# Measuring Human Capital in Portugal*

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**resumo**

**Apesar do capital humano ser largamente utilizado como um factor produtivo nos modelos de crescimento económico, em estudos empíricos a sua capacidade explicativa é discutível. Os resultados variam desde efeitos sobre a taxa de crescimento do produto, sobre o nível do produto ou mesmo não se encontrando relação entre o capital humano e o crescimento económico. O capital humano é normalmente medido através de variáveis ligadas ao conhecimento ou à escolaridade. Estas variáveis estão sujeitas a importantes erros de medição, que podem justificar os diferentes resultados empíricos. O presente estudo reconhece a importância de uma boa medição do capital humano. Constroem-se três séries anuais para Portugal, uma delas baseada na escolaridade média para o período 1960-2001, mas com uma metodologia diferente de outros estudos disponíveis para Portugal, e outras duas séries baseadas no rendimento do trabalho para o período 1982-1998.**

**résumé / abstract**

Bien que le capital humain soit largement utilisé comme un facteur productif dans les modèles de croissance économique, sa capacité explicative, lors d'études empiriques, est discutable. Les résultats peuvent varier des effets sur le taux de croissance du produit au niveau du produit et on peut même ne trouver aucune relation entre le capital humain et la croissance économique. Normalement, le capital humain est mesuré au moyen de variables liées à la connaissance ou à la scolarité. Ces variables sont soumises à d'importantes erreurs de mesure, lesquelles peuvent justifier les différents résultats empiriques. La présente étude reconnaît l'importance d'une bonne mesure du capital humain. Pour le Portugal, trois séries annuelles ont été établies : l'une d'entre elles basée sur la scolarité moyenne pour la période 1960-2001, mais avec une méthodologie différente d'autres études disponibles pour le Portugal, et les deux autres basées sur le revenu du travail pour 1982-1998.

Although human capital is widely used as an input in modern economic growth models, in empirical studies, its importance in explaining economic growth is still an open issue. In fact, results range from influence in Gross Domestic Product growth rates to just a levels effect, and there are even several studies that find no significant explaining capability of human capital in economic growth. Human capital is usually measured through a proxy related to the population knowledge or to education. These proxies are prone to important measurement errors that may be the basis for the different found results of their effects on economic growth. The present study recognizes the importance of a good measure of human capital. It builds three annual series for Portugal, one of them based on years of schooling for the period 1960 to 2001, with a methodology different from other studies available for Portugal, and two others based on the market labour income for the period 1982 to 1998.

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## 1. Introduction

Human Capital may be defined as the set of resources embedded in people. It has a multifaceted nature, ranging from knowledge to health. Investment in human capital can be defined as "...activities that influence future real income through the imbedding of resources in people. This is called investment in human capital" (Becker, 1962: 9).

Many authors emphasize the importance of these resources of people in economic growth (e.g., Lucas, 1988; and Romer, 1990). Empirical studies that introduce a proxy of human capital stock in modelling economic growth such as Mankiw et al. (1992), Kyriacou (1991), Benhabib and Spiegel (1994), Pritchett (2001), Temple (1999), Bassanini and Scarpetta (2002), de la Fuente and Doménech (2001b) have not been consensual in the results found in terms of sign and significance of the human capital stock.

The proxies used are related to knowledge, usually measured by the population's education, because theoretical models emphasize this dimension as a pre-requisite to the production of research and utilization of new technologies.

An argument accepted by many, as Cohen and Soto (2001) and de la Fuente and Doménech (2000), to justify these empirical disparities, are the probable measurement errors contained in the series of human capital stock. The present study recognizes the importance of improving the series of human capital. We build three annual series of human capital stock for Portugal. One is a series of average years of schooling, and two other based on the labour market value of human capital.

The average years of schooling is a measure with a widespread use, although the construction methodology differs among studies. Broadly, we can divide these studies in terms of the kind of data they use: some rely on enrolment data (Lau et al., 1991; Nehru et al. 1995), and others rely primarily on census data (Psacharopoulos and Arriagada, 1986, Barro and Lee, 1993; 1996; 2000; de la Fuente and Doménech, 2000; 2001a; 2002; Cohen and Soto, 2001).

Using data from the censuses is conceptually more correct than relying only on enrolment data, since the censuses give us directly the educational attainment of the population in a given year, which is a stock variable, while the enrolment data is a flow variable. Nevertheless, when trying to fill the years between censuses, it is necessary to use some kind of flow data.

Specifically for Portugal we emphasize the annual series built by Teixeira (1997; 1998; 2004), Teixeira and Fortuna (2003), Pina and St. Aubyn (2002) and Pereira (2004). The series constructed by Teixeira rely on the methodology of Barro and Lee (1993) to get data on a five-year basis, and then use the methodology of Kyriacou (1991) to fill in the remaining years. Pina and St. Aubyn (2002) also use the methodology of Barro and Lee (1993), but then fill the remaining years with straight interpolation.

The series of average years of schooling, constructed in the present study, is an improved version of Pereira's (2004) and covers the period from 1960 to 2001. This is done using a methodology that improves on existing series for Portugal, by using some variables that were not used in those studies and by appealing less to interpolations and estimations, as will be explained in section 2.

The average years of schooling, has however some limitations, for example, it assumes perfect substitution between workers with different levels of schooling. By weighting the population by the level of education attained, in a linear way, it implies that a person with twice the years of schooling of another person would be twice as productive. It also does not take into account the quality dimension of educational systems, which can be very limiting, especially when the series are used in cross-country studies. For example, Lebre de Freitas (2000) in a comparative analysis of the growth sources of Ireland, Spain and Portugal, and using as a source The World Competitiveness Yearbook (1997), places, in a ranking of 46 countries, Ireland's education

quality in 2nd, Spain in 34th and Portugal in 41st. On the other hand, a measure based on average years of formal education has necessarily an upper bound.

An alternative measure of the human capital stock is based on its labour market value. The population by educational attainment is weighted by the market value of the corresponding level of education. This is a conceptually more correct proxy of the human capital stock but it is more difficult to obtain, especially when we are trying to build annual series. Some studies that follow this approach are Mulligan and Sala-i-Martin (1995), Koman and Marin (1997), Laroche and Mérette (2000), Pereira (2004) and Silva (2004).

In this study, as in Pereira (2004), we present two annual series of human capital stock based in the labour market income for the period 1982-1998. As far as we know, this study, together with Silva (2004), constitute the first attempt to build annual series of human capital stock for Portugal based on this method.

The paper is organized as follows: in the next section we calculate the educational attainment of the Portuguese population, which will serve as the basis for all the human capital series we will build, in section 3 we calculate the average years of schooling, in section 4 we compare our series of average years of schooling with others available for Portugal, in section 5 we calculate our series based on the market value of human capital, finally section 6 concludes and presents some ideas for further research.

