# Returns to schooling in Uruguay

Graciela Sanroman
Departamento de Economía, FCS, UDELAR
Junio 2006

Preliminary and incomplete. Please do no quote.

**Abstract**

This paper analyzes the economic returns of schooling in Uruguay. Instrumental variables mean and quantile regressions are estimated. An indicator of whether an Internet connection is available at home is used as an instrument for the years of schooling of the household's head. The evidence show that the simple Mincer's OLS estimates are downward biased. Controlled for measurement error in schooling reports the estimates indicate that an additional year of schooling increases wage rates by 22 percent.

**Resumen**

Este artículo analiza la rentabilidad de la educación y el efecto de la crisis uruguaya del 2002 sobre la misma. Se utilizan variables instrumentales para estimar regresiones medias y cuantílicas. Un indicador de la disponibilidad de conexión a Internet en el hogar es usado como instrumento para los años de educación del jefe de hogar. La evidencia analizada muestra que las estimaciones MCO de la ecuación de Mincer están sesgadas hacia cero. Las estimaciones que controlan por la presencia de errores de medida en el relevamiento de los años de educación indican que un año adicional de educación aumenta el salario en 22 por ciento.

# 1 Introduction

How much to invest in education is by far one of the most important economic decisions that both individuals and policy-makers face.

Hundred of studies in many different countries and time period have confirmed that better-educated individuals earn higher wage rates, experienced less unemployment, and work in more prestigious occupations than their less-educated counterparts (Card, 1999). Schultz (2003) argues that there are three interrelated issues in the design of an efficient and equitable educational system. First, the productivity of similar workers with different level of schooling must be assessed. Second, the personal distribution of the benefits of an educational program should not add to economic inequalities, and if possible reduce them. Third, the specified levels of education should be produced at least private and public costs. This paper explore the first issue by estimating the private returns to education in Montevideo.

Two econometric issues arise from the empirical study of returns to schooling (Card, 1999; Ashenfelter and Krueger, 1994; Griliches, 1977 and 1979). First, as is common knowledge the effect of survey measurement error in schooling produce an attenuation bias on the estimates of the causal effect of education. Second, there is an unobservable heterogeneity problem, i.e. the expected relationship between unobservable ability and schooling upward biased any estimated effect.

This paper proposes to overcome these estimation problems by using an

instrumental-variables approach. An indicator of whether an Internet connection is available at home is used as an instrument for the years of schooling of the household's head.

The data used in this study are drawn from the Uruguayan Household Survey from 2001 to 2005 (Encuesta de Hogares, Instituto Nacional de Estadística, Uruguay). The sample includes household's head males aged 35-44, private-sector full-time salaried workers residents in Montevideo.

The results indicate that the economic returns to schooling in Uruguay may have been underestimated in the past. I find that, in mean, each year of additional schooling equaled an additional 22 percent which is 10 and 12 points higher than Bucheli and Furtado (2000) and Miles and Rossi (1999) estimates. It is important to note that different sample were used. Thus, in order to evaluated the attenuation bias associated with the presence of measurement error the comparison must be done with respect the 14 percent premium OLS estimate from the selected sample over the period 2001-2005.

There are six sections to the paper. In the first I include a brief survey about previous Uruguayan estimates of the returns to schooling. Section 2 is concerned with the description of the dataset. Section 3 examines the econometric issues related to the returns to schooling estimates. Section 4 presents the equation to be estimated as well as the strategies I proposed in order to overcome those issues. Results are analyzed in Section 5. Finally, Section 6 concludes.

# 2 Empirical evidence about returns to schooling in Uruguay

Many papers have studied the returns to schooling in Uruguay during the eighties and nineties (see Bucheli (2000) for an exhaustive survey).

The basic equation estimated correspond to a simple Mincer's (1974) equation; i.e. the log hourly wage rates is the dependent variable while regressors include education level, years of working experience and its square and other controls such as gender, tenure and industry.

Bucheli and Furtado (2000) estimates indicate that an additional year of schooling increases wage rates by 9,6 percent in mean during the nineties. They also found that returns to schooling decreased from 1986 to 1989 and then rose until 1995. As a result the education premium were higher in the nineties than in the eighties. An additional issue that is addressed by Bucheli and Furtado (2000) is whether that premium is constant along the education level. They included a quadratic form in years of schooling and found that the respective coefficient is not significant different than zero before 1994 but positive and increasing after that year.

