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Abstract

Wage equations with sample selection can provide more information than that which is normally considered. In this article, in a context of wage equations with sample selection, we propose a novel interpretation of the partial effects linked to education as additional measures of returns to education that complement the traditional one, which is directly obtained from the estimation of the wage offer equation. The aim of this work is to review these different effects, analyse their relevance and illustrate them with data for the case of Spain.

JEL classification: I21, J24.

Keywords: rate of return to education

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1. Introduction

The analysis of returns to education has been, and still is, a highly relevant topic in the economics of education literature. These returns are usually estimated by using the equation proposed by Mincer (1974) which relates the logarithm of wages with education, work experience and different control variables. In that equation, the parameter linked to education is interpreted as the return to an additional year of schooling.

The Least Squares (LS) estimates of the returns obtained from the Mincerian equation might be biased if wages of non participants in the labour market or those of the unemployed individuals are non observable. This sample selection problem in the classic Mincerian equation is extensively dealt with in the literature, especially when analysing women's returns (see for reference Harmon, Walker and Westergaard-Nielsen, 2001).

However, wage equations with sample selection can provide more information than that which is normally considered in empirical works. In a selection model other marginal effects with an economic interest can be defined and not only the return to education in terms of the wage offer which is obtained directly from the estimation of the wage equation[1]**.** The economic interest of these other effects comes from the fact that the selection equation usually has an economic interpretation and, in general, reflects the socioeconomic restrictions which determine if the individuals are employed or not (labour market restrictions, cultural or social constraints, etc.). The magnitude of these

[1] See in Maddala (1997), Greene (1997) and Wooldridge (2002) the general definition of marginal effects and, for instance, in Saha, Capps and Byrne (1997), their estimation in a household expenditure context.

restrictions is habitually related to the individuals' educational level, so that when the latter increases individuals are less likely to find restrictions preventing them from being employed[2]. In this context it would be of interest, when evaluating the economic effect of education, to take into consideration its influence on the restrictions affecting the probability of being employed.

However the literature on returns to education does not usually take into account that when there is sample selection it may be of interest to know these other partial effects as well as that usually estimated and that is traditionally interpreted as return to education. In this article, in a context of wage equations with sample selection, we propose a novel interpretation of the partial effects linked to education as additional measures of returns to education.

The aim of this work is to review the different measures of returns to education arising in the context of a wage equation with sample selection, to analyse their relevance and illustrate them for the case of Spain, using data from the enlarged 2000 survey of the European Household Panel. We believe that the case of Spain may be of interest since the high unemployment rates and low participation rates which there used to be in this country, especially for the case of women, suggest the existence of important socioeconomic restrictions for access to wage-employment. Table 1, which shows participation and unemployment rates for Spain, is especially significant. Focussing on what happens in the central core of women of working age (between 25 and 54 years), it is seen that they present participation rates not higher than 62% and very high unemployment rates, around 30% in 1994 and 20% in 2000. For the case of Spanish

[2] See Harmon, Walker and Westergaard-Nielsen (2001), Fersterer and Winter-Ebmer (2003), Marcenado and Navarro (2005), Blanco and Pons (2004), and De la Rica and Ugidos (1995) as examples of the positive effect of education on the probability of being employed.

men, the most relevant characteristic is that they have high unemployment rates, especially in 1994.

As well as this introduction, the paper contains four other sections. The second section presents the theoretical foundations. The third includes an illustration of the different measures of returns to education proposed in this article for a sample of Spanish men and women. The fourth makes some extensions to the analysis and the article finishes with a section of conclusions.

Table 1. Participation and unemployment rates by age group and gender in Spain

	Participation rate				Unemployment rate			
	Men		Women		Men		Women	
	1994	2000	1994	2000	1994	2000	1994	2000
16-19 years	29.4	30.1	24.5	21.5	49.1	28.2	58.1	43.4
20-24 years	66.7	64.6	58.7	56.9	38.2	18.1	47.4	30.6
25-54 years	92.7	92.6	54.3	62.4	16.4	8.0	28.4	18.7
+ 54 years	26.4	25.6	8.4	8.6	12.5	8.3	9.2	11.0
Total	63.3	63.8	35.6	39.8	19.8	9.7	31.4	20.5

Source: INE Database

2. The theoretical framework

Our objective is to measure the effect on wages of an increase in the educational level considering the existence of a selection equation which reflects the fact that part of the population receives no wages either because they are unemployed or inactive.

We shall contemplate two types of measures of the effect of education on wages, one defined on the basis of the wage offer, and the other on the basis of the final wage outcome really obtained by the individuals.

2.1. Wage offer equation

The initial framework is standard in the literature (Heckman, 1974 and Gronau, 1974). We shall consider a wage offer equation which relates the logarithm of the wage offer w^* to the years of education and other variables. So that:

$$\log w^* = \beta S + X\alpha + \varepsilon \qquad [1]$$

with

$E[\varepsilon | S, X] = 0$,

S = years of education

X = other determinants of the wage offer

α , is a vector of parameters and β is a parameter, we expect that $\beta \geq 0$

However, there is a selection equation which determines the individual wage-employment status, and, consequently, if w^* is observed or not.

$$I^* = \delta_S S + Z\delta + u \quad \begin{cases} I = 1 & if \quad I^* > 0 \\ I = 0 & if \quad I^* \le 0 \end{cases} \qquad [2]$$

with S = years of education, Z = other determinants of the wage-employment status, δ_S is a parameter and δ is a vector of parameters. Thus, actually, w^{*} is only observed if I = 1. Let us suppose, in addition, that[3] $\begin{bmatrix} \varepsilon \\ u \end{bmatrix} \sim N\left[0, \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon u} \\ \sigma_{\varepsilon u} & 1 \end{pmatrix}\right]$.

Note that the selection equation contains, among other things, the socioeconomic restrictions conditioning the individual wage-employment status. For instance, the economic restrictions which determine the existence of involuntary unemployment or, in the case of women, the social limitations imposed by their condition of principal carers of children and the elderly.

In this theoretical context, there are two relevant expected values of the logarithm of the wage offer obtained from [1] and [2]:

$$E\left[\log w^* \middle| S, X\right] = \beta S + X\alpha \qquad [3]$$

$$E\left[\log w^* \middle| S, X, I = 1\right] = \beta S + X\alpha + \sigma_{\varepsilon u}\lambda \qquad [4]$$

[3] σ_u^2 is asumed to be unity to avoid estimating to scalar proportions. This is a standard assumption in the econometric literature.

with $\lambda = \dfrac{\phi\left(\delta_S S + Z\delta\right)}{\Phi\left(\delta_S S + Z\delta\right)}$, and $\phi(.)$ y $\Phi(.)$ being, respectively, the standard normal density and cumulative distribution functions. λ is the inverse Mills ratio.

The function [3] measures the expected value of the logarithm of the wage offer, given the characteristics of the individual, whether the wage offer is finally observed or not. The function [4] measures the expected value of the logarithm of the wage offer for individuals who are employed and for whom we observe the wage offer as their current wage. Both functions coincide when $\sigma_{\varepsilon u} = 0$, namely, when there is no correlation between ε and u. However, in general, $\sigma_{\varepsilon u} \neq 0$ since it is expected that working is systematically correlated with the unobservables that affect the wage offer.

Both functions are relevant from an economic point of view. If we are interested in analysing the earnings that individuals "can potentially obtain" on the labour market, we can use function [3], but if we wish to analyse what happens in the case of individuals who really are employed we should use the truncated function [4].

Linked to each of these two functions there are two partial effects of education on the wage offer:

$$\beta_1 = \frac{\partial E\left[\log w^* \middle| S, X\right]}{\partial S} = \beta \qquad [5]$$

$$\beta_2 = \frac{\partial E\left[\log w^* \middle| S, X, I = 1\right]}{\partial S} = \beta - \sigma_{\varepsilon u}\delta_S\left[\left(\delta_S S + Z\delta\right)\lambda + \lambda^2\right] \qquad [6]$$

which is expected to have a positive sign reflecting that any increase in the educational level increases the probability of being employed.