## 2. Educational Attainment of the Population

In order to build these series, it is necessary, first, to calculate the educational attainment of the population. The methodology used is based on Laroche and Mérette's (2000), which we can consider as a refinement of the original contribution of Barro and Lee's (1993), in the sense that it combines data from censuses with flow variables, to build the values for the years between censuses.

The population relevant for this study is the population between 15 and 64 years old, because it mimics better the potential working force. A perpetual inventory method is used that anchors on data from censuses. We start in a census year and calculate all years until the next census, by using data on schooling completion, migration flows, mortality rates and retiring population. When we reach the next census, it is probable that the figures we have are different from those given by the census, so we include an adjustment variable.

This method introduces some improvements over that of Teixeira's (1997; 1998; 2004), Teixeira and Fortuna's (2003) and Pina and St. Aubyn's (2002) by the way that the years between censuses are filled. For example, the use of migration flows, that these other studies ignore, is an important variable to take into consideration in the Portuguese case, and it introduces an important variation dimension for the between censuses years. Another important aspect is that we use data on schooling completion instead of enrolment data, and we use a mortality rate to depreciate our human capital stock. We also present the Portuguese population divided into 10 levels of schooling, which is more than the ones presented in those studies. Due to the lack of data, however, we were not able to use different mortality rates by age and educational level, which would be theoretically more accurate.

For disaggregating the data in the censuses in additional levels of schooling than the ones available, we opted to do it by using the proportion of the level of schooling completion of the same year to determine the proportion of that level in the census data. We are aware that it is a strong assumption because we are using flow data to determine stock data in a straightforward manner. However, some other studies also combine the use of census data with flow data, like Kyriacou (1991), Barro and Lee (1993; 1996; 2000). We used this procedure for the censuses of 1960, 1991 and 2001. We also did some adjustments in census data due to classification differences.

The levels of education in which the population is divided are the following:

– Level **0**: no schooling.

– Level **nf**: no schooling, but acquired the ability to read and write.

– Level **pi**: incomplete primary.

– Level **1**: primary or 4 years of schooling.

– Level **2**: 6 years of schooling.

– Level **3**: 9 years of schooling.

– Level **4**: end of secondary in a sub sample and equivalent to 11 years of schooling.

– Level **5**: end of secondary in a sub sample and equivalent to 12 years of schooling.

– Level **6**: "ensino médio", a sort of lower higher education.

– Level **7**: higher education.

The number of individuals aged 15 up to 64 years old, whose higher level of education attained is $s$ in year $t$, $L_{s,t}$, and with $s = 0$, *nf, pi,* 1, 2, 3, 4, 5, 6, 7 is given by the following formula:

$$L_{0,t} = L_t - \sum_{s=1}^{7} L_{s,t} = L_{pi,t} - L_{nf,t}$$

$$L_{1,t} = L_{1,t-1}(1 - \delta_t) + PE_{1,t-15+4+6} - PE_{2,t-15+6+6} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{2,t} = L_{2,t-1}(1 - \delta_t) + PE_{2,t-15+6+6} - PE_{3,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{3,t} = L_{3,t-1}(1 - \delta_t) + PE_{3,t} - PE_{4,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{4,t} = L_{4,t-1}(1 - \delta_t) + PE_{4,t} - PE_{6,t} - PE_{7,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{5,t} = L_{5,t-1}(1 - \delta_t) + PE_{5,t} - PE_{7,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{6,t} = L_{6,t-1}(1 - \delta_t) + PE_{6,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

$$L_{7,t} = L_{7,t-1}(1 - \delta_t) + PE_{7,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

where:

$L_t$ is total population between 15 and 64 years old in year $t$.

$\delta$ is the average rate of mortality in year $t$.

$PE_{s,t}$ is the number of individuals that completed the level of schooling $s$ in year $t$ and that were in the level of schooling $s$-1 in $t$-1. In levels 1 and 2 we did not apply the mortality rate to the period that goes from the age of schooling completion to the 15 years old. We assumed it was zero. We considered that applying the average mortality rate to individuals with less than 15 years old, would be more biased than simply ignoring the mortality rate.

$OUT_{s,t}$ is the variable that captures people leaving the stock, i.e. those above 64 years old. It is estimated using the population with ages between 55 and 64 years old from the previous census (because censuses are usually separated by ten years), and then the mortality rate is applied.

$SM_{s,t}$ is the migratory balance of individuals with schooling $s$ in year $t$.

$AJ_{s,t}$ is the adjustment variable of schooling $s$ in year $t$, introduced in the formula in order that in the year of the census, the value returned by the formula equals the value of the census. The mortality rate was also considered.

$L_{pi,t}$ and $L_{nf,t}$ are not associated with levels of complete schooling, so the values between the census years were obtained through linear interpolation.

The values of $L_{s,t}$ are shown in Table 3 in the Appendix.

The task of calculating the schooling completion with the degree of detail that we needed for this study revealed itself a laborious one, because the Portuguese education system suffered several transformations since 1960. There is no available information for some years or for some education levels or for some territorial areas. The source of data was Education Statistics and the site of DAPP-Ministry of Education (www.dapp.min-edu.pt). The procedure used consisted in transversal cuts on the education system, corresponding to 4, 6, 9, 11, 12, 14, 15, 16 and 17 years of schooling. We adapted to changes in the duration of some courses by transferring them to the appropriate level considering the new duration of the course. We also took into account the several levels that existed within one course by classifying them into different levels of schooling when appropriate.

Whenever there was no information on schooling completion, we applied the same approval rate of the same course, in the same territorial area of the nearest previous year that had that information.

The Portuguese educational system suffered several modifications during the period between 1960 and 2001. One important change was the introduction of the 12$^{th}$ year of schooling as a pre university year in 1978. But, although it was necessary to have 12 years of schooling to enter university, that did not apply to level 6. To apply to this level it was only required the completion of level 4. Accordingly, the above-mentioned formulas had to be changed. Thus, for $t \geq 1978$ we now have:

$$L_{4,t} = L_{4,t-1}(1 - \delta_t) + PE_{4,t} - PE_{5,t} - PE_{6,t} - OUT_{s,t} + SM_{s,t} + AJ_{s,t}$$

and, of course: $L_{5,t} = 0$ for $t < 1978$

## 3. Average Years of Schooling

Based on Psacharopoulos and Arriagada (1986), in order to obtain our proxy for human capital stock, measured by the average years of schooling (*HS*), we multiply the fraction of population by level of schooling attained by the corresponding number of years of schooling of that level, using the formulas:

$$HS_t = \begin{cases} \dfrac{L_{nf,t} + 2L_{pi,t} + 4L_{1,t} + 6L_{2,t} + 9L_{3,t} + 11L_{4,t} + 14L_{6,t} + 16L_{7,t}}{L_t}, & t < 1978 \\ \dfrac{L_{nf,t} + 2L_{pi,t} + 4L_{1,t} + 6L_{2,t} + 9L_{3,t} + 11L_{4,t} + 12L_{5,t} + 14L_{6,t} + 16L_{7,t}}{L_t}, & 1978 \leq t < 1983 \\ \dfrac{L_{nf,t} + 2L_{pi,t} + 4L_{1,t} + 6L_{2,t} + 9L_{3,t} + 11L_{4,t} + 12L_{5,t} + 14L_{6,t} + HE_t}{L_t}, & t \geq 1983 \end{cases}$$

with:

$$HE_t = 16.L_{7,t} + PE_{7,t} + \sum_{j=1983}^{t-1}{}' \left( PE_{7,j} . \prod_{i=j}^{t-1} (1 - \delta_i) \right)$$

