Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 629

Mayo 2011

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BANCO CENTRAL DE CHILE

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Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
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Documento de Trabajo
N° 629

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RISK PREMIUM AND EXPECTATIONS IN HIGHER EDUCATION

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Abstract

This paper takes the risk of college participation into context when evaluating the return to college education. College dropout and a higher permanent income shock for those who graduate from college accounts for 51% of the excess return to college education. Using a simple risk premium approach, I reconcile the observed high average returns to schooling with relatively low attendance rates. A high dropout risk has two important effects on the estimated average returns to college education: via selection bias and via risk premium.

Resumen

Este estudio considera el riesgo involucrado en la decisión de continuar con educación superior al evaluar el retorno a la educación terciaria. El riesgo de no terminar el ciclo universitario y el mayor shock permanente en salarios para aquellos que se gradúan de la universidad explica un 51% del exceso del retorno a la educación. Utilizando un modelo simple de premio por riesgo, se concilian los altos niveles de retorno a la educación con bajas tasas de participación universitaria. Un alto riesgo de no graduarse de la universidad tiene dos importantes efectos sobre los retornos a educación estimados: el sesgo de selección y el premio por riesgo.

Special thanks are due to Yongsung Chang for his advice, encouragement and support in this and other projects. I also thank to Andrew Davis for useful comments. All errors are my own. Correspondence: gcastex@bcentral.cl.

1 Introduction

There is an extensive literature analyzing the return to college education and its evolution over time (see for example Card 1999). While the Mincer approach is widely utilized, there are also estimates of the internal rate of return of the college investment decision (see for example Carnoy and Marenbach 1975, Heckman, Lochner, and Todd 2008). The effort in the literature focuses on obtaining accurate estimates of the return to college, but little has been done to consider for the fact that college enrollment is a risky investment decision.[1]. Enrolling in college is a risky decision since dropout rates are about 50%, according to Census, NLSY79 and also documented in the literature (see for example Mayer 2008, Restuccia and Urrutia 2004, , and others). Students who dropout have larger accumulated debts from college financing and end up joining the labor force with a wage that does not fully compensate the foregone earnings and the additional year of education.[2] Particularly for those who dropout, college enrollment seems not always to be an optimal decision.

In this paper I examine college enrollment as a risky investment decision. Considering the dropout risk, is possible reconcile high average return to education with low enrollment rates. In 1980, only 41% of high schools enrolled on college.[3] Among those in the highest quartile of the cognitive ability distribution, measured by AFQT scores, 30% did not enroll in college. Previous literature relies on selection bias to explain this puzzle: different schooling levels may be attributed to differences in individual aptitudes and tastes for schooling relative to work (Card, 2001). However, the risk involved in college enrollment has not previously been considered in estimating return to college education.

The high dropout risk has two important effects on the estimated average returns to college: through selection bias (as in the traditional literature by Willis and Rosen, 1978, and Card, 2001) and risk premium (as in the equity premium literature such as Mehra and Prescott, 1985). Taking into account dropout risk, a simple risk premium calculation accounts for 51% of the excess return to college education.

To quantify how much of the excess return to college education is due to college risk, I evaluate in a simple framework the risk premium of this investment decision. I apply the theory of consumption behavior and asset pricing in a static representative agent model. I use the consumption based capital asset pricing model to quantify the risk premium of the risky college investment decision. Given the nature of the schooling

[1]Excepcions are Chen (2002), Castex (2010) and Chaterjee and Ionescu (2009).
[2]Source: National Longitudinal Sample of Youth 1979, hereafter NLSY79.
[3]Source: NLSY79.

choice as a human capital investment, a two-period model is suitable to quantify how much of the return to college is explained by its risk. In the first period agents acquire human capital by attending college. In the second period the payoff of the investment decision is realized. Agents may successfully graduate from college or may fail. I calibrate the model for different points in time for the U.S. economy, from 1960 to 2007, using Census data and the American Community Survey (ACS). I consider two sources of uninsurable risk: a permanent shock on the college-wage and the risk of failing college. The permanent shock on wages arises in the form of a permanent stochastic return to college education received after graduation (Chen 2002). The risk of failing college arises in the form of dropout risk.

