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Human capital earnings functions: The Portuguese case

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Abstract. It is the purpose of this research to present some estimates of human capital earnings functions for Portugal, using published data on mean earnings by age, education and sex. We provide estimates of the implicit rates of return to human capital - schooling and general O.J.T. Differential effects by sex are discussed. An application of the methodology is used to analyze returns differentials between different schooling categories. Research on the specification of the earnings-experience profiles is also performed.
Keywords. Earnings functions, Returns to schooling, On-the-job training, Male-Female earnings/wage, Differentials, Earnings profiles.
JEL. J31, J42, J24, J16.

1. Introduction

The acquisition of human capital through education and On-The-Job Training has been generally viewed as an investment. After major developments in the theory - in which Schultz, Becker and Mincer have been pioneers -, a substantial number of empirical papers have been produced intending to highlight the features of such an investment.

It is the purpose of this research to use available Portuguese cross-section information on earnings, schooling and an indirect measure of experience of the working population to

1. offer some estimates of the pattern of the (human capital) rates of return to schooling and general On-the-Job-Training.

2. illustrate some possible applications of the methodology used, namely in discrimination issues and evaluation of the results of some education policies [1].

3. infer some aspects of the current equilibrium in the Portuguese human capital market by comparison with international evidence.

We start by introducing the reader to some theoretical background in section II. In section III we present and discuss the log-earnings regression results for the male population. In section IV we analyze the male-female differentials in the implied pattern of compensation. Section V deals with the comparison of the general high-school with the extinct technical school system. Further extensions of the specifications of sections III and IV to

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include higher degree polynomial terms in experience are presented in section VI. Some final remarks are put forward in section VII. We conclude by summarizing the main results in section VIII.

2. Theoretical background

1. An individual has a potential working life of T+1 years. Assume that if he chooses 0 years of schooling, he will earn (in real terms) E_t^0 from t=0 to T; if he chooses s years, he will earn E_t^s, from t=s to T, incurring in costs C_t^s, during the schooling period, t = 0 to s-1. Then, the internal rate of return to human capital will be given by the rate r that equates:

$$\Sigma_{t=0}^{T} E_t^0/(1+r)^t = -\Sigma_{t=0}^{s-1} C_t^s/(1+r)^t + \Sigma_{t=s}^{T} E_t^s/(1+r)^t \quad (1.1)$$

The individual will choose to go to school if the rate of return to the human capital investment is higher than the borrowing rate he faces. Now, assume that money costs are zero - only opportunity costs in the use of time are involved in going to school [2]- and that the earnings streams are constant for both options - E^0 and E^s. Then, for $T \to \infty$ we obtain [3]:

$$E^0 \{1/[1-1/(1+r)]\} = E^s \{1/[1-1/(1+r)]\} / (1+r)^s \quad (1.2)$$

Thus:

$$E^s = (1+r)^s E^0 \quad (1.3)$$

Taking logarithms:

$$\ln E^s = \ln E^0 + s \log(1+r) \quad (1.4)$$

By Taylor's expansion and small values of r, $\log(1+r) \approx r$. The approximation to the rate of return to schooling can therefore be [4]:

$$\ln E^s = \ln E^0 + s\, r \quad (1.5)$$

If we use Taylor's expansion to a higher order term, we can get:

$$\ln E^s = a_0 + a_1 s + a_2 s^2 + a_3 s^3 + \ldots \quad (1.6)$$

A possible interpretation of the derivative of the expression with respect to s is the rate of return to human capital at each level of schooling [5].

$$d(\ln E^S)/ ds = r(s) \quad (1.7)$$

For example, if we take only to the term education squared,

$$d(\ln E^S)/ ds = a_1 + 2\, a_2\, s \quad (1.8)$$

Then, a value of $a_1 > 0$ and of $a_2 < 0$ will imply a diminishing rate of return to education.

Notice that we can therefore estimate the rate of return to human capital in an economy if we have (cross-section) data on earnings of individuals of different schooling years by simply regressing the logarithms of earnings on the schooling period.

2. In terms of interpretation, the rate in (1.1) through (1.5) - and the one we get from the regression (1.5) - is the equilibrium rate of the economy.

Psacharopoulos (1981) reports estimates of the average private rate of return from log-earnings regressions of 14,4% for the LDC's, 9,7% for intermediate countries and 7,7% for advanced countries[6]; the ranking of those rates seems to be maintained, as suggested by later surveys (Psacharopoulos 1985 and 1994). This would imply underinvestment in human capital in less advanced economies, being the basis for public support of the education systems - not only due to external effects associated with it but simply due to the major difficulty in access to credit for the investment. That is, people find it difficult to get credit from the bank to subsidize their schooling years, once there is no guarantee (or knowledge of the future intentions of the individual - usually he has no credit history) to the bank of the future payment of an eventual loan.

Empirical findings also suggest a declining rate as the level of schooling increases. This could be related to decreasing credit constraints. That is, individuals will engage in schooling if the rate of return to the investment is at least equal to the borrowing rate they face. Therefore, people that face lower interest rates will have higher levels of schooling. The observed equilibrium pattern would then be of a declining rate of return to schooling relative to the schooling level. Also, people who acquire more schooling may have relatively higher "taste for studying" - implying they receive utility from studying, compensating, in equilibrium, the smaller money-yielding returns of people that choose smaller schooling levels.

3. Apart from the investment in (general) human capital through schooling, the enhancement of the ability to earn may be acquired through On-the-Job Training (O.J.T.). Let t denote experience in the labor market, k_0 be the proportion of earnings potential (or time-equivalent units) invested at time 0 in the market and T the experience level till which investment is made. Then, if the ratio of investment to earnings potential declines linearly [7], we can write the natural logarithm of the observed earnings for experience level t and schooling s, Y_t^S as:

$$\ln Y_t^s = \ln E^0 + s\,r + r_t\,k_0\,t - (r_t\,k_0/2T)\,t^2 + \ln(1-k_0+k_0\,t/T) \quad (1.9)$$

An approximation to the pattern of earnings profiles will be obtained if we regress:

$$\ln Y_t^s = a_0 + a_1\,s + b_1\,t + b_2\,t^2 \quad (1.10)$$

If the proportion of potential earnings invested declines exponentially and at a rate b, (in which case there is investment through all the lifetime), we arrive to the Gompertz specification [8]:

$$\ln Y_t^s = \ln E^0 + s\,r + r_t\,k_0/b - (r_t k_0/b)\,e^{-bt} + \ln(1-k_0\,e^{-bt}) \quad (1.11)$$

Then, an approximation of the function can be obtained through the regression

$$\ln Y_t^s = a_0 + a_1\,s + b_1\,e^{-bt} + b_2\,e^{-2bt}\,, \quad (1.12)$$

where

$$b_1 = -(k_0 + r_t\,k_0/b)\,, \quad \text{and} \quad (1.13)$$

$$b_2 = -(k_0^2/2)\,. \quad (1.14)$$

Assume we have data on earnings, experience and schooling. For specific levels of b, e^{-bt} and e^{-2bt} can be computed and simple linear regression can yield estimates for a_0, a_1, b_1, and b_2.

4. If in expression (1.1) we enter private expenditure and (net or after-tax) returns, then we will obtain the private rate of return to education. If we considered the gross returns and effective implied total (public and private) expenditure with education, we talk about social returns to education. In practice, it has been observed that the actual social rate estimated for other countries is lower than the private one, due to the subsidization of schooling all over the world.

Notice that this seems somehow odd. In theory, social rates should be higher than private rates whenever there are positive externalities coming from a particular investment. In fact, the opposite has been observed; this occurs because in the actual estimates of social rates we do not include - because they are very difficult to measure - external benefits (and indirect costs).

Estimates of the social and private internal rates of return to schooling for different education levels using cost-benefit analysis - that is, for specific (adjacent) schooling categories for which there is data on labor

income streams for people in different years in working lifetime - have already been obtained for Portugal [9]. We will use the same data, and combine information on age to derive experience levels and take the log-earnings approach to infer about the structure of the rates of return.

Some estimates of rates of return to education for Portugal using log earnings regressions were derived in Silva (1985), and more recently, in Kiker & Santos (1991 and 1997). They use different data sets and our methodology differs from theirs in several ways - namely in the differentials approach followed, the experience coefficients interpretations, age group decomposition of profiles and the extensions here considered - and also, in some questions we aim to answer.

3. Rates of return to human capital: Male population

1. In Table II.1 we reproduce some regressions of the log of monthly earnings on schooling and experience for the Portuguese male sample (see Appendix 1 for a description of the sample and data used).

Equation (1) refers to the estimates of equation (1.5) and equation (2) to those of (1.10). Equation (2). implies a rate of 7,3%. This rate is somewhat smaller than the one derived in Silva (1985) - whose estimates ranged between 9,1 and 9,3% -, or Kiker & Santos (1991). For the U.S.[10], Mincer (1974) obtained (for data of 1959) a higher level: 10,3% [11]. However, for the Nordic countries, much smaller rates than ours seem to have been found [12].