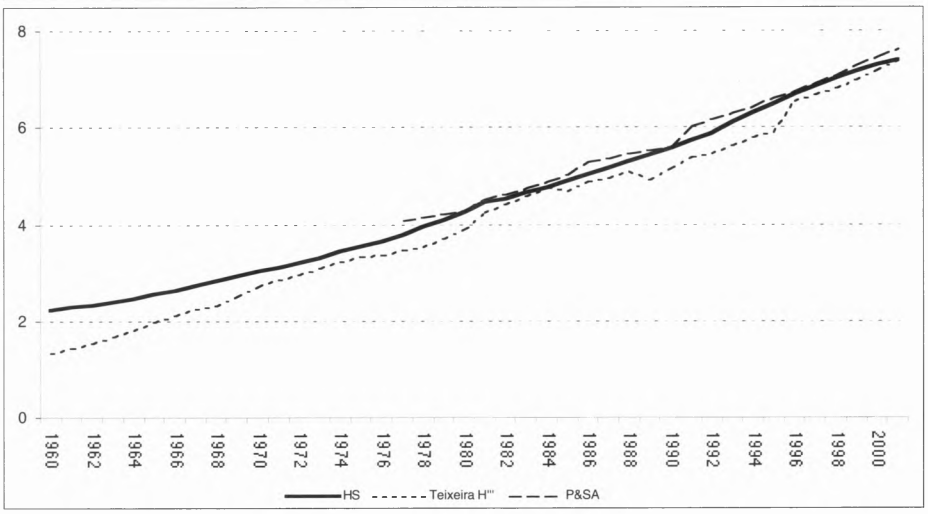
As showed above, we decided to give some weight to levels *nf* and *pi*, because we felt that it was needed to discriminate between illiterates and people that can read and write (may they have or have not been enrolled in primary school), on the grounds that, ceteris paribus, the latter have a slighter better ability, in their daily work, to interpret instructions not given on a verbal basis.

We decided to divide the period in three parts in order to accommodate the introduction of level 5 in 1978. There is a period before 1978 in which there is no level 5. A transition period between 1978 and 1983, in which people that completed level 5 and entered into higher education did not have the time to complete this last level, so level 7 receives the same weight as before. Finally, after 1983 we calculated the part of higher education (*HE*) as a weighted average of people that concluded level 7's before 1983 and people that entered to the stock after 1983 with one more year of education concluded. Data on schooling completion is presented in Table 4 in the Appendix.

## 4. Comparing HS with other Measures of Average Years of Schooling

At this stage we compare our measure of average years of schooling (HS) with other measures built for Portugal. Firstly we will start with other annual series. In Table 5 in the Appendix we present the series HS, the series of Teixeira (2004) and Pina and St. Aubyn (2002). Although we present the various series that Teixeira (2004) calculated, we will focus our discussion on the series H'", which considers that the population with incomplete secondary achieved at least the actual compulsory level of education, which is now 9 years of schooling. In Figure 1, we depict the profiles of these series.

**Figure 1 – Annual Human Capital Series for Portugal**




As shown, our series have a smoother profile than the other two, which presumably is an advantage, as it is counterintuitive to have sharp variations in the human capital stock, in a context of absence of shocks to the variables used, or even decreases in some years in the 1980s as happens in the Teixeira (2004) series. These different profiles are associated with the methodology used, since we do not rely in interpolations or econometric estimations to fill the years between censuses (such in Pina and St Aubyn, 2002), instead we apply a perpetual inventory method to all the years and, differently from Teixeira (2004) and Pina and St Aubyn (2002), we use an adjustment variable in a way that avoids sharp variations on data.

The average annual rate of growth for HS for the period 1960-2001 was 3,0%, while the series of Teixeira (2004) achieves a higher value of 4,2%. This significant difference between growth rates

is due to differences in initial values of the series. Recall that HS gives a weight to people that have incomplete primary or that learned to read and write without going to school. In the early years of the sample, there are many people that fall into these two levels (See Table 3 in appendix). Concerning the period 1977-2001, in which it is possible to compare with the series of Pina and St. Aubyn (2002), HS presents an average annual growth rate of 2,9%, Teixeira (2004) shows a value of 3,2%, and Pina and St. Aubyn (2002) 2,7%. We can see that Teixeira (2004) presents higher average growth rates than HS for both periods and higher than the series in Pina and St. Aubyn (2002) for the comparable period. Nevertheless, the Pearson linear correlation coefficients between these series are very high, which seems to be not of great help in order to compare them. We will, therefore use the concept of reliability ratio, developed by Krueger and Lindahl (2000), for comparing the above-mentioned series. This procedure was also used previously by several other authors such as Cohen and Soto (2001), de la Fuente and Doménech (2002), Pereira (2004) and Teixeira (2004).

The reliability ratio measures the reliability of a series *(X)*, when there are two series (X and *Y)* that try to measure the true series *(Z)*, by *cov(X,Y)/Var(X)*, and if there were no correlation between the measurement errors of (*X)* and (*Y)* it should assume values between 0 and 1 (the higher the value the more reliable will be the series).

Table 1 presents the computed reliability ratios for the series in differences. As Cohen and Soto (2001) point out, the reliability ratio of the series in levels tends to be high, and drops considerably when calculated in first differences, being the latter a better measure to distinguish between series, as it applies to the variations of the human capital proxies.

**Table 1 – Reliability Ratio of annual human capital series in first differences for Portugal**

| | HS | Teixeira (2004) | AP_MS (2002) |
|---|---|---|---|
| **HS** | – | 0.099 | 0.018 |
| **Teixeira (2004)** | **0,768** | – | 0.541 |
| **AP_MS (2002)** | 0.116 | 0.159 | – |

The values in the table should be read as the reliability ratio of the series in columns when compared with the series in rows. The series HS has the highest reliability ratio of the sample, reaching its maximum when compared with the series of Teixeira (2004) (0.768). Teixeira's series has the highest value when compared with the series of Pina and St. Aubyn (2002) (0.159), and conversely this has the highest ratio when compared with Teixeira's series.