The rest of the paper is organized as follows: Section 2 describes the main assumptions and characteristics of the model. A description of the data and the calibration strategy is presented in Section 3. Results are in Section 4. Section 5 concludes the paper.

2 The Model

Consider an economy with a representative agent that lives for two periods. The life-time utility for a college attendant is described by:

$$V^c = \mathbb{E}\{u(c) + \beta[\psi u(c \times (1 + \widetilde{r})) + (1 - \psi)u(c \times (1 + r_d))]\}$$

where c corresponds to consumption level of a single good in both periods; $\widetilde{r}$ is the stochastic return to college education; r_d is the return to college dropout; ψ corresponds to the probability of graduating from college; β is the discount factor, $u(.)$ is a current period utility function, and $\mathbb{E}\{.\}$ is an expectation operator over the stochastic return to college in period 2. There is no saving or borrowing technology in this environment and there is no insurance mechanism against the stochastic return to college.

Education can only be acquired during the first stage of the life-cycle ($t = 1$). The outcome of this investment opportunity is uncertain and realized at the second stage of the life-cycle ($t = 2$). For agents who do not acquire college education, consumption levels in the first and second period of their life-cycle correspond to high-school labor income, W_1 and W_2 respectively. If agents decide to attend college in the first period they forgo earnings and pay tuition. This cost is summarized by τ. In the second period these agents face uncertainty about college completion. With probability ψ an agent successfully graduates from college, in which case they obtain the return to college investment, denoted by $\widetilde{r} \sim N(r_c, \sigma^2_{r_c})$. This stochastic return to college education corresponds to the second source of uncertainty faced when agents make their enrollment decision. If the individual fails to graduate, they receive a fraction of the return to college denoted by r_d. Table 1 summarizes the payoffs of the college-enrollment decision problem.

	stage 1	stage 2
No College	W_1	W_2
College	$W_1(1-\tau)$	$\psi \int_{\widetilde{r}} W_2(1+\widetilde{r})dF(\widetilde{r}) + (1-\psi)W_2(1+r_d)$

Table 1: Payoffs of the model

Note: The table displays the payoff for the two period representative agent model for two educational alternatives. Attending college implies a cost τ in the first period and an uncertain payoff at the second stage.

The cost of the human capital investment decision is paid in the first stage of the life-cycle, when college students forego earnings and pay tuition, while the stochastic benefits are received in the second stage. The risk premium of the college decision is obtained by pricing tomorrow's consumption stream, considering an environment with and without uncertainty.

There are two sources of uninsurable risk under consideration in this environment. First, a permanent shock on wages after college graduation, when college-graduates draw their return to education $\widetilde{r}$. Second, the dropout risk of attending college, $1-\psi$.

Taking attending college as the risky asset, following Lucas (1978), the price of attending college, p, is obtained from the optimality condition.

$$-pu'(c_1) + \beta\mathbb{E}[\psi(1+\widetilde{r})u'(c_1 \times (1+\widetilde{r})) + (1-\psi)(1+r_d)u'(c_1 \times (1+r_d))] = 0 \tag{1}$$

The mathematical expectation is over the return to education drawn conditional on completing college, as shown in Table 1. The Previous specification corresponds to the price of attending college in an environment with two sources of risk.

Computing the return to college education in environments with and without risk allows me to quantify how much of the excess of return to college is explained by the dropout risk and permanent shock on wages (stochastic return).

2.1 The stochastic return to college education

In this subsection, I estimate the stochastic return to college education to quantify how much of the excess of return to college is due to the permanent shock on wages and college dropout risk.

The internal rate of return plays a key role in economics of human capital: an additional level of schooling is considered profitable if the internal rate of return exceeds the opportunity cost. Carnoy and Marenbach (1975) estimate the rate of return to college education by using the standard discount formula:[4]

$$0 = \int_0^T (Y_t - C_t)e^{-rt}dt$$

where Y_t corresponds to the difference in average wage income in period t between those workers with college education and those without college education (high school graduates). C_t corresponds to the cost of schooling in period t, which includes tuition cost and foregone earnings while in school, $C_t = 0$ after individuals join the labor force. r represents the marginal internal rate of return of college education. T corresponds to the total number of periods under consideration, from the beginning of the college education to the end of working life.

