MATH2005 Econometrics Coursework – Cross section

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Module Taught in Semester 1, Academic Year 2019/20

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I. ABSTRACT (131 WORDS)

Capital is a key element that has always been studied for economic growth. However, the capital does not only refer to the machinery, tools and equipment: workers have also a significant impact on the production of wealth. They receive earnings, which are determined by different factors. These factors are explained through the Human Capital Theory. Education, experience and health care are the main parts of this theory, but we can observe some gap in earnings that are not related to the skills of the workers. By using the working individuals' wages data collected in the UK at the beginning of 2019, this paper tempts to put in evidence the importance of Human Capital in the determinants of wages, but also the persistent disadvantages that can encounter women in the labour market.

II. INTRODUCTION (122 WORDS)

The idea of the "human capital" arose a half-century ago with a related theory developed by famous economists such as J. Mincer, TW. Schultz or G. Becker. Hence, the Human Capital Theory aims to characterize each individual in terms of productivity. By itself, it covers a huge part of all wage's

difference within countries. Thus, we are going to run an empirical study on the differences seen among workers' earnings. This study pursues the goal to compare raw data with theoretical assumptions. First, a literature review is required to introduce the main concepts of the Human Capital Theory. A presentation of the data and the methodology used will follow the summarizing theory part. A conclusion and several recommendations will end this paper.

III. LITERATURE REVIEW (796 WORDS)

The existing literature on the Human Capital Theory has specified several determinants as an explanation of the differences in earnings. Firstly, Adam Smith (1776) is known as the first to link the skills of the worker with higher wages [1]. He and more generally the classical economists considered a "natural wage" which corresponded to a wage paid to 'common labourers' with no skills. However, what is called Human Capital has known its beginnings in the early 1970s thanks to the contributions of Ted Schultz, Jacob Mincer and more.

Theodore W. Schultz (1982) had a similar idea as A. Smith. He considered "normal wages" that increase at the same time as the worker gain skills, i.e. if a worker is more skilled than another worker, he or she gets wage supplements in addition to the normal wage. Schultz qualified the hourly pay as 'the price of human time'. In one of his books [3], he compared the pay gaps in 1900 and 1970 between unskilled workers and skilled workers such as manufacturing workers, teachers and associate professors. These data highlight a larger gap in favor of associate professors, which are, the more qualified within the three groups. Besides, this difference increases considerably between those two years. Indeed, in 1900 a manufacturing worker gained 0.02 dollars more than an unskilled worker while in 1970 this gap increased at 0.79 dollars. The same statement is noticed for the two other groups. Overall, this shows that the workers' skills got more valuable over time. The aim of Schultz's study was to demonstrate the growing importance of human capital investment, especially in education, and its link with the workers' earnings nowadays.

Human capital investment can be viewed as expenditures of resources of time, money, and effort (education, training, health, etc.) that tend to raise an individual's earning capacity, according to J. Mincer (1974) [2]. Education is one of the most important investment in human capital. A more recent economist, G. Becker (1994) [5], stressed that, despite of the costs of schooling, high school and college education raise a person's income. In the 1960s [4], college graduates earned about 60 percent more than high school graduates. It knew a fall during the next decade, but in 1997 this percentage rose to 75 percent. This is explained by the fact that education tends to increase productivity and hence

increase wages. Moreover, Mincer highlighted the changeability of the earnings over the worker's life cycle. Indeed, the "skill level" of an individual raise over time, so do one's wage. The age of a worker is consequently an important determinant of wages because it is a good representation of the experience gained. Finally, Becker stresses that a healthy and well-educated country is more propitious to a higher average wage [4]. He considers that investment in health care is also very important for Human Capital growth. Indeed, a good health care system or a high population's life expectancy in a country is favourable for the human capital growth and implicitly for the GDP rate.