These results might be interpreted as an indicator that the series HS is a better series for proxying the average years of schooling for Portugal, than the other two series considered. However, there should be some caution when interpreting these ratios because, as pointed out by Teixeira, *"...given the highly likelihood of these three data series present correlated measurement errors and the fact that Pearson linear correlation coefficients are very high for the whole set of data series, the relative performance and validity of these three proxies have to be tested against growth regression exercises."* (Teixeira, 2004, p. 14).

Next we turn to a comparison with series that have a widespread use in several international studies (Barro and Lee (2000); de la Fuente and Doménech (2002); Cohen and Soto (2001)). These series are not annual but presented on a five or ten year basis.

The two series of Barro and Lee (2000) are for the population over 25 years old and 15 years old, de la Fuente and Doménech (2002) calculate the series for the population over 25 years old, and so do Teixeira (2004) and Pina and St. Aubyn (2002). Both the series HS and the series of Cohen and Soto (2001) are related to the population with ages between 15 and 64 years old.

**Table 2 – Comparison of series specific for Portugal with series used in international cross-country studies**

| | B_L_25 (2000) | B_L_15 (2000) | D_D (2002) | C_S (2001) | Pereira (2004) | Teixeira H''' (2004) | AP_MS (2002) |
|---|---|---|---|---|---|---|---|
| **Anos** | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **1960** | 1.94 | 1.86 | 4.37 | 3.15 | 2.24 | 1.36 | |
| **1965** | 2.24 | 2.44 | 4.62 | | 2.56 | 2.01 | |
| **1970** | 2.44 | 2.60 | 4.87 | 4.11 | 3.05 | 2.74 | |
| **1975** | 2.79 | 2.77 | 5.29 | | 3.54 | 3.34 | |
| **1980** | 3.27 | 3.78 | 5.73 | 5.57 | 4.26 | 3.91 | 4.29 |
| **1985** | 3.57 | 3.85 | 6.06 | | 4.89 | 4.69 | 5.03 |
| **1990** | 4.33 | 4.91 | 6.41 | 5.91 | 5.59 | 5.15 | 5.61 |
| **1995** | 4.54 | 5.47 | | | 6.50 | 5.90 | 6.60 |
| **2000** | 4.91 | 5.87 | | 7.28 | 7.29 | 7.19 | 7.47 |
| | | | | | | | |
| **Δ% 1960-2000** | 2.4% | 2.9% | | 2.1% | 3.0% | 4.3% | |
| **Δ% 1960-1990** | 2.7% | 3.3% | 1.3% | 2.1% | 3.1% | 4.5% | |
| **Δ% 1980-2000** | 2.1% | 2.2% | | 1.4% | 2.7% | 3.1% | 2.8% |

Source: Barro and Lee (2000), Columns (1) and (2); de la Fuente and Doménech (2002), column (3); Cohen and Soto (2001), column (4); Teixeira (2004), column (6) and Pina and St. Aubyn (2002), column (7). Column (5) presents the series HS of the present study.

Comparing with the series that have values for the three sub periods, we can see that the series HS and the series of Teixeira (2004) have higher annual growth rates except for the case of the series B_L_15 for the period 1960-1990 (whose growth rate is higher than the one of the series HS). The series of Barro and Lee (2000) have significantly lower values for the year 2000 than the other series, which turns out to be more striking when we know that they share part of the methodology. This highlights our perception that not only the methodology is important, but also how direct are the sources of information used. It seems that as we use more national sources, the noise that different classifications introduce will diminish. The value that we obtain for the year 2000 is reassuring because it resembles the values obtained by other studies using different methodologies.

## 5. Measures Based on the Market Value of Human Capital

As said before, the average years of schooling relate worker's productivity with the level of formal education obtained in a straightforward manner, i.e. schooling differences are mapped into productivity differences in a linear way. This alternative approach to compute a proxy of human capital is based on their market value, allowing for the weighting of the population to depend on a parameter that reflects the value the market gives to schooling and therefore is conceptually more correct. This approach was followed, for example, by Mulligan and Sala-i-Martin (1995), Koman and Marin (1997) and Laroche and Mérette (2000). For Portugal we have the studies of Silva (2004) and Pereira (2004). The former follows the methodology of Mulligan and Sala-i-Martin (1995), while the latter follows the methodology of Koman and Marin (1997) and Laroche and Mérette (2000). The methodologies are similar in substance but while the former uses the

ratio between skilled workers and the zero-skilled worker, the latter uses the marginal returns to schooling.

Using the marginal returns to schooling has the advantage of being a variable that is already available on some studies. A disadvantage is the probable bias in its estimation by OLS. This parameter is the coefficient associated to schooling in a Mincer equation. This equation formulated by Jacob Mincer (1974) has underlying it an analysis between the investment in education and the return of that education during the lifetime period. In its simplest form, this equation establishes a loglinear relationship of wages with years of schooling (several other explaining variables can be included).

Consider $W_s$ the labour income of individuals with $s$ years of schooling, $W_0$ the labour income of individuals without any schooling, $r$ the rate of return of an extra year of schooling and $s$ the number of years of schooling. The resulting equation is:

$$ln\ W_s = ln\ W_0 + r.s$$

We present in this study the series of Pereira (2004) with some corrections. The data on returns to schooling are taken from Pereira and Martins (2002), which is a study of OLS estimates of returns to schooling in Portugal from 1982 to 1998. The data they use is taken from "Quadros de Pessoal", a Portuguese data set on labour data. Although Hartog et al. (2001) also supply the returns to schooling for Portugal, covering the 1980s and early 1990s, it is not computed on an annual basis.

The measure Hrl (or HRL in aggregate terms) uses constant marginal returns to schooling (11%), and the measure Hr (or HR in aggregate terms) uses different marginal returns to schooling, according to the levels of schooling attainment. The formulas are:

$$HR = \prod_s L_s^{\omega_s} \quad \text{with} \quad \omega_s = \frac{e^{\gamma_s} \cdot L_s}{\sum_s e^{\gamma_s} \cdot L_s}$$

$$HRL = \prod_s L_s^{\omega_s} \quad \text{with} \quad \omega_s = \frac{e^{\gamma \cdot s} \cdot L_s}{\sum_s e^{\gamma \cdot s} \cdot L_s}$$

Where $\gamma$ is the returns to schooling.

