Analysis of Education Wage Premium in Spain

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1st October 2007

Abstract

We estimate the demand for education in Spain, and use the estimated demand curve to analyze whether the evolution of the education wage premium in the 1980s and 1990s can be explained by a demand-supply framework. Our empirical results show that growth in the demand for education in the 1980s was very similar to growth in the 1990s. Differences in the evolution of the education wage premium between the two decades can be explained by combining observed changes in labor supply with stable labor demand growth.

JEL codes: J24, J31, O33

*U. Pablo de Olavide. I thank to participants in the VI Workshop on International Economics organized by Departament of Theory and Economic History (University of Málaga) and in the Department of Economics seminars in University of Pablo de Olavide for very useful comments. I specially thank to Jesus Rodriguez, Antonio Ciccone and José Ignacio García for very useful suggestions. I gratefully acknowledge support of project 30.07.10.27.01 (Efectos de las políticas fiscales y sociolaborales sobre el crecimiento). Ctra de Utrera, s/n, 41013, Seville, Spain. Email: mhidper@upo.es

1 Introduction

The last decades have seen substantial heterogeneity in the evolution of the education wage premium, both across countries and over time. A natural starting point for analyzing these differences is the demand-supply framework (D&S) (Katz, Loveman, and Blanchflower 1995, Gottschalk and Smeeding 1997, Gottschalk and Joyce 1998, Acemoglu 2003). The purpose of the D&S framework is to examine whether the evolution of the education wage premium can be approximated by supply-driven movements along a labor demand curve with a stable slope, plus shifts in labor demand. The results have been quite encouraging in a variety of contexts. Katz and Murphy (1992), for example, conclude that the education wage premium in the U.S. between 1963 and 1987 can be explained by stable, secular shifts in the demand for educated workers combined with observed changes in relative supply. Katz, Loveman, and Blanchflower (1995) show that the D&S framework is also useful for understanding the evolution of the wage premium in 4 OECD countries (the U.S., U.K., Japan and France). Card, Kramarz, and Lemieux (1999) incorporate wage-setting institutions in a D&S framework and show that this helps explaining relative wage trends among less-skilled workers in the U.S., Canada and France in the 1980s. And Acemoglu (2003) finds that the D&S with stable, secular shifts in the demand for educated workers can account for the differences in the evolution of wage inequality between Finland and Norway.

Our goal here is to analyze whether the D&S framework can help in explaining the evolution of the education wage premium in Spain during the 1980-2000 period. While the Spanish education wage premium has been studied quite intensively,[1] the literature has not yet explored whether some of the facts may fit with the D&S framework. Our main finding is that the evolution of the Spanish education wage premium in the 1980s and the 1990s can be well approximated by combining the observed changes in labor supply with stable growth in the demand for education over the 1980-200 period. Interestingly, our estimates of the slope of the Spanish demand curve for education and our estimates of

[1] See Abadíe (1997), Arellano, Bentolila, and Bover (2001), Torres (2002) and Martinez-Ros (2001) for example.

growth in Spanish education demand are quite similar to U.S. estimates for the same period.

One of the key elements of the D&S framework is the slope of the demand curve for education (which, in the standard D&S framework, is the inverse of the elasticity of substitution between more and less educated workers). The main difficulty faced when estimating this slope is that the supply of education and the education wage premium are determined simultaneously by demand and supply. Estimation therefore requires solving the standard identification problem (see Hamermesh, 1993, for a summary of this problem in the context of labor demand estimation). The empirical literature on the demand curve for education stretches back to the 1970s. Johnson (1970) using a cross section of U.S. states in 1960, estimated the elasticity of substitution between more and less educated workers to be 1.34. Ciccone and Peri (2005), using a panel of US states for the 1950-1990 period, found an elasticity of substitution around 1.5. They use a variety of instrumental-variables estimation methods, and employ Acemoglu and Angrist's (2001) state-time-dependent child labor and compulsory school attendance laws as instruments for changes in the supply of education. Angrist (1995) finds an elasticity of substitution around 2 using data on Palestinian workers in the West Bank and the Gaza Strip during the 1980s. He uses the number of local higher-education institutions as an instrument. Fallon and Layard (1975) obtain an estimate of the elasticity of substitution of 1.49 with cross country data, using income per capita as an instrument for the supply of education. Caselli and Coleman (2000), who apply a D&S framework with endogenous technology adoption to cross-country data, obtain an elasticity of substitution of 1.31. Katz and Murphy (1992), on the other hand, obtain the elasticity of substitution with U.S. time-series data for the 1963-1987 period. They find an elasticity of substitution around 1.4. For Spain, the national time series data is insufficient to estimate the elasticity of substitution. We therefore adapt the KM approach to estimate the elasticity of substitution in a panel of Spanish regions. The instruments used to predict the regional evolution of education supply will be the beginning-of-period population structure. This approach ends up yielding an estimate of the elasticity of substitution between more and less educated workers in Spain that is close to KM's and CP's US estimates.

Our estimate of the slope of the Spanish demand curve for education for the 1980-2000 period allows us to implement the D&S framework to see how well it can explain the evolution of the Spanish education wage premium in the 1980s and 1990s. The main empirical result is that the fit between the evolution of the education wage premium predicted by the framework and the actual evolution is quite close. For example, our estimates imply a fall in the relative wage of more educated workers during the 1980s of 0.6% and an increase of 1.1% in the 1990s, which comes close to the actual 0.7% drop of relative wages in the 1980s and the 1.4% increase in the 1990s. Interestingly, we find that the rate of growth of education demand in Spain was quite similar in the 1980s and 1990s, 2.7% in the 1980s and 3.1% in the 1990s. These estimates are close to estimates for the U.S.; for example, Katz and Murphy (1992) estimate relative US demand shifts of around 3.3% per year, while Acemoglu (2002) reports an increase of around 2.5% per year.

Our conclusions are robust to accounting for the role of labor-market institutions. Wage-setting institutions have been considered as a possible explanation for the heterogeneity of cross-country wage inequality changes, specially in Europe (Acemoglu 2003). Collective bargaining and minimum wages are the most popular reasons put forward (see Card, Kramarz, and Lemieux, 1999, in comparisons between the effects of institutional changes on the wage premium in the US, Canada and France and Abraham and Houseman, 1993, for the case of Germany). As Spanish wage-setting institutions fit into the "European model", we examine whether our conclusion regarding the D&S framework applied to Spain are affected by accounting for effects of institutional changes on the evolution of the education wage premium. In particular, we show that our conclusion remain unchanged when we exclude wage categories that could have been affected by collective bargaining.

The rest of the paper is structured as follow: section 2 explains the data used. Section **??** explains how to obtain accurate relative wage and worker supply estimates. Section 4 presents the estimation and decomposition results. Section 5 evaluates the possible effects of institutional change on relative demand estimates and section 6 concludes.

2 The Demand and Supply Framework

According to the demand and supply framework, the relative wage of more relative to less educated workers (the education wage premium) is determined by education demand and supply. The simplest model of relative demand is based on the constant elasticity of substitution (CES) firm-level production function (see, for example, Katz and Murphy, 1992). The model assumes that firms f have access to the following production function : [2]

$$Y = [A_f L^\rho + B_f H^\rho]^{\frac{1}{\rho}} \tag{1}$$

where Y is output, H is the input of more educated (skilled) workers, and L the input of less educated (unskilled) workers. A_f and B_f denote the levels of factor-augmenting technology that the firms has access too. And ρ determines the elasticity of substitution between factors σ according to the equation $\sigma = 1/(1-\rho)$; hence, and if $\rho \leq 1$ is necessary for the technology to be convex and the education demand curve to be well-defined ($\rho = 1$ corresponds to the case where the two types of labor are perfect substitutes, while $\rho \to -\infty$ implies that there is no substitutability at all between more and less educated workers).