Miles and Rossi (1999) estimate quantile regressions with the aim of analyzing how do the returns to schooling varies among the different socioeconomic groups. They estimate the premium to an additional year of schooling measured within each of the five quintiles of the empirical wage distribution. The authors found a U-shaped relationship between education premium and

quintiles. That is, the returns to each additional year of schooling is higher at the initial and the tertiary education relative to the secondary education. Finally, they conclude that the returns to schooling in the highest quintile have experienced a significant increase during the nineties.

Bucheli and Casacuberta (2001), Torello and Casacuberta (1997) and Bucheli (1992) suggest that the returns to schooling varies along the years of schooling. In particular, they argue that there is a "degree premium" associated to complete an education cycle and thus they propose to estimate the returns to schooling using dummy variables for each education level. Arim and Zopollo (2000) use the same approach and conclude that the premium to the highest education level with respect to primary education decreases from 1986 to 1991 and then increases until 1996. The evidence they analyze also show that the premium of the secondary cycle is almost constant over that period.

Bucheli *et al* (2000) find that the returns to schooling increases over the life cycle. However they also show the rise in the returns to education during the nineties have especially favored the youngest cohorts' earnings.

Finally, some articles show that the returns to schooling is higher within the private-sector workers (Trylesinky, 1991; Bucheli, 1994 and 1995).

# 3 Data

The data used in this study are drawn from the Uruguayan Household Survey from 2001 to 2005 (Encuesta de Hogares, Instituto Nacional de Estadística,

Uruguay). The survey frame is the civilian population of Uruguay living in housing units in urban areas, decomposed in a survey for the metropolitan area of Montevideo and another one for the population living in cities in the rest of Uruguay.

The survey includes information about individual's characteristics such age, gender, labor status, education, wage rates and hours worked. The survey ask about the last education level completed by the person and the number of years approved in that level. During the period cover by the used sample (2001-2005) there were neither changes on the questions about education nor on those about wage rates and hours worked.

It is important to note that the question about the availability of an internet connection at home is included in the 2001 questionnaire and after but not before.

The sample I use includes household's head males 35-44 years old resident in Montevideo. I only include those who had a positive salary in the month preceding the interview, i.e. at least one-month tenure, and who had worked at least 34 hours during the week before the interview. I restrict the sample to those who were employed in the private sector excluding entrepreneurs, self-employed and those who work in the public sector.

The variable of interest is the real hourly wage, obtained as the salary and benefits in the month just before the interview divided by four times the hours worked in the week previous to the interview. We assume that the hours worked in the week previous to the interview are the same for the

whole month just before the interview.

In Table 1 I present some descriptive statistics of the main variables.

# 4 Econometric issues

Recent studies of education and wage determination are almost always embedded in the framework of Mincer's (1974) human capital earning function (Card, 1999). According to this model, the log of wage rates (w) in a given time period can be decomposed into an additive function of a linear education term and a quadratic working experience term,

$$\log w_i = \alpha S_i^* + \beta \exp_i^* + \gamma \left(\exp_i^*\right)^2 + e_i \tag{1}$$

where $S_i^*$ is true schooling, $\exp_i^*$ is years of working experience and $e_i$ is an unobservable random variable. $\alpha, \beta$ and $\gamma$ are unknown parameters to be estimated.

In the early literature following Mincer's approach, equation [1] was commonly estimated by means of ordinary least square (OLS). This estimation techniques assumes that the explanatory variables are uncorrelated with the unobserved disturbance in the equation which for various reasons might no be fulfilled. Many papers find conclusive evidence of the importance of the measurement error in schooling levels (see, e.g., Ashenfelter and Krueger, 1994; Griliches, 1977 and 1979). Moreover, various research put into question whether the observed positive correlation between schooling and wage rates is caused by education or because correlation between schooling and

unobserved worker ability.

Therefore two main econometric issues arise in the empirical study of returns to schooling. First, the effect of survey measurement error in schooling. Measurement error in schooling would be expected to lead to a downward biased in any OLS estimation of the relationship between schooling and earnings.