Pay differences are not only related to skills. JS. Pischke, a German economist, puts in evidence exceptions inside the Human Capital Theory. Indeed, he mentioned in a paper last year [6] three different cases where wage differences are not explained by the differences in skills. Among them, discrimination on gender must not be ignored despite over twenty years of equal pay legislation (European Commission website). Women can face direct and indirect discrimination and systematic disadvantage in acquiring human capital [7]. Mincer pointed out in 1966 relative wage differential between men and women of the same age [2] which was close to 40% between husbands and wives, and over 10% among men and single women. These differences in wage levels were mainly due to the difference of work experience. However, these significant differences are also due to discrimination. Indeed, women are often segregated into lower paid jobs through discrimination, or are discriminated against higher paid jobs in terms of promotion [9]. A very small percentage of women are part of senior jobs.

In a more recent research, Becker [5] emphasized an important labour force change during the end of the twentieth century. Henceforth, women seem to increase their value in the labour market and tend to choose more qualified jobs. The trend in women's education is consequently disrupted. So, is the gender pay gap still an issue nowadays? It is well known that this phenomenon is not completely erased. The European Commission highlighted last year that, in the UE, women earn over 16% less than men per hour. Plus, for a same full-time or part-time job (highly-qualified or not), women tend to earn less per hour than men [8]. That is what we are going to focus on in this paper: gender pay inequality.

IV. THEORY SECTION / CONCEPTUAL MODEL (173 WORDS)

As seen in the preceding section, Human Capital Theory is essential to help us understand the determination of hourly pays. Education of workers, their age, their experience and even their health are keys to determine their earnings. In our studied model, we are going to pay attention on all these

factors, but we will focus on gender gaps. The distinction between human capital and discrimination is overdrawn, so we want to clarify through the UK data if there is a real and significant gap between the two sexes. Labour market segregation is a point that we need to consider carefully because it is a phenomenon that we must differentiate from discrimination. It is acknowledged that, despite of the recent ameliorations highlighted by Becker, women are often crowded in low-paid and part-time jobs, close to minimum wages. We will include some specific independent variables, that we will see in the next part, to delete some bias that could wrong the results, and in order to only focus on the 'unequal' differences in gender pay.

V. METHODOLOGY AND DATA (302 WORDS)

The studied data is coming from the *Labour Force Survey* and cover 9,600 working individuals aged 16 plus living in the UK. There were collected between January and March 2019. These data give us an average wage of 15.28 pounds and a mean age of the respondents of 42 years old. We decided to take the logarithm of the hourly pay dependent variable in order to get our output in percent units, through the software GRETL.

To compute an Ordinary Least Square model, we needed to recode some of the variables into 0-1 dummies (DUMMY_HEALTH, SEX, DUMMY_MARSTA, FTPTWK, EVEROT). In the case of education, which is a multicategory variable, we had to separate each qualification in different dummies (see the table page 5). We only kept four out of five of them.

Following the elements stressed at the end of the theory part, 'part-time or full-time job' and 'ever work over time' variables aim to bypass a part of the pronounced differences in wage levels. The 'London' variable is going to be part of our model too. In fact, London is synonym to higher wages and can bias the results, so it is relevant to include it. We need to compute variables that will aim to identify differences between male and female, such as the evolution of earnings when a male worker gets older in contrast to a female worker (FEMALE_AGE). We would also like to compare the earnings of men and women that work in part-time jobs. Finally, we will seek the differences between married women and men, in order to compare with Mincer's findings.

Thus, two models are studied in this paper. One includes the main parts of the Human Capital Theory, and the other adds all the specific variables (some to remove bias, the other related to female workers).