For each individual, it follows:

$$Hr = \frac{HR}{L} = \frac{\prod_s L_s^{\omega_s}}{L}$$

$$= \frac{L_0^{\omega_0} \ldots L_n^{\omega_n}}{L}$$

$$= \prod_s \left( \frac{L_s}{L} \right)^{\omega_s} \quad \text{because} \quad \sum_s \omega_s = 1$$

and,

$$Hrl = \frac{HRL}{L} = \frac{\prod_s L_s^{\omega_s}}{L}$$

$$= \frac{L_0^{\omega_0} \ldots L_n^{\omega_n}}{L}$$

$$= \prod_s \left(\frac{L_s}{L}\right)^{\omega_s} \text{ because } \sum_s \omega_s = 1$$

We also use a fixed weight $W_s$, which is the average of the values for the entire period of the series. The use of this fixed weight is based on the fact that annual variation of returns to schooling may reflect, not only changes on the quality of human capital, but also labour market conditions. It is not clear to what extent each of these factors influences changes in $\gamma$, but assuming that schooling quality has a more structural nature, it is reasonable to admit that yearly significant changes of $\gamma$ will reflect mainly labour market conditions. The series are presented in Table 7 in the appendix.

There is one result that contrasts with the results obtained by Koman and Marin (1995) and Laroche and Mérette (2000), although these authors study other countries, like Austria, Germany and Canada. These authors find that the series built with constant marginal returns to schooling (a labour market measure of human capital) grow faster than the series of average years of schooling. Here we only see that result with the series that uses different returns to schooling for each level of schooling.

This is a consequence of the fact that the weight (years) in the average years of schooling grows faster than the weight used in the series Hrl that depends on the value of 11% for the marginal returns to schooling.

These two series are presented in Table 7. We can see that the series Hr grows faster than the series Hrl, which implies that the wage dispersion has been growing. This result can be seen on the data of the different marginal returns to schooling according to the levels of education presented in Pereira and Martins (2002), and is confirmed by the studies of Hartog et al. (2001) and Machado and Mata (2001).

Comparing these series with the values obtained by Silva (2004), we point out that this author presents values for four years (1989, 1992, 1995, 1998), using a methodology based on the ratio of the wage of the skilled worker to the wage of the zero skilled worker, and when we compare the evolution, for example between 1989 and 1998, the implicit values of the referred ratio show a decrease in the period, while both our series show an increase, which is more coherent with the results obtained in the series of average years of schooling. This result obtained by Silva (2004) may mean that his methodology is more sensible to labour market conditions that affect the distribution of wages. We may be more immune to this effect by using a fixed weight $W_s$ in the calculation of our series.

The series built on this study do not take into account neither changes in the quality of schooling or heterogeneity. This is an important drawback because the quality and type of schooling will affect human capital. For example Lee and Lee (1995), Hanushek and Kimko (2000) and Barro (2001) find significant results of proxies of schooling quality in growth specifications. On an empirical study of schooling heterogeneity, Murphy et al. (1991) find that countries with more concentration of engineers grow faster than countries with more concentration of lawyers.

## 6. Conclusion

In the present study we estimated series of human capital for Portugal that could improve on existing alternatives. We appealed less to interpolations and relied on more direct sources of data than some of the alternatives, and on the use of some variables that are ignored in other studies, like migratory flows. On a first account, when comparing with other series, our series of average years of schooling performs in an encouraging manner. For example, it shows a smoother profile than other annual series for Portugal, and it presents a high reliability ratio. Comparing our annual series based on labour market income, with the other study available for Portugal, we have some evidence that the methodology we use may be more efficient in the immunization against temporary labour market conditions.

However the best test that can be made to the series built on this study is by putting them into growth regressions. We think they could be useful for further empirical studies on the Portuguese growth process. Another important outcome of this study is the estimation of the educational attainment of the Portuguese population for a period of 41 years. This information could also be useful to other researchers that wish to build different series, but that are somehow dependent on the educational structure of the Portuguese population. Also the data on schooling completion, and other variables used to compute the series for this 41 years period may be of importance for other researchers.

This line of research can be deepened and extended in several ways. In the series based on labour market income, we should correct for the probable bias of the returns to schooling. This bias stems from the fact that the equation estimated lacks unobserved variables, like the individuals ability that will be captured by the schooling coefficient. It is important to consider also knowledge acquired after formal education. We could also divide the educational structure of the population by gender. It could be made an analysis of educational heterogeneity, and, finally, we think the biggest insight we could obtain, as a complement to what was made in this study, would be to study the evolution of the quality of the Portuguese educational system, namely by the construction of a series of human capital quality, although this task seems like a huge challenge due to the lack of sufficient data on the outcomes of students test scores.