The relation between log of earnings and experience in (2) suggests that a peak is reached at experience level of 27 years - 34 years for the U.S.

Equation (3) allows for a second-order term in the coefficient of education and an interdependence between experience and education, that is, r(s,t) is of the form

$$r(s,t) = d(\ln E_t^S)/ ds = a_1 + 2\, a_2\, s + a_3\, t \qquad (2.1)$$

The corresponding estimates yield:

$$r(s,t) = d(\ln E_t^S)/ ds = 0{,}099 + 0{,}002\, s - 0{,}001\, t \qquad (2.2)$$

This implies - as we can see in Table II.2 - a convex profile for log of earnings with respect to schooling, contrary to what was found for other countries (diminishing rates of return). However, a_2 is not significant at the 5% significance level (although it is at 10%), thus suggesting that the rate of return is independent of the schooling level.

The interaction between experience and schooling is significantly negative - the same having been reported for the U.S.[13], for which:

$$r(s,t) = d(\ln E_t^S)/ ds = 0{,}255 - 0{,}0058\, s - 0{,}0043\, t \qquad (2.3)$$

Table II.1. *Human Capital Earnings Functions: Men*

Regres.	Int.	Educ	Educ2	Exp	Exp2	Exp*Edu	$e^{-.05x_t}$	$e^{-2*.05x_t}$
(1)	8.83	0.065						
		(0.003)						
	N = 392		R^2 =	0.52	F =	422.3	SSR =	36.304
(2)	8.02	0.073		0.054	-0.001			
		(0.002)		(0.002)	(3.8E-5)			
	N = 392		R^2 =	0.87	F =	884.5	SSR =	9.646
(3)	7.64	0.099	0.001	0.076	-0.001	-0.001		
		(0.006)	(2.8E-4)	(0.003)	(3.6E-5)	(1.1E-4)		
	N = 392		R^2 =	0.91	F =	793.9	SSR =	6.702
(4)	9.69	0.075		-0.013			-1.5	-0.384
		(0.002)		(0.004)			(0.489)	(0.313)
	N = 392		R^2 =	0.89	F =	759.7	SSR =	8.542
(5)	9.79	0.053	0.001	-0.014			-1.591	-0.327
		(0.005)	(2.9E-4)	(0.004)			(0.477)	(0.305)
	N = 392		R^2 =	0.89	F =	643.5	SSR =	8.1

Taking s=0, the maximum earnings are obtained at 38 years, very close to the implied level for the U.S. - 41 years.

2. Several Gompertz specifications were tried - with b from 0,05 to 0,30. The best results (adjusted R^2) were obtained for the smallest rates - 0,05 and 0,10. For the U.S., the best results corresponded to values of 0,10 and 0,15 - the rate of decline would seem to be slightly lower in Portugal.

We report the estimates corresponding to 0,05, once they resulted in meaningful signs for the interpretations implied in (1.13) and (1.14). That is, we have implied estimates of general O.J.T. rates of return (r_t) and the initial proportion of earnings capacity devoted to training (k_0). In the regression we also included experience, which coefficient is interpreted as the depreciation rate of human capital [14].

Table II.2. *Implicit Rates of Return to Human Capital Investments: Men. (%)*

	r_s by Years of Schooling						k_0	T	r_x	d
Regression	0	4	6	9	11	16		(years)		
(2)	7.3	7.3	7.3	7.3	7.3	7.3	74.0	27		
(3)										
Exp.										
0	9.9	10.7	11.1	11.7	12.1	13.1		38		
5	9.4	10.2	10.6	11.2	11.6	12.6		38		
10	8.9	9.7	10.1	10.7	11.1	12.1		38		
20	7.9	8.7	9.1	9.7	10.1	11.1		38		
30	6.9	7.7	8.1	8.7	9.1	10.1		38		
40	5.9	5.7	7.1	7.7	8.1	9.1		38		
50	4.9	4.7	6.1	6.7	7.1	8.1		38		
(4)	7.5	7.5	7.5	7.5	7.5	7.5	87.6		13.6	1.3
(5)	5.3	6.1	6.5	7.1	7.5	8.5	80.9		14.8	1.4

The numbers (Tables II.1 and II.2) suggest that the initial investment is very high - 80 to 88%. (Also, for the U.S., for b = 0,10, k_0 = 56%; for b = 0,15,

k_0 = 81%). The rate of return to O.J.T. is rather high: 13,6-14,8% (for the U.S., for b = 0,10, r_t = 13,1%; for b = 0,15, r_t = 6,7%). The depreciation rate is 1,3-1,4%. (1,2% for the U.S.)

The Portuguese schooling profile - equation (5) - is again convex. There would seem to be underinvestment at high schooling levels[15], or more important signaling effects for increasing schooling levels in Portugal.

Table II.3. *Human Capital Earnings Functions by Age Group: Men.*

Age Group	Int.	Educ	Educ2	Exp	Exp2	Exp*Educ
14-24	7.32	0.121		0.083	4.60E-4	
		(0.007)		(0.016)	(0.001)	
	N = 66	R^2 = 0.845		F = 112.5	SSR =	1.399
14-24	5.83	0.332	-0.007	0.338	-0.009	-0.018
		(0.051)	(0.002)	(0.053)	(0.002)	(0.004)
	N = 66	R^2 = 0.892		F = 99.34	SSR =	0.971
25-34	8.04	0.083		0.046	-3.90E-4	
		(0.004)		(0.009)	(2.70E-4)	
	N = 80	R^2 = 0.893		F = 212.4	SSR =	0.657
25-34	7.24	0.137	-0.001	0.123	-0.002	-0.003
		(0.071)	(0.002)	(0.067)	(0.001)	(0.003)
	N = 80	R^2 = 0.899		F = 131.5	SSR =	0.623
35-44	8.9	0.068		-0.003	1.82E-4	
		(0.004)		(0.012)	(2.28E-4)	
	N = 80	R^2 = 0.94		F = 394.5	SSR =	0.469
35-44	9.39	0.011	0.002	-0.024	3.86E-4	0.001
		(0.084)	(0.001)	(0.08)	(0.001)	(0.002)
	N = 80	R^2 = 0.943		F = 243.7	SSR =	0.445
45-54	9.51	0.069		-0.031	4.69E-4	
		(0.005)		(0.021)	(2.98E-4)	
	N = 80	R^2 = 0.916		F = 277.5	SSR =	0.798
45-54	10.15	-0.002	0.002	-0.051	0.001	0.001
		(0.143)	(0.002)	(0.136)	(0.002)	(0.003)
	N = 80	R^2 = 0.92		F = 169.6	SSR =	0.766
55-65	10.72	0.051		-0.058	4.78E-4	
		(0.007)		(0.039)	(4.22E-4)	
	N = 86	R^2 = 0.807		F = 114.1	SSR =	2.129
55-65	9.69	0.089	-3.33E-4	-0.02	1.29E-4	-0.001
		(0.231)	(0.002)	(0.217)	(0.002)	(0.004)
	N = 86	R^2 = 0.807		F = 66.81	SSR =	2.128

Also, experience profiles would seem to have peaks at the same level of experience - being, of course, lower but also flatter in Portugal [16].

3. Table II.3 presents the regression results of the log-earnings equations of linearly decreasing investment in h.c. through O.J.T. - that is, of form (2) and (3) of tables II.1 and II.2. We were trying to see whether different cohorts might result in different regression patterns.

One of the results implied - comparing results of form (2) - is a decreasing rate of return to schooling by age group, from 12,1% for people aged 14-24 to 5,1% for people aged 55-65. This reminds us of the negative

coefficient, found for the total population in the U.S., of (2.3). It may be related to nonlinear depreciation of human capital. Usually, the experience profile shows switched signs relative to the US results- even if one of the coefficients is, in general, not statistically significant for Portugal.

Simultaneously, the intercept, associated with earnings at level 0 of schooling, consistently increases. This would suggest that somehow for older cohorts the returns to education are lower but individuals start(ed) at higher levels of earnings. Whether compensation patterns are more related to age than experience (or tenure - or compensation "rules" in implicit contracting terms), it is difficult to measure here, once our proxy uses age and education (we cannot distinguish the effects of age and experience). Possibly, compensation patterns are also more diffuse (less disperse and, thus, less dependent on schooling levels) at higher age levels.

The performance of form (3), allowed us to get "correct" signs - as compared to the U.S. - of the parameters for ages 14-34. The "wrong" signs of some coefficients for the group aged 35-44 years are not significant. And for the last two groups the results for this regression were usually poor, suggesting, rather a form of type (2).