Incorporating the dropout risk and the permanent income shock in wages, the stochastic internal rate of return is obtained from:[5]

$$0 = \int_0^{t_2=2} (Y_t - C_t)e^{-\widetilde{r}t}dt + \int_{t_2=2}^{T} (\psi(\widetilde{Y}_t - C_t) + (1-\psi)(Y_t^D - C_t))e^{-\widetilde{r}t}dt \qquad (2)$$

Where $\widetilde{Y}_t$ corresponds to the stochastic wage differential between college graduates and high school graduates, which depends on the wage draw after college graduation (permanent income shock as in Chen 2002). Y_t^D corresponds to the earning differential between college-dropouts and high school graduates. Agents successfully graduate from college with probability ψ.

The college premium plays a key role in determining the stochastic internal rate of return to college. Agents draw a stochastic wage premium after college graduation that is permanent in their lives, a permanent income shock in wages. Given this stream of income is possible to obtain the internal rate of return, $\widetilde{r}$, from

[4] See also Heckman et al. (2008).

[5] For simplicity is assumed that dropout occurs at the end of the second year of college education.

equation 2.

The difference between these two measures of the stochastic return to education, internal rate of return and college-wage premium, is that the former one already incorporates the cost of the investment opportunity, in terms of foregone earnings and tuition cost. The second measure just captures the benefit of acquiring college education and not the investment cost.

Next subsection describes the data and calibration strategy to estimate first the internal rate of return (monetary return to college) and then the risk premium using the Lucas (1978) asset pricing model as described in the previous subsection.

3 Data and Calibration

In order to analyze the risk and return to college education across time for the US economy, I use data from the Census from 1960 to 2000 and from the American Community Survey (ACS) from 2001 to 2007, both provided by the IPUMS-CPS project,[6] where I obtain individual earnings at different educational levels across age. In particular I analyze total wage and salary income,[7] considering white males aged 18 to 65 years old that are part of the labor force.[8]

For each cohort, I estimate average wage for each age and educational level to construct the wage profile along the agent's life-cycle. Standard deviations are also computed to quantify the difference between those workers with college education and those with high school education (permanent income shock in wages). With the wage profile streams is possible to estimate the internal rate of return to college education, incorporating the tuition cost and foregone earnings while in college (see equation 2).[9]

The return to college education is quantified according the descriptions of the previous subsection. r_c corresponds to the average monetary return to college graduation, r_d corresponds to the monetary return to college dropout, σ_r corresponds to the standard deviation of the monetary return. s corresponds to the college graduate wage premium, s_d corresponds to the college dropout wage premium and σ_s the standard deviation of the wage premium.[10]

[6] King et al. 2008, see technical details on the CPS and ACS data at http://cps.ipums.org/cps/samples.shtml.
[7] This variable reports the respondents total pre-tax wage and salary income from previous calendar year.
[8] See summary statistics in Appendix A.
[9] Tuition cost from 1960 to 2007 for U.S. is reported in Appendix A, source: College Board.
[10] Values from 2001 to 2007 are available upon request to the author.

Year	1960	1970	1980	1990	2000	2005
r_c	6.72%	9.18%	9.13%	13.54%	16.82%	18.55%
r_d	5.6%	6.68%	6.86%	10.06%	12.42%	13.28%
σ_r	2.71%	2.78%	3.35%	2.75%	2.91%	2.89%
s	31.06%	38.33%	34.12%	56.85%	64.79%	73.80%
s_d	17.74%	21.42%	23.30%	21.80%	25.83%	21.53%
σ_s	11.80%	12.30%	11.05%	18.49%	20.82%	22.81%

Table 2: Monetary Return to College and College Premium
Note: The table displays return to college education, r_c, return to college dropouts, r_d, standard deviation of the return to college, σ_r, college wage premium, s, dropout wage premium, s_d and standard deviation of the college wage premium, σ_s. Source Census, computed as described in equation 2.

As documented by Goldin and Katz (2007), the college premium has been increasing during the last decades and technological advance has outpaced the number of students enrolling in college. Both measures of the return to college, monetary terms and wage differential, are 98.6% correlated across time. The difference is explained by the investment cost that is not considered in the college wage premium approach.

