degree of inequality than those of the region. In 1995, a total of 10 negative dominances, 2 positive dominances and 5 comparisons in which there is no dominance were recorded, while in 2002 these results are 9, 4 and 4 respectively. These findings suggest that in the majority of the Spanish regions the relative returns are different from the national average, to the point of generating a different degree of wage inequality. A particularly interesting finding is that in Madrid positive dominances are recorded in both years, which indicates its high relative weight in Spain. The results as a whole reveal, in any event, that the regional differences in relative returns play a relevant role in generating wage inequalities between regions, which is consistent with the presence of significant differences in the regional mechanisms for determining wages.

The second question which the study examines is the extent to which all the Spanish regions share a declining trend in wage inequality which has been experienced in recent years in Spain as a whole. In this respect, table 6 includes the results derived from applying the stochastic dominance comparisons to the bilateral comparisons of the wage distributions of 1995 and 2002 both for Spain and for each of the regions (the first column presents the result of the comparison of all of the distributions and the second presents the detailed results of the comparisons in each decile). It can therefore be confirmed that the decreasing pattern of inequality is practically generalised, as there is no region which has experienced an increase in inequality, while only three regions (Andalusia, Galicia and Madrid) do not exhibit a clear inequality trend (furthermore, in the first two regions this result is determined exclusively by the highest part of the wage distributions – and more specifically in the ninth decile -, with the rest ot their respective distributions experiencing a reduction in inequality). On the other hand, in the other Spanish regions, a lower inequality is observed: more specifically, in 10 regions a stronger dominance of the distribution is observed in 2002 with respect to 1995, while in another four (Navarra, Valencia Castilla-Leon and Aragon) a weak dominance can be observed.

For the whole of Spain, a weak dominance may be observed in the wage distribution corresponding to 2002 over 1995. This result is interesting insofar as the results of the comparisons based on inference-based techniques of stochastic dominance confirm the findings of other research studies that indicate that Spain is experiencing a significant reduction in wage inequality. However, this result also reveals that this reduction is not statistically significant in certain segments of the distribution. In order to analyse this point in more depth, table 7 contains the detailed results of the dominance comparisons applied to each decile of the distributions of 1995 and 2002. Since the contrast statistic in one decile is also a measurement of the distance existing between the coordinates of the two curves at this point, the specific size of this statistic can be used in this context as an indicator to determine which deciles have experienced a relatively

more pronounced reduction in inequality. In practice, it may be observed that the contrast statistics have very high values in the first deciles which reduce considerably in the central parts, particularly above the distribution. They begin by being systematically significant at 1% in the first deciles, then only being so at 10% in the eighth decile, while in the ninth decile they do not show conventional levels of significance. This evidence suggests that the reduction in inequality experienced in Spain during the period of analysis is more intense in the lower half of the wage distribution, and that it has no effect on the highest part.

5. Conclusions

The aim of this study is to examine wage inequality and its changes in Spain from a regional perspective, with the aim of improving the knowledge of this phenomenon and its determinants. In addition to being one of the few studies for Spain that introduces the regional dimension in the analysis of wage inequality, another of its notable aspects is the use of inference-based techniques of Lorenz stochastic dominance, a methodology that enables us to construct an ordering of wage distributions in accordance with their inequality, of which there are hardly any previously published national or international studies applied to the analysis of wage inequality.

The field of study is of particular interest because Spain is one of the few developed countries in which the majority of collective bargaining is developed through industry-wide agreements on an infra-national scale applied exclusively to provinces or regions. This infrequent regional dimension of collective bargaining on an industry level implies the presence in Spain of wage determination mechanisms that are differentiated by region, which give rise to the existence of differences in wage structures between regions. However, while this circumstance has been analysed in the case of regional differences of average wages, studies related to the analysis of wage inequality are scarce.

The results obtained in the empirical analysis reveal that there are significant and persistent differences between the levels of wage inequality of the Spanish regions and that these differences tend to become more pronounced over time. The detailed analysis of the cause of these differences reveals that the regional differences existing in the composition of the workforce and the companies constitute a primary determinant of the regional differences in wage inequality. However, it may also be observed that in the majority of Spanish regions there are relative returns that differ from the national average and that the regional differences in returns generally play a relevant role in generating wage inequalities between regions. This evidence confirms the presence of significant regional differences in the mechanisms of wage determination.

Lastly, from a time perspective, the most interesting finding is that the majority of Spanish regions share the declining trend in wage inequality which has been experienced in recent years in Spain as a whole. This implies the general nature of this phenomenon for the whole of the Spanish

labour market, contrasting with the overall trend of developed countries, which are experiencing an increase in wage dispersion caused by factors such as technological change or globalisation.

References

Ahamdanech, C.; García, C. (2007): "Welfare, Inequality and Poverty Rankings in the European Union using an Inference-based Stochastic Dominance Approach", en Bishop J. y Y. Amiel (eds.) *Research On Economic Inequality (Vol. 14): Inequality and Poverty*, ed. Elsevier JAI.