β_1 measures the mean effect of a variation in the years of education on potential wages and is the partial effect on which the returns to education literature is focused (for reference, see Harmon et al., 2001). β_2 measures the mean effect of a variation in the years of education on wages for the population of individuals who are in wage-employment. Note that β_2, which is the effect for the population whose wage offer is observed, has two components: the direct effect of *S* on the mean of w^* and a correction term which includes the fact that the effect of the change in *S* is measured on the basis, not of the wage offer in general, but on the observed wage offer. For this correction term to be different from zero, δ_S should be different from zero, namely, education has to affect the probability of being wage-employed since, if not, $\beta_1 = \beta_2$ even though the functions [3] and [4] do not coincide. In any case, the empirical evidence available suggests that, in general, $\delta_S > 0$ and that $\sigma_{\varepsilon u} \neq 0$, at least for the case of women, which is the one where there is most evidence (see Harmon, Walker and Westergaard-Nielsen, 2001, Fersterer and Winter-Ebmer, 2003, Marcenado and Navarro, 2005, Blanco and Pons, 2004, and De la Rica and Ugidos, 1995).

These two partial effects are of economic interest. Thus, β_1 measures the economic return to education in terms of the wage offer, whether this is observed or not, for an individual randomly drawn from the population and, as a result, it can be considered as being a measure of the potential return to education[4]. On the other hand, β_2 is the measure of return to education conditional on I=1 and, therefore, it can be considered as being the return to education really received[5].

Unlike β_1, which is the same for all the individuals, β_2 is different for each individual depending on his/her characteristics. In this respect, and given that $0 < \left[\left(\delta_S S + Z\delta\right)\lambda + \lambda^2\right] < 1$ and that we expect that $\delta_S > 0$, that $\beta_2 \leq \beta_1$ or $\beta_2 \geq \beta_1$ depends on the sign of $\sigma_{\varepsilon u}$. If $\sigma_{\varepsilon u} = 0$, $\beta_2 = \beta_1$. If $\sigma_{\varepsilon u} > 0$, β_1 will overvalue β_2. If $\sigma_{\varepsilon u} < 0$, β_1 will undervalue β_2.

2.2. Earned Wages equation

From an economic point of view, it could be of interest, not only to measure the returns to education on the basis of the wage offer, but also on the basis of wages actually earned by individuals, that is to say, taking into account that many individuals do not receive any wage income, either because they do not receive any wage offer, or because the latter is below the opportunity costs of being in work due, to a great extent, to the existence of socioeconomic restrictions in the labour market. Our objective is to explicitly be aware of the effects of education on the wages actually earned by individuals.

In the conceptual framework previously described we consider that the earned wage Y will be given by:

[4] In the context of traditional human capital models this increase would be a measurement of the mean potential increases in productivity generated by the investment in education.
[5] In the context of traditional human capital models this increase would be a measurement of the mean increases observed in productivity generated by the investment in education.

$$Y = \begin{cases} w^* & if \quad I = 1 \\ 0 & if \quad I = 0 \end{cases} \qquad [7]$$

Again, there are two relevant expected values, in this case for the wage really obtained, which are, from [7]:

$$\begin{aligned} E[Y|S,X,I=1] &= \exp\left(E\left[\log w^* | S,X,I=1\right] + \frac{1}{2}\sigma_\varepsilon^2 \right) = \\ &= \exp\left(\beta S + X\alpha + \sigma_{\varepsilon u}\lambda + \frac{1}{2}\sigma_\varepsilon^2 \right) \end{aligned} \qquad [8]$$

$$\begin{aligned} E[Y|S,X] &= \Phi\left(\delta_S S + Z\delta\right) E[Y|S,X,I=1] = \\ &= \Phi\left(\delta_S S + Z\delta\right) \exp\left(\beta S + X\alpha + \sigma_{\varepsilon u}\lambda + \frac{1}{2}\sigma_\varepsilon^2 \right) \end{aligned} \qquad [9]$$

The function [8] measures the expected value of wage income given the educational level and other characteristics, assuming that the individual is wage-employed[6]. This function is completely equivalent to the function [4] previously described, but now written in terms of the earned wage instead of in terms of the wage offer. The function [9] measures the expected value of the earned wage for a randomly selected individual. As can be seen, for any individual, his/her expected wage income is that obtained in the case of being employed, multiplied by the probability of actually being employed. The individuals' characteristics, including their level of education, affect the wages they obtain if they are employed, and also the probability of being employed.

Linked to these two mean values and to variations in the level of education, there are also two partial effects. On one hand we have:

6 The fact that the wage offer follows a lognomal distribution has been taken into account.

$$\frac{\partial E\left[Y|S,X,I=1\right]}{\partial S} = \beta_2 \exp\left(E\left[\log w^* \middle| S,X,I=1\right] + \frac{1}{2}\sigma_\varepsilon^2 \right) \qquad [10]$$

And in terms of the percentage change in the expected value:

$$\frac{\partial E\left[Y|S,X,I=1\right] \big/ E\left[Y|S,X,I=1\right]}{\partial S} = \beta_2 \qquad [11]$$

And on the other:

$$\frac{\partial E\left[Y|S,X\right]}{\partial S} = \frac{\partial \Phi\left(\delta_S S + Z\delta\right)}{\partial S} E\left[Y|S,X,I=1\right] + \Phi\left(\delta_S S + Z\delta\right)\frac{\partial E\left[Y|S,X,I=1\right]}{\partial S} =$$

$$= \left[\delta_S \phi\left(\delta_S S + Z\delta\right) + \beta_2 \Phi\left(\delta_S S + Z\delta\right)\right]\exp\left(E\left[\log w^* \middle| S,X,I=1\right] + \frac{1}{2}\sigma_\varepsilon^2 \right)$$

[12]

In terms of percentage variation in the expected value and provided that we evaluate the function in one point with $E\left[Y|S,X\right] \neq 0$ we consider that[7]:

$$\beta_3 = \frac{\partial E\left[Y|S,X\right] \big/ E\left[Y|S,X\right]}{\partial S} = \beta_2 + \delta_S \lambda \qquad [13]$$

The effect described by [11] is simply the effect β_2 seen before. β_3 is a new return which measures the mean effect of a variation in years of education on the wages actually earned. β_3 takes into consideration that an additional year of schooling not only

[7]Note that [13] is the decomposition suggested by McDonald and Moffitt (1980).

modifies the average wage due to human capital investment, but it also alters, and possibly reduces, the probability of experiencing episodes of unemployment or inactivity. This measure explicitly incorporates and quantifies the fact that the socioeconomic restrictions which prevent individuals from being employed change with any variation in their educational level. In this respect, it is logical to think that, when coming to decisions on human capital investment, the individuals take this effect very much into account.

3. An illustration for the case of Spain.

Using data from the enlarged survey of the European Household Panel for Spain in 2000, both for men and women, the three partial effects defined in the above section were estimated. The sample is constituted by individuals aged between 16 and 65 who are not engaged in entrepreneurial activities. We have data from 11,364 men and 13,196 women. Of this total, 7,494 men and 4,684 women were wage-earners. In Appendix I there is a detailed description of the variables used in the analysis and in Appendix II the descriptive statistics of the most relevant variables are presented.

With the 11,364 men and 13,196 women, probit models for the determination of the probability of being employed have been estimated for men and women and are presented in Table 2. The variables included in the models aim to cover the economic and social factors which may have an influence on this probability. The wage equations estimated with the salaried 7,494 men and 4,684 women are presented in Table 3 (column I). These include as regressors: education, experience and its square, the inverse Mills ratio obtained from the probit models and a group of variables which

Table 2. Probit equation for the probability of wage-employment

(Dependent variable: "Wage-Employment")

Variables	**Men**	**Women**
Constant	-4.348 (0.132)	-4.224 (0.132)
Education	0.030 (0.004)	0.084 (0.003)
Age	0.256 (0.007)	0.188 (0.007)
Age^2	-0.003 (0.00001)	-0.002 (0.00001)
Caring duties	-0.203 (0.048)	-0.126 (0.030)
Income of the rest of the household	$-5.48x10^{-8}$ ($0.82 x 10^{-8}$)	$-5.88x10^{-8}$ ($0.73 x 10^{-8}$)
Number of children	-	-0.153 (0.020)
Income of the rest of the household * Number of children	$2.13x10^{-8}$ ($0.58 x 10^{-9}$)	$1.76x10^{-8}$ ($0.43 x 10^{-8}$)
Marital status	0.653 (0.042)	-0.251 (0.033)
χ^2_6 **variables of region of residence**	96.572	142.058
SE	0.398	0.427
N	11,364	13,196

Note: Standard errors in parentheses. SE=Standard Error of the regression .