The results relative to the experience terms led us to believe about the convenience of experimenting with higher order polynomials in t - performed in section V. There is, nevertheless, some reason to believe that different cohorts, which made their decision in the past, may have suffered different economic and schooling conditions, which somehow may have influenced the set of results thus obtained. (This consideration is not the same as those made in the cohort differentials literature, usually associated with differences in the returns to schooling in different points in time[17].)

4. Male-female earnings differentials

1. In Tables III.1 to III.2 we present the results for women equivalent to those of Table II.1 to II.2. The quality of the estimation is, in general, poorer than for men, as expected: the female labor force is usually characterized by a break in participation in the fertility period, which, with the corresponding depreciation in human capital, makes the use of the proxy for experience as calculated a little inapplicable. Therefore, more interesting - correct - conclusions might be drawn from the cohort disaggregation (here much more than in the male case).

Table III.1. Human Capital Earnings Functions: Women.

Regres.	Int.	Educ	Educ2	Exp	Exp2	Ex*Edu	$e^{-.05x_t}$	$e^{-2*.05x_t}$
(1)	8.61	0.07						
		(0.003)						
	N = 308		R^2 =	0.64	F =	533.8	SSR =	17.819
(2)	8.05	0.08		0.033	-4.13E-4			
		(0.002)		(0.003)	(4.7E-5)			
	N = 308		R^2 =	0.81	F =	425.5	SSR =	9.407

(3)	7.78	0.11	-0.001	0.047	-0.001	-0.001		
		(0.01)	(4.5E-4)	(0.004)	(5.6E-5)	(2.0E-4)		
	N = 308		R^2 =	0.82	F =	275.1	SSR =	8.805
(4)	8.86	0.081		-0.003			-0.476	-0.52
		(0.002)		(0.005)			(0.663)	(0.441)
	N = 308		R^2 =	0.82	F =	335	SSR =	9.012
(5)	8.88	0.078	2.21E-4	-0.003			-0.484	-0.517
		(0.007)	(4.2E-4)	(0.005)		(0.664)	(0.442)	
	N = 308		R^2 =	0.82	F =	267.7	SSR =	9.004

The implied estimates of rates of return to schooling are usually higher for women than men. This would correspond - the estimated rate is the prevailing equilibrium rate - to less women with advanced schooling than men. Women would deter from going to school, which would drive their rate of return up. Or, signaling effects of schooling are stronger for women than for men. The fact is that lately, women seem to have entered the education systems in at least equal number as men, suggesting a response to that high rate of return.

Other studies of human capital earnings functions for Portugal did not find such a relation between rates of return to human capital for men and women, but rather the inverse - for example, Silva (1985) found rates between 8,4 and 9,0% for women while (recall from section II) rates of 9,1 to 9,3% for men in similar regressions. That is also an unusual finding in contrast with some international evidence, where female rates of return are usually lower than men's [18] - being such evidence in favor of the discrimination hypothesis. Nevertheless other international surveys report – see Psacharopoulos (1994) - report the pattern here presented; Kiker & Santos (1991), using 1985 data, also find such result for Portugal.

Table III.2. *Implicit Rates of Return to Human Capital Investments: Women. (%)*

	r_S by Years of Schooling						k_0	T	r_X	d
Regression	0	4	6	9	11	16		(years)		
(2)	8.0	8.0	8.0	8.0	8.0	8.0	41.3	40		
(3) Years of Experience:										
0	11.0	10.2	9.8	9.2	8.8	7.8		24		
5	10.5	9.7	9.3	8.7	8.3	7.3		24		
10	10.0	9.2	8.8	8.2	7.8	6.8		24		
20	9.0	8.2	7.8	7.2	6.8	5.8		24		
30	8.0	7.2	6.8	6.2	5.8	4.8		24		
40	7.0	6.2	5.8	5.2	4.8	3.8		24		
50	6.0	5.2	4.8	4.2	3.8	2.8		24		
(4)	8.1	8.1	8.1	8.1	8.1	8.1	102.0		7.33	0.3
(5)	7.8	8.0	8.1	8.2	8.3	8.5	101.7		7.38	0.3

The other distinguishing feature relative to males is the "correct signs" relative to the U.S. (male population).

Table III.3. *Human Capital Earnings Functions by Age Group: Women.*

Age Group	Int.	Educ	Educ2	Exp	Exp2	Exp*Educ
14-24	7.28	0.138		0.063	0.001	
		(0.008)		(0.017)	(0.001)	
	N = 54	R^2 = 0.873		F = 114.3	SSR =	0.94
14-24	6.44	0.213	-0.001	0.236	-0.006	-0.01
		(0.061)	(0.002)	(0.057)	(0.002)	(0.004)
	N = 54	R^2 = 0.919		F = 108.4	SSR =	0.601
25-34	8.15	0.083		0.024	-1.98E-4	
		(0.005)		(0.011)	(3.32E-4)	
	N = 72	R^2 = 0.886		F = 175.7	SSR =	0.822
25-34	9.57	-0.049	0.003	-0.093	0.002	0.005
		(0.088)	(0.002)	(0.083)	(0.002)	(0.004)
	N = 72	R^2 = 0.889		F = 106.2	SSR =	0.795
35-44	7.67	0.084		0.059	-0.001	
		(0.007)		(0.03)	(0.001)	
	N = 68	R^2 = 0.834		F = 107.3	SSR =	1.391
35-44	11.22	-0.097	0.002	-0.162	0.003	0.006
		(0.17)	(0.003)	(0.167)	(0.003)	(0.005)
	N = 68	R^2 = 0.842		F = 65.86	SSR =	1.329
45-54	8.62	0.071		0.005	-5.77E-5	
		(0.01)		(0.044)	(0.001)	
	N = 66	R^2 = 0.766		F = 67.53	SSR =	2.214
45-54	12.25	-0.001	-0.001	-0.181	0.002	0.002
		(0.288)	(0.004)	(0.272)	(0.003)	(0.007)
	N = 66	R^2 = 0.781		F = 42.72	SSR =	2.073
55-65	9.73	0.078		-0.049	0.001	
		(0.012)		(0.07)	(0.001)	
	N = 48	R^2 = 0.742		F = 42.23	SSR =	1.951
55-65	12.12	0.096	-0.002	-0.151	0.002	2.42E-4
		(0.382)	(0.004)	(0.378)	(0.004)	(0.007)
	N = 48	R^2 = 0.754		F = 25.72	SSR =	1.864

The experience profiles are, as expected, flatter for women than for men; our proxy for experience, however, extremely overestimates the true experience of women - once they may have non-participating periods much larger than men - and, possibly, increasingly with the age group considered, once female participation has increased over the years. Even if this was not the case, implicit contracting, due to the smaller attachment of women to the labor market, may cause "true" experience profiles to be flatter for women.

Table III.4. Human Capital Earnings Functions: Sex Differentials.

Age Group/ Regression	Sex	Sex*Educ	Sex*Exp	FTest1*	FTest2**	FTest3***
All (1)	-0.227	0.005		39.50	-	39.50
	(0.041)	(0.005)		(2, 696)	-	(2, 696)
	N = 700	R^2 = 0.603		F = 352.3	SSR =	54.12

All (2)	-0.12	0.006	-0.004	71.58	27.93	62.75
	(0.04)	(0.003)	(0.001)	(3, 693)	(1, 692)	(4, 692)
	N = 700	R^2 = 0.855		F = 678.8	SSR =	19.82
All (3)	-0.086	0.005	-0.005	97.11	14.83	58.89
	(0.037)	(0.003)	(0.001)	(3, 691)	(3, 688)	(6, 688)
	N = 700	R^2 = 0.879		F = 626.8	SSR =	16.51
All (4)	-0.125	0.006	-0.004	78.86	13.31	54.32
	(0.038)	(0.003)	(0.001)	((3, 692)	(2, 690)	(5, 690)
	N = 700	R^2 = 0.866		F = 640.3	SSR =	18.23
All (5)	-0.13	0.007	-0.004	79.39	10.54	46.61
	(0.038)	(0.003)	(0.001)	(3, 691)	(3, 688)	(6, 688)
	N = 700	R^2 = 0.869		F = 571.8	SSR =	17.89

Notes: * Testing the joint hypothesis of null sex dummies. ** Comparison of the regression with freeing all parameters (that is, against the hypothesis of different regressions for men and women). *** Comparison of Regression without sex dummies against the hypothesis of different regressions for men and women (Chow test).

Therefore, we see that the rate of return to experience in the Gompertz specification is much lower than for men.