Alonso, J.; Izquierdo, M. (1999): "Disparidades regionales en el empleo y el desempleo", *Papeles de Economía Española*, nº 80, pp. 79-98.

Abowd, J.M.; Kramarz, F. (1999): "The Analysis of Labour Markets Using Matched Employer-Employee Data", in O. Ashenfelter and D. Card (ed.) *Handbook of Labour Economics*, ed. North-Holland.

Ahn, N.; Izquierdo, M.; Jimeno, J.F. (2001): "El componente demográfico de la desigualdad salarial: diferencias entre Comunidades Autónomas españolas", *Fundación Caixa Galicia*, Documento de Economía nº 10.

Alcalá, F.; Hernández, P.J. (2006): "Las externalidades del capital humano en la empresa española", *Revista de Economía Aplicada*, nº 41 (vol. XIV), pp. 61-83.

Amuedo-Dorantes, C.; De la Rica, S. (2006): "The Role of Segregation and Pay Structure on the Gender Wage Gap: Evidence from Matched Employer-Employee Data for Spain", *Contributions to Economic Analysis & Policy*, 5(1), pp. 1-32.

Atkinson, A.B. (1970): "On the Measurement of Inequality", *Journal of Economic Theory*, 2(3), pp. 244-263.

Bande, R.; Fernández, M.; Montuenga, V. (2008): "Regional unemployment in Spain: Disparities, business cycle and wage setting", *Labour Economics*, vol. 15(5), pp. 885-914.

Bayard, K.; Hellerstein, J.; Neumark, D. y Troske, K. (2003): "New evidence on sex segregation and sex differences in wages from matched employee-employer data", *Journal of Labor Economics*, vol. 21, nº 4, pp. 887-922.

Beach, C.M.; Davidson, R. (1983): "Distribution-free statistical inference with Lorenz curves and income shares", *Review of Economic Studies*, 50, pp. 723-735.

Beach, C.M.; Chow, K.V.; Formby, J.P.; Slotsve, G.A. (1994): "Statistical inference for decile means", *Economic Letters*, 45 (2), pp. 161-167.

Bentolila, S.; Dolado, J.J. (1991): "Mismatch and internal migration in Spain, 1962-1986", en F. Padoa-Schioppa (ed.), *Mismatch and labour mobility*, ed. Cambridge University Press.

Bentolila, S.; Jimeno, J.F. (1998): "Regional Unemployment Persistence (Spain, 1976-1994)", *Labour Economics*, vol. 5(1), pp. 25-51.

Blau, F.D.; Kahn, L.M. (1996): "International Differences in Male Wage Inequality: Institutions versus Market Forces", *Journal of Political Economy*, 101(4), pp. 791-837.

Blau, F.D. y Kahn, L.M. (1999): "Institutions and Laws in the Labor Market", en O. Ashenfelter y D. Card (ed.) *Handbook of Labor Economics*, ed. North-Holland.

Blau, F.D.; Kahn, L.M. (2005): "Do cognitive test scores explain higher US wage inequality?", *The Review of Economics and Statistics*, 87(1), pp. 184-193.

Bishop, J.A.; Formby, J.P.; Thistle, P.D (1989): "Statistical inference, income Distributions and social welfare", en D.J. Slotje (ed.), *Research on Economic Inequality*, Vol.1, Greenwich, CN: JAI Press.

Bishop, J.A.; Formby, J.P.; Thistle, P.D (1991): "Rank dominance and international comparisons of income distribution", *European Economic Review*, 35, pp. 1399-1409.

Bishop, J.A.; Formby, J.P.; Thistle, P.D (1994). "A dominance evaluation of distribution of income and the benefits of economic growth in the Unites States", en Bergstrand, J., T. Cosimano y R.G. Sheehan (eds.), *The changing distribution of income in an open U.S. economy*, North Holland, 69-109.

Bishop, J.A.; Formby, J.P.; Thistle, P.D.(1997): "Changing American Earnings Distributions: One-Half Century of Experience", *Empirical Economics*, 22(4), págs 501-514.

Bover, O.; Velilla, P. (2005): "Migrations in Spain: Historical Background and Current Trends", en K. Zimmerman (ed.) *European Migration. What Do We Know?*, ed. Oxford University Press.

Card, D.; De la Rica, S. (2006): "Firm-level Contracting and the Structure of Wages", *Industrial and Labor Relations Review*, vol. 59 (4), pp. 573-593.

Del Río, C.; Ruiz Castillo, J. (1996): "Ordenaciones de bienestar e inferencia estadística. El caso de las EPF de 1980-81 y 1990-91", en *La desigualdad de recursos. II Simposio sobre Igualdad y Distribución de la Renta y la Riqueza*, Fundación Argentaria, Colección Igualdad, vol. 6, pp. 9-44.