Second, there is an unobservable heterogeneity problem, i.e. the expected relationship between unobservable ability and schooling bias any estimated effect.

Three approaches have been used to try to deal with these potential problems (Ashenfelter *et al*, 1999; Card,1999). First, to use a proxy variable (like IQ tests) for unobservable ability. Second, estimates based on the earnings and schooling of siblings and twins. Third, to follow an instrumental-variable estimation strategy.

The first approach deals with the issue of ability bias by including explicit measures that proxy for unobserved ability. IQ and related tests are an example of such proxies (Griliches, 1977; Griliches and Mason, 1972). The results of these studies have suggested that there is an upward bias in results that lack an ability measure. The method of adding ability proxies has been criticized, however, because it is extremely difficult to develop ability measures that are not themselves determined by schooling. When the ability measure is itself influence by schooling, the use of ability proxies will, in fact bias estimates of returns downward.

The 'siblings' or 'twins' approach exploit a belief that siblings are more alike then a randomly selected pair of individuals, given that they share common heredity, financial support, peer influences, and environment. The approach attempts to overcome omitted ability bias by estimating the returns to schooling from differences between siblings or twins in levels of schooling and earnings. Studies based on sibling or twin comparisons have suffered from to primary criticisms. First, if ability has an individual component as well as a family component, which is not independent of the schooling level, the within-family approach may not yield estimates that are less biased than OLS estimates. Second, if schooling is measured with error, this will account for a larger fraction of the differences between the twins than across the population as a whole. This would imply that the bias from measurement error in schooling is likely to increase by forming differences between twins, which means the within-twin estimates will be biased downward. Following the lead of Ashenfelter and Krueger (1994) innovative paper, many contributions to the siblings literature have attempted to deal with the measurement error problem by collecting multiple measures of schooling by questioning the siblings about each other or by using independent measures of error variances to adjust the estimates (see, e.g., Ashenfelter and Rouse,1998; Miller *et al*, 1995; Rouse, 1997). Many of these within-twin studies suggest that ability bias is relatively small, although this is only the case when measurement error has been controlled. Controlling for measurement error using instrumental variable regressions Ashenfelter and Krueger (1994) find that the estimate of

the returns to schooling nearly double the simple OLS estimate.

Finally, the instrumental variable approach includes instrumental variables estimates of the returns to education based on institutional features of the education system and estimates based on either controlling for family background or using family background as an instrument for schooling (Card, 1999).

One of the most important new direction of research in the recent literature on schooling is the use of institutional feature of the schooling system as a source of credible identifying information for disentagling the casual effects of schooling.

There are various studies that use the instrumental variable approach (for a detailed survey see Card, 1999). Angrist and Krueger (1991) from U.S. data use an individual's quarter of birth (interacted with the year of birth or the state of birth) as an instrument for schooling. Their IV estimates of the returns to education are typically higher than the corresponding OLS estimates.

Staiger and Stock (1997) re-analyze the 1980 Census samples used by Angrist and Krueger and compute a variety of asymptotically valid confiedence intervals for standard IV and limited information maximum likelihood (LIML) estimates. They estimates are somewhat above the corresponding conventional IV estimates and 50-70 percent higher than OLS estimates.

Card (1995) finds that when college proximity is used as an instrument for schooling in the National Longitudinal Survey (NLS) Young Men sam-

ple, the resulting IV estimator is substantially above the corresponding OLS estimator, although rather imprecise. Card also propose an alternative specification that uses interaction of college proximity with family background variable as instrument for schooling, and includes college proximity as a direct control variable. The IV estimate from this interacted specification is somewhat lower than the estimate using college proximity alone, but still 30 percent above OLS estimate.

Harmon and Walker (1995) examines the returns to education among a relatively large sample of British male household heads. The authors use as instrumental variables for schooling a pair of dummy variables that index changes in the minimum school leaving age in Britain -from 14 to 15 in 1947, and from 15 to 16 in 1973. Their IV estimate is 2.5 times higher than their OLS estimate. Card (1999) highlight that there are several aspects of their estimation strategy that suggest their estimates may be upward biased.