Table 3. Wage equation (Dependent variable: log(hourly wage))

	I		II	
	LS with selectivity correction		IV with selectivity correction	
	Men	Women	Men	Women
Constant	6.001 (0.033)	5.333 (0.062)	5.803 (0.061)	4.740 (0.082)
Education	0.058 (0.001)	0.081 (0.003)	0.098 (0.005)	0.108 (0.004)
Experience	0.020 (0.002)	0.032 (0.002)	0.005 (0.002)	0.037 (0.002)
Experience ^{2}	-0.0001 (0.00004)	-0.0005 (0.00005)	0.0002 (0.00005)	-0.0006 (0.00004)
Selectivity term	-0.184 (0.023)	0.143 (0.032)	-0.380 (0.034)	0.415 (0.040)
χ_6^2 variables of region of residence	186.179	83.489	66.608	137.68
F on excluded instruments (number of instruments)	-	-	69.526 (5)	415.721 (5)
p-value Hausman exogeneity test	-	-	0.000	0.003
p-value Sargan test			0.063	0.054
SE	0.390	0.381	0.384	0.387
N	7,494	4,684	7,494	4,684

Note: White standard errors in parentheses, SE=Standard Error of the regression .

indicate the individuals' region of residence. As suggested by Pereira and Silva (2004), a simple specification of the Mincer equation was used for a better perception of the direct and indirect effects of education on wages.

From the results presented in both tables three facts can be highlighted. First, that both for men and women the probability of being employed grew as the education level increased, this effect being greater in the case of women which is in agreement with the empirical evidence given above[8]. Second, that the inverse Mills ratio was significantly different from zero in the wage equation, which can be interpreted as evidence of the existence of sample selection. And third, the fact that the inverse Mills ratio had a different sign in the wage equation of the men to that of women, which possibly reflects the difference between men and women in the nature of the restrictions determining whether a wage is received or not. The non observation of the wages in men usually represents an unemployment problem, while in the case of women it is more often a non participation situation. Thus, in our sample, excluding students, the number of inactive individuals is five times that of unemployed ones in women and less than twice in men. Additionally, in the case of women, 76% of the inactive ones devote themselves to housework or child or adult care compared to 10% in the case of men.

For women, the positive coefficient associated with the correction term, a result also found by Marcenaro and Navarro (2005) and Caparrós, Gamero, Marcenaro and Navarro, (2001), can be interpreted in the sense that the women whose wages are observed have higher wages than those of any woman randomly selected. Since this coefficient is the covariance of the error terms in the earnings and in the selection

[8] If one calculates the mean partial effect of education on the probability of being employed, a value of 0.027 for women and 0.008 for men is obtained.

equation, its positive sign indicates that a shock to the selection equation that increases female labour market participation also increases the conditional expectation of wages.

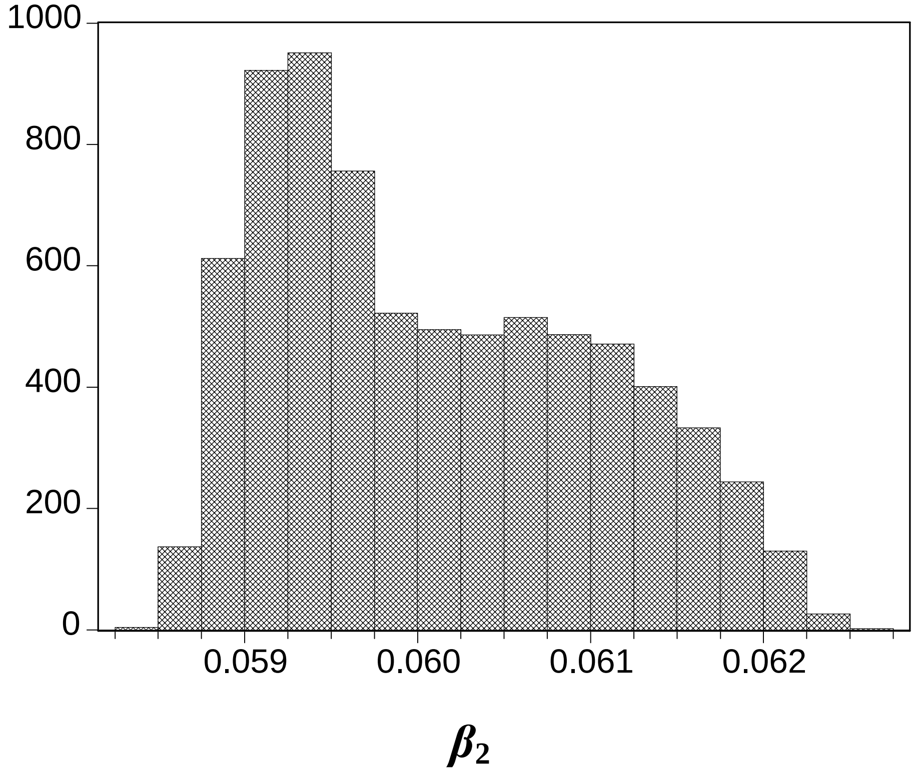
For the case of men, the selection term is negative, a result also found by Marcenaro and Navarro (2005) and Caparrós et al (2001), which are two of the few works for Spain correcting selection in the case of men. This result can be interpreted in the sense that the wages of randomly selected individuals are higher than those of men whose wages are observed.

Table 4 (column I) shows the estimates of the three marginal effects β_1, β_2 and β_3 calculated from the results presented in Tables 2 and 3 (column I). Since S is part of the selection equation, β_2 and β_3 vary as a function of the individuals' characteristics, so that in Table 4 the sample mean and the standard error for that mean are presented. Figures 1 and 2 show the sample distribution of β_2 and β_3 for men and women [9].

The results presented in Table 4 (column I) show the similarity between β_1 and the mean of β_2 in the case of men. This would seem to indicate that, on average, truncation is not especially relevant for measuring the returns to education in salaried men. This similarity between both effects shows that, on the basis of the wage offer, the average return of an additional year of schooling for salaried individuals is not so different from that of an individual randomly drawn from the population. In the β_2 histogram for the men, included in Figure 1, it is observed that for a large proportion of salaried men the returns were around 5.9-6% and that in no case did they exceed 6.3%, which confirms the similarity between both partial effects.

[9] While for β_2 calculations are made with the sample of salaried individuals, for β_3 the whole sample is used.

Figure 1. Histograms for men. LS estimates (2000)