Table III.5.1. *Human Capital Earnings Functions: Sex Differentials.*

Age Group/ Regression	Sex	Sex*Educ	Sex*Exp	FTest1*	FTest2**	FTest3***
14-24 (1)	-0.087	0.018	-0.007	4.90	0.34	3.73
	(0.136)	(0.01)	(0.01)	(3, 113)	(1, 112)	(4, 112)
	N = 120	R^2 = 0.857		F = 112.8	SSR =	2.346
14-24 (2)	-0.169	0.024	-0.002	7.95	1.99	4.98
	(0.116)	(0.009)	(0.008)	(3, 111)	(3, 108)	(6, 108)
	N = 120	R^2 = 0.899		F = 123.8	SSR =	1.652
25-34 (1)	0.074	-0.001	-0.016	44.94	0.19	33.57
	(0.138)	(0.007)	(0.006)	(3, 145)	(1, 144)	(4, 144)
	N = 152	R^2 = 0.902		F = 222.6	SSR =	1.481
25-34 (2)	0.062	-8.59E-5	-0.015	44.53	1.38	23.14
	(0.138)	(0.007)	(0.006)	(3, 143)	(3, 140)	(6, 140)
	N = 152	R^2 = 0.903		F = 167.3	SSR =	1.46
35-44 (1)	-0.568	0.017	0.008	51.36	3.69	40.17
	(0.229)	(0.008)	(0.007)	(3, 141)	(1, 140)	(6, 140)
	N = 148	R^2 = 0.903		F = 218.0	SSR =	1.909
35-44 (2)	-0.567	0.017	0.008	50.29	2.64	27.74
	(0.231)	(0.008)	(0.007)	(3, 139)	(3, 136)	(6, 136)
	N = 148	R^2 = 0.904		F = 163.1	SSR =	1.888

Notes: * Testing the joint hypothesis of null sex dummies. ** Comparison of the regression with freeing all parameters (that is, against the hypothesis of different regressions for men and women). *** Comparison of regression without sex dummies against the hypothesis of different regressions for men and women (Chow test).

By age group, we see the same pattern for women and men in what refers to the returns to schooling - specification (2) also shows a decreasing rate by age group, starting at 14% for the 14-24 years group and being 7-8% for the 45-65 years group. The estimates of the experience coefficients have very large standard errors.

Table III.5.2. *Human Capital Earnings Functions: Sex Differentials*

Age Group/ Regression	Sex	Sex*Educ	Sex*Exp	FTest1*	FTest2**	FTest3***
45-54 (1)	-0.246	0.001	-0.001	41.96	0.73	31.59
	(0.384)	(0.01)	(0.009)	(3, 139)	(1, 138)	(4, 138)
	N = 146	R^2 = 0.87		F = 154.4	SSR =	3.028
45-54 (2)	-0.23	0.001	-0.001	41.46	2.67	22.83
	(0.388)	(0.01)	(0.009)	(3, 155)	(3, 134)	(6, 134)
	N = 146	R^2 = 0.87		F = 114.9	SSR =	3.009
55-65 (1)	-1.142	0.028	0.016	15.37	0.03	11.44
	(0.567)	(0.013)	(0.01)	(3, 127)	(1, 126)	(4, 126)
	N = 134	R^2 = 0.824		F = 98.81	SSR =	4.081
55-65 (2)	-1.067	0.025	0.014	15.05	0.63	7.77
	(0.575)	(0.013)	(0.011)	(3, 125)	(3, 122)	(6, 122)
	N = 134	R^2 = 0.825		F = 73.52	SSR =	4.054

Notes: * Testing the joint hypothesis of null sex dummies. ** Comparison of the regression with freeing all parameters (that is, against the hypothesis of different regressions for men and women). *** Comparison of regression without sex dummies against the hypothesis of different regressions for men and women (Chow test).

2. A set of tests were performed trying to evaluate the significance of the difference between female and male earnings. The method involves the use of sex-dummies (Sex_i=1 if i refers to woman, 0 if man). The results are presented in Tables III.4 and III.5. In general, and as expected, different regressions are advisable for the two sexes.

A negative coefficient is found for Sex. In logarithms, the difference found corresponds - approximately - to the percentage difference of women's earnings relative to the men's level. Thus, the sex-dummy (Table III.4) reads a 22,7% wage differential between women and men - the initial earnings start at a level 22,7% lower than that of men. As we include more explanatory variables, this differential decreases to 12% (formulation (2)) and 8,6% with formulation (3). The Gompertz specification indicates a value of 13%.

In the age-group decomposition, the sex-dummy yields maximum differentials for women 55-65 and 35-44, being lower at young ages, and higher for older women. As expected, results worsen with the cohorts´age; it is possible that the situation has improved in more recent periods: some of the differentials of earlier years may have persisted even if not affecting posterior earnings growth.

The sex dummy interacted with education yields a positive bias in favor of women, which was already discussed. The differential is negative for ages 25-34, but not significant. Simultaneously, the bias is negative with respect to experience. Again, differentials may be overstated due to the experience proxy used, specially if education and ("true") experience are positively correlated - which we cannot measure with the data we have available: then, part of the (positive) influence would be captured in the education coefficient for women.

Finally, different specifications are advisable for men and women - not only for both separately (from FTest2 in table III.4, we conclude that just including the dummies is not enough to account for the differences), but also, as we will see below, higher order polynomial forms may fit the data more accurately.

3. Discrimination studies usually decompose the wage gap between men and women in the following way[19]:

$$W_F - W_M = (Z_F - Z_M)\, B_F + (B_F - B_M)\, Z_F \quad (3.1)$$

where Z_j refers a vector of (mean) levels of productivity characteristics (say, schooling and experience) of an individual of group j and B_j the coefficients representing the contribution of those characteristics to the determination of the productivity of group j. Alternatively, we can write:

$$W_F - W_M = (Z_F - Z_M)\, B_M + (B_F - B_M)\, Z_M \quad (3.2)$$

The first term evaluates the differences of the values of the Z's at the price of women in (3.1) and of men in (3.2). The second term, evaluates the sex price differential at the value of the women's set of characteristics in (3.1), and of men's in (3.2). This second term is, thus a measure of market discrimination.

We have no information on the mean levels of the characteristics for the male and female samples. We can, however, construct the series of differentials in earnings for given characteristics - schooling and experience. We can infer the dimension of those second coefficients, i.e., the price differentials, through the regression:

$$(W_{Fi} - W_{Mi}) = (B_F - B_M)\, Z_{Mi} = B_{F-M}\, Z_{Mi} \quad (3.3)$$

where i refers to a specific level of schooling and experience. We can therefore see how the prices differ for each category, that is, estimate the vector B_{F-M}. We performed several regressions of the earnings differentials on the characteristics available. We used W_{ji}, j=F,M, in logarithms, to conform with the previous results - also, the estimated price differences, captured in the intercept and in the coefficients, have the advantage of allowing an interpretation in percentage difference terms.

Table III.6.1. *Female-Male Earnings Differentials. (%)*

	Years of Schooling						
Experience:	0	4	6	9	11	14	16
0	10,2	7,8	6,6	4,8	3,6	1,8	0,6
5	12,7	10,3	9,1	7,3	6,1	4,3	3,1
10	15,2	12,7	11,6	9,8	8,6	6,8	5,6
20	20,2	17,8	16,6	14,8	13,6	11,8	10,6
30	25,2	22,8	21,6	19,8	18,6	16,8	15,6
40	30,2	27,8	26,6	24,8	23,6	21,8	20,6
50	35,2	32,8	31,6	29,8	28,6	26,8	25,6

Firstly, the average differential in the sample is of about 18,9% (women's earnings being about 18,9% lower than those of men)[20].

The regression of the log-earnings differential on education and experience yielded:

$$\text{DifLogWage} = -0{,}102 + 0{,}006\ s - 0{,}005\ t \qquad (3.4)$$
$$(0{,}002)\quad (0{,}001)$$
$$R^2 = 0{,}2 \qquad F_{(2,305)} = 38{,}213$$

This would suggest that the gap would start (no schooling, no experience) at a female 10,2% disadvantage relative to the male earnings level; a one year increase in education would diminish the earnings gap by 0,6%, but an extra year of experience would increase it by 0,5%. Both coefficients are highly significant.

In table III.6.1 we can analyze the evolution implied by these numbers: the differential for high levels of education is very small (0,6% for the highest degree of education) at the starting levels, but increases with the schooling levels and range between 20% to 35% at high levels of experience.

Table III.6.2. *Female-Male Earnings Differentials. (%)*

	Years of Schooling						
Experience:	0	4	6	9	11	14	16
0	-13,0	-22,2	-25,6	-29,2	-30,6	-31,2	-30,6
5	8,0	-1,2	-4,6	-8,2	-9,6	-10,2	-9,6
10	21,9	12,7	9,3	5,7	4,3	3,7	4,3
20	37,3	28,1	24,7	21,1	19,7	19,1	19,7
30	46,9	37,7	34,3	30,7	29,3	28,7	29,3
40	56,3	47,1	43,7	40,1	38,7	38,1	38,7
50	63,4	54,2	50,8	47,2	45,8	45,2	45,8

Other specifications were, thus, tried:

$$\text{DifLogWage} = 0{,}13 + 0{,}027\ s - 0{,}001\ s^2 - \qquad (3.5)$$
$$(0{,}002)\quad (0{,}001)$$
$$- 0{,}051\ t + 0{,}002\ t^2 - 4{,}191\text{E-}5\ t^3 + 3{,}239\text{E-}7\ t^4$$
$$(0{,}013)\quad (0{,}001)\quad (2{,}315\text{E-}5)\quad (1{,}992\text{E-}7)$$
$$R^2 = 0{,}344 \qquad F_{(6,301)} = 26{,}313$$

The implied pattern of wage differentials can be examined in table III.6.2. At the initial experience levels (till 5 years) the estimated differential does not favor men. As we increase experience, the gap increases - decreasing with the schooling level - ranging between 38 and 63% in the highest experience levels.