(to be completed)

# 5 Econometric approach

A conventional assumption is that observed schooling ($S_i$) differs from true schooling by an additive error,

$$S_i = S_i^* + v_i \tag{2}$$

where $v_i$ is a random variable that satisfies $\mathrm{E}[v_i] = \mathrm{E}[S_i^* v_i] = 0$, and $\mathrm{E}[v_i^2] = \sigma_v^2$.

It is also frequent in the literature to assume that $e_i$ is a random two component error term,

$$e_i = \eta_i + \varepsilon_i \tag{3}$$

I assume $\eta_i \sim (0, \sigma_\eta^2)$ represents unobservable characteristics of the individual (such as ability or family background) that are potentially correlated with $S_i^*$. On the contrary $\varepsilon_i \sim (0, \sigma_\varepsilon^2)$ capture unobservable agent's characteristics that are independent of $S_i^*$.

The influence of working experience on the wage rates is captured by a quadratic form. The dataset does not includes any question about the individuals' working experience thus just the potential working experience (defined as $Age - S_i - 6$) would be observable. It is important to notice that this measure is also contaminated by the measurement error in schooling reports.

With the goal of overcome the latest problem I select a sample of males aged 35-44. Within this group a linear term would be enough for capturing the earnings heterogeneity that comes from working experience.

Therefore, manipulating equation [1], under the assumption that $\gamma = 0$ I obtain,

$$\log w_i = \delta_0 + \delta_1 S_i + \delta_2 Age_i + \zeta_i \tag{4}$$

$$\zeta_i = \eta_i - \alpha v_i + \varepsilon_i \tag{5}$$

where $\delta_1 = \alpha - \beta$ and $\delta_2 = \beta$. It is clear that it is possible to recover the structural parameters of interest (in particular $\alpha$) if consistent estimates of

$\delta_1$ and $\delta_2$ were available.

Unfortunately, as was previously addressed, the OLS estimate of $\delta_1$ in equation [4] is biased and inconsistent. The OLS estimate is more biased toward cero (the attenuation bias) the greater is the variance of the measurement error ($\sigma_v^2$) with respect to the variance of true schooling ($\sigma_{s^*}^2$) . On the other hand, recall that a positive correlation between true schooling and ability -and thus between observed schooling $S$ and unobserved heterogeneity $\eta_i$- would overestimate $\delta_1$.

I propose to use an indicator of whether an Internet connection is available at home as an instrument for the years of schooling of the household's head. From my point of view it seems reasonable to think that this indicator has nothing to do with schooling measurement error. Unfortunately the independence of this instrument with respect to unobserved ability or family background could be debatable. Thus, the instrumental variable estimates could be somewhat upward biased. However, the evidence analyzed by previous studies show that this bias is very small compared to the bias caused by schooling measurement error. Moreover, at the end of the day, it is possible to think that the instrumental variables estimates correspond to an upper bound to the returns to schooling, while the OLS estimates correspond to the lower bound.

# 6 Econometric results

## 6.1 OLS and quantile estimates

Table 2 reports the results based on pooled cross-section OLS and quantile regressions for the period 2001-2005. These results are comparable to the previous estimates from Uruguayan data. Notice that these estimates ignore the potential bias introduced by the correlation between, e.g., earnings and either schooling level and family background or the schooling measurement error.

The OLS regression estimates indicate that each additional year of schooling increases by 14 percent the hourly wage rate in the private sector. That numer is somewhat greater than the Miles and Rossi (1999) estimates for the period 1986-1997 (10.0 to 12.1 percent) and substantially higher than the OLS estimation by Bucheli and Furtado (2000) for that period (8.6 to 10.5 percent). There are two aspects that could also contribute to explain the difference with respect to Bucheli and Furtado results. First, as they do I use a sample of salaried private-sector workers but I restrict the data to males aged 35-44, while they select a sample of both males and females aged 18+. Second, their estimate includes controls for firm size and industry, which has the effect of reducing the estimated effect of education. In conclusion, evidence seems to indicate that there were an moderated increase of the returns of schooling between the nineties and the first half of the current decade.

I can also compare the quantile regressions results to those of Miles and Rossi (1999). They find a U-shaped relationship between education premium and quantiles. The estimates in this paper (see Table XX), however, indicate that there is a monotonically increasing pattern of the returns to schooling over the deciles of the empirical distribution. The average return is 10.5 percent (9.1 plus 1.4) at the first decile and rise to 17.8 percent ( 15.4 plus 2.4) at the ninth decile.