Firms are assume to take wage in the labor market as given when they make their hiring decisions. In this case, the firm's profit-maximizing demand (D) for education (the relative demand for more relative to less educated workers) is

$$\left(\frac{H}{L}\right)_D = \left(\frac{B_f}{A_f}\right)^\sigma \left(\frac{w^H}{w^L}\right)^{-\sigma},$$

where we have used that $\sigma = 1/(1-\rho)$.

The D&S framework can be applied to the regional level by assuming that firms in region i have levels of factor-augmenting technology $A_f = A_i$ and $B_f = B_i$. A region's equilibrium education wage premium can now be determined by equating education demand with education supply $(H/L)_{iS}$ in the region,

$$\left(\frac{w^H}{w^L}\right)_i = \left(\frac{B}{A}\right)_i \left(\frac{H}{L}\right)_{iS}^{-\frac{1}{\sigma}}.$$

[2] Different interpretations of this technology are presented in Acemoglu (2002).

Taking logs on both sides yields

$$\omega_i = b_i - \frac{1}{\sigma} h_{Si}; \tag{2}$$

where $\omega_i = Ln(w^H/w^L)$, $b = Ln(B/A)$ and $h = Ln(H/L)$. Taking differences over time yields

$$\Delta\omega_{it} = \Delta b_{it} - \frac{1}{\sigma}\Delta h_{iSt}. \tag{3}$$

Changes in the education wage premium, $\Delta\omega_{it}$, are equal to shifts in education demand, Δb_{it}, plus supply-driven movements along the education demand curve, $-\frac{1}{\sigma}\Delta h_{iSt}$. The strength of this effect of supply changes on the wage depends the slope of the inverse education demand curve, $1/\sigma$, which is the inverse of the elasticity of substitution between more and less educated workers. When the elasticity of substitution is high, supply changes will have small effects on the education wage premium (the inverse demand curve is flat). As the elasticity of substitution between more and less educated workers falls, the education wage premium becomes more sensitive to change in education supply. Figure 1 illustrates the relative wage effects of demand shifts and supply-drive movements along the demand curve graphically. An increase in the relative supply, from h to $h^{'}$ moves the equilibrium point along the downward sloping relative demand curve (A to B) and reduces the education wage premium. A positive increase in relative demand moves the equilibrium point to C and increases the education wage premium. Mixing both shifts changes the wage premium, however final location of equilibrium point D and wage premium increase or decrease depends on which of both shifts prevails.

The key feature of (3) from our point of view is that, once the elasticity of substitution between more and less educated workers has been estimated, it can be used to determine the role played by supply and demand for the evolution of th education wage premium. Estimating the elasticity of substitution requires valid instrument for changed in the regional supply of education in order to resolve the standard simultaneous equation identification problem.

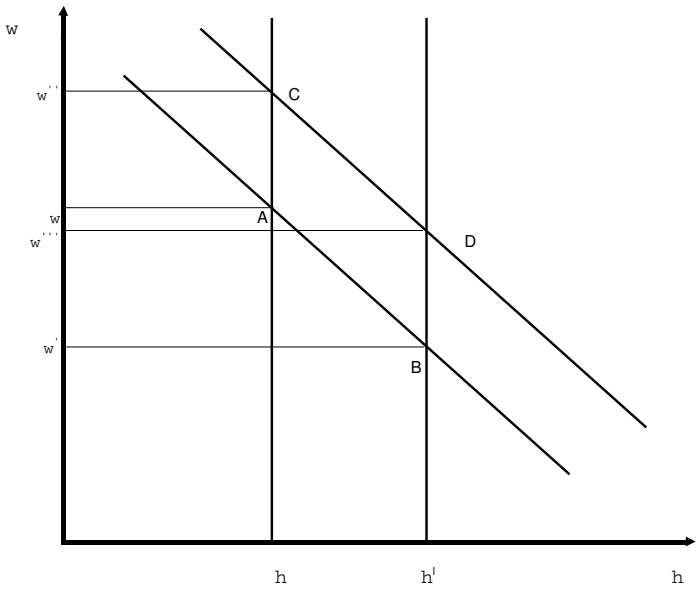


Figure 1: The Relative Demand for Education.

3 Data and Measurement

3.1 Data

Various surveys have been conducted to estimate the relative demand for more educated workers. This paper draws regional relative supply series from aggregate series on education-classified employment compiled by the Instituto Valenciano de Investigaciones Económicas (IVIE) (The Valencian Institute for Economic Research.)

Regional relative wage data series were constructed from data drawn from the Spanish Household Budget Survey (Encuesta de Presupuestos Familiares, EPF, in Spanish) which covers individual wages, educational level and other characteristics. There are other candidate sources[3] but unfortunately none of them provides sufficient information (they either lack specific data on certain critical variables, like education, or,

[3]The Wage Structure Survey, the Survey of wages in industry and services, the Labor Cost Survey and the Quarterly Labor Cost Survey.

when they have the data, they cover only very short periods). EPF is also preferred because, first, despite adjustments in methodology over the years, most of the characteristics requested from workers are homogeneous, and, second, for the sake of comparability, because other Spanish studies have used these data.[4]

Individual Wages

Regional education wage premium were calculated from Household Budget (EPF) and Continuous Household Budget (ECPF) Survey data.[5] Although the main focus of these surveys is household consumption, they cover a wide range of individual characteristics, such as education, age, region, annual wage, type of employment contract, etc. These are EPF surveys for 1974, 1980-81 and 1990-1991 and ECPF surveys for every quarter since 1985. Because this paper evaluates the long-run, it concentrates on structural change and uses only data from 1980-1981, 1990-1991 and adjusted quarterly ECPF for the years 2000 and 2001. The 1974 survey is not considered because it provides no clear education data.

Despite some differences, the information given by EPF and ECPF are closely similar. Because the information for some individuals is incomplete, the data used are for heads of family, [6] between the ages of 20 and 65 only footnote This range was taken because some individuals below the age of 20 may bring education to the job, whereas I am interested in the connection between skills (finished, if possible) and wages. and working under a full-time contract.[7] The self-employed were dropped. The data for the chosen selection include wage in current pesetas, age, and level of education. Because schooling is not equally

[4]For a more complete analysis see Hidalgo (2006)

[5]Dating from 1985, but with a change in methodology in 1997 and processed by the Spanish National Institute of Statistics (INE)

[6]In 1990-91 and 2000-01 some characteristics are included for the head of family only.

[7]Because wage bills are expressed in total wage per year and there are no available data for number of hours worked, I homogenize the data by considering only self-declared full-time workers.

described for the entire period, the data are homogenized by using the minimum number of years needed to achieve the given level of schooling. The various levels of education were linked with years of schooling, following an approach used in other research on Spain (Vila and Mora 1998).