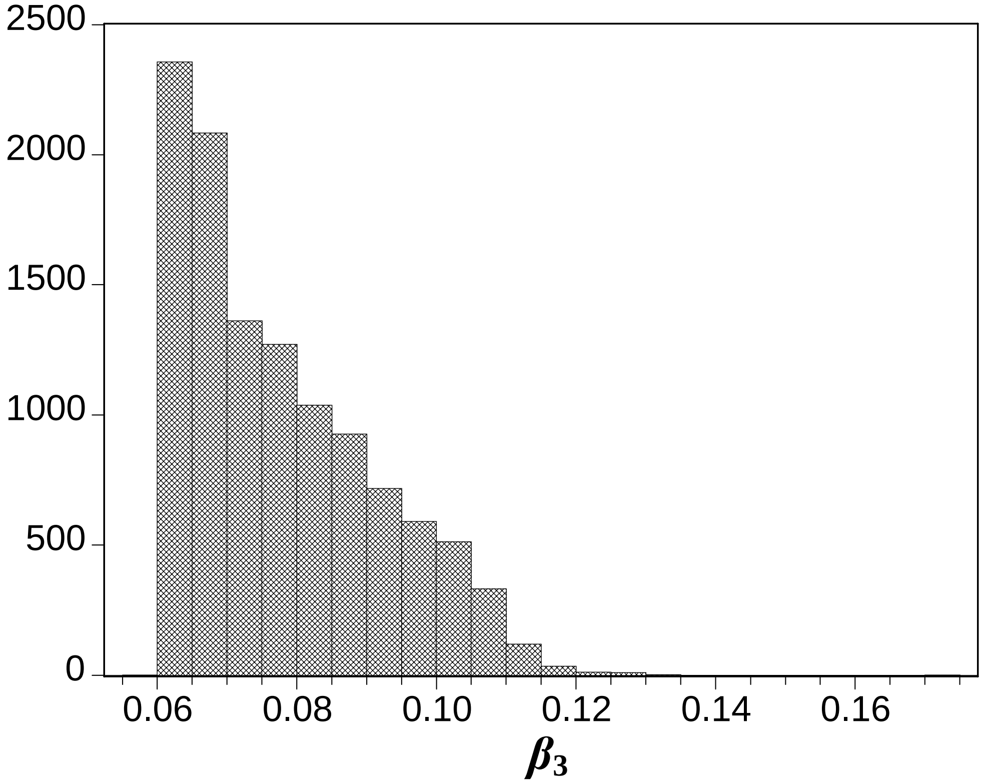
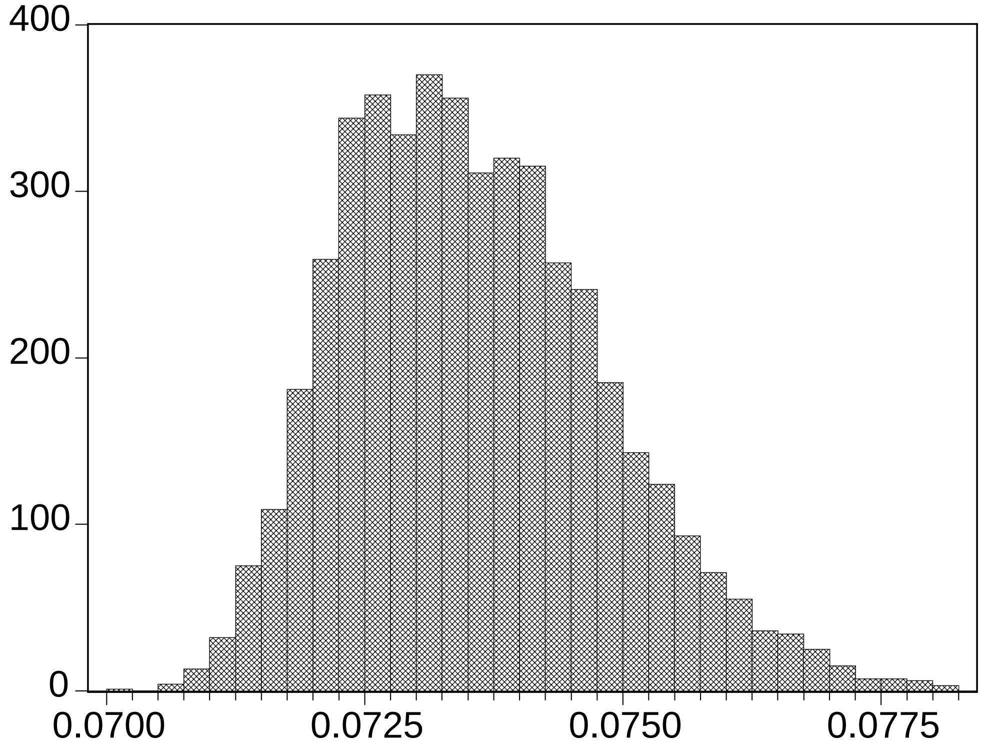
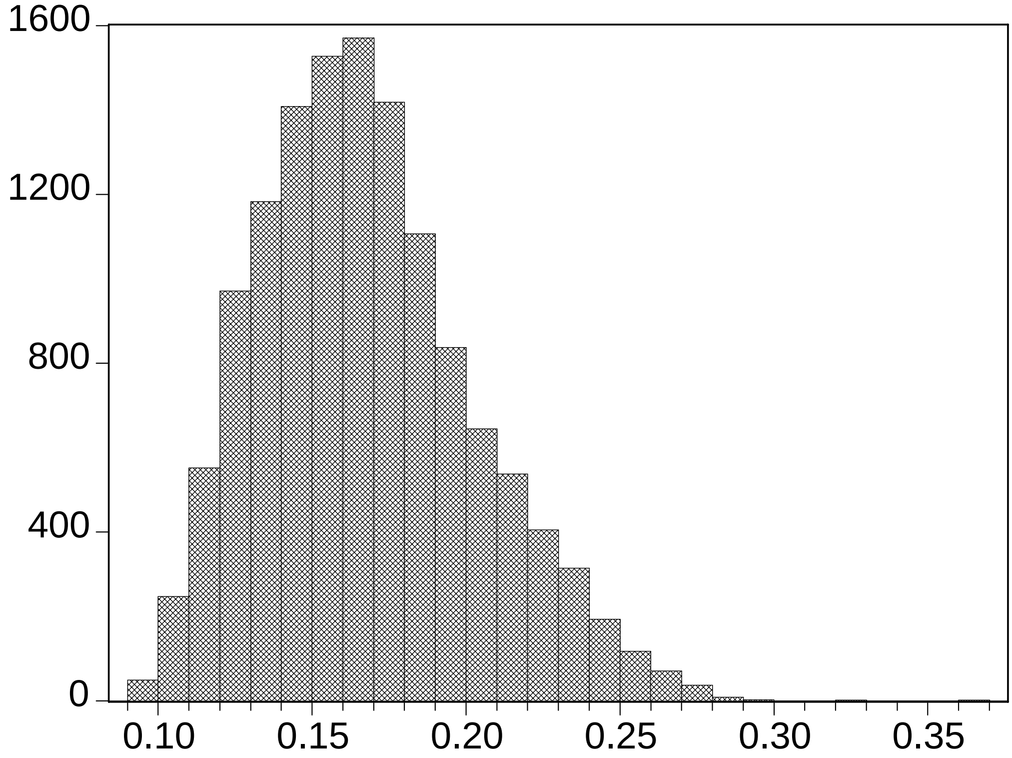


Figure 2. Histograms for women. LS estimates (2000)



β_2



β_3

Table 4. Returns to education

	I		II	
	Least Squares		Instrumental Variables	
	Men	Women	Men	Women
β_1	0.058 (0.001)	0.081 (0.003)	0.098 (0.005)	0.109 (0.004)
β_2 [(a)]	0.060 (0.001)	0.074 (0.001)	0.103 (0.002)	0.087 (0.004)
β_3 [(b)]	0.078 (0.014)	0.168 (0.035)	0.121 (0.015)	0.180 (0.030)

Notes: Standard errors in parentheses. [(a)] Calculations are made with the sample of salaried individuals.
[(b)] Calculations are made with the whole sample.

It was not the same for the women, where the differences between β_1 and the mean of β_2 were around 10%. On average, the woman who worked obtained a 10% lesser return to education than that of a woman randomly drawn or, in percentage points, β_1 overestimates, on average, β_2 by 0.7 percentage points. The β_2 histogram for the women shown in Figure 2 confirms these differences, since for most of the salaried women the returns are between 7.3 and 7.6% and in no case did they exceed 7.8%. The substantially higher value of β_1 indicates that there are some groups of women who would potentially obtain high returns to education but who are not employed. In spite of obtaining high returns from their education investment (higher than those of many employed women) they are not employed because of the socioeconomic restrictions that make their reservation wage exceeds their wage offer and prevent them from working.

With respect to the effect of the variations in education on wages really received, the large differences between β_2 and β_3 should be mentioned, especially for women, observed in the means presented in Table 4 (column I) and in the histograms in Figures 1 and 2. The higher value of β_3 is because an additional year of schooling not only raises the average wages of those employed but also increases the probability of becoming employed and, therefore, of having a positive income (see [13]).

In this respect, β_3 can be broken down into two elements: that which is related to the changes in the probability of being employed and that which concerns the changes in the average value of wages. In terms of the human capital theory, it might be considered that the first component (β_2) measures the wage increase due to the higher productivity generated by the investment in education, while the other term ($\delta_S \lambda$) measures the greater probability of being employed, and therefore having a non zero wage, produced by this investment in education.

If we apply this decomposition to the Spanish case, it is seen that, for the men, 23% of the mean return is due to the increase in the probability of being employed because of the increase in the educational level, while for the women this percentage is 56.5%. This result shows to what extent, in Spain, there are many incentives for investing in education, not only because the latter promotes an increase in the wages obtained but also because it raises the probability of obtaining any wage at all. This is possibly so because any increase in education helps to overcome the socioeconomic restrictions which prevent individuals from being employed.