Du Caju, P.; Gautier, E.; Momferatou, D.; Ward-Warmedinger, M. (2008): "Institutional features of wage bargaining in 23 European countries, the US and Japan", ECB Working Paper No 974.

El-Attar, M.; López-Bazo, E. (2006): "Heterogeneidad en las distribuciones salariales entre las regiones españolas", *Papeles de Economía Española*, 107, pp. 214-230.

Eurostat (2005): *Employment in Europe. 2005*.

García, I.; Molina, J.A. (2002): "Inter-regional wage differentials in Spain", *Applied Economics Letters*, 9, pp. 209-215.

Hamermesh, D. (2008): "Fun with matched firm-employee data: Progress and road maps", *Labour Economics*, vol. 15(4), pp. 662-672.

Izquierdo, M.; Lacuesta, A. (2006): "Wage inequality in Spain: Recent developments", Documento de Trabajo del Banco de España Nº 0615.

Jimeno, J.F., Izquierdo, M.; Hernanz, V. (2001): "La desigualdad salarial en España: Descomposición y variación por niveles de salarios", *Papeles de Economía Española*, nº 88, pp. 113-125.

Juhn, C., Murphy, K.; Pierce, B. (1993): "Wage inequality and the rise in returns to skill", *Journal of Political Economy* 101, 31, pp. 410-442.

Katz, L.F. y Autor, D.H. (1999): "Changes in the Wage Structure and Earnings Inequality", en O. Ashenfelter y D. Card (ed.) *Handbook of Labor Economics*, ed. North-Holland.

López-Bazo, E.; Motellón, E. (2009): "Human Capital and Regional Wage Gaps", Documents de Treball IREA, Nº. 24, 2009

OCDE (2007): *Employment Outlook 2007*.

Palacio, J.I. y Simón, H. (2004): "Dispersión salarial entre establecimientos y desigualdad salarial en España", *Revista de Economía Aplicada,* Vol. XII(36), págs 47-81.

Serrano, L. (2002): "Salarios regionales y dotaciones de capital humano", *Revista de Economía Aplicada*, 28, pp. 23-38.

Simón, H.; Ramos, R.; Sanromá, E. (2006): "Collective bargaining and regional wage differences in Spain: An empirical analysis", *Applied Economics*, 38, pp. 1749–1760.

Simón, H. (2009): "La desigualdad salarial en España: Una perspectiva internacional y temporal", *Investigaciones Económicas*, vol. XXXIII(3), pp. 439-471.

Simón, H. (2010): "International Differences in Wage Inequality: A New Glance with European Matched Employer-Employee Data", *British Journal of Industrial Relations*, 48(2), pp. 310-346.

Stoline, M.R.; Ury, H.K. (1979): "Tables of the Studentized Maximum Modulus Distributions and an Application to Multiple Comparisons Among Means", *Technometrics*, 21, pp. 87-93.

Vamvakidis, A. (2008): "Regional Wage Differentiation and Wage Bargaining Systems in the EU", IMF Working Paper 08/43.

Figure 1
Hesse diagram of Lorenz dominance. 1995.

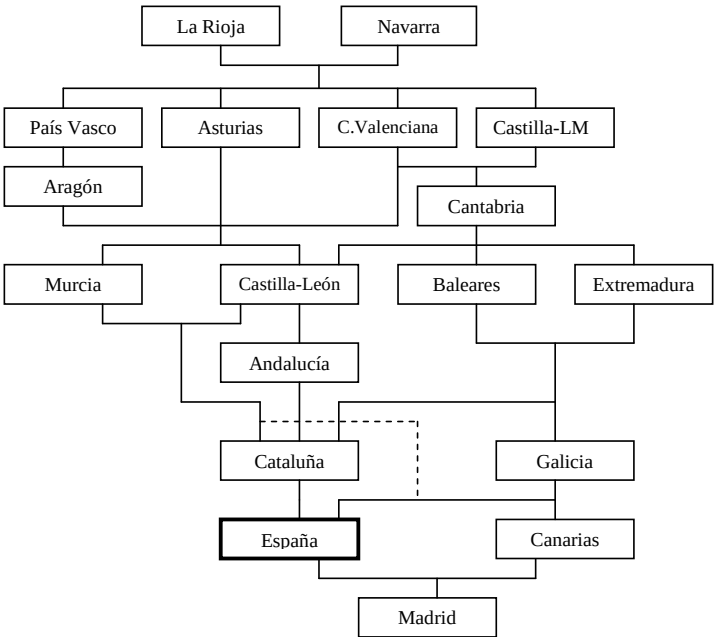

Figure 2
Hesse diagram of Lorenz dominance. 2002.