Supply Data

Relative supply was taken from Instituto Valenciano de Investigaciones Económicas (IVIE) time series (Mas, Pérez, Uriel, Serrano, and Soler 2002). This institution compiles 1964-2001 time-series data on employment, unemployment, and working-age population, for different sectors and regions and classified by education levels, as follows:

1. Illiterate
2. None or primary only (total less than eight years of schooling).
3. Lower level secondary education (total between eight and twelve years of schooling).
4. Complete secondary education (total of thirteen years)
5. College degree (total of sixteen-eighteen years)

Less educated (skilled) workers are defined as belonging to one of the second and third groups (the illiterate category is dropped because of its almost null weight). Then, a worker is defined as lower skilled worker when he has completed less than twelve years of schooling. A higher educated (skilled) worker is a member of one of the other groups.

These definitions are quite similar to others that have been defined for the US, UK and other countries analysis.[8]

[8]Acemoglu (2002) defines this classification for the US. However, he considers this a simplification in a context in which there is a continuum of imperfectly substitutable skills.

3.2 Measurement and Descriptive Stats

Education Wage Premium

The problem when estimating the education wage premium is that individual non-education characteristics bias the education cohorts' wages, and thereby relative wages. No treatment would mistake other differences in individual characteristics (i.e. experience, gender...) for changes in the education relative wage. Thus, there are two possible strategies. The first would give a narrow definition of worker cohorts using all the individual characteristics available, after which it would be possible to calculate relative wages for each cohort and derive the aggregate relative wages using weights. Estimates for the remaining years would be obtained in the same way, using constant weights in order to remove any other subject-specific effects on aggregate relative wages.

Implementation of this strategy requires a great detail of information, however. The greater the number of records, the more narrowly the cohorts can be defined. Because EPF and ECPF have not a wide range of data, the second strategy, which is the one used in this paper, is to isolate schooling effects in wages. This method is based on a Spanish regional Mincer equation estimation (Mincer 1974), which obtains cleaned wage data for each year and region using the estimated coefficient for years of schooling (the education variable).

Thus, the following equation was estimated for j individuals, in year t and region i:

$$ln(w^i_{j,t}) = \alpha^i_t + \beta^i_t S_{j,t} + \gamma^i_{1,t} E_{j,t} + \gamma^i_{1,t} E^2_{j,t} + \mu^r_t X_{j,t} + \varepsilon_{j,t}; \quad \text{for i} = 1, ..17 \tag{4}$$

The left hand side represents the logs of individual wages and the right hand side the wage-explanatory variables: schooling (years of education, $S_{j,t}$), experience ($E_{j,t}$), and other k variables (represented by the $k \times 1$ vector $X_{j,t}$) such as marital status, sector index, gender... The definition of the logs implies that β^i_t is the return to education, which

means the percentage change in region $i's$ wages as a result of one extra year of education. Experience is calculated as age minus the years needed to achieve the level of education minus six.

Special attention must be given to the likely event of endogenous correlation between education and wages, which is a problem generated by non-observable characteristics, such as ability, which are correlated with education. This endogenous correlation implies that the Mincer estimation gives biased coefficient estimates. One solution is to use instruments correlated with errors or non-observable characteristics. But these are hard to obtain for Spain.

Some Spanish studies estimate return to education using instrumental variables. But none have used EPF or ECPF for this purpose, because these surveys do not provide suitable instruments. For example, Barceinas et alia (2000) used Wage Structure Survey and changes in Education Laws as instruments. Pons and Gonzalo (2001) used the European Community Household Panel and a Survey of Structure, Conscience and Biography of Class and other instruments such as Education Law, family background... in a two-stage least square procedure to estimate return to education. Other papers have tried the same method for Spain (i.e. Garcia et al., 2001). In all these cases, the surveys used provide tools for the estimations. The surveys used here, however are hardly difficult, so it is better to assume some potential upward bias due to inadequate instruments. This is the option taken in this paper. Then, implicitly this paper assumes that bias is constant through time, so analysis with first differences might remove this problem. Then, the (4) estimation has been done by OLS. This specification implies that, previous schooling level achieved is not important for one more year and for wages increases. In other words, the wage increase due to one more year of schooling is the same for worker with a secondary education as it is for one with a primary education. This assumption can be dropped if dummies for each level of schooling are used instead of years. Then, however, it is found that there is insufficient information for some regions and some education categories. For example, regions like Rioja lose estimation potential, because not all the coefficients associated with these dummies are accurately estimated, and the analysis is therefore far from conclusive. This is the reason why it has been used only one variable to condensate the

Table 1: Spanish Returns to Education. 1980/81, 1990/91 and 2000/01.

	1980-81	1990-91	2000-01
β_t	0.064	0.060	0.070
	(0.001)	(0.001)	(0.003)

Note: Estimations for 1980/81 and 1990/91 are based on EPF and 2000/01 on ECPF. β_t represents the average return to education for Spain. Data in parenthesis represent standard deviations. The re- turns are estimated using Mincer equations and OLS. The sample is limited to heads of family and non self-employed workers.

education information.

Table 1 shows the Spanish average estimated β. These are the coefficients obtained when (4) is estimated using all the Spanish data.[9] These coefficients show that the return to education falls during the eighties and slightly increases during the nineties. These results are similar to those found for other countries (see for some examples Gottschalk and Smeeding 1997, Freeman and Katz 1995, Acemoglu 2003). There are other previous similar results for Spain. For example, Abadíe (1997) finds that Spanish wage inequality falls during eighties, partly due to a decrease in return to education. But other works point in a different direction, maybe because of the use of different surveys to compare trends in the return to education.[10]

Once the returns to education have been estimated, relative wages are calculated (in log terms) for each region and year,

$$\omega_{it} = ln(w_{it}^H) - ln(w_{it}^L),$$

[9]Some of the values of the estimated regional coefficients are not shown.

[10]Barceinas, Oliver, Raymond, and Roig (2000b) estimated the return to education using EPF for 1980 and ECPF for 1985 - 1996. They found that return to education increased during this period with a depressible short period between 1985 and 1991. This implies that despite the similarity of the long-term trend; the trend between 1980 and 1990 is different. They estimated a return to education of 5.9% for 1980 and 7.0% for 1990. The estimates obtained in this paper are 6.4% for 1980, 6.0% for 1990 and 7.0% in 2000. The major differences in the 1990 figures are due to the use of ECPF data for that year.

where w_{it}^H and w_{it}^L are the wages of the more and less educated for region i and year t. Using (4) the relative wage premium can be approximated by

$$\omega_{it} = \beta_t^i(S_{it}^H - S_{it}^L); \tag{5}$$

where S_{it}^H and S_{it}^L are the regional average years of schooling for more and less educated workers in year t.

Relative Supply

To obtain relative supply, it is first necessary to aggregate the different education subgroups into the two more and less educated categories in efficiency terms.[11] To be more concise, each subgroup is aggregated by

$$L_{it} = L_{it}^1 + a_{it}^L L_{it}^2,$$

where a_{it}^L is some parameter used to aggregate in efficiency terms. In this case, a_{it} is approximated by relative wages in region i and year t. L_{it}^1 and L_{it}^2 are the amount of workers in the two low skilled groups. The first group represents workers without any studies or only a primary school education.

Also, for more educated workers,

$$H_{it} = H_{it}^1 + a_{it}^H H_{it}^2,$$

where, as above, a_{it}^H are the relative wages among high skilled workers, and H_{it}^1 and H_{it}^2 represents their number. The first group consists of workers with pre-tertiary studies.