Table III.6.3. *Female-Male Earnings Differentials. (%)*

	Years of Schooling							
	0	4	6	9	9T	11	14	16
	29,1	29,8	14,5	12,3	12,8	14,3	11,1	20,0
Experience:								
0	-16,1	-13,6	-28,1	-29,5	-28,5	-24,4	-27,2	-18,2
5	4,4	6,9	-7,6	-9,0	-8,0	-3,9	-6,7	2,3
10	17,6	20,1	5,6	4,2	5,2	9,3	6,5	15,5
20	30,7	33,2	18,7	17,3	18,3	22,4	19,6	28,6
30	36,3	38,8	24,3	22,9	23,9	28,0	25,2	34,2
40	40,0	42,5	28,0	26,6	27,6	31,7	28,9	37,9
50	40,3	42,8	28,3	26,9	27,9	32,0	29,2	38,2

Other specifications included the use of dummy variables for education. The simple use of education dummies (no experience variables included) originated the pattern of the first line of Table III.6.3. This measures the simple mean differential between schooling categories. In the following lines we report the results when we include as well the quartic representation of experience (the 4-th term is almost significant at the 10% level) - of the several regressions performed in the log-earnings differentials, this showed the highest adjusted R^2.

In terms of schooling differentials only (first line) the highest gap is found at no schooling or primary school (29-30%). The gap decreases till 9 years, jumps to 14% at 11 years, decreases at 11 years and jumps again to 20% at "licenciatura".

Controlling also for experience (the interaction between schooling and experience was not significant), using a quartic approximation for the experience profile, we see that schooling is not the cause of the differential in earnings (we have negative values at the initial experience). Rather, experience seems to be the cause of the negative differential Interestingly, the differential seems to decrease with schooling (by experience level), but we see some increases at the highest levels as suggested by the results of the first line. Differences between high-school degree holders and technical school are not significant.

Whether a segmented labor market interpretation for these findings may be appropriate is not explored here. Rather, given the limited information we have, only a quantitative statement of the observed differentials is presented [21].

5. Technical versus high-school systems

1. In Table IV.1. and IV.2 we can see some evidence concerning differentials between high-school and technical systems. The unified system abolished the technical schools. We use a dummy variable (D91=1 if the individual completed the technical-school degree, 0 otherwise)

Table IV.1. *Male Earnings: Technical versus High-School Systems.*

	Independent Variables									
Group	Int.	Educ	Educ2	Exp	Exp2	Exp3	Edu*Ex	D91	D91Exp	$D91Ex^2$
1 Male	8.02	0.073		0.054	-0.001			-0.021		
		(0.002)		(0.002)	(4E-5)			(0.024)		
	N= 392		R^2 =	0.873		F =	663.3		SSR =	9.626
2 Male	7.64	0.098	0.001	0.076	-0.001		-0.001	0.019	0.001	-2.5E-5
		(0.006)	(3E-4)	(0.003)	(4E-5)		(1E-4)	(0.063)	(0.006)	(1E-4)
	N= 392		R^2 =	0.912		F =	493.6		SSR =	6.686
3 Male	8.42			0.099	-0.003	2.28E-5				
S=9 years				(0.007)	(3E-4)	(4E-6)				
	N= 100		R^2 =	0.913		F =	334.5		SSR =	0.798
4 Male	8.42			0.097	-0.003	2.28E-5		0.007	0.003	-9.0E-5
S=9 years				(0.007)	(3E-4)	(4E-6)		(0.057)	(0.005)	(1E-4)
	N= 100		R^2 =	0.915		F =	167.1		SSR =	0.776
5 Male	8.45			0.091	-0.002	1.90E-5				
S=90 years				(0.009)	(4E-4)	(5E-6)				
(H.Sc.)	N= 50		R^2 =	0.927		F =	194.6		SSR =	0.329
6 Male	8.40			0.106	-0.003	2.66E-5				
S=91 years				(0.01)	(5E-4)	(6E-6)				
(T.Sc.)	N= 50		R^2 =	0.905		F =	146.2		SSR =	0.439

The dummy coefficient seems to indicate that individuals with a technical school degree earn slightly more than those with the equivalent high-school years, even if not significantly. (Notice that the dummy D91 aggregates differences in the rate of return and in the intercept - initial earnings.) The technical school experience profiles, however, seem to be flatter, but not significantly, for men; the contrary seems to occur for women.

Table IV.2. *Female Earnings: Technical versus High-School Systems*

	Independent Variables									
Group	Int.	Educ	Educ2	Exp	Exp2	Exp3	Edu*Ex	D91	D91Exp	D91Ex2
1	8.05	0.079		0.033	-4.1E-4			0.044		
Female		(0.02)		(0.003)	(5E-5)			(0.029)		
	N= 308		R^2 =	0.809		F =	321.0		SSR =	9.337
2	7.78	0.107	-3.0E-4	0.047	-0.001		-0.001	0.071	-0.003	6.98E-5
Female		(0.011)	(5E-4)	(0.004)	(6E-5)		(2E-4)	(0.094)	(0.009)	(2E-4)
	N= 308		R^2 =	0.822		F =	172.4		SSR =	8.711
3	8.66			0.061	-0.002	1.35E-5				
Female				(0.014)	(0.001)	(8E-6)				
S=9 years	N= 85		R^2 =	0.571		F =	35.92		SSR =	1.886
4	8.60			0.069	-0.002	1.60E-5		0.081	-0.01	-2.2E-4
Female				(0.015)	(0.001)	(8E-6)		(0.114)	(0.01)	(2E-4)
S=9 years	N= 85		R^2 =	0.581		F =	18.05		SSR =	1.84

5	8.54		0.082	-0.002	2.36E-5			
Female			(0.019)	(0.001)	(1E-5)			
S=90 years(H.Sc.)	N= 42	R^2 =	0.598		F =	18.88	SSR =	0.844
6	8.75		0.046	-0.001	6.47E-6			
Female			(0.02)	(0.001)	(1E-5)			
S=91 years (T.Sc.)	N= 42	R^2 =	0.576		F =	17.70	SSR =	0.971

International evidence – collected in Psacharopoulos (1985) – suggests a smaller rate of return on technical/vocational curricula relative to the general, academic type. We found no such difference – if some is present, it seems to go in the opposite direction. One cannot infer from the findings here presented for Portugal whether the extinct technical school system was or not irrelevant - the results may simply indicate an equilibrium situation achieved with the simultaneous systems, each performing each function.

2. We also used the log-earnings differentials approach used in section III. The earnings differentials are not very high, and neither the significance of the regressions performed for each sex:

For men, workers with a technical school degree earned about 1,8% more than people with the equivalent high-school years. The earnings differential was negatively correlated with experience - even if not significantly. The regression of the difference of log-earnings gave the following results:

$$DLEarn(Tech\text{-}High) = 0{,}047 - 0{,}001\ Exp$$
$$(0{,}001)$$
$$R^2 = 0{,}024 \qquad F_{(1,48)} = 1{,}185$$

Using the Gompertz specification, the coefficients showed higher significance but the regression was not significant at the 10% significance level:

$$DLEarn(Tec\text{-}Hig) = -0{,}068 + 0{,}511\ e^{-0{,}05Ex} - 0{,}513\ e^{-0{,}05Ex^2}$$
$$(0{,}245) \qquad (0{,}258)$$
$$R^2 = 0{,}085 \qquad F_{(2,47)} = 2{,}188$$

For women, the differential was 1,5% and positively (not significantly at the 10% level) correlated with experience. A quadratic term in experience proved significant:

$$DLEarn(Tech\text{-}High) = 0{,}199 - 0{,}026\ Exp + 0{,}001\ Exp^2$$
$$(0{,}013) \qquad (2{,}734E\text{-}4)$$
$$R^2 = 0{,}15 \qquad F_{(2,34)} = 2{,}999 \text{ (significant at 10\% level)}$$

The best regression for women with the Gompertz terms was significant at 10% but not at the 5% significance level:

$$DLEarn(Tech\text{-}High) = -1{,}114 + 1{,}365\, e^{-0{,}05Exp} + 0{,}027\, Exp$$
$$(0{,}641) \qquad (0{,}012)$$
$$R^2 = 0{,}132 \qquad F_{(2,34)} = 2{,}576$$

6. Empirical specifications of the experience-earnings profiles

Another application of log-earnings functions included the study of more complex experience profiles. If we may to some extent lose the interpretation in the above formulations, we may get more accurate descriptions of the patterns implied.