The probability of success in college is estimated from the data. It is the fraction of people who graduated from college conditional on college enrollment for each particular cohort. The values are consistent with reports in previous literature, such as Restuccia and Urrutia (2004) and Mayer (2008) and are similar to those calculated using the NLSY79 sample. The values across time are reported in Table 3.[11]

Year	1960	1970	1980	1990	2000	2005
ψ	0.4786	0.4565	0.4458	0.5216	0.5161	0.4780

Table 3: Probability of college success (white male, source: Census, ACS)
Note: Computed as the fraction of students who do not graduate conditional in college enrollment. Source Census.

To quantify the risk premium associated with the college enrollment decision, I parameterize the model such that the first period occurs when agents are 18 to 22 years old, representing the period in which individuals decide whether to acquire human capital by attending college. The second period occurs when agents are 23 to 65 years old and actively participate in the labor market.[12]

At time zero, a risk adverse agent decides whether to attend college during the first stage of the life-cycle or to join the labor force as an unskilled worker. This decision is not only based on the return to college, but also on its risk.

[11] Dropout rates from 2001 to 2007 are available upon request to the author.
[12] Parameters and consumption levels are converted in annual terms.

To quantify how much of the return to college is explained by its risk, I first solve the model considering a risk-free environment. Then I add the dropout risk and the volatility of the college return. The difference in excess returns to college obtained in each setup allows me to evaluate the risk premium involved in the college enrollment decision. The price of the college decision is computed for each of the risky frameworks as described in Table 4.

Environment	Optimality condition
Model 1, No risk	$-p_{M_1}u'(c_1) + \beta[(1 + r_c) * u'(c_1(1 + r_c))] = 0$
Model 2, Permanent shock	$-p_{M_2}u'(c_1) + \beta\mathbb{E}[(1 + \widetilde{r}) * u'(c_1(1 + \widetilde{r}))] = 0$
Model 3, Dropout risk	$-p_{M_3}u'(c_1) + \beta[\psi(1 + r_c)u'(c_1(1 + r_c)) + (1 - \psi)(1 + r_d)u'(c_1(1 + r_d))] = 0$
Model 4, Dropout and Permanent shock	$-p_{M_4}u'(c_1) + \beta\mathbb{E}[\psi(1 + \widetilde{r})u'(c_1(1 + \widetilde{r})) + (1 - \psi)(1 + r_d)u'(c_0(1 + r_d))] = 0$

Table 4: Optimality conditions for college attendance
Note: The expressions correspond to the pricing formula for one unit of college education as a consumption good, under 4 scenarios.

The utility function is restricted to the constant relative risk aversion class, $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$. The parameter γ measures the curvature of the utility function. Its value is assumed to equal 2, as standard in the literature. The discount factor, β, is assumed to equal 0.96. Consumption values are expressed in per-year units.

4 Results

To evaluate the extent to which the excess return to college is explained its risk, in the form of dropout risk and a permanent income shock on college-wages, I use the proposed two-period model under 4 scenarios: no risk, considering only the permanent shock on college-wages, considering only the college dropout risk, and considering both sources of uncertainty. Each framework is evaluated for the US economy from 1960 to 2005. I evaluate the excess return to college education under linear utility first to evaluate the effect of the curvature of the utility function on excess return to college education.

In a risk neutral environment, it is possible to compute the dropout effect on the return to college education directly from Tables 2 and 3. The return to college education in 1980 is 9.13% conditioning on successful students only. This implies a 5.13% excess return to college education, compared to a 4% risk free asset. Adding the dropout risk reported in Table 3, the return to college decreases to 7.87%,[13] implying an excess return to college education of 3.87%. Considering the dropout risk of college education, the excess return to college decreases by 25% in 1980s (21% on average from 1960 to 2007). Results are shown in second column of Table 5.

Introducing risk aversion, I start by estimating Model 1. This specification does not consider any source of uncertainty. When there is no dropout risk, individuals who choose to acquire college education join the labor market as college educated workers. Additionally, in this setup there is no uncertainty about the college premium they will draw, i.e., no stochastic component of the permanent shock on wages. The excess returns to college education in this environment is reported in the first column of Table 5.