Then, the log of relative supply is defined as

$$h_{i,t} = ln\frac{H_{it}}{L_{it}}$$

[11] Without studies or primary and secondary-school for the less educated and pre-tertiary and tertiary for the more educated workers.

Descriptive Stats

Examining the Spanish results in Figure 2 and table 2, the logs of relative wage show a downward trend from 1980 to 1990 (0.51 and 0.43) and a sharp reversal between 1990 and 2000 (0.43 to 0.49), which implies a decrease of around -0.8% per year in the eighties and an increase of 0.6% in the nineties. This trend in the wage premium was contemporary with a sharp increase in relative supply of 5.2% in the eighties and 2.3% in the nineties. If relative demand has a negative slope, this evolutionary pattern, especially in the nineties, must be due to the existence of a demand shift which increases relative prices and compensates the rise in relative supply.

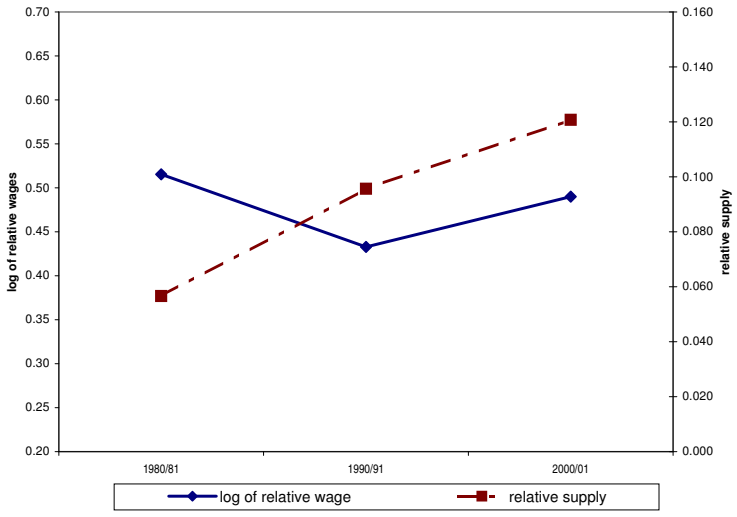


Figure 2: Education Wage Premium and Relative Supply of Skills in Spain. 1980-2000. (More educated workers have previous to college or college education)

Figure 3 represents the regional logs of relative wages and supplies between 1980 and 2000. This figure clearly shows a negative relation between the two variables for each year of that period. The region with

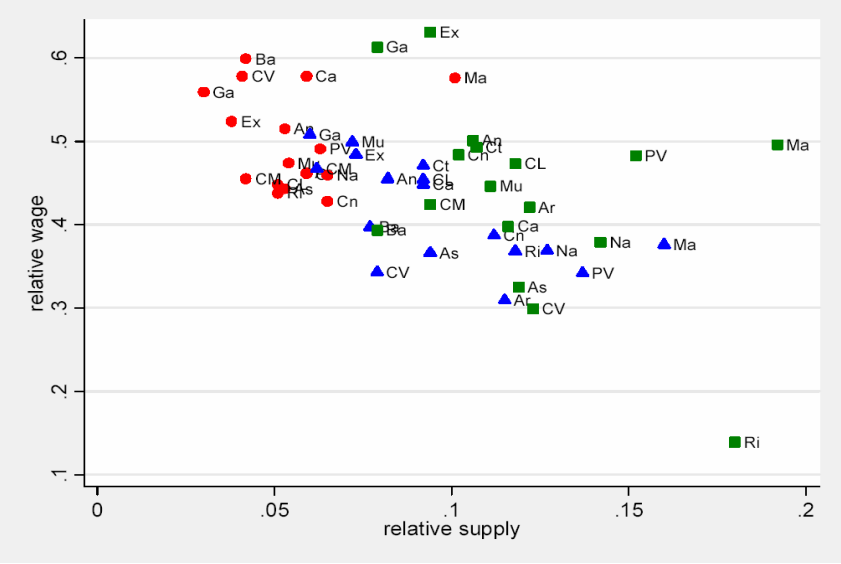
Table 2: Relative supply and logs relative wage in Spain.

	1980-81	1990-91	2000-01
w_t	0.51	0.43	0.49
h_t	0.057	0.096	0.121

Note: w_t denotes the Spanish average education wage premium for year t while h_t represents relative supply for better-educated workers.

the higher relative supply has the lower relative wage. Also, it can be assumed from these data that relative demand shifts, over decades, to the right, a trend that becomes more apparent in 2000. Then, the main interest lies on this estimated negative relation that takes into account regional and inter-decade differences.

Figure 3: Regional relative wages and supplies.



Note: Better-educated workers are those with pre-tertiary or tertiary education

(Red circles are 1980/81, blue triangles are 1990/91 and green squares are 2000/01)

The weakness of this exercise is that these results are given by the two group aggregation strategy. That negative slope for the relative demand depends on the groups it is comparing. Then, alternative education classifications could be used. For example, secondary-educated workers might be included as skilled workers and then, only primary (or less) educated workers would be considered unskilled. If this new definition is used to replicate the measurement explained above, the wage premium and the relative supply show the pattern presented in table 3 and figures 4 and 5.

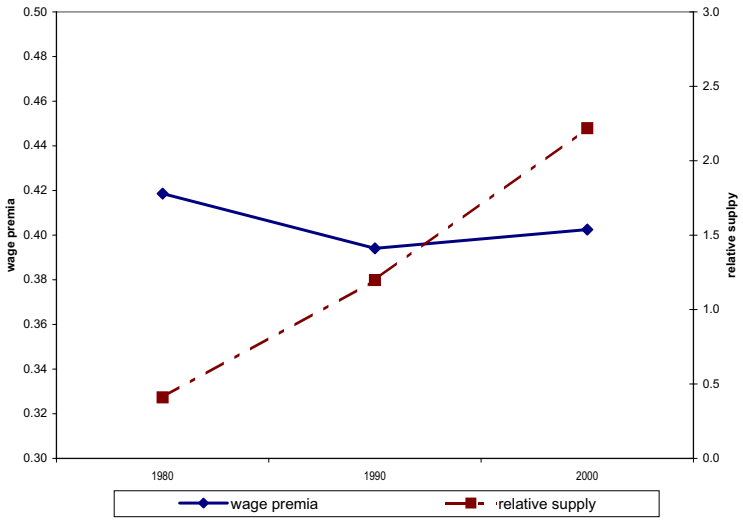


Figure 4: Education Wage Premium and Relative Supply of Skills in Spain. 1980-2000. (More educated workers have secondary or higher education)

The pattern is quite similar but prompts some comments. First, there is a higher increase in the supply rate of secondary-educated workers during this period, especially in the nineties. Thus, thinking in relative demand and supply terms, this explains the lower increase in the relative wage for this group relative to the pre-tertiary group. Second, figure 5 shows that the negative slope persists except for 2000. The main reason is likely to be the huge increase in secondary-educated workers during the eighties together with great heterogeneity across the regions. Nevertheless, while acknowledging the need for further