A recent study[22] concluded that in the U.S. a 4-th degree polynomial in t (experience) - a quartic rather than a quadratic specification - would give a more adequate representation of the male earnings profiles.

Table V.1.1. *Experience Profiles: Men*

		Independent Variables							
Regr./ Educ.	Int.	Exp	Exp2	Exp3	Exp4	Exp5	Exp6	Ed	Ed*Exp
(1)	7.425	0.116	-0.003	4.60E-5	-2.86E-7			0.109	-0.001
All		(0.009)	(0.001)	(2E-5)	(1E-7)			(0.003)	(1E-4)
	N =	392	R^2 =	0.921	F =	748.27		SSR =	5.972
(2)	6.367	0.296	-0.012	2.3E-4	-1.55E-6				
0		(0.031)	(0.002)	(4E-5)	(2.6E-7)				
	N =	52	R^2 =	0.932	F =	160.013		SSR =	0.203
(3)	2.682	1.196	-0.094	0.004	-8.10E-5	8.9E-7	-3.9E-9		
0		(0.128)	(0.012)	(0.001)	(1.5E-5)	(2E-7)	(9.E-10)		
	N =	52	R^2 =	0.978	F =	326.48		SSR =	0.067
(4)	7.558	0.154	-0.005	7.05E-5	-3.9E-7				
4		(0.02)	(0.001)	(3E-5)	(2.6E-7)				
	N =	52	R^2 =	0.96	F =	280.023		SSR =	0.201
(5)	7.821	0.073	0.003	-2.6E-4	5.77E-6	-4.2E-8			
4		(0.042)	(0.004)	(2E-4)	(2.9E-6)	(2E-8)			
	N =	52	R^2 =	0.963	F =	242.25		SSR =	0.183
(6)	7.54	0.215	-0.009	1.88E-4	-1.4E-6				
6		(0.015)	(0.001)	(3E-5)	(2.5E-7)				
	N =	52	R^2 =	0.974	F =	438.95		SSR =	0.187

Table V.1.2. Experience Profiles: Men

		Independent Variables							
Regr./ Educ.	Int.	Exp	Exp2	Exp3	Exp4	Exp5	Exp6	Ed	Ed*Exp
(7)	8.344	0.128	-0.005	9.8E-5	-7.4E-7				
9		(0.013)	(0.001)	(3E-5)	(3E-7)				
	N = 100		R^2 =	0.918	F =	265.588		SSR =	0.75
(8)	8.22	0.191	-0.014	0.001	-1.0E-5	7.47E-8			
9		(0.023)	(0.003)	(1E-4)	(2.9E-6)	(2E-8)			
	N = 100		R^2 =	0.926	F =	236.197		SSR =	0.674

(9)	8.6	0.121	-0.006	1.4E-4	-1.4E-6			
11		(0.032)	(0.003)	(8E-5)	(8.2E-7)			
	N = 48		R^2 =	0.808	F =	45.275	SSR =	0.867
(10)	8.807	0.01	0.009	-0.001	1.72E-5	-1.5E-7		
11		(0.056)	(0.007)	(4E-4)	(8.0E-6)	(7E-8)		
	N = 48		R^2 =	0.83	F =	41.091	SSR =	0.767
(11)	9.251	0.023	0.001	-2.9E-5	1.45E-7			
14		(0.033)	(0.003)	(1E-4)	(1.2E-6)			
	N = 44		R2 =	0.662	F =	19.055	SSR =	0.926
(12)	9.182	0.044	-0.001					
14		(0.007)	(2E-4)					
	N = 44		R^2 =	0.649	F =	37.981	SSR =	0.959
(13)	9.227	0.101	-0.004	7.08E-5	-6.4E-7			
16		(0.035)	(0.003)	(1E-4)	(1E-6)			
	N = 44		R^2 =	0.732	F =	26.568	SSR =	1.021
(14)	9.313	0.07	-0.001					
16		(0.007)	(2E-4)					
	N = 44		R^2 =	0.722	F =	53.361	SSR =	1.056

In fact, such finding in no way diminishes the explanatory power of human capital theory, only suggests that other patterns of investment rather than the linear or exponential patterns are observed. Moreover, Taylor expansion to higher degree for both forms would yield higher degree polynomials. The advantage of the second-degree polynomial forms is that they provide readily interpretations for the coefficients and implied estimates of initial investment, or rates of return to O.J.T., etc. In order to describe the pattern of compensation, other nonlinear forms can be applied[23].

Table V.2.1. *Experience Profiles: Women*

				Independent Variables				
Regr./ Educ.	Int.	Exp	Exp2	Exp3	Exp4	Exp5	Educ	Ed*Exp
(1)	7.714	0.067	-0.001	1.115E-5			0.1	-0.001
All		(0.007)	(2.7E-4)	(3.1E-6)			(0.005)	(1.8E-4)
	N = 308		R^2 =	0.827	F =	287.872	SSR =	8.481
(2)	8.034	0.052	-0.001	1.102E-5				
0		(0.017)	(0.001)	(4.9E-6)				
	N = 49		R^2 =	0.371	F =	8.861	SSR =	0.259
(3)	4.63	0.686	-0.044	0.001	-2.00E-5	1.12E-7		
0		(0.152)	(0.01)	(3.3E-4)	(4.9E-6)	(2.8E-8)		
	N = 49		R^2 =	0.554	F =	10.683	SSR =	0.184
(4)	7.716	0.104	-0.003	2.97E-5				
4		(0.011)	(4.3E-4)	(4.8E-6)				
	N = 52		R^2 =	0.867	F =	104.442	SSR =	0.407
(5)	7.851	0.126	-0.004	3.58E-5				
6		(0.014)	(0.001)	(7.4E-6)				
	N = 47		R^2 =	0.873	F =	98.411	SSR =	0.561
(6)	7.572	0.203	-0.01	1.99E-4	-1.52E-6			
6		(0.032)	(0.002)	(6.3E-5)	(5.8E-7)			
	N = 47		R^2 =	0.891	F =	85.458	SSR =	0.483
(7)	8.657	0.061	-0.002	1.35E-5				
9		(0.014)	(0.001)	(7.9E-6)				
	N = 85		R^2 =	0.571	F =	35.919	SSR =	1.886

Therefore, some estimates were performed using higher order polynomials, for men and women for all the individuals and for each education group. The regression results are presented in Tables V.1 (men) and V.2 (women). The Gompertz specifications were also enlarged - Tables V.3 and V.4.

Table V.2.2. *Experience Profiles: Women*

	Independent Variables							
Regr./ Educ.	Int.	Exp	Exp2	Exp3	Exp4	Exp5	Educ	Ed*Exp
(8)	8.792	0.055	-0.001	-2.05E-6				
11		(0.021)	(0.001)	(1.5E-5)				
	N = 36		R^2 =	0.596	F =	15.727	SSR =	1.049
(9)	8.52	0.218	-0.026	0.001	-3.64E-5	3.17E-7		
11		(0.077)	(0.01)	(0.001)	(1.3E-5)	(1.1E-7)		
	N = 36		R^2 =	0.682	F =	12.874	SSR =	0.825
(10)	9.397	0.023	-0.002	5.93E-5				
14		(0.055)	(0.003)	(5.3E-5)				
	N = 21		R^2 =	0.446	F =	4.566	SSR =	0.682
(11)	10.052	-0.207	0.021	-0.001	1.090E-5			
14		(0.118)	(0.011)	(4.08E-4)	(5.1E-6)			
	N = 21		R^2 =	0.57	F =	5.308	SSR =	0.529
(12)	9.539	0.041	-0.001	1.421E-5				
16		(0.027)	(0.001)	(2.2E-5)				
	N = 18		R^2 =	0.304	F =	2.041	SSR =	0.376
(13)	9.588	0.025	-0.001					
16		(0.011)	(2.6E-4)					
	N = 18		R^2 =	0.284	F =	2.975	SSR =	0.387

For each regression performed to the males data, we present the 4-th order polynomial in the experience proxy and (when a different degree offered better estimates) the polynomial form that gave the best fit (adjusted R^2). The 4-th order gave the best fit for the sample as a whole, and only for the education group with 6 years of schooling (secondary school). For people with

- no schooling, 6-th degree gave the best fit
- primary schooling, 5-th degree gave the best fit
- high-school (9-years), 5-th degree gave the best fit
- complementary high-school (11 years), 5-th degree gave the best fit
- B.A. and "licenciatura" (14 and 16 years), 2nd degree gave the best fit.