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## Appendix

### Table 3 – Population with ages between 15 and 64 years old by level of schooling, $L_{s,t}$

| Years | Levels of schooling | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | Nf | pi | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1960 | 1,900,326 | 464,505 | 1,145,717 | 1,803,480 | 131,307 | 55,433 | 23,897 | | 21,076 | 43,132 | 5,588,873 |
| 1961 | 1,908,188 | 447,749 | 1,121,013 | 1,830,429 | 170,319 | 61,479 | 26,020 | | 21,564 | 43,313 | 5,630,074 |
| 1962 | 1,900,338 | 430,993 | 1,096,309 | 1,851,683 | 211,142 | 67,660 | 28,434 | | 22,052 | 43,280 | 5,651,891 |
| 1963 | 1,872,408 | 414,237 | 1,071,605 | 1,875,036 | 252,448 | 74,893 | 30,842 | | 22,615 | 43,329 | 5,657,413 |
| 1964 | 1,824,501 | 397,481 | 1,046,901 | 1,895,176 | 294,729 | 81,655 | 33,352 | | 22,907 | 43,066 | 5,639,768 |
| 1965 | 1,752,586 | 380,725 | 1,022,197 | 1,911,540 | 334,753 | 87,865 | 37,351 | | 22,712 | 43,154 | 5,592,883 |
| 1966 | 1,667,072 | 363,969 | 997,493 | 1,932,733 | 375,347 | 93,567 | 41,085 | | 22,590 | 43,026 | 5,536,882 |
| 1967 | 1,593,324 | 347,213 | 972,789 | 1,963,726 | 415,528 | 101,114 | 44,356 | | 22,505 | 43,536 | 5,504,091 |
| 1968 | 1,516,931 | 330,457 | 948,085 | 1,996,799 | 454,513 | 109,061 | 49,373 | | 22,453 | 43,807 | 5,471,479 |
| 1969 | 1,416,407 | 313,701 | 923,381 | 2,011,726 | 485,602 | 116,252 | 55,555 | | 22,215 | 43,406 | 5,388,245 |
| 1970 | 1,306,405 | 296,940 | 898,680 | 2,050,770 | 518,460 | 126,020 | 62,290 | | 22,520 | 44,420 | 5,326,505 |
| 1971 | 1,278,340 | 275,230 | 896,588 | 2,099,873 | 510,508 | 140,426 | 67,069 | | 27,209 | 48,049 | 5,343,292 |
| 1972 | 1,233,689 | 253,520 | 894,496 | 2,158,800 | 504,038 | 157,424 | 72,713 | | 33,156 | 51,911 | 5,359,747 |
| 1973 | 1,180,544 | 231,810 | 892,404 | 2,195,327 | 515,163 | 173,979 | 80,610 | | 38,526 | 56,064 | 5,364,427 |
| 1974 | 1,188,828 | 210,100 | 890,312 | 2,288,760 | 523,704 | 219,485 | 96,508 | | 45,892 | 65,096 | 5,528,685 |
| 1975 | 1,248,715 | 188,390 | 888,220 | 2,408,981 | 568,352 | 261,285 | 111,730 | | 55,981 | 73,739 | 5,805,393 |
| 1976 | 1,225,636 | 166,680 | 886,128 | 2,445,479 | 588,676 | 288,354 | 124,664 | | 64,252 | 84,511 | 5,874,380 |
| 1977 | 1,199,297 | 144,970 | 884,036 | 2,459,437 | 643,894 | 311,764 | 142,290 | | 68,410 | 95,367 | 5,949,465 |
| 1978 | 1,152,171 | 123,260 | 881,944 | 2,493,539 | 659,316 | 365,603 | 146,485 | 16,668 | 74,953 | 109,171 | 6,023,110 |
| 1979 | 1,100,174 | 101,550 | 879,852 | 2,530,519 | 690,464 | 398,941 | 164,911 | 33,896 | 77,643 | 120,906 | 6,098,856 |
| 1980 | 1,025,859 | 79,840 | 877,760 | 2,584,027 | 728,280 | 428,305 | 180,403 | 59,337 | 79,665 | 132,062 | 6,175,538 |
| 1981 | 903,512 | 58,125 | 875,670 | 2,640,191 | 753,849 | 455,372 | 200,290 | 75,763 | 80,894 | 143,449 | 6,187,115 |
| 1982 | 899,828 | 55,737 | 858,347 | 2,672,103 | 789,974 | 465,001 | 242,577 | 75,046 | 81,984 | 154,857 | 6,295,454 |
| 1983 | 865,011 | 53,349 | 841,024 | 2,685,770 | 816,850 | 485,237 | 260,967 | 90,972 | 83,269 | 166,452 | 6,348,901 |
| 1984 | 833,756 | 50,961 | 823,701 | 2,696,020 | 849,904 | 504,355 | 277,248 | 108,651 | 84,312 | 178,617 | 6,407,525 |
| 1985 | 793,593 | 48,573 | 806,378 | 2,683,610 | 888,208 | 533,188 | 290,321 | 124,422 | 85,893 | 191,103 | 6,445,289 |
| 1986 | 741,481 | 46,185 | 789,055 | 2,662,009 | 936,682 | 561,171 | 302,993 | 145,550 | 88,038 | 201,505 | 6,474,669 |
| 1987 | 688,113 | 43,797 | 771,732 | 2,632,333 | 984,494 | 600,926 | 306,636 | 160,502 | 90,069 | 213,403 | 6,492,005 |
| 1988 | 632,220 | 41,409 | 754,409 | 2,604,533 | 1,039,430 | 623,635 | 316,976 | 181,373 | 89,340 | 225,436 | 6,508,761 |
| 1989 | 569,023 | 39,021 | 737,086 | 2,572,643 | 1,078,740 | 668,914 | 319,932 | 209,313 | 88,558 | 236,160 | 6,519,390 |
| 1990 | 504,540 | 36,633 | 719,763 | 2,540,654 | 1,110,939 | 709,544 | 327,812 | 240,423 | 87,729 | 247,217 | 6,525,254 |
| 1991 | 451,899 | 34,241 | 702,441 | 2,505,699 | 1,145,811 | 753,291 | 331,109 | 278,499 | 87,162 | 261,845 | 6,551,997 |
| 1992 | 440,572 | 30,817 | 675,561 | 2,476,498 | 1,154,541 | 816,253 | 358,678 | 312,697 | 82,224 | 281,451 | 6,629,292 |
| 1993 | 372,235 | 27,393 | 648,681 | 2,447,584 | 1,151,534 | 892,908 | 384,766 | 347,064 | 77,539 | 304,030 | 6,653,734 |
| 1994 | 320,344 | 23,969 | 621,801 | 2,414,310 | 1,141,087 | 955,192 | 428,529 | 371,668 | 72,954 | 336,368 | 6,686,222 |
| 1995 | 282,177 | 20,545 | 594,921 | 2,372,836 | 1,116,770 | 1,034,096 | 444,908 | 412,667 | 68,385 | 370,563 | 6,717,868 |
| 1996 | 255,857 | 17,121 | 568,041 | 2,316,208 | 1,109,640 | 1,095,187 | 472,326 | 443,932 | 63,911 | 407,194 | 6,749,417 |
| 1997 | 232,640 | 13,697 | 541,161 | 2,255,555 | 1,139,662 | 1,144,298 | 495,519 | 458,827 | 59,568 | 446,692 | 6,787,619 |
| 1998 | 213,462 | 10,273 | 514,281 | 2,214,464 | 1,144,845 | 1,189,739 | 525,872 | 470,158 | 55,297 | 490,229 | 6,828,620 |
| 1999 | 209,735 | 6,849 | 487,401 | 2,167,865 | 1,150,240 | 1,232,982 | 560,710 | 472,324 | 51,081 | 534,549 | 6,873,736 |
| 2000 | 209,510 | 3,425 | 460,521 | 2,121,209 | 1,147,034 | 1,295,686 | 587,054 | 476,208 | 47,144 | 582,338 | 6,930,129 |
| 2001 | 223,994 | 0 | 433,638 | 2,085,442 | 1,145,973 | 1,345,540 | 625,131 | 470,357 | 43,329 | 632,618 | 7,006,022 |