4. Extensions to the analysis

In this section we shall present four possible extensions to the analysis: the consideration of education as a discrete variable, the consideration of the endogenous character of education in the wage equation, the contemplation of a double selection model (participation and employment) and an analysis of the evolution of returns to education.

4.1. Education as a discrete variable. Return to educational level.

In the literature, analyses of returns to education are made both per additional year of schooling and per educational level (see, for a review of the empirical evidence in Spain, Oliver, Raymond, Roig and Barceinas, 1999, and for Europe, Harmon et al.,

2001. The theoretical foundations considered in the second section are easily extensible to the case in which it is desired to estimate the wage equation including as a regressor the educational level completed by the individual (see Appendix III).

Using the data from the previous section and considering eight educational levels, the three effects were estimated[10]. Tables 5 and 6 show, respectively, the probit model and the wage equation, including as regressors the dummy educational level variables instead of the years of education. Table 7 presents the results of the calculation of β_1, β_2 and β_3 per educational level in comparison to the lowest educational level (no studies). β_2 and β_3 were calculated, respectively, with the sample of the salaried individuals and with the whole sample.

The results given in Table 7 confirm, for all the educational levels, what was obtained in the previous section (Table 4, column I) in the sense that β_1 is slightly lower than β_2 in the case of the men and higher in the case of women and that, in both cases, although especially in that of the women, β_3 is much higher than β_2.

When examining the results per educational level, two things stand out. First, the notable change produced in the three effects for university studies and, second, the small relative magnitude of the effects for the "general upper secondary education". Both results would together explain why general upper secondary studies in Spain basically make sense as they are indispensable for obtaining access to higher education.

There are striking differences between β_2 and β_3, both for men and women and for all the educational levels. As was pointed out in Section 2, the higher value of β_3 indicates

[10] See Appendix I for more details on educational levels.

Table 5. Probit equation for the probability of wage-employment
Education as a discrete variable
(Dependent variable: "Wage-Employment")

	Men	Women
Constant	-4.503 (0.144)	-3.659 (0.141)
Primary	0.364 (0.060)	0.074 (0.057)
General lower secondary	0.680 (0.061)	0.334 (0.058)
Vocational lower secondary	0.859 (0.078)	0.775 (0.071)
Vocational upper secondary	0.970 (0.076)	0.984 (0.071)
General upper secondary	0.272 (0.066)	0.344 (0.063)
Short cycle university	0.628 (0.078)	1.151 (0.067)
Long cycle university	0.885 (0.081)	1.213 (0.072)
Age	0.244 (0.007)	0.173 (0.008)
Age^2	-0.003 (0.00001)	-0.002 (0.00001)
Caring duties	-0.222 (0.049)	-0.140 (0.030)
Income of the rest of the household	$-4.55x10^{-8}$ (0.83×10^{-8})	$-5.84x10^{-8}$ (0.74×10^{-8})
Number of children	0.037 (0.022)	-0.130 (0.020)
Income of the rest of the household * Number of children	$1.36x10^{-8}$ (0.70×10^{-9})	$1.74x10^{-8}$ (0.44×10^{-8})
Marital status	0.591 (0.046)	-0.257 (0.033)
χ^2_6 **variables of region of residence**	75.699	141.599
SE	0.388	0.423
N	11,364	13,196

Note: Standard errors in parentheses. SE=Standard Error of the regression .

Table 6. Extended wage equation
(Dependent variable: log(hourly wage))

	LS with selectivity correction	
	Men	**Women**
Constant	6.240 (0.039)	5.610 (0.064)
Primary	0.099 (0.024)	0.188 (0.040)
General lower secondary	0.186 (0.025)	0.293 (0.040)
Vocational lower secondary	0.273 (0.027)	0.472 (0.046)
Vocational upper secondary	0.380 (0.027)	0.628 (0.047)
General upper secondary	0.437 (0.027)	0.565 (0.042)
Short cycle university	0.676 (0.029)	0.986 (0.048)
Long cycle university	0.774 (0.031)	1.115 (0.049)
Experience	0.021 (0.002)	0.033 (0.002)
Experience ^{2}	-0.0002 (0.00004)	-0.0005 (0.00005)
Selectivity term	-0.187 (0.025)	0.156 (0.033)
χ^2_6 **variables of region of residence**	204.041	102.504
SE	0.349	0.377
N	7,494	4,684

Note: White standard errors in parentheses, SE=Standard Error of the regression.

Table 7. Return to educational levels (Base: no studies).

	Men			Women		
	β_1	β_2 [(a)]	β_3 [(b)]	β_1	β_2 [(a)]	β_3 [(b)]
Primary	0.104	0.110	0.668	0.207	0.203	0.587
General lower secondary	0.204	0.220	1.112	0.340	0.321	1.698
Vocational lower secondary	0.314	0.342	1.559	0.603	0.541	4.295
Vocational upper secondary	0.462	0.510	2.000	0.874	0.767	6.235
General upper secondary	0.548	0.577	1.021	0.759	0.709	2.576
Short cycle university	0.966	1.052	2.860	1.680	1.459	9.810
Long cycle university	1.168	1.294	3.981	2.050	1.762	12.118

Notes: [(a)] Calculations are made with the sample of salaried individuals. [(b)] Calculations are made with the whole sample.

Table 8. Probability of "Employment" (Φ) and average "wage" predictions (all sample).

	Men		Women	
	Φ	Hourly wage (in pesetas)	Φ	Hourly wage (in pesetas)
No studies	0.399	703.320	0.144	485.284
Primary	0.599	802.374	0.190	593.609
General lower secondary	0.688	778.089	0.295	604,426
Vocational lower secondary	0.754	840.890	0.499	700.233
Vocational upper secondary	0.828	973.521	0.596	762.268
General upper secondary	0.513	879.795	0.302	730.114
Short cycle university	0.739	1,273.560	0.643	1,107.672
Long cycle university	0.845	1,477.522	0.696	1,213.736

that an extra year of schooling not only affects expected wages but also the probability of being employed. Table 8 shows the predictions, obtained from the estimates in Tables 5 and 6, of the average probability of being employed and of the average wages for all educational levels. In general, it is observed that as the educational level rises, both the average hourly wage and the probability of being employed increase. One especially prominent result is that obtained for the "general upper secondary" level of education. On comparing it to "vocational upper secondary" (a similar educational level although with a very different training orientation), it is observed that, on average, a lower wage and a lesser probability of employment are obtained. This result confirms what was achieved previously, i.e. that the general upper secondary level of education makes sense only if considered as being a prior step to going to university.

4.2. Endogeneity of education

LS estimates of the returns obtained from the Mincerian wage equation may be biased due to the endogeneity of education. With the aim of analyzing the possible impact of this bias on the results presented in Section 3. the wage equation was estimated by Instrumental Variables (IV). Variables which reflect some change or exogenous intervention affecting the individuals' choice of education but not their wages are suitable instruments. Card (1993), for instance, employs the proximity of a college to the residence of the individual as an instrument for education, Harmon and Walker (1995) use the changes in the compulsory schooling age and Uusitalo (1999) chooses variables reflecting the individual's family background (parents educational level, etc.)

In this paper we have used as an instrument the variable WAR reflecting if the individual's education was affected by the Spanish Civil War[11], on the lines of Ichino and Winter-Ebmer (1999) and (2004), whose instruments are based on whether the individual's education was affected by the Second World War[12].

The wage equation was estimated by Two-Stage Least Squares using as instruments for the educational level the variable WAR as well as, following the suggestion of Woolridge (2002), all the exogenous variables of the probit equation. The results are shown in Table 3 (column II). A fundamental aspect when applying IV techniques is the validity of the instruments employed. Table 3 (column II) presents the "F statistic on excluded instruments" suggested by Bound, Jaeger and Baker (1995), obtained from the

[11] This variable is used as an instrument by Arrazola, Hevia, Risueño and Sanz (2003). García, Hernández and López-Nicolás (2001) employ a slightly different one but which is also related to the effects of the Spanish Civil War on education.
[12] See Appendix I for details on the definition of the variable.

reduced form education equation. Both for men and women, the statistics would allow us not to reject the validity of the instruments. In addition, the Sargan test does not reject the over-identification restrictions at a 5% significance level. The null hypothesis of exogeneity of education can be rejected using the Hausman test.