The next step is to estimate Model 2. This model specification departs from the benchmark environment by incorporating one source of uncertainty: a permanent shock component on college wages. The wage shock component is summarized by σ_r^2. However, as there is no college dropout risk in this setup: all agents successfully graduate from college and draw a monetary return $\widetilde{r} \sim N(r_c, \sigma_r^2)$. The third column of Table 5 reports the excess return to college education in this risky environment.

I proceed by estimating Model 3. In this setup the only source of risk is the possibility of dropping out from college. Successful graduation for participating individuals occurs with probability ψ, but with probability $1 - \psi$ agents fail and join the labor force as college dropouts. Agents who successfully graduate do not face uncertainty about the monetary return they draw. Column 4 in Table 5 provides the estimated excess return to college education across time under this scenario. Differences between values reported in column 4 and column 2 are explained by risk aversion.

Finally I estimate the complete model, Model 4. In this framework I allow for two sources of risk: a permanent shock on the college premium and college dropout risk. The results are shown in the last column of Table 5.

For each of the 5 model specifications, the excess return is computed with respect to a risk free asset, an asset which pays one unit of the consumption good in the second period. I use a 4% return on the risk free asset.

The following table shows excess return to college education under various assumptions. Values are shown

[13] $9.13\% \times 44.58\% + 6.86\% \times 55.42\%$

in monetary return units, as in Table 2.[14]

Year	Model 1 No risk	Linear utility considering dropout	Model 2 Permanent shock	Model 3 Dropout risk	Model 4 Perm. shock + Dropout risk
1960	2.72%	2.14%	2.65%	2.13%	-0.17%
1970	5.18%	3.82%	5.11%	3.81%	1.36%
1980	5.13%	3.87%	5.03%	3.86%	1.36%
1990	9.54%	7.88%	9.47%	7.85%	5.59%
2000	12.82%	10.69%	12.75%	10.65%	8.30%
2005	14.55%	11.80%	14.48%	11.74%	9.19%

Table 5: Excess return to college education

Note: The table displays the excess return to college education compared to a 4% risk free asset. Return to college education is computed as described in Table 4. Data source: Census.

Results summarized in Table 5 show the excess returns to college education under each model specification. Values are reported per year of college education.

The model without uncertainty, Model 1, shows the return to college education across time in an environment without dropout risk and no permanent graduation shock on wages. Agents who decide to accumulate human capital successfully graduate from college and obtain the average monetary return as a payoff. Agents consuearn in the second stage of their life-cycle a wage that fully incorporates the college premium with no uncertainty. Values under this model specification match the values reported in Table 2.

The second column in Table 5 shows the monetary return to college education under a linear utility specification, considering the dropout risk from Table 3. The excess return to college education is reduced by 21% (25% in 1980). Agents are willing to reduce the college return to avoid college dropout.

Model 2 is specified by adding one source of uncertainty in the form of permanent income shock in this setup risk adverse individuals do not know in advance the college premium thry will obtain after college graduation. The difference in returns to college education estimated from model 1 and model 2 is explained by this permanent income shock. This source of uncertainty explains about 1% of the excess return to college education (2% in 1980). Chen (2002), who analyzed data from NLSY79, reports that 23% of the college return is explained by this average risk differential.[15] Risk adverse agents who face uninsurable risk in college returns, specifically the uncertain college premium, require a larger return to compensate for the risk. The effect of the permanent income shock on wages is much larger in an environment with dropout

[14] Considering a 4% risk free asset. Values in college wage premium units are shown in Appendix A. The mapping to convert the units corresponds to the one described in Table 4.

[15] Chen 2002, performs a certainty equivalent approach to estimate how much return to college education is explained by the wage volatility differential between high school and college graduate wages.

risk, see below in model 4.