Table V.3.1. *Gompertz - Men*

	Int	E	E^2	Exp	k_0	r_X (%)
Years of Education:						
0	8.441	2.531	-4.789	0.008	3.095	0.91
		(0.921)	(0.826)	(0.005)		
	N = 52	R^2 = 0.927		F = 202.664	SSR =	0.217
4	10.317	-1.725	-1.093	-0.019	1.479	10.83
		(0.741)	(0.544)	(0.005)		
	N = 52	R^2 = 0.958		F = 364.29	SSR =	0.21
6	10.072	-0.386	-2.136	-0.014	2.067	5.93
		(0.678)	(0.45)	(0.005)		
	N = 52	R^2 = 0.97		F = 520.191	SSR =	0.214
9	10.052	-0.536	-1.189	-0.01	1.542	6.74
		(0.653)	(0.404)	(0.005)		
	N = 100	R^2 = 0.919		F = 364.03	SSR =	0.738
11	10.649	-1.849	-0.118	-0.016	0.486	24.02
		(1.664)	(1.005)	(0.014)		
	N = 48	R^2 = 0.798		F = 57.898	SSR =	0.913
14	12.534	-5.536	2.292	-0.051		
		(2.007)	(1.103)	(0.019)		
	N = 44	R^2 = 0.663		F = 26.265	SSR =	0.921
16	12.087	-2.909	0.048	-0.042		
		(2.156)	(1.181)	(0.02)		
	N = 44	R^2 = 0.731		F = 36.182	SSR =	1.024

For women, the equivalent regressions suggested the use of a 3rd-degree polynomial for the sample as a whole, 4 years and 9 years of schooling. For the others:

- no schooling, 5th degree
- 6 years, 3rd degree
- 11 years, 5th degree
- B.A. (14 years), 4th degree
- "licenciatura" (16 years), 2nd degree.

The Gompertz regressions were first performed by education group in order to see whether some implied pattern for the (general) O.J.T. rate of return could somehow be deduced.

The implied estimates for the male sample show a mixed pattern, with some trade-off with the initial endowment. For high schooling levels no real solution was found for k_0 and r_X. A 4th degree polynomial in the exponential term gave the best fit for the population as a whole, no schooling workers and 6 years of schooling.

Table V.3.2.1. *Gompertz - Men*

Years of Ed.	Inter.	E	E^2	E^3	E^4	E^5	E^6	Ed	Ex	Ed*Ex
All	11.62	-9.572	16.738	-20.04	8.814			0.109	-0.038	-0.001
		(3.63)	(7.921)	(8.86)	(3.72)			(0.003)	(0.01)	(1.E-4)
	N =	392	R^2 =	0.922		F =	648.76		SSR =	5.895
0	9.468	1.851	-23.92	62.097	-53.28				-0.009	
		(4.82)	(14.9)	(23.5)	(14.0)				(0.012)	
	N =	52	R^2 =	0.982		F =	510.32		SSR =	0.053
4	13.574	-18.46	48.322	-72.00	38.185				-0.063	
		(6.559)	(16.5)	(21.4)	(10.5)				(0.021)	
	N =	52	R^2 =	0.971		F =	307.12		SSR =	0.145
4	33.941	-159.3	764.76	-2339	4067.5	-3681	1339.4		-0.313	
		(20.88)	(94.2)	(270)	(442)	(379)	(131)		(0.04)	
	N =	52	R^2 =	0.993		F =	955.99		SSR =	0.033
6	14.876	-19.999	40.153	-46.02	18.728				-0.084	
		(6.49)	(14.8)	(17.4)	(7.671)				(0.022)	
	N =	52	R^2 =	0.976		F =	372.51		SSR =	0.173

Table V.3.2.2. *Gompertz - Men*

Years of Ed.	Inter.	E	E^2	E^3	E^4	E^5	E^6	Ex	Ed	Ed*Ex
9	10.378	-0.687	-4.506	7.399	-4.412			-0.016		
		(7.13)	(15.02)	(16.4)	(6.799)			(0.03)		
	N =	100	R^2 =	0.923		F =	224.80		SSR =	0.705
9	11.454	-5.055	5.024	-3.201				-0.032		
		(2.34)	(3.12)	(1.60)				(0.01)		
	N =	100	R^2 =	0.922		F =	282.61		SSR =	0.708
11	16.206	-23.75	46.132	-50.31	20.616			-0.099		
		(19.75)	(40.3)	(43.2)	(17.59)			(0.08)		
	N =	48	R^2 =	0.804		F =	34.519		SSR =	0.884
11	41.665	-143.3	395.0	-650.3	543.52	-178.26		-0.456		
		(52.75)	(149)	(251)	(216)	(73.5)		(0.17)		
	N =	48	R^2 =	0.829		F =	33.086		SSR =	0.773
14	17.51	-23.99	38.618	-37.33	14.539			-0.127		
		(26.6)	(49.0)	(47.9)	(18.0)			(0.12)		
	N =	44	R^2 =	0.669		F =	15.395		SSR =	0.904
14	44.663	-140.6	343.26	-513.8	396.53	-120.7		-0.524		
		(77.07)	(195)	(300)	(238)	(75.09)		(0.27)		
	N =	44	R^2 =	0.691		F =	13.796		SSR =	0.845
16	6.881	18.763	-48.98	56.008	-23.63			0.033		
		(28.58)	(52.1)	(50.6)	(18.97)			(0.13)		
	N =	44	R^2 =	0.755		F =	23.431		SSR =	0.932
16	16.379	-15.211	14.751	-6.793				-0.115		
		(8.566)	(9.985)	(4.58)				(0.05)		
	N =	44	R^2 =	0.745		F =	28.499		SSR =	0.97

For women (Tables V.4.1 and V.4.2), a 2nd-degree term usually performed better. The results imply a pattern of the rate of return to O.J.T. and initial investment which indicates (as expected) that the pattern may not be of the Gompertz type.

A 1st-degree polynomial seems to be sufficient for the sample as a whole. For women with no schooling and a B.A., a 4-th degree polynomial is best, and a 5-th term is includable for women with primary schooling. For these categories, the experience term is positive. This suggests the use of a form with the experience terms, rather than with the Gompertz specification.

The implied pattern for all women suggests (Table V.4.2) an initial investment of 74,7% of initial earnings potential and a rate of return to O.J.T of 12,9% - which compares with 100% (for initial investment) and 7,3% (rate of return) implied by specification (4) of tables III.1 and III.2, where we got a much smaller rate - the interaction of experience with education yields, thus, different estimates.

Table V.4.1. *Gompertz - Women*

Years of Education	Int	E	E^2	Exp	k_0	r_X (%)
0	8.084	2.234	-3.162	0.009	2.515	0.56
		(1.332)	(1.343)	(0.007)		
	N = 49	R^2 = 0.412		F = 10.503	SSR =	0.242
4	7.669	3.195	-3.539	0.022	2.660	-1.01
		(1.019)	(0.748)	(0.007)		
	N = 52	R^2 = 0.871		F = 107.766	SSR =	0.397
6	8.404	2.563	-3.457	0.014	2.629	0.13
		(1.287)	(0.869)	(0.01)		
	N = 47	R^2 = 0.891		F = 117.678	SSR =	0.479
9	9.842	-0.697	-0.546	-0.009	1.045	8.33
		(1.396)	(0.881)	(0.011)		
	N = 85	R^2 = 0.572		F = 36.141	SSR =	1.879
11	12.357	-5.167	1.635	-0.058		
		(2.665)	(1.514)	(0.025)		
	N = 36	R^2 = 0.592		F = 15.449	SSR =	1.06
14	4.59	8.008	-3.178	0.115	2.521	-10.88
		(7.346)	(4.061)	(0.074)		
	N = 21	R^2 = 0.401		F = 3.798	SSR =	0.737
16	10.742	-1.209	0.018	-0.021		
		(3.194)	(1.723)	(0.031)		
	N = 18	R^2 = 0.299		F = 1.987	SSR =	0.379

Table V.4.2. *Gompertz - Women*

Years Educ.	Inter	E	E^2	E^3	E^4	E^5	Ex	Ed	Ed*Ex
All	9.122	-1.182	-0.279				-0.006	0.101	-0.001
		(0.664)	(0.432)				(0.005)	(0.005)	(1.8E-4)
	N = 308		R^2 =	0.827	F =	288.126		SSR =	8.475
All	9.294	-1.601					-0.009	0.101	-0.001
		(0.149)					(0.002)	(0.005)	(1.8E-4)
	N = 308		R^2 =	0.826	F =	360.75		SSR =	8.487
0	3.766	30.219	-117.44	232.626	-173.34		0.062		
		(12.98)	(44.38)	(79.12)	(53.61)		(0.031)		
	N = 48		R^2 =	0.591	F =	12.406		SSR =	0.168
4	-6.456	81.258	-283.62	584.55	-612.93	249.89	0.207		
		(26.22)	(91.76)	(188.5)	(195.9)	(79.55)	(0.065)		
	N = 52		R^2 =	0.895	F =	63.757		SSR =	0.323
14	-92.586	330.39	-563.7	532.56	-199.36		1.7		
		(114.2)	(206.8)	(206.3)	(81.45)		(0.547)		
	N = 21		R^2 =	0.631	F =	5.133		SSR =	0.454

Finally, we point out the fact that the education coefficient of the best regression for men and women now show a smaller rate of return to schooling for females than for males at each schooling level.