Table 4 (column II) presents the estimates of β_1, β_2 and β_3 now obtained from the results in Tables 2 and 3 (column II). With respect to β_1, which is the return to education usually presented in empirical works, it can be noted that the IV estimates are higher, both for men and women, than the LS estimates given in Table 4 (column I), which is on the lines of other works in the literature both for Spain (see, for instance, Arrazola et al. 2003) and other countries (see Card, 1999 and 2001). With respect to the comparison between β_1, β_2 and β_3, it is important to point out that the results obtained by LS (Table 4, column I) were maintained although all the IV returns were higher.

Table 9. Returns to education (1994)

	I		II	
	Least Squares		Instrumental Variables	
	Men	Women	Men	Women
β_1	0.060 (0.002)	0.082 (0.004)	0.099 (0.007)	0.110 (0.006)
β_2 [(a)]	0.063 (0.001)	0.074 (0.001)	0.102 (0.001)	0.085 (0.002)
β_3 [(b)]	0.086 (0.015)	0.177 (0.028)	0.126 (0.015)	0.188 (0.028)

Notes: Standard errors in parentheses. [(a)] Calculations are made with the sample of salaried individuals.
[(b)] Calculations are made with the whole sample.

4.3. Evolution of the return to education

Changing conditions in the labour market and in the education system suggest that returns to education may not be constant in the time. If we compare 1994 (the first year in which data from the European Household Panel for Spain became available) to 2000, a substantial improvement in the behaviour of the Spanish labour market can be seen, with an increase in the participation rate and a drop in unemployment, both for men and women (Table 1). In addition, in this period, a rise in the average educational level of the Spanish people had occurred. For instance, the percentage of the population aged over 16 with higher studies went from 9.2% to 18.5% in men and 8.5% to 16.7% in women.

Many papers have dealt with the analysis of the evolution of returns in different countries, both in the eighties and the nineties, but their results have not been very conclusive (see Trostel, Walker and Wooley, 2002, for an analysis of different OECD countries). There is not much evidence for the Spanish case although there are some works on the evolution of returns to education in the 80's and 90's (see Oliver et al., 1999, for a summary of the literature in Spain, and Caparrós et al., 2001, for a comparison from 1994-1996 with data from the European Household Panel).

In order to analyse the evolution of the returns to education in Spain in the past few years using the three effects defined in this article, the calculations of β_1, β_2 and β_3 have been reproduced, by taking both LS and IV estimates for the year 1994. Appendix IV contains the Tables with the probit and the wage equations for 1994. Table 9 shows the estimates of β_1 and of the mean values of β_2 and β_3 for 1994 calculated by taking LS and IV estimates.

If we compare Table 4, column I, (LS for 2000) to Table 9, column I, (LS for 1994), we can conclude that both for men and women the returns have hardly varied since β_1 and β_2 have been maintained and only a slight decline is noted in β_3, the return in terms of the earned wage for an individual whether he/she is employed or not. Given that β_3 is formed by β_2 and another component which retrieves the effect of education on the probability of working, and as β_2 has not varied, it can be concluded that throughout the nineties changes have occurred in the effect of education on the probability of being employed. Also, when comparing Table 4, column II, (IV for 2000) to Table 9, column II, (IV for 1994), it can be affirmed that returns have remained very stable in the 90's. Although the rise in the educational level in Spain in the period from 1994 to 2000 could have caused a decline in returns to education, the results suggest that the good behaviour of the labour market has permitted them to be maintained.

It is important to point out that in the comparison between β_1, β_2 and β_3 no changes occurred. Both for 1994 and 2000 it was obtained that the return to education in terms of the wage offer is, in the case of men, the same for salaried ones as for an individual randomly drawn from the population, while for salaried women the return was lesser. Likewise, in terms of wages received, it is observed that, both in men and women, the return of the salaried individuals was lesser.

4.4. A double selection framework.

In the previous sections it was considered that the observation of the wage offer is determined by a single equation. However, it could be of interest to consider that observation of the wage offer is determined by a sequential double selection scheme.

Initially, the individuals would make the decision to participate, or not, in the labour market and, in a second stage, they would, or not, find a job. We believe that the sequential scheme is especially relevant for the case of women since they usually have considerably lower participation rates and higher unemployment rates than those of men.

The theoretical framework proposed is the one suggested by Catsiapis and Robinson (1982) and mentioned in Maddala (1997), and presented in detail in Appendix V. In that Appendix the partial effects linked to education are also obtained.

The three effects linked to this scheme for the samples of Spanish women in the years 2000 and 1994 were estimated. In Appendix VI the estimations of the participation, wage-employment and wage equations are presented for the case of Spanish women[13]. The selection terms linked to both decisions are significant in the wage equation.

Table 10 presents the estimations of the three measures of returns to education for the years 1994 and 2000. If we compare the results obtained to those presented in previous sections, a diminution in the three effects can be noted, although that occurring for β_1 is especially striking. These results suggest that the differentiation between the participation decision and the situation of being employed or not may be especially relevant for evaluating this measure of the return to an additional year of education. However, with respect to the comparison of the three measures, it should be underlined that the basic results of previous sections have been maintained in the sense that β_2 is

[13] It should be indicated that to explain the probability of finding employment, a variable which reports if the individual has been sporadically unemployed during the past five years, has been incorporated to the analysis.

similar to β_1 and under β_3. No great variations between these measures were noted if we compare the results for the sample of 1994 to that of 2000.

Table 10. Returns to education with double selection - women

	1994	2000
β_1	0.071 (0.003)	0.074 (0.002)
β_2 [(a)]	0.070 (0.003)	0.070 (0.003)
β_3 [(b)]	0.170 (0.042)	0.153 (0.025)

Notes: Standard errors in parentheses. [(a)] Calculations are made with the sample of salaried individuals. [(b)] Calculations are made with the whole sample.

5. Conclusions

The wage equation models with sample selection can provide more information than that which is usually considered in the literature, where it is usually overlooked that when there is sample selection, as well as the estimate of the return provided directly by the coefficient associated with education in the wage equation, there are other effects of economic interest.

In this article, in a context of wage equations with sample selection, we propose a novel interpretation of the partial effects linked to education as additional measures of returns to education that complete the one traditionally considered. Three possible partial effects of education have been considered: the return in terms of the wage offer for an individual randomly drawn (which we call β_1), the return in terms of offered or received wages for salaried individuals (β_2) and the return in terms of earned wages for any individual whether he/she works or not (β_3). The estimation of β_1 is what is usually focussed on by empirical works of returns to education.

Using European Household Panel 2000 data for Spain these three partial effects were calculated both for men and women. In men, β_1 and β_2 are very similar, which shows that in terms of the wage offer, the mean return of an extra year of education for salaried individuals is not so different from that of an individual randomly drawn from the population. This is not the same for women, for whom the differences between β_1 and the mean of β_2 are around 10%. On average, working women obtain a 10% lesser return to education than that of a woman taken at random. This would appear to indicate that there are groups of women who would potentially obtain high returns to education and are not employed, probably due to the socioeconomic restrictions, which make their reservation wage exceed their wage offer and which prevent them from working.

The broad differences between β_2 and β_3, especially for women, should be highlighted. The high value of β_3 is due to the fact that an additional year of education not only means an increase in the average wage of employed individuals but also raises the probability of being employed and, therefore, of receiving positive wages. To be specific, it was found that for men 23% of the average return was due to an increase in the probability of being employed, which was induced by a rise in their educational level, while for women this percentage was 56.5%.

The results obtained on comparing the three effects were maintained when the endogeneity of education was considered in the wage equation, education was held to be a discrete variable, when the analysis was performed for 1994 and when a double selection structure was contemplated for the case of women.

These results show to what extent there are many incentives in Spain for investing in education, not only because it means an increase in wages but also because it raises the probability of obtaining any wage at all, possibly due to the fact that an increase in education helps to overcome the socioeconomic restrictions that prevent individuals from being employed. All of which is in full agreement with what has occurred with the demand for education in Spain in the past few years (see Albert, 1998, and Beneito et al., 1995).