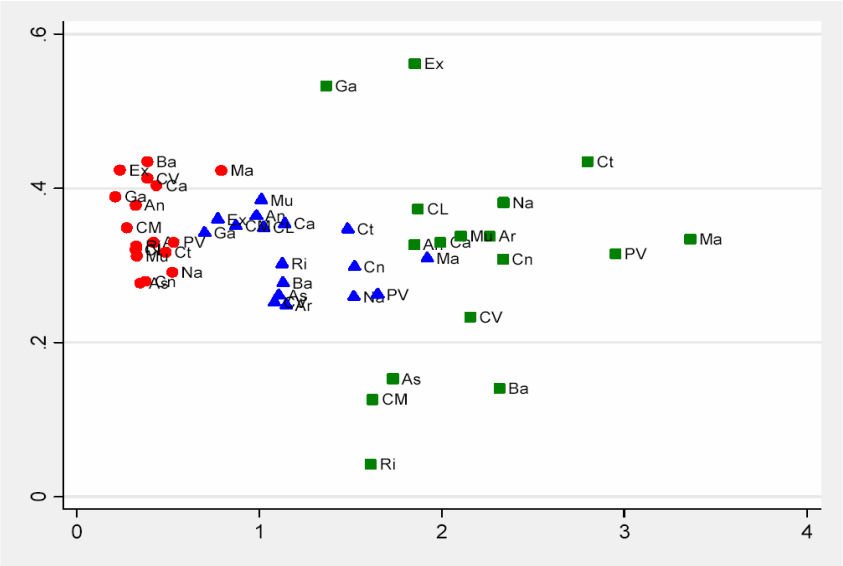
Table 3: Relative supply and logs relative wage in Spain (II)

	1980-81	1990-91	2000-01
w_t	0.42	0.39	0.40
h_t	0.41	1.20	2.22

Note: w_t denotes the Spanish average education wage premium for year t while h_t represents relative supply for better-educated workers.

explanation for the last year of the period, each classification generates a downward-sloping relative demand curve.

Figure 5: Regional relative wages and supplies (II).



Note: Better-educated workers are those with a secondary education or higher

(Red circles are 1980/81, blue triangles are 1990/91 and green squares are 2000/01)

4 Estimation and Results

Using regional data, the endogenous relation between relative supply and relative wage change implies the identification problem expressed by equation (6).

For the purpose of estimating (equation above) with regional data, it will be useful to write it as

$$\Delta\omega_{it} = \Delta b_t - \frac{1}{\sigma}\Delta h_{iSt} + (\Delta b_{it} - \Delta b_t). \tag{6}$$

where Δb_t captures national shifts in education demand, $-(1/\sigma)\Delta h_{iSt}$ captures supply-driven movements along regional education demand curves, and $\Delta b_{it} - \Delta b_t$ are regional shocks to labor demand.

The regional long-run relative supply of better educated workers is likely to be positively correlated with shifts in regional relative demand (v_{it}), which implies that coefficient $\rho-1$ cannot be estimated using least squares, the main reason being possible migration between regions with different relative wages due to the high probability of workers' moving to higher relative wage regions from areas that pay a lower education premium. Alternatively, people living in regions where skills are highly paid may decide to remain in school longer and accumulate more skills, thus increasing the supply of highly-skilled workers. Then, in areas with a faster-growing education premium, the relative supply might also grow at a higher rate. These reasons would induce a positive relation between relative wages and relative supplies so that the estimation of $\rho - 1$ for a higher relative wage region is positively biased. Therefore this paper relies on instrumental variable estimation.

Of course, previous works have already tried to tackle the task using a variety of instruments. Some authors have relied on microeconomic estimates of the elasticity of substitution (Johnson 1997), on restrictions and structural specifications (Krusell et al 2000) or on simple assumptions such as the constancy over time of skill-biased technological change (Katz and Murphy 1992). But the paper that comes closest to our objective is that of Ciccone and Peri (2005), who use Acemoglu and Angrist (2001) state-dependent child labor and compulsory school attendance laws as instruments for (endogenous) changes in the relative supply of more educated workers in the U.S. states between 1950

and 1990.

Such instruments can not easily be found for Spain. In this case, the proposed instruments are demographic variables correlated with the variation of relative supply, but not with changes in relative wages, so they will be able to identify the relative supply. The population structure is assumed to be weakly exogenous to the process of technological change and capital accumulation possibly underlying relative demand shifts. Then, intuition suggests demographic variables to be good candidates because they respond to variation in conditions that are external to economics.

The intuition is straightforward. Suppose a region with, say, higher youth than adult participation at the beginning of a period. Assuming that all the regions are likely to offer the same educational opportunities, [12] the participation of better-educated workers in the labor market can be expected to grow at a faster rate in the coming years. Equal opportunities combined with different levels of participation for different population age-segments boost the supply of skilled workers to higher levels.

This paper therefore hopes to estimate consistently $\rho - 1$ by means of instrumental variable estimation (IV) using population instruments that are correlated to the relative supply shifts but uncorrelated to the relative demand shift.

The candidate instruments are demographic variables correlated with relative supply growth, but not correlated with relative wage growth. Intuition says that demographic variables are good candidates because they respond to variation in conditions that are external to economics, as revealed by the Spanish Population Census for 1981 and 1991. This instrument, therefore, is the share of people aged between 16 and 20 in each region's population.

Figure 6 shows the relation between the share of people aged between 16 and 20 at the start of the period and the variation in relative supply over the following ten years. This picture tells the expected story: there exits a direct relation between these two variables, so this instrument can be supposed to be of use in obtaining an unbiased es-

[12] The characteristics of the Spanish education system are largely homogeneous across regions, although responsibility for education has been devolved to local authorities in some regions.

timation for $\rho - 1$.

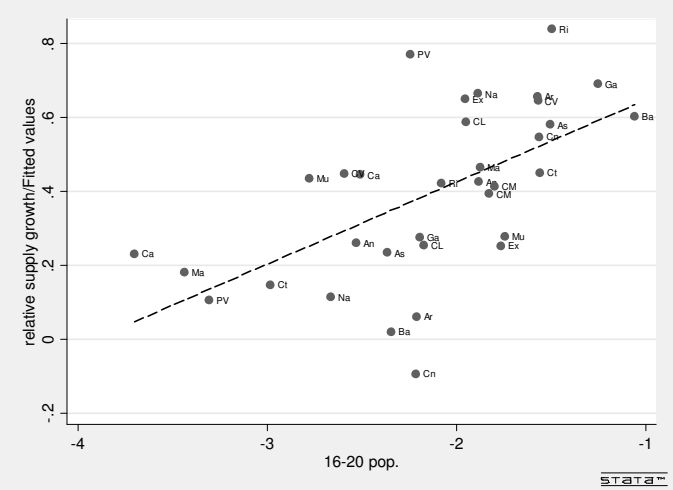


Figure 6: Relation between instruments and relative supply growth

Table 4 presents the first stage regression. The introduction of fixed effects to control for region-specific features that may influence the relative supply trend as well as the instruments, does not change the results. The estimation implies that a one percent increase in the share of population aged between 16 and 20 increases the relative supply growth by 22% over the following ten years. A five percent increase would double relative supply growth. Therefore, the regional share of people aged between 16 and 20 is a good candidate instrument for the estimation of relative demand.

Then, using the described instrumental variable estimation, the results of the second stage estimation of equation (**??**) are presented in table 5. Estimating in first differences avoids those heterogeneous characteristics that are constant through the time. In this case, fixed effects represent the regional relative demand shift and the nineties dummy is an average, because a common coefficient was estimated for all regions, these shifts differ according to the decade that is observed.