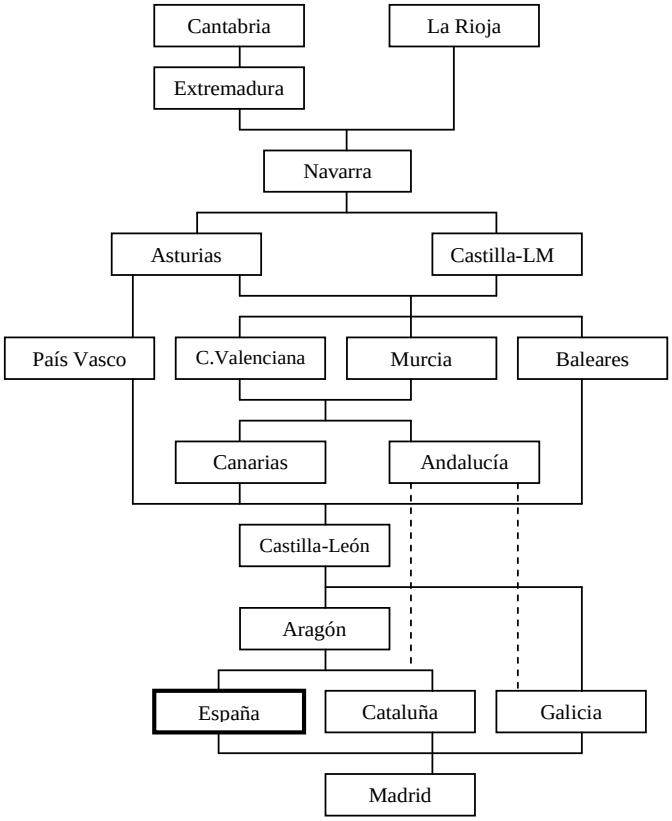

Table 1
Average wages and wage inequality in Spanish regions.

	1995			2002		
	Average wage (euros)	Gini index	Theil index	Average wage (euros)	Gini index	Theil index
Spain	8,25	0,317	0,184	9,46	0,297	0,167
Andalucía	8,32	0,305	0,161	9,53	0,304	0,175
Aragón	7,91	0,291	0,153	9,61	0,269	0,135
Asturias	7,79	0,284	0,142	8,46	0,248	0,113
Baleares	7,50	0,310	0,211	8,74	0,267	0,150
Canarias	7,26	0,339	0,222	8,34	0,291	0,167
Cantabria	7,09	0,278	0,140	7,58	0,208	0,086
Castilla-La Mancha	6,91	0,295	0,164	7,98	0,264	0,135
Castilla y León	7,92	0,298	0,154	8,93	0,282	0,144
Cataluña	9,27	0,315	0,178	10,68	0,300	0,164
Comunidad Valenciana	7,51	0,288	0,154	8,91	0,270	0,140
Extremadura	6,32	0,314	0,182	6,64	0,224	0,102
Galicia	7,06	0,313	0,186	8,59	0,308	0,195
Madrid	10,34	0,355	0,231	11,11	0,350	0,230
Murcia	6,25	0,283	0,150	7,53	0,245	0,126
Navarra	8,01	0,251	0,115	9,76	0,226	0,094
País Vasco	9,62	0,273	0,133	11,20	0,249	0,110
La Rioja	6,54	0,249	0,126	7,96	0,215	0,095
Coefficient of variation	0,154	0,092	0,201	0,150	0,142	0,280

Table 2
Contrasts of Lorenz dominance. 1995.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	+***																
Aragón	+***	+															
Asturias	+***	+	=														
Baleares	+	x	x	x													
Canarias	x	x	-	-	-												
Cantabria	+***	+	x	x	+	+											
Castilla-La Mancha	+***	+	x	x	+	+***	+										
Castilla y León	+***	+	-	-	x	+	-	x									
Cataluña	+	-	-***	-***	-	x	-	-	-***								
Comunidad Valenciana	+***	+	x	x	+	+***	+	=	+	+***							
Extremadura	+	x	x	x	=	+	-	-	X	+	-						
Galicia	+	x	x	x	-	+	-	-	X	x	-	-					
Madrid	-***	-***	-***	-***	-	-	-***	-***	-***	-***	-***	-	-**				
Murcia	+	x	-	-	x	+	x	-	X	+	-	x	x	+***			
Navarra	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***	+***		
País Vasco	+***	+	+	=	x	+	x	x	+	+***	x	x	x	+***	+	-***	
La Rioja	+***	+	+	+	+***	+***	+	+	+	+***	+	+***	+***	+***	+	x	+

Notes: A positive (negative) sign in a cell implies that the wage distribution in the region of the row Lorenz dominates (is Lorenz dominated) to the region of the spine. ***, ** and * indicate that the dominance is statistically significant in all deciles at the 1%, 5% and 10% level, respectively. The symbol x indicates that there are cuts between Lorenz curves of wage distributions, so there is no dominance of any sign.