Furthermore, these results are also relevant with respect to the discussion on the social role of education, since the high magnitude of β_3 in relation to the other two effects shows the importance of education as an instrument for minimizing the private and social costs associated with not having a job. This is an extra argument to be taken into account in the discussion on public subsidies for education. Another item of great interest remaining to be explained in future work is the ultimate reason why education has this very positive influence on the probability of being employed. Another possible further extension could be to study the influence of education on the probability of having a temporary or permanent contract, and, consequently, to calculate the returns associated with this fact.

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Appendix I. Description of variables

From the information contained in the European Household Panel (EHP), the variables used in the analysis were built in the following way:

Hourly net wage: This was calculated from information available in EHP on hours worked weekly and on monthly net wages. It was considered that a month had 4.3452 weeks.

Education: EHP provides information on the highest level of education completed by individuals. For each level of education it assigns a numeric value equal to approximately the number of years it takes to finish. So the value of the variable we are using is: 2 for illiterate individuals or without education, 5 for people with primary education, 8 for people with general lower secondary education, 9 for people with vocational lower secondary education, 11 for people with vocational upper secondary education, 12 for people with general upper secondary education, 15 for people with short cycle university studies, 17 for people with long cycle university studies and post graduates.

Experience: This variable has been defined on the basis of the information provided by EHP. Experience has been computed as the difference between the age of the individual and the age at which the individual declares he began to work. In generating this variable, we impose the restriction that it must be below the difference between the official age of retirement (65 years old) and the years of schooling.

Other characteristics of the individual:

Marital status: This variable takes on value 1 for married individuals or those who live with another person, and 0 if neither was true.

Region of Residence: EHP consider seven regions of residence: the Northwest, the Northeast, Madrid, Central Spain, the East, the South, and the Canary Isles. For the empirical analysis a dummy variable was created for each possible region of residence, which took on value 1 if the individual lived in that area and 0 if not.

Caring duties: In EHP the individuals are asked if their daily activities include as a non remunerated duty the looking after their own or other people's children or the caring of other adults. On the basis of this information, a dummy variable was created with the value of 1 if the individual looked after children, adults or both, and 0 if not.

Number of children: EHP does not supply direct information on the individuals' number of children. This has been constructed from the information provided on the relationships between the individuals in the household, assigning each individual as the number of children all those individuals in the household who figured as his/her full or adoptive children.

Net income in the rest of the household (in 1999): This was constructed from the information provided in EHP as the difference between the total net income of the household in 1999 and the total net income of the individual in the same year.

Wage-Employment (Observation of wage): A dummy variable was created with the value of 1 for wage earners and a value of 0 for individuals not working (i.e. whose monthly wage was zero). Employers were excluded from the sample.

This variable was used as dependent variable in the probit of the first stage when the sample selection was taken into account.

Participation: A dummy variable was created with the value of 1 for participants in the labour market (wage earners and unemployed individuals) and a value of 0 for non participants. This variable was used as dependent variable in one of the probit models of the first stage when the double selection scheme was taken into account.

War: This is a dummy variable which attempts to reflect whether the individuals' education was affected by the Spanish Civil War. It took on value 1 for those individuals who were over 55 years of age in 2000 and 0 for the remainder.

Unemployment situation in the past five years: This variable takes on a value of 1 for those individuals who have endured a period of unemployment in the past five years, and 0 if they have not.

Appendix II. Descriptive Statistics

Table A.II.1: Descriptive Statistics

	Men					
	Hourly-wage[a]		Work Experience		Number of wage earners	Number of individuals
	Mean	SE	Mean	SE		
Educational Levels:						
No studies	792.7	329.6	36.2	12.1	276	723
Primary	882.7	319.0	30.0	11.9	1,314	2,227
General lower secondary	863.1	341.3	18.2	11.8	2,276	3,280
Vocational lower secondary	908.2	330.0	14.6	10.7	637	828
Vocational upper secondary	1,041.4	431.2	14.6	10.8	871	1,024
General upper secondary	1,113.1	539.8	17.5	11.2	877	1,737
Short cycle university	1,460.3	694.8	17.7	11.2	532	722
Long cycle university	1,679.2	848.3	16.5	10.9	711	823
Total	1,037.6	542.2	19.9	12.9	7,494	11,364

	Women					
	Hourly-wage[a]		Work Experience		Number of wage-earners	Number of individuals
	Mean	SE	Mean	SE		
Educational Levels:						
No studies	593.6	236.3	33.0	14.1	115	1,060
Primary	682.1	254.2	24.9	13.0	541	2,933
General lower secondary	677.6	287.0	15.9	11.8	1,072	3,448
Vocational lower secondary	759.3	305.4	14.0	10.3	427	829
Vocational upper secondary	817.2	327.2	10.4	8.5	552	920
General upper secondary	881.4	371.8	14.6	10.6	622	1,975
Short cycle university	1,272.1	708.8	14.9	11.1	722	1,117
Long cycle university	1,394.5	647.0	11.8	9.5	633	914
Total	915.5	526.1	15.7	12.0	4,684	13,196

[a] In pesetas.

Appendix III: Education as a discrete variable.

In this section we have considered the so-called extended Mincerian wage equation, which relates the log of the wage offer w^* to dummy variables, which indicate the individual's educational level and other variables. Considering for simplicity only two educational levels we have:

$$\log w^* = \beta_0 + \beta S + X\alpha + \varepsilon$$

with $E[\varepsilon | S, X] = 0$

$S = \begin{cases} 1 & if \quad educational\ level = 1 \\ 0 & if \quad educational\ level = 0 \end{cases}$ and

X = other relevant variables.

Once again, it is considered that there is a selection equation determining whether the individual is "wage-employed" or not and, consequently, that w^* can be observed or not.

$$I^* = \delta_0 + \delta_1 S + Z\delta + u \quad \begin{cases} I = 1 & if \quad I^* > 0 \\ I = 0 & if \quad I^* \leq 0 \end{cases}$$

with, $S = \begin{cases} 1 & if \quad educational\ \ level = 1 \\ 0 & if \quad educational\ \ level = 0 \end{cases}$ y Z = other variables.

So that w^* is observed if I = 1. We assume, too, that $\begin{bmatrix} \varepsilon \\ u \end{bmatrix} \sim N\left[0, \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon u} \\ \sigma_{\varepsilon u} & 1 \end{pmatrix}\right]$

The same as in section 2, the selection equation contains the socioeconomic restrictions which condition the individuals to be employed or not.

Again, there are two relevant expected values of the wage offer:

$$E\left[\log w^* \middle| S, X\right] = \beta_0 + \beta S + X\alpha$$

$$E\left[\log w^* \middle| S, X, I = 1\right] = \beta_0 + \beta S + X\alpha + \sigma_{\varepsilon u}\lambda$$

with $\lambda = \dfrac{\phi\left(\delta_0 + \delta_1 S + Z\delta\right)}{\Phi\left(\delta_0 + \delta_1 S + Z\delta\right)}$, $\phi(.)$ y $\Phi(.)$ being, respectively, the standard normal density and cumulative distribution functions and λ being the inverse Mills ratio.

Linked to each of these two functions there are also two relevant partial effects of education:

$$\beta_1 = \exp\left\{E\left[\log w^* \middle| S = 1, X = x\right] - E\left[\log w^* \middle| S = 0, X = x\right]\right\} - 1 = \exp\left(\beta\right) - 1$$

$$\beta_2 = \exp\left\{E\left[\log w^* \middle| S = 1, X = x, I = 1\right] - E\left[\log w^* \middle| S = 0, X = x, I = 1\right]\right\} - 1 =$$

$$= \exp\left\{\beta + \sigma_{\varepsilon u}\left(\lambda_{S=1} - \lambda_{S=0}\right)\right\} - 1$$

The first effect, β_1, measures the difference existing in the expected value of the wage offer of two individuals only differentiated by their educational level, whether they are employed or not. β_2 measures the difference in the expected value of the wage offer between two wage employed individuals only differentiated by their educational level.