(**??**) might also have a mis-specification problem because of omitted

Table 4: First Stage Regression.

Dependent Variable	Changes in log of relative supply.			
	I		II	
16-20 years old	0.229	***	0.428	***
	(0.069)		(0.106)	
Constant	0.877	***	1.242	***
	(0.131)		(0.194)	
fixed effects	no		yes	
R^2	0.307[1]		0.601	
F-statistic	8.32		11.31	

Note: dependent variable are log changes in regional relative supply due to extra education.
The regressor (the 16-20 age group variable) represents the regional share in total population of people aged between 16 and 20.
Column I shows results exclusive of fixed effects, while column II shows results inclusive of fixed effects.
Data in parenthesis are standard errors.
*** means signicance at 1%.
(1) In I regression is adjusted R^2

variables. Robustness checks were therefore performed using other variables such as physical capital stock per worker for all sectors, physical capital per worker in intensive ICT sectors and level of employment.[13] Data on physical capital per worker is available from BD-Mores, which is published by the Spanish Ministry of Economy (Department of Economy). Some kind of capital may be more complementary with more-educated workers. This is well-known in the case of ICT capital.

The issue is addressed by introducing series of regional capital per worker, aggregate and ICT-sector-specific data. Moreover, this last variable serves to calculate whether cross-sector changes in regional production may affect the education wage premium. Finally, the log of end-of-period employment controls for possible scale effects.

At a first glimpse, the results show that the slope is roughly between -0.58 and -0.65. Therefore, the first result is clearly the downward sloping relative demand for better- educated workers. This result only shows what was obviously apparent in the previous information. In all cases, the null hypothesis of the slope being equal to zero is rejected at the ten percent level at least. The robustness checks uphold the findings in all cases. Importantly, the trend also upholds the results. The hypothesis of different relative demand shifts between decades is rejected with these data. This implies that the steady demand hypothesis for Spain between 1980 and 2000 cannot be rejected.

Remember that, once the slope has been obtained, the elasticity of substitution value (σ) between skilled and unskilled workers can then be derived. When (**??**) is used for this, the value is around 1.5, which is similar to estimates for some other countries. Johnson (1970), for example, estimates the elasticity of substitution between more and less educated workers to be 1.34, using a cross section of U.S. states in 1960. Fallon and Layard (1975), using income per capita as the estimation instrument, found the elasticity of substitution between less and more educated workers for cross country data to be 1.49. Angrist (1995), studying the relationship between the return to education and the relative supply of better-educated workers among Palestinians in the West Bank and the Gaza Strip during the 1980s, reported elasticity of substitution to be around 2. Caselli and Coleman (2000) estimated

[13] ICT (Information and Communication Technology) sectors are those with a high technological content (Mas, Pérez, and Uriel 2006).

Table 5: Relative Demand Estimation

Dependent variable: log changes in regional education wage premium.

	I	II	III	IV
Δb_t	0,275***	0,245**	0,281***	0,024
	(0.084)	(0.114)	(0.082)	(0.291)
$\rho - 1$	-0,654***	-0,596**	-0,654***	-0,582***
	(0.199)	(0.251)	(0.207)	(0.176)
γ	0.066	0.064	0.077	0.063
	(0.140)	(0.139)	(0.141)	(0.132)
Δk	-	0,116	-	-
	-	(0.291)	-	-
Δk_{ict}	-	-	-0,050	-
	-	-	(0.294)	-
employ.	-	-	-	0,035
	-	-	-	(0.044)
Adj. R^2	0,48	0,49	0,48	0,49
n	34	34	34	34

Note: The dependent variable is changes in logs of regional relative wages due to extra education. Δb_t estimates changes in the(inverse) relative demand intercept. $\rho - 1$ estimates the coefficient associates to changes in logs of regional relative supply due to extra education or the (inverse) relative demand slope. γ is the coefficient of the dummy variable, which takes zero values for the eighties and ones for the nineties. Δk are changes in logs of regional physical capital per workers and Δk_{ict} are changes in logs of regional physical capital per workers in ICT sectors. Employment responds to log of regional employment at the start of the period. All estimations are performed controlling for regional and time effects.
*** implies significance at 1%, ** at 5% and * at 10%.
Values in parenthesis are standard deviations.

the aggregate elasticity of substitution between more and less educated workers using cross-country data to be 1.31. Katz and Murphy (1992) reported an estimated aggregate elasticity of substitution between more and less educated workers using U.S. time-series data for the 1963-1987 period of around 1.4. Ciccone and Peri (2005) using different estimation methods argue that long run elasticity of substitution in the US between 1950 and 1990 was between 1 and 2.

Special attention is also due to the constant coefficient, which is estimated at 0.275 (the average value for Spain) when fixed effects are introduced with a common constant. Because this coefficient measures the increase (or decrease) in relative demand over a ten-year period, the average shift per year in Spain is around 2.8%. As is well known, the US values fall between these two limits, as obtained by Katz and Murphy (1992), who report a value of 3.3%. However Ciccone and Peri (2005) estimates relative demand shifts for the US states between 1950 and 1990 to be between 5% and 7% depending on the decade.

This result only reveals that the relative demand for better-educated workers has grown by around 3% per year. This value appears to offset the nineties increase in relative supply and prevents a greater fall in relative wages in the eighties.[14] The reason for this growth deserves deeper analysis in the future.

Thus, the estimation yields two important results. First, that relative demand grows at a similar rate, around 3%, between the 80s and the 90s, which is close to estimates for other countries. Second, the elasticity of substitution is also quite similar to that of other countries. It appears, therefore, that all those characteristics specific to Spain, that may imply a different level of substitutability between different workers, lack importance. [15]

Estimation of (**??**) allows us to simulate a decomposition of the education wage premium growth between relative demand and supply

[14]Recall that relative supply grew by 5% in the 1980s and by 2.3% during the 1990s

[15]This intuition comes from the definition of elasticity of substitution as a technical parameter. I assume that (1) represents how consumers combine different quantities of two kinds of goods, one with a high skill component, the other with a low skill component. With this interpretation, I can assume that the aggregate consumer utility function in Spain is not widely different from in other countries. In other words, preferences are fairly similar or homothetic.

Table 6: Decomposition of Relative Wage Changes.

	wages	supply	demand	error
1980/81 − 1990/91	-0,7	-3,4	2,8	0,0
1990/91 − 2000/01	1,4	-1,7	2,8	0,4
Average	0,4	-2,6	2,8	0,2

Note: *Supply* represents relative wage growth rates if the only change is in relative supply, or changes in relative wages along the relative demand curve. Wages are the values for relative wages derived from section 3.2. *Demand* represents the growth rates given by the common constant in (6).

or between movements along the relative demand and shifts in relative demand. Table 6 shows this exercise. The changes in relative wages only with relative supply change (along the relative demand curve) are approximately -2.6% for the whole period, but would be double in the eighties compared with the estimate for the nineties. Since changes in the relative wage in Spain grew at a rate of 0.4% between 1980 and 2000, this implies an average 2.9% increase in relative demand for the period. Shifts in relative demand can therefore be evaluated at around 3% and as constant for the whole period.