Table 3
Contrasts of Lorenz dominance. 2002.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	+*																
Aragón	+	x															
Asturias	+***	+	+***														
Baleares	+**	=	+	-													
Canarias	+	=	x	-	=												
Cantabria	+***	+***	+***	+***	+***	+***											
Castilla-La Mancha	+***	+***	+	x	+	+**	-**										
Castilla y León	+***	x	+	-	-	-	-***	-									
Cataluña	x	-	-**	-***	-	-	-***	-***	-***								
Comunidad Valenciana	+***	+	+	-	=	=	-***	-	+	+							
Extremadura	+***	+***	+**	+	+***	+***	-	+**	+***	+***	+***						
Galicia	x	-	x	-	-	-	-***	-***	-	x	-	-***					
Madrid	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-***	-				
Murcia	+***	+	+	-	=	+	-***	-	+	+**	x	-**	+	+***			
Navarra	+***	+***	+***	+	+***	+***	-	+	+***	+***	+***	-	+***	+***	+*		
País Vasco	+***	x	+	-	x	x	-	x	+	+***	x	-	x	+	x	-	
La Rioja	+***	+***	+**	+	+***	+***	=	+	+***	+***	+***	=	+***	+***	+**	+	+

Notes: See notes of table 2.

Table 4
Position indicators of regions in Hesse diagrams.

	1995			2002		
	Actual wages	Hypothetical wages 1	Hypothetical wages 2	Actual wages	Hypothetical wages 1	Hypothetical wages 2
Andalucía	-6	0	10	-3	11	15
Aragón	4	-2	2	-9	-10	3
Asturias	5	10	0	8	-2	4
Baleares	0	-12	3	0	-1	8
Comunidad Valenciana	9	-6	6	1	8	9
Canarias	-12	2	0	-1	8	-7
Cantabria	5	-13	-14	16	-8	-4
Castilla-La Mancha	-3	6	2	-6	0	-4
Castilla y León	9	-14	2	7	-12	6
Cataluña	-11	12	11	-13	14	5
España	-14	-1	-5	-13	5	-5
Extremadura	-1	-7	-14	14	-8	-15
Galicia	-5	14	-3	-11	15	-1
La Rioja	16	-9	-11	15	-16	-3
Madrid	-17	15	-4	-17	5	-15
Murcia	-3	-15	-17	2	11	-15
Navarra	16	11	16	11	10	15
País Vasco	6	9	16	0	12	15

Notes: The position indicator measures the number of dominances exerted in bilateral comparisons by other regions on the reference region minus the number of dominances of the region above the rest. Hypothetical wages 1 and 2 correspond to those generated for each of the regions from equations (A.6) and (A.7), respectively.

Table 5
Constrast of Lorenz dominance.
Comparison of regional counterfactual wage distributions.

	1995	2002
Andalucía	-	-
Aragón	-	-
Asturias	=	-
Baleares	-	+
Canarias	-	=
Cantabria	-	x
Castilla-La Mancha	-	-
Castilla-León	=	-
Cataluña	-	+
Comunidad Valenciana	=	-
Extremadura	=	=
Galicia	+***	+
Madrid	+	+**
Murcia	=	=
Navarra	-	-
País Vasco	-	-
La Rioja	-	-

Notes: A positive sign (negative) in a cell implies that the distribution of hypothetical wages 2 in the region Lorenz dominates (is Lorenz dominated) by the distribution of hypothetical wages 1. ***, ** and * indicate that the dominance is statistically significant in all deciles at the 1%, 5% and 10% level, respectively. The symbol x indicates that there are cuts between Lorenz curves of wage distributions, so there is no dominance of any sign. Hypothetical wages 1 and 2 correspond to those generated for each of the regions from equations (A.6) and (A.7), respectively.

Table 6
Longitudinal comparisons of inequality between 1995 and 2002.
Results of contrasts of Lorenz dominance and contrasts by deciles.

	Lorenz dominance	Deciles with significant differences
Spain	+	1-8 (+)
Andalucía	x	1-7 (+) 9(-)
Aragón	+	1-4 (+)
Asturias	+***	1-9 (+)
Baleares	+***	1-9 (+)
Canarias	+***	1-9 (+)
Cantabria	+***	1-9 (+)
Castilla-La Mancha	+***	1-9 (+)
Castilla-León	+	1-7 (+)
Cataluña	+***	1-9 (+)
Comunidad Valenciana	+	1-8 (+)
Extremadura	+***	1-9 (+)
Galicia	x	1-7 (+) 9 (-)
Madrid	x	1-3 (+) 6-7 (-)
Murcia	+***	1-9 (+)
Navarra	+	1-4 (+)
País Vasco	+***	1-9 (+)
La Rioja	+***	1-9 (+)

Notes: The first column shows the results of the contrasts of Lorenz dominance comparisons for the set of Lorenz curves. A positive (negative) sign in a box in that column indicates that in the territory of reference the 2002 wage distribution Lorenz dominates (is Lorenz dominated). ***, ** and * indicate that the dominance is statistically significant in all deciles at the 1%, 5% and 10% level, respectively. The symbol x indicates that there are cuts between Lorenz curves of wage distributions, so there is no dominance of any sign. The second column contains the detailed results of the comparisons of Lorenz curves in each decile of the distributions (specifically, the deciles for which statistical tests reveal differences in the curves with a significance of at least 10%).