Concept	*Variable*	*Hypothesis*	*Literature*
Demographics	**Sex** SEX: MALE = 0, FEMALE = 1	Men are more likely to earn more than women per hour	Mincer (1974) Olsen and Walby (2004) Pischke (2019) European Commission (2019)
	London LONDON = 1, other = 0	Average wage in London is higher than other cities / counties	
Human Capital	**Experience** AGE FEMALE_AGE =SEX*AGE EVEROT: ever work over time (yes) = 1, no = 0	Experienced workers are more likely to have a higher wage Female wages do no evolve as rapidly as male wages through time	Becker (2019 and 1994) Mincer (1974) Pischke (2019)
	Type of job FTPTWK: full-time = 0, part-time = 1 FEMALE_FTPTWK = SEX*FTPTWK	Female workers earn on average less in a part-time job	European Commission (2019)
	Education HIGHER_EDUCATION =1, other = 0 A_LEVEL = 1, other = 0 GCSE = 1, other = 0 OTHER_QUAL = 1, other = 0	The more a worker is educated, the more he or she would earn	Smith (1776) Schultz (1982) Mincer (1974) Becker (1994)

	Health DUMMY_HEALTH: Health limits activity = 1, it does not = 0	Health issues lead to lower wages	Becker (2019 and 1994)
Family	**Marital status** MARSTA: married or ever married = 1, single = 0	Married men are more paid than married women	Mincer (1974)

VI. RESULTS (504 WORDS)

1.1 FIRST MODEL

First of all, it is important to specify that our model passes the RESET test. The null hypothesis that the specification is adequate is not rejected at 5% and even at 10% significance, because the p-value given by the test is greater than 0.05 (see the table).

This first model is simple and contains the main assumptions of the Human Capital Theory (education, experience given by age, health). The SEX variable has been added to have a first point of view.

The importance of the experience is noticeable in the model, but very low. Indeed, when a worker's age raises of 1%, his or her wage also increases by 1%. Nevertheless, being qualified is a key point in the earnings' determination and is highly significant at the 1% level: a worker who owns a degree earns 72% more than a worker with no qualifications, which is consistent with the observations of Mincer in 1974. Qualifications such as A-Levels or GCSE have an impact on earnings, but not as significant as a degree. This means that the more a worker is qualified, the more his or her wage would be high. Our model is consequently consistent with the literature review and shows the importance of skills in the determination of wages.

Finally, being a woman seems to be a real disadvantage. Effectively, on average a woman earns 20% less than a man. Bad health has also a negative impact on earnings, as expected.

1.2 SECOND MODEL

Our results are a little bit surprising. Actually, probably because of the numerous of variables and the collinearity between them, the variable 'SEX' has this time a positive coefficient, with a p-value significant at the 5% level. Omitted variable bias in the first model also led to overestimate or underestimate some of the coefficients.Indeed, the first model is poor in variables, so the effects of the missing variables are concentrated in the actual ones and bias the results/coefficients.

We tried to add dummies such as differences between female that owns a degree and a male that owns a degree, but the computation turned out that it was not significant enough to include them in our model.

The data show some differences within gender that are statistically significant. Our slope dummies related to female workers, which are 'FEMALE_AGE', 'FEMALE_MARSTA' and 'FEMALE_FTPTWK', have

all negative coefficients, consistent with expectations. A married man earns 13% more than a single worker, but a married woman earns only 6.8% (12.9-6.16) more than a single worker. While a man sees his wage increases by nearly 5% when his age rises by 1%, a woman sees her wage increasing only by 3.8% when she gets older by 1%. This shows that an experienced woman worths less than an experienced man. Thus, there is a growing gap between male and female wages.

Finally, a difference between men and women with a part-time job is apparent, like the European Commission assesses. Actually, a female with a part-time job earns on average 9% less than a man with a part-time job.