These results imply two conclusions. First, movements in relative wages are driven by two dominant forces. The first is the uneven movement in relative supply derived from major growth in Spanish education in recent decades. The second is an important relative-demand-shift effect. There is no doubt that relative demand played an important role in the relative wage trend between 1980 and 2000 in Spain. The following analysis is to evaluate to what extent this pattern is due to labor institutions and non-market forces. In other words, will relative demand shift estimates be affected by introducing institutions into the analysis? The next section will attempt only an initial approximation to these issues.

5 Labor Institutions

Perfect competition, the production function (1) and firm cost minimization imply that wages are becoming increasingly equal to marginal productivities. Perfect competition implies non-market interferences. But the influence of wage-setting institutions may change this result. Without institutions, using production functions such as (1), Δb_t represents relative demand movements along the relative supply curve because of market changes. But a different conclusion can be drawn if some of the wages are the result of an institutional deal, rather than market equilibrium. Also, changes in prices, brought about as the result of collective bargaining agreements, would induce relative demand changes, increasing (decreasing) factor demand at relatively lower (higher) prices.

Wage-setting institutions have changed in almost all countries during the last decades. The Spanish case, while being no exception, is an odd example. The new Constitution (1978) and laws expanding it,[16] drew up a new labor relation in the early eighties. The most important change in the Spanish wage structure, was newly centralized collective bargaining (CB) system,[17] which implies that wages are negotiated between unions and employers' associations, as in other European Countries, such as Germany.[18] A few years later, studies conducted to evaluate the consequences defined CB as the most influential labor institution to explain the wage structure and relative wages (Dolado, Felgueroso, and Jimeno 1997) (hereafter DFJ).[19] These authors explain that in Spain not all the wages are a direct function of or derived from CB. Spanish agreements set a floor only for wages and level of employ-

[16] Ley del Estatuto de los Trabajadores (1980)

[17] Almost 50 per cent of negotiations take place at sector and provincial level, followed by 26.6% at sector and national level.

[18] The results of these negotiations are binding on the parties, non-union affiliated workers included. Almost 80% of workers are covered by some collective bargaining agreement despite very low union affiliation.

[19] Dolado, Felgueroso, and Jimeno (1997) also explain that the real value of the minimum wage does not play any role in wage determination. They show that in the Spanish case, the floor in wage determination is given by wages negotiated in CB, which are higher than the minimum wage and not linked between them. Then, relative wages will be only influenced by those wages dealt by unions and firms associations.

Table 7: : Growth in Unemployment Rate by Education Groups in Spain.

	1980-85	1985-90	1990-95	1995-00
None or primary only	77.3	-20.1	51.6	-34.2
secondary	63.3	-35.4	28.8	-45.5
pre-tertiary	56.4	-27.5	47.2	-34.0
tertiary	75.4	-27.4	31.1	-43.7

Note: data from Human Capital Series compiled by IVIE. Spain

ment. But only about 18 percent of workers are paid at the negotiated rate, the rest being paid above it. Actual pay exceeded negotiated pay by 25.7 percent on average (Dolado, Felgueroso, and Jimeno 1997).

Two approaches have been used to evaluate institutional effects on wages. One is to use indirect observation to determine whether wage-compression due to CB is important, by analyzing to find which skill group is most affected by unemployment, for example. The other is to re-estimate the relative demand for better-educated workers removing from the analysis those whose wages would be bound by the CB guarantee.

First, table 7 shows increases in unemployment rates by worker education categories. Assuming that less-educated workers are more heavily represented in groups earning wages set by CB, their unemployment rates must be strongly affected. The table shows that, over the last twenty years, this variable has followed a similar trend across all education categories.

Despite periods of higher growth in unemployment among less-educated workers, there is clearly no trend against them. Between 1980 and 1985, for example, which was a time of rising overall unemployment, the rates for both high and low educations groups exhibited a similar trend. Between 1995 and 2000, a period strongly characterized by falling unemployment, both the primary and the pre-tertiary education groups registered the same decline. Thus, the hypothesis implies that there are no major differences in unemployment trends across education levels, so the relative demand for less-educated workers is not

heavily influenced by potential wage compression by wage-setting intuitions.

The second approach is to try to evaluate the effects of wage-setting institutions on the education wage premium by re-estimating relative demand while controlling for this possibility. This paper uses a strongly intuitive control method.

DFJ show in their paper that it is the negotiated lower bound for the minimum wage rather than the minimum wage itself that is relevant. Moreover, this lower bound follows an upward trend in real terms, which means that collectively bargained wages register higher year on year growth than the real minimal wage. Figure 7 shows the evolution of the minimum wage in Spain, in real terms (1980 is indexed to one). The CPI (consumer price index) is used to obtain the real values. As can be seen, the real minimum wage fell steadily throughout this period. This implies two consequences; first, CB wages are linked to other references, such as inflation or productivity; second, minimum wages will have an increasing rather than an offsetting effect on the relative wage. Using DFJ's conclusions and results, this paper proposes to remove from the sample workers earning below the minimum wage plus 25%, 40% and 60%, for 1980, 1990 and 2000 respectively, which is close to the DFJ calculated lower bounds for the first two of these periods and, the 2002 Wage Structure Survey- based value for 2000.

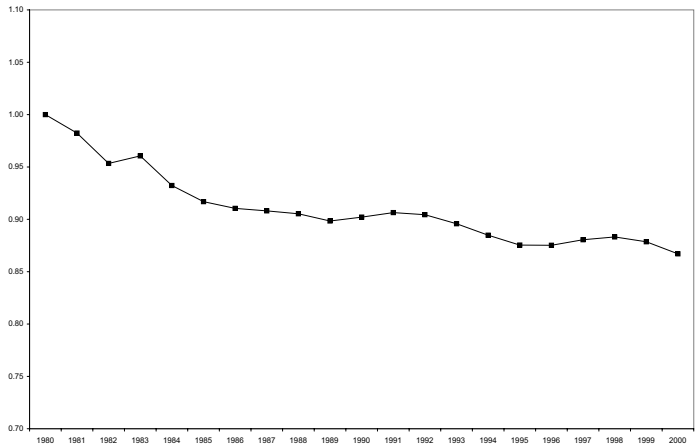


Figure 7: Real Minimum Wage in Spain. 1980-2000 (1980=1)

Table 8 shows the results after repeating the same estimates as in section 4. The slope and the intercept are scarcely dissimilar from those yielded by the results for the whole sample. The slope value is almost the same, using fixed effects and instruments. Any test will declare the two results statistically indifferent. So, in this case, not only the slope but the elasticity of substitution is equal to that estimated with the whole sample. All our previous results therefore still hold.

6 Conclusions

The main aim of this paper was to perform an in-depth analysis of the main forces (demand or supply shifts) behind the Spanish education wage premium. The initial finding is that relative supply is a predominant force. The sharp increase in this variable over recent years had a relevant effect on factor allocation and relative prices, especially during the eighties. However, demand shifts also seem to be important. This is because relative demand shifts were quite capable of changing the trend of the education wage premium in the nineties. This paper also finds that Spanish relative demand shifts were around 2.8% per year over the last two decades, which is well within the range of other international results. Decomposition of relative wage movements shows that the main force in the eighties was the increase in relative supply over relative demand, while in the nineties the latter offset the former. Moreover, the findings of this paper imply that the relative demand grew at a constant rate throughout the two decades. This estimation yields another significant finding: the elasticity of substitution between more and less educated workers, at around 1.5, is within the range of estimates for other countries, specifically the United States.