Table 7
Detailed results of contrasts by deciles of the comparison of 1995 and 2002 wage distributions in Spain.

Decile	Coordinates of Lorenz curve		Contrast statistic
	1995	2002	
1	0,0382 (0,0001)	0,0432 (0,0001)	-31,43***
2	0,0873 (0,0002)	0,0973 (0,0002)	-33,47***
3	0,1433 (0,0003)	0,1577 (0,0004)	-31,63***
4	0,2068 (0,0004)	0,2241 (0,0005)	-27,78***
5	0,2801 (0,0005)	0,2972 (0,0006)	-21,35***
6	0,3657 (0,0007)	0,3789 (0,0007)	-13,42***
7	0,4654 (0,0008)	0,4736 (0,0009)	-7,01***
8	0,5833 (0,0009)	0,5876 (0,0010)	-3,13*
9	0,7312 (0,0010)	0,7341 (0,0011)	-1,94

Notes: A positive sign (negative) of the statistic indicates that, in the decile considered, the ordinate of the Lorenz curve for 2002 is higher than in 1995. ***, ** and * indicate that the dominance is statistically significant in all deciles at the 1%, 5% and 10% level, respectively.

Appendix 1

A.1. Statistical inference applied to the study of Lorenz dominance

Let us assume a wage distribution that is divided into K+1 quantiles. The K values of the x-axis of the Lorenz curve would be $p_1 < p_2 < ... < p_K$, with K wages (ξ_{pi}) delimiting this axis and K coordinates of the Lorenz curve $L_1 < L_2 < ... < L_K$. The average conditional variance for wages less than or equal to ξ_{pi} will be respectively, $\gamma_i \equiv E(w / w \leq \xi_{pi})$ and $\lambda_i^2 \equiv E[(w-\gamma_i)^2 / w \leq \xi_{pi}]$. Taking the expression of the conditional averages into account, the coordinates of the generalised Lorenz curve for wage distribution will be $G = (p_1\gamma_1, p_2\gamma_2, ..., p_K\gamma_K, \mu)'$. If all the wages are ordered from the lowest ($w_{(1)}$) to the highest ($w_{(N)}$), obtaining $w_{(1)} \leq w_{(2)} \leq ... \leq w_{(N)}$, $w_{(J)}$ the jth observation will have a weight ω_j. If $\hat{\xi}_{pi}$ is the rth order statistic, so that $\hat{\xi}_{pi} = w_{(r_i)}$, the $\hat{\xi}_{pi}$ statistics will be asymptotically distributed as a multivariate normal distribution.

Based on this approach, Beach and Davidson (1983) derive the variance and covariance matrix of the generalised Lorenz curve coordinates, and prove that the vector of generalised Lorenz coordinates $\hat{G} = (\hat{G}_1, \hat{G}_2, ..., \mu)'$ is asymptotically normal, as $\sqrt{n}(\hat{G} - G)$ has a K variate normal distribution limit with an average of zero and variance and covariance matrix Π. Taking into account that the coordinates of the Lorenz curve can be written as a transformation of the generalised curve, $\hat{L}_i = \hat{G}_i / \mu$, where μ is the average of the variable analysed, based on Π the variance and covariance matrix of the Lorenz curve coordinates can be extracted, with the distribution of $\sqrt{n}(\hat{L} - L)$ in this case also being multivariate normal. With respect to these distributions, Bishop, Formby and Thistle (1989) suggest the use of statistical contrasts to compare coordinate pairs of the Lorenz curve in which the null and alternative hypotheses are:

$$H_{0,i} : L_i^A = L_i^B \text{ and } H_{a,i} : L_i^A \neq L_i^B \quad \forall \text{ i = 1, 2, …, K} \tag{A.1}$$

where L_i^A and L_i^B are the Lorenz curve coordinates for each *i* of the wage vectors of *A* and *B* respectively. The statistical contrast for the ith element of the vectors L^A and L^B would be:

$$T_{Li} = \frac{\hat{L}_i^A - \hat{L}_i^B}{\left[\left(\frac{\hat{v}_{ii}^A}{n_A}\right) + \left(\frac{\hat{v}_{ii}^B}{n_B}\right)\right]^{1/2}} \quad \text{for i = 1, 2,…, K} \tag{A.2}$$

where $\hat{v}$ is the estimator of the elements of the variance and covariance matrix associated with the distribution of the Lorenz curve coordinates. Under the null hypothesis T_{Li} it is asymptotically normal. The critical values for the contrast are obtained through the distribution of the

studentized maximum modulus (Stoline and Ury, 1979) which contemplates the correlation between the coordinates which are compared.