Other considerations arise from results in Table 2. First, a dummy variable that capture the occurrence of the 2002 Uruguayan crisis is included. The respective OLS estimate indicates that the average wage rates has exhibited a significant fall of approximately 30% between January 2001-September 2002 and October 2002-December 2005. That fall, moreover, shows a decreasing behavior along the wage distribution. It attains a significant 40% within the two first deciles, decreases to approximately 25% for the forth, fifth and sixth deciles and becomes no significant in the four highest deciles. According to this result the crisis effect was concentrated in the poor groups of the population, an thus, it has increased the income inequality.

Furthermore, an interaction between years of schooling and the crisis's dummy (SDC) is included in order to determine whether the crisis has affected the education premium. The coefficient is not significant both in the mean and the quantiles regressions.

## 6.2 Instrumental variable estimates

I propose to use an instrumental variable estimation strategy in order to overcome the potential bias of the OLS estimates caused by that measurement error in schooling reports. I use an indicator of whether an Internet connection is available at home as an instrument for the years of schooling of the household's head. This variable is clearly independent of the measurement error and it is expected to be correlated with true schooling. In particular, an OLS regression of observed schooling over the proposed instrument performs an R-square of 0.22 and estimates a strongly significant coefficient of 3.95 with a t-ratio of 27.

Table 3 reports the corresponding estimates. Consistent with all the empirical literature, the estimates are much larger than those using OLS techniques. Results indicate that each year of schooling increase the wage rates by 22 percent (19.4 plus 2.9), which is substantially greater than the OLS estimate of 14 percent.

A conventional Hausman test of the difference between the OLS estimates and the instrumental-variables estimates rejects the hypothesis that these (and the remaining coefficients) are equal with a $\blacksquare^2$ of 201 (p-value 0.00). This result can be interpreted as evidence of the presence of measurement error in schooling reports.

This estimate is surprisingly higher than expected and a bit greater than the international standards (see, e.g., Ashenfelter and Krueger, 1994). However it matchs the fact that, in the used sample, the unconditional mean of

the wage rate of a 12-year educated worker more than double that of a 6-year educated; and the mean wage rate of a 16-years educated worker exactly double the average salary of a 12-years educated one. The IV estimate of the dummy is also very high relative to that of OLS techniques, and attains in mean to 39 percent, indicating that the effect of the crisis on the wage rate was higher than the OLS result suggests. On the other hand, the results of the IV quantile regressions differ from the traditional because the former indicates that the fall of the wage rates was significant in all the decile groups. IV estimates indicate that the wage rates decline approximately 30 percent first three deciles, 22 percent in the deciles fourth to eighth and 16 percent in the ninth decile. In conclusion, there is evidence that the wage rates have experienced a strong fall because of the crisis.

In addition, and different than in the OLS estimation, the coefficient of the interaction between the years of schooling and the crisis's dummy results significant and positive, of the order of 3.5 percent. Notice, however, that this coefficient is significant in the first three deciles while insignificant different than zero in the remaining deciles.

The increase of the returns to schooling from the crisis could be interpreted as evidence about a greater international mobility of the more skilled workers with respect to those who are less educated: the labor demand has to pay more or -as is the case in the recent years- at least reduce less the wage rates in order to keep the employees. Pellegrini and Vigorito (2005) analyze evidence that indicates that this would be the case because the well-

educated are overrepresented within the group of those who have emigrated from Uruguay during the last years.

# 7 Concluding remarks

Results indicate that each year of schooling increase the wage rates by 22 percent. Thus, it is possible to conclude that education is a very profitable investment in Uruguay. The evidence show also that returns to schooling have been increasing over the two last decades, and also have increased from 2002 uruguayan crisis. As is well known those who have being enrolled in the highest levels of education is disproportional from better-educated and wealthiest families. That evidence put under question the fairness and the efficiency of public subsidies for education, in particular for those which go to the tertiary cycle. (to be completed)

# References


[1] Angrist, J. and A. Krueger (1991) "Does compulsory school attendance affect schooling and earnings." *Quarterly Journal of Economics,* 106(4), pp. 979-1014.