Finally, another important claim is that market forces are the primary culprits behind this trend in the wage premium, as revealed by the analysis performed to explore the institutional role in the process. This result is extremely important because Spain has lived through a particularly outstanding transformation of its labor institutions since 1980, and therefore provides an interesting case for further study to contribute to the stock of empirical evidence to identify the possible determinants of wage structure patterns over time.

Table 8: Relative Demand Estimation exclusive of institutional effects. .

	I	II	III	IV
Δb_t	0.267***	0.237**	0.271***	-2.800
	(0.085)	(0.115)	(0.083)	(4.180)
$\rho - 1$	-0.632***	-0.574**	-0.631***	-0.535***
	(0.200)	(0.252)	(0.208)	(0.198)
γ	0.063	0.063	0.074	0.064
	(0.141)	(0.140)	(0.143)	(0.131)
Δk	-	0,112	-	-
	-	(0.252)	-	-
Δk_{ict}	-	-	-0,038	-
	-	-	(0.208)	-
employ.	-	-	-	0,488
	-	-	-	(0.198)
Adj. R^2	0,47	0,49	0,49	0,49
n	34	34	34	34

Note: The dependent variable is changes in logs of changes in logs of regional relative wages to due extra education. Δb_t estimates changes in the (inverse) relative demand intercept. $\rho - 1$ estimates the coefficient for changes in logs of regional relative supply due to extra education or the (inverse) relative demand slope. γ is the coefficient of the dummy variable, which takes zero values for the eighties and ones for the nineties. Δk are changes in logs of regional physical capital per worker and Δk_{ict} are changes in logs of regional physical capital per worker in ICT sectors. Employment represents the log of regional employment at the start of the period. All estimations are performed controlling for regional and time effects. Institutional effects are assumed to be removed by deleting workers with wages below 25
Institutions are assume to be eliminated deleting those workers with wages lower than 25%, 40% and 60% of minimum wage for 1980/81, 1990/81 and 2000/01.
*** implies significance at 1%, ** at 5% and * at 10%.
Values in parenthesis are standard deviations.

References

Abadíe, A. (1997): "Changes in Spanish Labor Income Structure During the 1980's: A Quantile Regression Approach," *Investigaciones Económicas*, XXI(2), 253–272.

Abraham, K. G., and S. N. Houseman (1993): "Earnings Inequality in Germany," Staff Working Papers 94-24, W.E. Upjohn Institute for Employment Research.

Acemoglu, D. (2002): "Technical Change, Inequality, and the Labor Market," *Journal of Economic Literature*, 40(1), 7–72.

——— (2003): "Cross-Country Inequality Trends," *Economic Journal*, 113(485), 121–149.

Acemoglu, D., and J. Angrist (2001): "How Large are the Social Returns to Education: Evidence from Compulsory Schooling Laws," in *NBER Macroeconomic Annual 2000*, ed. by B. Bernanke, and K. Rogoff, pp. 9–59. Cambridge, MA: The MIT Press.

Angrist, J. (1995): "The Economic Returns to Schooling in the West Bank and Gaza Strip," *American Economic Review*, (85), 1065–1087.

Arellano, M., S. Bentolila, and O. Bover (2001): "The Distribution of Earnings in Spain During the 1980s: The Effects of Skill, Unemployment and Union Power," CEPR Discussion Papers 2770, C.E.P.R. Discussion Papers.

Barceinas, F., J. Oliver, J. Raymond, and J. Roig (2000a): *Education and Earnings in Europe: a Cross Country Analysis of the Return to Education*chap. Spain.

——— (2000b): "Los Rendimientos de la Educación en España," *Papeles de Economía Española*, (86).

Card, D., F. Kramarz, and T. Lemieux (1999): "Changes in The Relative Strustures of Wages and Employment: A Comparision of the United States, Canada and France," *The Canadian Journal of Economics*, 32(4), 843–877.

Caselli, F., and W. Coleman (2000): "The World Technology Frontier," *NBER working papers*, 7094.

Ciccone, A., and G. Peri (2005): "Long-Run Substitutability Between More and Less Educated Workers: Evidence from U.S. States, 1950-1990," *The Review of Economics and Statistics*, 87(4),

652–663.

Dolado, J., F. Felgueroso, and J. Jimeno (1997): "The Effects of Minimum Bargained Wages on Earnings: Evidence from Spain," *European Economic Review*, 41, 713–721.

Fallon, P., and P. Layard (1975): "Capital-Skill Complementarity, Income Distribution and Output Accounting," *Journal of Political Economy*, 83, 279–302.

Freeman, R., and L. F. Katz (1995): *Differences and Changes in Wage Structures*chap. Introduction and Summary. University of Chicago Press, Chicago, freeman, richard and lawernce f. katz edn.

Gottschalk, P., and M. Joyce (1998): "Cross-National Differences In The Rise In Earnings Inequality: Market And Institutional Factors," *The Review of Economics and Statistics*, 80(4), 489–502.

Gottschalk, P., and T. M. Smeeding (1997): "Cross-National Comparasions of Earnings and Income Inequality," *Journal of Economic Literature*, 35, 633–687.

Hamermesh, D. (1993): *Labor Demand*. Princetown University Press.

Hidalgo, M. A. (2006): "Overall Wage Inequality in Spain," .

Johnson, G. E. (1970): "The Demand for Labor by Educational Category," *Southern Economic Journal*, (37), 190–203.

——— (1997): "Changes in Earnings Inequality: The Role of Demand Shifts," *Journal of Economic Perspectives*, 11(2), 41–54.

Katz, L., G. Loveman, and D. Blanchflower (1995): *Differences and Changes in Wage Structures*chap. A Comparison of Changes in the Structure of Wages in Four OECD Countries. University of Chicago Press, Chicago, freeman, richard and lawernce f. katz edn.

Katz, L. F., and K. M. Murphy (1992): "Changes in Relative Wages, 1963-1987: Supply and Demand Factors," *The Quarterly Journal of Economics*, 107(1), 35–78.

Krusell, P., L. Ohanian, V. Rios-Rull, and G. Violante (2000): "Capital Skill Complementary and Inequality: A Macroeconomic Analysis," *Econometrica*, 68(5), 1029–53.

Martinez-Ros, E. (2001): "Wages and Innovations in Spanish Manufacturing Firms," *Applied Economics*, 33(1), 81–89.

Mas, M., F. Pérez, and E. Uriel (2006): *El stock y los servicios del capital en españa y su distribución territorial (1964-2003)*. Fundación BBVA.

Mas, M., F. Pérez, E. Uriel, L. Serrano, and A. Soler (2002): "Metodología para la Estimación de las Series de Capital Humano. 1964-2001," .

Mincer, J. (1974): "Scholling, Experience and Earnings," Discussion paper, National Bureau of Research, New York.

Pons, E., and M. T. Gonzalo (2001): "Returns to Schooling in Spain. How Reliable Are IV Estimates?," Working Papers 446, Queen Mary, University of London, Department of Economics.

Torres, V. X. T. (2002): "Dispersión salarial y cambio tecnológico en la industria española," *Investigaciones Economicas*, 26(3), 551–571.

Vila, L., and J. Mora (1998): "Changing Returns to Education in Spain During the 1980s," *Economics of Education Review*, 17(2), 173–178.