**Table 4 – Schooling completion, $PE_{s,t}$**

| Years | Levels of schooling | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 1956 | 87,743 | | | | | | | |
| 1957 | 93,858 | | | | | | | |
| 1958 | 103,913 | 17,197 | | | | | | |
| 1959 | 113,968 | 21,791 | | | | | | |
| 1960 | 122,308 | 25,682 | 10,842 | 4,674 | | 2,854 | 2,287 | 168,647 |
| 1961 | 132,920 | 29,464 | 11,975 | 5,341 | | 3,408 | 2,184 | 185,292 |
| 1962 | 134,586 | 32,159 | 12,956 | 5,819 | | 3,466 | 2,121 | 191,107 |
| 1963 | 137,801 | 34,550 | 14,702 | 6,228 | | 3,564 | 2,278 | 199,123 |
| 1964 | 138,646 | 35,182 | 14,880 | 6,315 | | 3,377 | 2,164 | 200,564 |
| 1965 | 141,452 | 37,164 | 16,878 | 8,254 | | 2,970 | 2,704 | 209,422 |
| 1966 | 140,139 | 37,110 | 16,586 | 8,120 | | 3,050 | 2,542 | 207,547 |
| 1967 | 138,586 | 37,572 | 17,919 | 7,891 | | 2,956 | 2,959 | 207,883 |
| 1968 | 142,818 | 39,247 | 19,989 | 9,441 | | 2,949 | 2,683 | 217,127 |
| 1969 | 147,049 | 40,922 | 22,058 | 10,990 | | 2,941 | 2,406 | 226,366 |
| 1970 | 141,100 | 62,640 | 24,771 | 12,244 | | 3,213 | 3,321 | 247,289 |
| 1971 | 147,875 | 73,917 | 20,789 | 13,718 | | 4,573 | 3,068 | 263,940 |
| 1972 | 151,933 | 85,124 | 24,616 | 15,459 | | 5,750 | 3,082 | 285,964 |
| 1973 | 150,459 | 88,689 | 27,805 | 18,230 | | 5,347 | 3,613 | 294,143 |
| 1974 | 153,986 | 119,168 | 58,697 | 26,374 | | 6,252 | 6,414 | 370,891 |
| 1975 | 176,677 | 100,483 | 46,008 | 22,372 | | 8,066 | 4,339 | 357,945 |
| 1976 | 176,929 | 103,870 | 50,594 | 31,338 | | 8,109 | 9,764 | 380,604 |
| 1977 | 181,743 | 110,874 | 47,206 | 31,783 | | 3,982 | 9,805 | 385,393 |
| 1978 | 167,174 | 98,406 | 68,746 | 23,045 | 12,260 | 6,328 | 12,725 | 388,684 |
| 1979 | 165,356 | 104,432 | 57,238 | 31,944 | 11,061 | 2,445 | 10,643 | 383,119 |
| 1980 | 164,336 | 103,366 | 57,762 | 36,318 | 19,064 | 1,759 | 10,101 | 392,706 |
| 1981 | 173,721 | 107,607 | 54,600 | 33,534 | 11,246 | 1,266 | 10,942 | 392,916 |
| 1982 | 171,814 | 123,958 | 52,429 | 63,078 | 13,544 | 1,241 | 8,581 | 434,645 |
| 1983 | 175,004 | 140,415 | 58,896 | 57,711 | 30,956 | 1,596 | 9,209 | 473,787 |
| 1984 | 180,618 | 143,098 | 57,569 | 57,554 | 33,282 | 1,293 | 9,775 | 483,189 |
| 1985 | 181,140 | 144,976 | 66,519 | 55,160 | 32,717 | 2,021 | 10,658 | 493,191 |
| 1986 | 175,445 | 153,720 | 71,489 | 59,801 | 36,717 | 2,688 | 8,962 | 508,822 |
| 1987 | 182,604 | 153,637 | 72,784 | 47,743 | 33,085 | 2,732 | 10,969 | 503,554 |
| 1988 | 176,923 | 159,075 | 66,974 | 58,231 | 39,539 | 0 | 11,316 | 512,058 |
| 1989 | 168,602 | 155,005 | 90,039 | 57,699 | 46,079 | 0 | 10,370 | 527,794 |
| 1990 | 160,281 | 154,497 | 96,000 | 67,126 | 50,353 | 0 | 11,034 | 539,291 |
| 1991 | 148,573 | 151,574 | 101,742 | 71,188 | 59,877 | 0 | 14,039 | 546,993 |
| 1992 | 148,507 | 149,872 | 115,897 | 76,198 | 68,666 | 0 | 21,449 | 580,589 |
| 1993 | 148,755 | 154,287 | 129,507 | 76,828 | 70,999 | 0 | 23,981 | 604,357 |
| 1994 | 140,932 | 160,812 | 134,456 | 95,254 | 71,336 | 0 | 33,913 | 636,703 |
| 1995 | 123,353 | 142,100 | 145,865 | 88,269 | 90,684 | 0 | 36,410 | 626,681 |
| 1996 | 118,836 | 139,480 | 133,681 | 92,902 | 83,941 | 0 | 39,116 | 607,956 |
| 1997 | 124,092 | 131,592 | 104,155 | 75,255 | 70,381 | 0 | 42,014 | 547,489 |
| 1998 | 120,793 | 119,902 | 110,009 | 83,895 | 71,362 | 0 | 46,478 | 552,439 |
| 1999 | 117,758 | 117,757 | 106,787 | 81,616 | 63,831 | 0 | 47,929 | 535,678 |
| 2000 | 122,675 | 120,606 | 112,398 | 72,408 | 65,021 | 0 | 49,380 | 542,488 |
| 2001 | 117,002 | 114,696 | 100,507 | 74,774 | 56,261 | 0 | 51,224 | 514,464 |

Source: Education Statistics (INE) and (DAPP - Ministry of Education).