On the other hand, the alternative hypothesis may be contemplated as a double hypothesis:

$$H^{+}_{a,i} : L_i^A > L_i^B \text{ and } H^{-}_{a,i} : L_i^A < L_i^B \quad \text{(A.3)}$$

If the null hypothesis is rejected, there are three possible results for the wage inequality comparisons between regions A and B. There is weak dominance in the wage distribution of A (and consequently less wage inequality in this region than in B) if for some quantiles $L_i^A > L_i^B$ and for others $L_i^A = L_i^B$ (for practical purposes, it is important to point out that the contrasts have been developed for the deciles of the distributions); there is strong dominance if for all i $L_i^A > L_i^B$, and the Lorenz curves are cut and there is no dominance if for some quantiles $L_i^A > L_i^B$ and for others $L_i^B < L_i^B$.

A.2. The Juhn et al. (1993) technique

Taking the wage distribution for the whole of Spain as a reference for generating regional counterfactual distributions, the technique proposed by Juhn et al, (1993) is based on the separate estimate of the following equations of individual wages:

$$w_i^{Esp} = X_i^{Esp}\beta^{Esp} + \varepsilon_i^{Esp} \quad \text{(A.4)}$$

$$w_i^{reg_k} = X_i^{reg_k}\beta^{reg_k} + \varepsilon_i^{reg_k} \quad \text{(A.5)}$$

Where the super-indices *Esp* and reg_k correspond to Spain and the region k, respectively; w_i^j corresponds to the gross hourly wage of the individual i in territory j (j=Spain, region k); X_i^j is a vector of observed characteristics (among which a constant term is included) of the individual i; β^j is the vector of parameters estimated in the territory j; and ε_i^j is an individual term of random error.

Juhn et al. (1993) suggest the decomposition of the differences existing between the two distributions by the auxiliary use of counterfactual distributions calculated for scenarios in which the differences between distributions caused by the effect of unobservable factors and relative returns are eliminated. In particular, these authors propose a control of the effect of the unobservable factors in the generation of differences between the two distributions based on the principle that the error term of an individual corresponds with his/her position in the residual distribution. So, if $\theta_i = F(\varepsilon_i | X_i)$ is the residual percentile of the worker i with observed characteristics X_i, by definition $\varepsilon_i = F^{-1}(\theta_i | X_i)$ can be expressed where F^{-1} is the inverse of the cumulative distribution function. This enables the individual i to be assigned a residue of a residual distribution different to his/her own based on the residue corresponding to the percentile θ_r. In

this way, if the residual distribution for Spain as a whole is taken as a reference, $F^{-1,Esp}$, and the wage structure estimated for Spain is also taken as a reference, $\hat{\beta}^{Esp}$, the hypothetical wage that the individual i would have in region k if it were determined by relative returns and the unobservable factors of Spain as a whole and by its own individual characteristics (which we will call hypothetical wage 1) would be:

$$whip1_i^{reg_k} = X_i^{reg_k}\hat{\beta}^{Esp} + F^{-1,Esp}(\theta_i \mid X_i^{reg_k}) \qquad \text{(A.6)}$$

All of the hypothetical wages generated by this method for the individuals in region k constitute the counterfactual wage distribution of that region under the assumption that the relative returns and unobservable factors of the region are the same as those of Spain as a whole. The counterfactual distribution variations for region k derived from the equation (A.6) with respect to the wage distribution that is actually observed for Spain, derived from the equation (A.4), are solely due to the differences existing between region k and Spain in the observed characteristics of individuals and companies. Furthermore, the comparison for different regions of the counterfactual distributions generated with the equation (A.6) allows us to observe the extent to which their differences in wage inequality are due to different endowments of characteristics.

The technique proposed by Juhn et al. (1993) enables an alternative counterfactual distribution to be generated for each region under the hypothesis that the wage of the individuals in region k is determined by the unobservable factors of Spain as a whole, the relative returns of the region and their own individual characteristics (which we will call hypothetical wage 2):

$$whip2_i^{reg_k} = X_i^{reg_k}\hat{\beta}^{reg_k} + F^{-1,Esp}(\theta_i \mid X_i^{reg_k}) \qquad \text{(A.7)}$$

The counterfactual wage distribution shaped by the wages generated in this way for all of the workers of region k differs from the counterfactual wage distribution derived from equation (A.6) exclusively in terms of the differences existing between the relative returns of the region and those of Spain. The differences existing in the comparison of the respective regional counterfactual distributions generated with equations (A.6) and (A.7) for the different regions enable us to observe, therefore, the extent to which the differences in wage inequality are due to regions differences in returns.