7. Some final remarks

1. We interpreted the results in terms of standard human capital theory, associating

- schooling with investment through education.
- experience with general O.J.T.

Earnings functions may have other interpretation than that advanced in section I. [24]. The positive effect of schooling in earnings can be associated with signaling effects. A positive relation between tenure (and, thus, because we have no data on tenure, experience which is positively correlated with it) and earnings can be explained by implicit contract theories without human capital theory. Therefore, our results may have something of both sources. Also, hedonic wage functions may have been found, in which case, we have a mixture of supply and demand considerations in the formation of an empirically observed relation between the variables.

Also, as observed before, some segmented labor market interpretations maybe applicable for the earnings and returns differentials observed [25]. We preferred to offer a quantitative account of the latter.

2. The results may suffer from ability bias (usually considered to bias estimates of rates of return upwards), self-selection (usually causing a downward bias), or other problems [26], some explained along the exposition and in the Appendix. Nevertheless, the results seem to show a good fit to the data - and most biases cannot be corrected without more information regarding other variables.

8. Summary and conclusions

We performed some estimates - made for other countries - of log-earnings regressions specifications with the available data for the Portuguese labor force. We can summarize the main conclusions as follows:

1. The estimates of the rates of return to schooling for the male sample indicate a convex pattern - that is, an increasing rate of return with the schooling level. The average rate of return to schooling is (was in 1977) about 7,3%.

2. Male experience profiles indicate much higher rates of return for O.J.T. -13-15%. (Notice, however that general and specific O.J.T may be causing these high values, once we have no information on tenure and a positive correlation must exist between tenure and experience.)

3. Results for women indicated an average rate of 8% and a decreasing profile of schooling rates of return. Rates of return to O.J.T. are much lower than for men - which may be partly attributed to the bad proxy for female experience available.

4. Wage differentials by sex indicate a substantial difference between men and women, the data suggesting the negative difference relative to men comes from experience price and not from the schooling reward. (Again, these results are clouded by the bad proxy for experience of women. Caution must therefore be taken when interpreting these issues as symptoms of discrimination.)

5. When we consider estimates by age groups, we get a declining pattern of returns to schooling with groups age; this occurs even when age/experience within the group is controlled for.

6. The extinct technical school system does not show significant differences in the pattern of rewards relative to the high-school system.

7. A quartic representation of the earnings-experience profile seemed to be adequate for the male sample. A cubic representation was achieved for women.

Notes

[1] Although the primary interpretations adopted in the paper are in consonance with standard neo-classical theory, some complementary references of segmented labor market literature are also presented in the treatment of this subject.

[2] This seems a reasonable assumption (specially in private terms), once education is heavily subsidized. Also, compared to opportunity costs - that is, of foregone income due to the fact that the individual is using time to study instead of working -, those costs are small. Notice that these costs are sometimes (at least partly) supported by parents, and not by the individual himself; so in private terms the assumption is even more accurate (assuming a setting where schooling of children is viewed as utility-yielding-consumption by parents and not in an intergenerational transfer context). Part-time income of students is also not accounted for, which would also off-set part of the money costs of schooling.

[3] Using the fact that we are summing the terms of an infinite geometric series.

[4] See Mincer (1974).

[5] See, for example, Weiss (1986). As is well known, earnings regressions maybe interpreted in an hedonic framework - see Rosen (1974) and Willis (1986).

[6] The estimates from earnings regressions are usually lower than those obtained by direct methods - see Willis (1986).

[7] See Mincer, op. cit.

[8] See Mincer, op. cit.

[9] See Soares, Pedro & Magalhães (1984).

[10] In the comparisons we will present, we sometimes refer to results for the U.S. in which log of weeks worked during the year by the individual were included in the regression. We have no corresponding information - and use mean data on individuals, assuming the mean week would be the same for every class considered.

[11] Notice that we cannot exclude the possibility of 7,3% being still a very high rate. Kula (1985) presents an estimate of 7,2% for the Portuguese rate of time preference (However, the interest rate maybe higher than this rate - see MaCurdy (1981)).

[12] See Asplund, Barth, Le Grand, Mastekaasa & Westergård-Nielsen (1991), were rates of return for Denmark, Sweden, Norway and Finland are reported. Only for Finland do the estimates approximate our result of 7%, with 4 and 5% for the other countries.

[13] See Mincer, op. cit.

[14] See Mincer, op. cit.

[15] See the Appendix: this could come from the fact that we are not using after-tax earnings, the tax system being convex.

[16] Experience-earnings profiles as implied by Human Capital theory could also be explained in an implicit contract theory context. The increasing earnings over the life-cycle would be associated with the need to keep workers in their jobs, delaying payments (but rewarding them at the prevailing interest rate). Specific human capital investments, associated with tenure on the job - related to experience in the labor market and of which both us and Mincer had no information about - would thus be preserved. Then, the flatter profile in Portugal could be due to implicit contracts implying a smaller necessity for postponing payments to keep employees, due to the smaller (job) mobility of the Portuguese labor force.

[17] See Freeman (1986) for a discussion of the problem and a survey of relevant literature.

[18] See, for example Asplund et al, op. cit.

[19] See Cain (1986). See also and Tzannatos (1990) for a survey of the literature.

[20] Recall that the data we have - see the Appendix - refers to mean earnings for each category. To know the correct mean difference, we should weight by the percentage of people in each cell, but such information is not available.

[21] See Taubman & Wachter (1986) and McNabb & Ryan (1990) for recent surveys. Also, see Hartog & Vriend (1990), and Magnac (1991) for an attempt to distinguish the two hypothesis (neo-classical and segmented labor market). This same comment applies to all the differential approaches.

[22] Murphy & Welch (1990).

[23] We could have also experimented using earnings - and not log of earnings - as de dependent variable. Foreign evidence suggests that the log-earnings specifications are the ones that have provided the best predicting power of earnings profiles. See Freeman (1986) for further references.

[24] See Willis, op. cit.

[25] See footnote 21.

[26] See Willis, op. cit.

Appendix

1. The data used was published in Soares, São Pedro & Magalhães (1984). There, we find tables - one for men and another one for women - of mean monthly earnings of individuals by age and schooling categories for 1977. The data is based on the annual survey "Quadros de Pessoal" conducted by the Labor Ministry.

2. We constructed experience - as in Mincer (1974) - by subtracting, from the age, the schooling years and 6 (initial schooling age). That is for individuals of class i:

$$\text{Experience}_i = \text{Age}_i - 6 - \text{Years of Education}_i \qquad \text{(A.1)}$$

3. We considered the following equivalence in terms of schooling years relative to the category of schooling for which mean earnings level by age was reported:

No Schooling	0 years
"Primário"	4 years
"Preparatório"	6 years
"Secundário Liceal"	9 years
"Secundário Técnico"	9 years
"Secundário Complementar"	11 years
"Universitário (3 anos)"	14 years
"Universitário (5 years)"	16 years

In the text, we used the term B.A. for the 14 years degree - even if the correspondence is not completely accurate. The higher degree (16 years) is referred to as "licenciatura".

Notice that nowadays an extra schooling year has been created - the "12º Ano" - between High-School and University. However, such was not the case at (till) the time - 1977.

We abstracted from the fact that some people may have taken more than those years to complete that schooling level - therefore experience may be over-estimated by the index (A.1), even if people always worked since leaving school. If the over-approximation is homogeneously (additively) distributed among the population, this will not affect the estimates.

Also, some people did not complete a schooling category and have more years of schooling than the adjacent lower category. This implies that we overestimate schooling and, implicitly, underestimate experience. Again, this will only affect the estimates of the rates of return in some special cases.

4. The information on earnings reported does not correspond to net private earnings - recall §.4 of section I -, but, to our knowledge, they are the only available (published) information at the moment. Being the tax system progressive, this will yield a tendency towards overestimation of the rates of return to schooling. This could also be related to the finding of a positive correlation between the rate of return to schooling and the schooling level for men, the overestimation being, thus, increasing with the schooling level.

5. The data refers to monthly earnings - the earnings that we should use would be annual. We assume that annual earnings are a fixed multiple of monthly earnings, that is:

$$E_{annual} = E_{monthly} \times 14 \quad (A.2)$$

Therefore, in log-earnings terms:

$$\ln E_{annual} = \ln E_{monthly} + \text{constant}. \quad (A.3)$$

This implies that, apart from the intercept, the interpretation of the coefficients in the regressions will not be altered.

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