[2] Arim R. and G. Zoppolo (2000) "Distribución y estructura de las remuneraciones. Uruguay 1986/2000.", Ponencia presentada en el IV Seminario de la Red de Economía Social, 17 al 20 de julio de 2000, Panamá.

[3] Ashenfelter, O.; Harmon, C. and H. Oosterbeek (1999) "A Review of Estimates of the Schooling/Earnings Relationship, with Tests for Publication Bias." *Labour Economics*, 6(4), pp 453-70.

[4] Ashenfelter O. and A. Krueger (1994) "Estimates of the economic returns to schooling from a new sample of twins." *American Economic Review*, 84(5), pp 1157-1173.

[5] Ashenfelter, O. and C.E. Rouse (1998) "Income, schooling and ability: evidence from a new sample of identical twins." Quarterly Journal of Economics, 113(1), pp. 1157-1173.

[6] Bucheli, M. and C. Casacuberta (2001) "Sobreeducación y prima salarial de los trabajadores con estudios universitarios en el Uruguay." DT 06/01 Departamento de Economía, FCS, UDELAR.

[7] Bucheli, M. (2000) "El empleo de los trabajadores con estudios universitarios y su prima salarial." DT 08/00 Departamento de Economía, FCS, UDELAR.

[8] Bucheli, M. and M. Furtado (2000) "La evolución de la participación de las fuentes de ingreso en Uruguay (1986/1997)." Ponencia presentada en el "Seminario de Economía Social" organizado por la Red de Economía Social y el Capítulo uruguayo de LACEA/BID/BM.

[9] Bucheli, M. (1995)., "El mercado de trabajo de los asalariados públicos," mimeo.

[10] Bucheli, M. (1994) "Los efectos de la política salarial y de incentivos al retiro de los funcionarios públicos sobre el personal," mimeo.

[11] Bucheli, M. (1992) "Los logros educativos y los niveles de ingreso." DT 03/92 Departamento de Economía, FCS, UDELAR.

[12] Bucheli, M.; Vigorito, A. and D. Miles (2000) "Un análisis dinámico de la toma de decisiones de los hogares en América Latina. El caso uruguayo." *Revista de Economía*, Segunda Época, Vol. VII, No. 2, Banco Central del Uruguay, pp 5-56.

[13] Card, D. (1999) "The causal effect of education on earnings." in *Handbook of Labor Economics*, Volumen 3, edited by O. Ashenfelter and D. Card, 1802-1863.

[14] Card, D. (1995) "Using geographic variation in college proximity to estimate the return to schooling." In: L. Christofides, E. Grant and R. Swidinsky, eds. Aspects of labour market behaviour: essays in honour of John Vanderkamp. University of Toronto Press, Toronto, Canada, pp. 210-222.

[15] Casacuberta, C. and M. Torello (1997) "La medición del capital humano en Uruguay." Ponencia presentada en las Jornadas de Economía del Banco Central del Uruguay.

[16] Griliches, Z. (1977) "Estimating the returns to schooling: some econometrics problems." *Econometrica* 45(1), pp 1-22.

[17] Griliches, Z. and W. Mason (1972) "Education, Income and Ability." Journal of Political Economy, 80(2), pp. 74-103.

[18] Griliches, Z. (1979) "Sibling models and data in economics: beginnings of a survey." *Journal of Political Economy,* 87(5), Part 2, pp S37-S64.

[19] Harmon, C. and I. Walker (1995) "Estimates of the economic return to schooling for the United Kingdom." *American Economic Review*, 85(5), pp. 1278-1286.

[20] Mincer, J. (1974) *Schooling experience an earnings.* New York. National Bureau of Economic Research.

[21] Schultz, T.P. (2003) "Evidence of returns to schooling in Africa from household survey: monitoring and reestructuring the market for education." CDP No. 875, Economic Growth Research Centerm, Yale University.

[22] Staiger, D. and J. Stock (1997) "Instrumental variables regression with weak instruments." *Econometrica*, 65(3), pp. 557-586.

[23] Trilesinsky, F. (1991) "Las diferencias salariales entre empleados públicos y privados. El caso uruguayo." Ponencia presentada en las Jornadas de Economía del Banco Central.