If I instead use the second source of uncertainty by only considering dropout risk, this yields the specification of model 3. Risk adverse agents who decide to accumulate human capital face the probability of failing to graduate from college. The probability of college success is reported in Table 3. The differences between the excess returns to college education under model 1 and model 3 are explained by the dropout risk, which accounts for 22% of the estimated excess of return to college education (25% in 1980). Dropping out implies a lower return to college investment corresponding to a fraction of the total college premium, appromimately 55% of the college premium in 1960 and decreasing to 27% of the college premium in 2006. Comparing outcomes of model 3 and the linear utility specification, it is possible to see the risk aversion effect on the excess return generated by dropout risk, that corresponds to 0.52% during the time period analyzed.

Model 4 combines both sources of uncertainty agents who decide to attend college may fail to graduate and obtain only a fraction of the college premium (as in model 3). Those who successfully graduate face a second source of risk: a permanent shock on wages (as in model 2). The full model including both sources of uninsurable risk accounts for 51% of the excess of return to college, 73% in 1980 (these values are obtained by comparing estimation outcomes from model 1 and model 4).

This paper applied a simple risk premium approach to estimate the excess of return explained by the risk in college education, that have been estimated around 51%.

5 Conclusion

I incorporate risk into the context of the college investment decision. Risk can reconcile the high average return to education with the observed low enrollment rate. Risk arises from two sources: a permanent income shock on wages after college graduation (Chen 2002, as in) and college dropout (as measured about 52%).

I utilize a simple approach, as in Mehra and Prescott (1985), to quantify how much of the excess return to college is explained by its risk. The permanent income shock on wages explains 1% of the excess return to college education. Dropout risk explains 22% of the estimated excess college return. Both sources of risk combined explains 51% of the excess return to college education. Risk adverse individuals prefer a lower return to college education if it reduces the risk associated with college completion.

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A Data: U.S. From 1960 to 2007

In this appendix I report summary statistics from the CPS data used to quantify the return to education from 1960 to 2007.[16]

	High school			College dropouts			College graduates		
year	number obs.	average wage	sd wage	number obs.	average wage	sd wage	number obs.	average wage	sd wage
1960	93,372	5,154	2,930	31,370	5,911	3,690	34,182	7,228	4,487
1970	129,755	8,053	4,317	43,316	9,323	5,561	51,564	12,216	7,244
1980	160,370	15,556	8,726	67,550	17,603	10,527	83,987	22,572	13,255
1990	159,181	22,600	15,248	113,636	27,596	19,953	104,233	40,708	31,356
2000	161,915	29,068	22,844	131,272	36,201	30,142	123,097	58,502	55,268
2001	68,196	30,174	22,339	58,180	37,843	29,434	62,272	64,793	60,706
2002	59,569	30,529	22,535	51,280	38,397	30,127	56,003	62,612	56,892
2003	65,775	30,910	22,848	56,797	38,343	29,080	62,602	63,868	56,156
2004	64,068	31,495	23,287	57,114	40,101	30,747	63,875	65,724	50,363
2005	154,685	32,399	24,342	135,202	41,261	31,647	147,662	69,588	54,214
2006	160,055	32,582	25,339	136,440	41,301	32,026	150,614	71,691	65,889
2007	159,335	34,035	27,385	136,517	43,273	34,622	154,188	75,977	70,935

Table A.1: Average wage and salary income by educational level across time

Tuition cost for the period analyzed is reported in Table A.2. For details see Board (2007)

Year	1960	1970	1980	1990	2000	2001	2002	2003	2004	2005	2006	2006
Tuition	3,200	3,500	3,800	8,000	8,000	8,400	8,700	9,100	9,500	9,600	9,900	10,300

Table A.2: College tuition costs. Source: College Board, values in 2007 dollars adjusted by CPI.

Table A.3 reports the excess return to college education under the four model scenarios. The measure of the excess return corresponds to a log wage difference.

	Model 1	Model 2	Model 3	Model 4
Year	No risk	Permanent shock	Dropout risk	Perm. shock + Dropout risk
1960	14.64%	14.56%	13.34%	10.80%
1970	20.17%	20.09%	17.08%	14.34%
1980	20.06%	19.94%	17.20%	14.39%
1990	30.28%	30.20%	26.34%	23.72%
2000	38.16%	38.07%	32.97%	30.17%
2005	42.40%	42.31%	35.61%	32.54%

Table A.3: Excess return to college education. Measured in low wage differential

[16] Raw data available upon request to the author.

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