## Table 5 – Average Years of Schooling

| Years | Pereira | Teixeira (2004) | | | | AP_MS (2002) |
|---|---|---|---|---|---|---|
| | HS | H | H' | H'' | H''' | H |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 1960 | 2.237 | 1.623 | 1.337 | 1.286 | 1.362 | |
| 1961 | 2.286 | 1.729 | 1.425 | 1.374 | 1.450 | |
| 1962 | 2.339 | 1.863 | 1.534 | 1.482 | 1.560 | |
| 1963 | 2.403 | 2.009 | 1.653 | 1.599 | 1.680 | |
| 1964 | 2.474 | 2.200 | 1.810 | 1.752 | 1.838 | |
| 1965 | 2.555 | 2.403 | 1.978 | 1.919 | 2.008 | |
| 1966 | 2.644 | 2.544 | 2.096 | 2.030 | 2.128 | |
| 1967 | 2.734 | 2.690 | 2.215 | 2.143 | 2.251 | |
| 1968 | 2.829 | 2.787 | 2.295 | 2.221 | 2.332 | |
| 1969 | 2.929 | 3.018 | 2.484 | 2.395 | 2.528 | |
| 1970 | 3.051 | 3.276 | 2.690 | 2.581 | 2.744 | |
| 1971 | 3.122 | 3.423 | 2.823 | 2.708 | 2.880 | |
| 1972 | 3.212 | 3.523 | 2.919 | 2.803 | 2.978 | |
| 1973 | 3.314 | 3.672 | 3.058 | 2.937 | 3.119 | |
| 1974 | 3.438 | 3.783 | 3.169 | 3.048 | 3.229 | |
| 1975 | 3.541 | 3.886 | 3.279 | 3.162 | 3.337 | |
| 1976 | 3.655 | 3.913 | 3.325 | 3.216 | 3.379 | |
| 1977 | 3.777 | 3.994 | 3.414 | 3.310 | 3.467 | 4.073 |
| 1978 | 3.937 | 4.074 | 3.500 | 3.398 | 3.551 | 4.145 |
| 1979 | 4.092 | 4.239 | 3.664 | 3.563 | 3.715 | 4.217 |
| 1980 | 4.262 | 4.439 | 3.851 | 3.741 | 3.906 | 4.289 |
| 1981 | 4.450 | 4.781 | 4.179 | 4.061 | 4.239 | 4.510 |
| 1982 | 4.540 | 4.960 | 4.354 | 4.232 | 4.415 | 4.641 |
| 1983 | 4.654 | 5.144 | 4.518 | 4.383 | 4.585 | 4.772 |
| 1984 | 4.765 | 5.316 | 4.671 | 4.523 | 4.744 | 4.903 |
| 1985 | 4.887 | 5.248 | 4.616 | 4.473 | 4.688 | 5.034 |
| 1986 | 5.022 | 5.466 | 4.825 | 4.675 | 4.899 | 5.294 |
| 1987 | 5.153 | 5.527 | 4.886 | 4.733 | 4.962 | 5.374 |
| 1988 | 5.285 | 5.665 | 5.018 | 4.861 | 5.097 | 5.454 |
| 1989 | 5.432 | 5.453 | 4.841 | 4.698 | 4.912 | 5.534 |
| 1990 | 5.585 | 5.700 | 5.078 | 4.928 | 5.152 | 5.614 |
| 1991 | 5.739 | 5.982 | 5.322 | 5.150 | 5.408 | 6.041 |
| 1992 | 5.887 | 6.024 | 5.369 | 5.194 | 5.457 | 6.181 |
| 1993 | 6.093 | 6.198 | 5.530 | 5.343 | 5.624 | 6.322 |
| 1994 | 6.299 | 6.370 | 5.710 | 5.524 | 5.804 | 6.462 |
| 1995 | 6.497 | 6.463 | 5.811 | 5.624 | 5.904 | 6.602 |
| 1996 | 6.683 | 7.132 | 6.422 | 6.202 | 6.532 | 6.743 |
| 1997 | 6.847 | 7.263 | 6.559 | 6.339 | 6.668 | 6.923 |
| 1998 | 7.006 | 7.411 | 6.713 | 6.493 | 6.822 | 7.104 |
| 1999 | 7.146 | 7.579 | 6.886 | 6.666 | 6.996 | 7.284 |
| 2000 | 7.289 | 7.770 | 7.080 | 6.861 | 7.190 | 7.465 |
| 2001 | 7.409 | 7.985 | 7.296 | 7.076 | 7.405 | 7.645 |

Source: Teixeira (6), columns (2) to (5); Pina and St. Aubyn (2002), column (6). Column (1) contains the series calculated in the present study.

**Table 6 – Population by level of schooling, $L_{s,t}$, for Hr and Hrl**

| Years | Levels of schooling | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| 1981 | 1,837,307 | 2,640,191 | 753,849 | 455,372 | 276,053 | 112,690 | 111,653 | 6,187,115 |
| 1982 | 1,813,912 | 2,672,103 | 789,974 | 465,001 | 317,623 | 118,937 | 117,904 | 6,295,454 |
| 1983 | 1,759,384 | 2,685,770 | 816,850 | 485,237 | 351,939 | 125,369 | 124,352 | 6,348,901 |
| 1984 | 1,708,418 | 2,696,020 | 849,904 | 504,355 | 385,899 | 131,406 | 131,523 | 6,407,525 |
| 1985 | 1,648,544 | 2,683,610 | 888,208 | 533,188 | 414,743 | 138,185 | 138,811 | 6,445,289 |
| 1986 | 1,576,721 | 2,662,009 | 936,682 | 561,171 | 448,543 | 145,429 | 144,114 | 6,474,669 |
| 1987 | 1,503,642 | 2,632,333 | 984,494 | 600,926 | 467,138 | 151,571 | 151,901 | 6,492,005 |
| 1988 | 1,428,038 | 2,604,533 | 1,039,430 | 623,635 | 498,349 | 155,302 | 159,474 | 6,508,761 |
| 1989 | 1,345,130 | 2,572,643 | 1,078,740 | 668,914 | 529,245 | 159,231 | 165,487 | 6,519,390 |
| 1990 | 1,260,936 | 2,540,654 | 1,110,939 | 709,544 | 568,235 | 164,497 | 170,449 | 6,525,254 |
| 1991 | 1,188,581 | 2,505,699 | 1,145,811 | 753,291 | 609,608 | 170,645 | 178,362 | 6,551,997 |
| 1992 | 1,146,950 | 2,476,498 | 1,154,541 | 816,253 | 671,375 | 168,841 | 194,834 | 6,629,292 |
| 1993 | 1,048,309 | 2,447,584 | 1,151,534 | 892,908 | 731,830 | 168,389 | 213,180 | 6,653,734 |
| 1994 | 966,114 | 2,414,310 | 1,141,087 | 955,192 | 800,197 | 170,607 | 238,716 | 6,686,222 |
| 1995 | 897,643 | 2,372,836 | 1,116,770 | 1,034,096 | 857,575 | 172,677 | 266,272 | 6,717,868 |
| 1996 | 841,019 | 2,316,208 | 1,109,640 | 1,095,187 | 916,258 | 175,493 | 295,613 | 6,749,417 |
| 1997 | 787,498 | 2,255,555 | 1,139,662 | 1,144,298 | 954,346 | 178,901 | 327,360 | 6,787,619 |
| 1998 | 738,016 | 2,214,464 | 1,144,845 | 1,189,739 | 996,030 | 183,376 | 362,151 | 6,828,620 |

**Table 7 – Series of human capital based on labour market earnings**

| Years | *Hr* | *Hrl* |
|---|---|---|
| 1982 | 0.04240 | 0.11831 |
| 1983 | 0.04403 | 0.12137 |
| 1984 | 0.04567 | 0.12420 |
| 1985 | 0.04743 | 0.12713 |
| 1986 | 0.04893 | 0.13008 |
| 1987 | 0.05073 | 0.13278 |
| 1988 | 0.05240 | 0.13531 |
| 1989 | 0.05390 | 0.13792 |
| 1990 | 0.05530 | 0.14043 |
| 1991 | 0.05703 | 0.14282 |
| 1992 | 0.05950 | 0.14527 |
| 1993 | 0.06245 | 0.14799 |
| 1994 | 0.06622 | 0.15048 |
| 1995 | 0.06996 | 0.15245 |
| 1996 | 0.07369 | 0.15399 |
| 1997 | 0.07733 | 0.15510 |
| 1998 | 0.08109 | 0.15600 |

**Table 8 – Equivalence of the levels of Schooling between the two types of series**

| Series Hr and Hrl | Seres HS |
|---|---|
| 0 | 0 + *nf* + pi |
| 1 | 1 |
| 2 | 2 |
| 3 | 3 |
| 4 | 4 + 5 |
| 5 | 6 + "bacharelato" |
| 6 | 7 - "bacharelato" |