Dependent Variable: log hourly pay		
Equations:	**1**	**2**
Constant	1.825 ***(64.25) ******	0.831 ***(12.48) ******
Demographics		
Sex	-0.201 ***(-21.57) ******	0.222 ***(2.491) *****
London	… …	0.2625 ***(18.37) ******
Human Capital		
Age / Experience	0.010 ***(28.37) ******	0.050 ***(14.64) ******
Age / Experience for a woman	… …	-0.12 ***(-2.502) *****
Ever work over time	… …	0.066 ***(7.281) ******
Part-time job	… …	0.213 ***(9.449) ******
Part-time job for a woman	… …	-0.090 ***(-3.513) ******
Degree	0.722 ***(31.41) ******	0.587 ***(26.65) ******
A Levels	0.357 ***(15.41) ******	0.292 ***(13.35) ******
GCSE	0.223 ***(9.034) ******	0.182 ***(8.064) ******
Other qualifications	0.180 ***(6.569) ******	0.107 ***(4.133) ******
Health	-0.115 ***(-8.834) ******	-0.092 ***(-7.539) ******
Family		
Marital status for a man	… …	0.130 ***(8.121) ******
Marital status for a woman	… …	-0.062 ***(-2.823) ******

Squared variables		
Squared age	… …	-0.0005 ***(-12.38) ******
Squared female age	… …	0.0001 ***(2.259) *****
R-squared	0.27	0.36
P(R-sq=0)	0.000	0.000
Normality p-value	0.000	0.000
RESET p-value	0.426	0.000
Figures in brackets are heteroscedastic robust t-statistics (application of robust standard errors) *** significant at the 5% level* **** significant at the 1 % level*		

<u>Note:</u> Notice that the models fail both the normality test. It is not an issue because the data set used is big (9,600 observations), so the consequences for our statistical tests are mild and our t-tests are valid. Furthermore, the RESET test still fails for the model 2, despite of the added squared values of AGE and FEMALE_AGE. We tried to add other non-linear terms with no success. This is due to multicollinearity, which occurs when explanatory variables are highly correlated.

VII. CONCLUSIONS AND RECOMMENDATIONS (410 WORDS)

As a result, modern economists such as Becker or Mincer seem to agree that education, experience and health care are the main aspects to improve the human capital, increase the economic outputs and boost the wages. Human Capital Development Theory aims to link the investment in the skills of workers with a greater production of economic outputs and the determination of their wages. Productive workers will receive larger earnings. The results from our study confirmed these assumptions, particularly in education, which turned out an important factor of the wage's determination. A degree is more valuable than any other qualification to increase earnings. Moreover, the hourly pay in our model is a function of age and increase as long as the worker gets older and becomes more experienced.

Unfortunately, gaps occur in wage determination. A part of the population knows unequal differentiations that are not related directly to the difference of skills. Indeed, women tend to earn less than men, on average. As she gets older, a female worker will see her wage increases less quickly than a male worker (see Model 2). The European Commission even assesses that, 'the older you are, the bigger the gap'. A high pay gap within a country is most of the time explained by a labour market in which women are segregated in a restricted number of sectors, but it can also be explained by discrimination, even if it is illegal in the UE. Besides, women tend to take more career breaks (e.g. maternity leave), and thus their gains in experience is delayed. That is why the EU has created the Work-Life balance Directive, which encourages a more equal sharing of childcare responsibilities in a family. All the factors listed above lead to fewer wages for women [8]. Then, gender policies encouragement, increasing public awareness and evolution of mindset are necessary to narrow the existing gap in gender pay.

Ultimately, the Human Capital Theory in wage determination can be completed by the knowledge of the Market Theory of Wage Determination. This theory believes that, in a perfectly competitive labour market, earnings are the result of a process between supply and demand. The number of jobs and workers, the location of the jobs and even the skills involved are the keys to determine earnings. This implies that the price of labor is determined such like every other price in a free market : equilibrium wage rate corresponds to the intersection of supply and demand [9].