Appendix 2

Table A.1
Contrasts of Lorenz dominance. Hypothetical wages 1. 1995.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	=																
Aragón	x	-															
Asturias	+	+	+														
Baleares	-	-	-	-													
Canarias	+	+	x	-	+												
Cantabria	-	-	-	-*	=	-											
Castilla-La Mancha	-***	-***	-	-***	-	-	=										
Castilla y León	+	+	+	=	+	+	+	+***									
Cataluña	+	+	+	x	+	+	+	+***	+								
Comunidad Valenciana	-	-	x	-**	+	-	+	+	-***	-***							
Extremadura	-	-	-	-	+	-	+	+	-	-*	=						
Galicia	+	+	+	x	+	+	+	+**	+	+	+	+**					
Madrid	+***	+	+	+	+*	+	+*	+***	+	x	+***	+	x				
Murcia	-***	-	-	-***	-	-	=	=	-***	-	-	-	-***	-***			
Navarra	+	+	+	=	+*	+	+	+***	+	x	+**	+	x	-	+***		
País Vasco	+	+	+	=	+***	+	+	+***	+	-	+***	+	-	-	+***	=	
La Rioja	-	-	-	-	+	-	=	=	-	-**	=	=	-**	-*	+	-***	-***

Notes: See notes of table 2.

Table A.2
Contrasts of Lorenz dominance. Hypothetical wages 2. 1995.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	+***																
Aragón	+	-															
Asturias	+	-	=														
Baleares	x	x	x	x													
Canarias	x	-	x	x	=												
Cantabria	-	-***	-**	-**	-	-											
Castilla-La Mancha	+	-	x	x	=	=	+										
Castilla y León	+	-	x	+	x	x	+**	x									
Cataluña	+*	=	+	+	x	+	+**	+	+								
Comunidad Valenciana	+	-	x	+	x	+	+	=	+	-							
Extremadura	-	-***	-	-	-*	-*	=	-***	-	-***	-***						
Galicia	x	x	x	x	-	-	+	-	X	-	-	+					
Madrid	x	-	-	-	x	x	+	x	-	-	-	+	x				
Murcia	-***	-***	-***	-***	-**	-***	-	-***	-***	-***	-***	-	-	-***			
Navarra	+*	+	+	+	+	+	+***	+	+	+	+**	+***	+	+	+***		
País Vasco	+***	+	+	+	+	+	+***	+	+*	+	+	+***	+	+***	+***	=	
La Rioja	-	-	-	-	-	-	+	-	-	-	-	+	-	-	+	-***	-***

Notes: See notes of table 2.

Table A.3
Contrasts of Lorenz dominance. Hypothetical wages 1. 2002.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	+																
Aragón	-	-															
Asturias	-	-	+														
Baleares	-	-	+	=													
Canarias	=	=	+	+	+												
Cantabria	-	-	x	=	-	-											
Castilla-La Mancha	-**	-**	-	-	-	-	-										
Castilla y León	-	-	+	+	=	-	+	+									
Cataluña	+**	x	+	+	+	+	+	+***	+								
Comunidad Valenciana	+	-	+	x	+	=	+	+	+	-							
Extremadura	-	-	+	=	-	-	=	=	-	-	-						
Galicia	+	+	+	+	+	+	+	+	+	x	+	+					
Madrid	x	x	+	x	+	-	+	+	+	-	-	+	-				
Murcia	-	-**	x	-	-	-	-	=	-	-*	-	=	-	-			
Navarra	-	-	=	-	-	-	=	=	-	-	-	=	-	-	=		
País Vasco	+	x	+	+	+	+	+	+***	+	x	x	+	x	x	+	+	
La Rioja	-	-	-	-	-	-	=	-	-	-	-	-	-	-	-	-	-

Notes: See notes of table 2.

Table A.4
Contrasts of Lorenz dominance. Hypothetical wages 2. 2002.

	Spain	And.	Arag.	Ast.	Bal.	Can.	Cant.	C-LM	C-L	Cat.	C.Val.	Ext.	Gal.	Mad.	Mur.	Nav.	P.V.
Andalucía	+																
Aragón	+	-															
Asturias	+	-	=														
Baleares	+	-	+	=													
Canarias	=	-**	-	-	-												
Cantabria	x	-	-	-	-	x											
Castilla-La Mancha	=	-	-	-	-	=	-										
Castilla y León	=	-	-	-	-	+	x	=									
Cataluña	+***	-	=	=	-	+	+	+	+								
Comunidad Valenciana	+	-	+	+	=	+	+	+	+	x							
Extremadura	-	-	-	-	-	-	-	-	-	-	-						
Galicia	x	-***	x	x	-	+	x	x	X	x	-	+					
Madrid	-	-*	-*	-*	-	-	-	-	-	-***	-	x	-				
Murcia	-	-*	-	-	-	-	-	-	-	-	-	=	-	x			
Navarra	+*	x	+	+	+	+	+	+*	+	+	+	+**	+	+**	+**		
País Vasco	+***	x	+	+	+	+*	+	+***	+*	+	+	+***	+	+***	+***	=	
La Rioja	=	-	=	=	=	=	=	=	=	-	-	+	-	+	+	-	-

Notes: See notes of table 2.

2009

2009/1. Rork, J.C.; Wagner, G.A.: "Reciprocity and competition: is there a connection?"
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