Similarly, the partial effect can be calculated in terms of the wage actually received:

$$\beta_3 = \frac{\Phi\left(\delta_0 + \delta_1 S + Z\delta \middle| S = 1\right)\exp\left(E\left[\log w^* \middle| S = 1, X = x, I = 1\right] + \frac{1}{2}\sigma_\varepsilon^2\right)}{\Phi\left(\delta_0 + \delta_1 S + Z\delta \middle| S = 0\right)\exp\left(E\left[\log w^* \middle| S = 0, X = x, I = 1\right] + \frac{1}{2}\sigma_\varepsilon^2\right)} - 1 =$$

$$= \frac{\Phi\left(\delta_0 + \delta_1 S + Z\delta \middle| S = 1\right)}{\Phi\left(\delta_0 + \delta_1 S + Z\delta \middle| S = 0\right)}\exp\left(\beta + \sigma_{\varepsilon u}\left(\lambda_{S=1} - \lambda_{S=0}\right)\right) - 1$$

Appendix IV. 1994 data

Table A.IV.1. Probit equation for the probability of wage-employment (Dependent variable: "Wage-Employment")

1994

Variables	Men	Women
Constant	-4.033 (0.192)	-3.983 (0.191)
Education	0.034 (0.005)	0.077 (0.005)
Age	0.207 (0.010)	0.167 (0.011)
Age^2	-0.003 (0.0001)	-0.002 (0.0001)
Caring Duties	-0.239 (0.054)	-0.096 (0.041)
Income of the rest of the household	$-9.58x10^{-8}$ (1.61×10^{-8})	$-6.15x10^{-8}$ (1.18×10^{-8})
Number of children	-	-0.083 (0.020)
Income of the rest of the household * Number of children	$2.47x10^{-8}$ (9.44×10^{-9})	-
Marital Status	0.673 (0.057)	-0.297 (0.048)
χ^2_6 **variables of region of residence**	61.364	32.412
Log likelihood	-3,081.7	-3,171.4
N	5,652	6,683

Note: Standard errors in parentheses.

Table A.IV.2. Wage equation (Dependent variable: log(hourly wage)) 1994

	I		II	
	LS with selectivity correction		**IV with selectivity correction**	
	Men	**Women**	**Men**	**Women**
Constant	5.792 (0.073)	4.987 (0.121)	5.397 (0.111)	4.284 (0.158)
Education	0.060 (0.002)	0.082 (0.004)	0.099 (0.007)	0.110 (0.006)
Experience	0.024 (0.004)	0.046 (0.003)	0.023 (0.005)	0.053 (0.004)
Experience ^{2}	-0.0002 (0.0001)	-0.0007 (0.0001)	-0.0001 ($6x10^{-5}$)	-0.0009 ($8x10^{-5}$)
Selectivity term	-0.222 (0.043)	0.141 (0.059)	-0.201 (0.056)	0.458 (0.076)
χ^2_6 **region of residence**	80.209	18.331	65.684	29.479
F on excluded instruments (number of instruments)	-	-	51.554 (5)	299.898 (5)
p-value Hausman exogeneity test	-	-	$1.34x10^{-10}$	$4.6x10^{-12}$
p-value Sargan test	-	-	0.120	0.300
SE	0.417	0.434	0.443	0.440
N	3,360	1,690	3,360	1,690

Note: White standard errors in parentheses, SE=Standard Error of the regression.

Appendix V: Double selection

In this section we have considered that the wage observation is determined in a double selection context. Firstly, the individuals decide if they want to actively seek employment (decision to participate in the labour market) and then, in a sequential manner, they may, or not, find employment.

In this context, the double selection scheme can be described by the following equations:

$$\text{Participation} \quad I_1^* = \delta_{S_1} S + Z_1 \delta_1 + u_1 \quad \begin{cases} I_1 = 1 & if \quad I_1^* > 0 \\ I_1 = 0 & if \quad I_1^* \leq 0 \end{cases}$$

$$\text{Wage-employment} \quad I_2^* = \delta_{S_2} S + Z_2 \delta_2 + u_2 \quad \begin{cases} I_2 = 1 & if \quad I_1^* > 0 \quad and \quad I_2^* > 0 \\ I_2 = 0 & if \quad I_1^* > 0 \quad and \quad I_2^* \leq 0 \end{cases}$$

with S = years of education and Z_1 = other determinants of the participation Z_2 = other determinants of the wage-employment status and $\delta_{S_1}, \delta_1, \delta_{S_2}$ and δ_2 are parameters.

Thus, actually, w^* is only observed if $I_2 = 1$. In this theoretical context, the two relevant expected values of the logarithm of the wage:

$$E\left[\log w^* \middle| S, X\right] = \beta S + X\alpha$$

$$E\left[\log w^* \middle| S, X, I_2 = 1\right] = \beta S + X\alpha + \sigma_{\varepsilon u_1}\lambda_1 + \sigma_{\varepsilon u_2}\lambda_2$$

with $\lambda_1 = \dfrac{\phi\left(\delta_{S_1}S + Z_1\delta_1\right)}{\Phi\left(\delta_{S_1}S + Z_1\delta_1\right)}$ and $\lambda_2 = \dfrac{\phi\left(\delta_{S_2}S + Z_2\delta_2\right)}{\Phi\left(\delta_{S_2}S + Z_2\delta_2\right)}$, and $\phi(.)$ y $\Phi(.)$ being, respectively, the standard normal density and cumulative distribution functions. λ_i is the inverse Mills ratio, $\sigma_{\varepsilon u_1}$ is the correlation between the errors of the wage and participation equations and $\sigma_{\varepsilon u_2}$ is the correlation between the errors of the wage and wage-employment equations.

Linked to each of these two functions there are three partial effects of education on the wage offer:

$$\beta_1 = \frac{\partial E\left[\log w^* \middle| S, X\right]}{\partial S} = \beta$$

$$\beta_2 = \frac{\partial E\left[\log w^* \middle| S, X, I_2 = 1\right]}{\partial S} = \beta - \sigma_{\varepsilon u_1}\delta_{S_1}\left[\left(\delta_{S_1}S + Z_1\delta_1\right)\lambda_1 + \lambda_1^2\right] -$$

$$- \sigma_{\varepsilon u_2}\delta_{S_2}\left[\left(\delta_{S_2}S + Z_2\delta_2\right)\lambda_2 + \lambda_2^2\right]$$

$$\beta_3 = \frac{\partial E\left[Y \middle| S, X\right] \big/ E\left[Y \middle| S, X\right]}{\partial S} = \beta_2 + \delta_{S_1}\lambda_1 + \delta_{S_2}\lambda_2$$

Appendix VI. Double selection results

Table A.VI.1. Participation and wage-employment probit results - women

	1994		2000	
	Participation	**Wage-employment**	**Participation**	**Wage-employment**
Constant	-4.173 (0.183)	-1.720 (0.290)	-4.787 (0.130)	-0.928 (0.228)
Education	0.070 (0.005)	0.055 (0.007)	0.085 (0.003)	0.034 (0.005)
Age	0.254 (0.011)	0.124 (0.016)	0.262 (0.008)	0.109 (0.013)
Age^2	-0.003 (0.0001)	-0.001 (0.0002)	-0.003 (0.0001)	-0.001 (0.0002)
Caring duties	-0.073 (0.041)	-0.350 (0.057)	-0.171 (0.030)	-0.126 (0.045)
Income of the rest of the household	$-1.24x10^{-7}$ (1.18×10^{-8})	-	$-5.85x10^{-8}$ ($5.96x10^{-9}$)	-
Number of children	-0.133 (0.019)	-	-0.152 (0.015)	-
Marital status	-0.490 (0.049)	-	-0.356 (0.034)	-
Unemployment situation in the past five years	-	-1.235 (0.056)	-	-1.038 (0.044)
χ^2_6 variables of region of residence	-	29.405	-	93.485
SE	0.438	0.426	0.436	0.386
N	6,683	3,031	13,147	6,053

Note: Standard errors in parentheses. SE=Standard Error of the regression .

Table A.VI.2. Wage equation with double selection - women
(Dependent variable: log(hourly wage))

	LS with selectivity correction	
	1994	**2000**
Constant	5.314 (0.083)	5.662 (0.048)
Education	0.071 (0.003)	0.074 (0.002)
Experience	0.041 (0.003)	0.027 (0.002)
Experience ^{2}	-0.0007 (0.00008)	-0.0004 (0.00004)
Selectivity term (participation)	0.221 (0.043)	0.179 (0.025)
Selectivity term (wage-employment)	-0.258 (0.033)	-0.348 (0.028)
χ^2_6 **variables of region of residence**	10.132	37.782
SE	0.425	0.374
N	1,690	4,667

Note: White standard errors in parentheses, SE=Standard Error of the regression .

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