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IX. APPENDIX:

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Model 1: OLS, using observations 1-9663
Dependent variable: l_HOURPAY

                coefficient   std. error    t-ratio    p-value
  ------------------------------------------------------------
  const          1.82493      0.0284028     64.25     0.0000    ***
  AGE            0.0103368    0.000364406   28.37     4.36e-170 ***
  SEX           -0.200537     0.00929776   -21.57     8.32e-101 ***
  DEGREE         0.722472     0.0230035     31.41     3.02e-206 ***
  A_LEVELS       0.356558     0.0231346     15.41     5.76e-053 ***
  GCSE           0.223173     0.0239880      9.304    1.65e-020 ***
  OTHER_QUAL     0.180396     0.0274635      6.569    5.34e-011 ***
  DUMMY_HEALTH  -0.114554     0.0129678     -8.834    1.19e-018 ***

Mean dependent var   2.572755   S.D. dependent var   0.532129
Sum squared resid    1992.601   S.E. of regression   0.454291
R-squared            0.271684   Adjusted R-squared   0.271156
F(7, 9655)           514.5143   P-value(F)           0.000000
Log-likelihood      -6082.926   Akaike criterion     12181.85
Schwarz criterion    12239.26   Hannan-Quinn         12201.32

Log-likelihood for HOURPAY = -30943.5

RESET test for specification (squares only) -
  Null hypothesis: specification is adequate
  Test statistic: F(1, 9654) = 0.634354
  with p-value = P(F(1, 9654) > 0.634354) = 0.425782

Test for normality of residual -
  Null hypothesis: error is normally distributed
  Test statistic: Chi-square(2) = 421.734
  with p-value = 2.64059e-092
```

Model 1 : first output from GRETL, with the related tests

```
Dependent variable: l_HOURPAY

                 coefficient    std. error    t-ratio    p-value
  ------------------------------------------------------------------
  const            0.830669     0.0665668     12.48     1.83e-035 ***
  AGE              0.0499734    0.00341316    14.64     5.00e-048 ***
  EVEROT           0.0664830    0.00913066     7.281    3.56e-013 ***
  FTPTWK           0.213111     0.0225538      9.449    4.22e-021 ***
  DEGREE           0.587084     0.0220328     26.65     5.33e-151 ***
  A_LEVELS         0.291981     0.0218677     13.35     2.62e-040 ***
  GCSE             0.182251     0.0226006      8.064    8.26e-016 ***
  OTHER_QUAL       0.107029     0.0258961      4.133    3.61e-05  ***
  LONDON           0.261625     0.0142400     18.37     3.98e-074 ***
  DUMMY_HEALTH    -0.0921424    0.0122219     -7.539    5.16e-014 ***
  SEX              0.221514     0.0889143      2.491    0.0127    **
  FEMALE_AGE      -0.0116218    0.00464446    -2.502    0.0124    **
  FEMALE_FTPTWK   -0.0903714    0.0257221     -3.513    0.0004    ***
  DUMMY_MARSTA     0.129733     0.0159754      8.121    5.20e-016 ***
  FEMALE_MARSTA   -0.0616140    0.0218242     -2.823    0.0048    ***
  sq_AGE          -0.000477422  3.85602e-05  -12.38     6.08e-035 ***
  sq_FEMALE_AGE    0.000119329  5.28247e-05    2.259    0.0239    **

Mean dependent var   2.572755   S.D. dependent var   0.532129
Sum squared resid    1757.027   S.E. of regression   0.426791
R-squared            0.357788   Adjusted R-squared   0.356723
F(16, 9646)          335.8730   P-value(F)           0.000000
Log-likelihood      -5475.038   Akaike criterion     10984.08
Schwarz criterion    11106.07   Hannan-Quinn         11025.44

Log-likelihood for HOURPAY = -30335.6

RESET test for specification (squares only) -
  Null hypothesis: specification is adequate
  Test statistic: F(1, 9645) = 42.9332
  with p-value = P(F(1, 9645) > 42.9332) = 5.95367e-011

Test for normality of residual -
  Null hypothesis: error is normally distributed
  Test statistic: Chi-square(2) = 663.702
  with p-value = 7.56823e-145
```

Model 2 : second output, with the related tests