Universidad del País Vasco/Euskal Herriko Unibertsitatea

Departamento de Fundamentos del Análisis Económico II

2007/2008

A Macroeconomic Assessment of the Gender Wage Gap Effect: The Case of Spain

A Master Thesis

Submitted for the Degree

MASTER IN ECONOMICS: EMPIRICAL APPLICATIONS AND POLICIES

By

Luis Pinedo Caro

Supervisors: Amaia Iza Padilla & Virginia Sánchez Marcos

Bilbao, Spain

A Macroeconomic Assessment of the Gender Wage Gap Effect:

The Case of Spain

Luis Pinedo Caro[1]

Supervisors: -Amaia Iza Padilla

-Virginia Sánchez Marcos

Departamento de Fundamentos del Análisis Económico II

Universidad del País Vasco

Abstract: In this paper we examine the output cost that Spain might be suffering due to the difference in earnings between men and women not explained by differences in their characteristics. To that end we use an overlapping generations model where two differences between genders are allowed: on the one hand females are discriminated against as regards their male counterparts and on the other hand males are better able to perform physical tasks. A baseline economy is calibrated to mimic some features of the Spanish economy, in particular the gender wage gap. Finally we find that if gender discrimination were eliminated from the baseline economy, GDP per capita would increase by 17%.

J.E.L. classification: J-17, J-13, O-52

Keywords: gender wage gap, output cost.

[1] E-mail: bizantino2@hotmail.com

1-Introduction

Gender discrimination[2] is fortunately now seen as something socially reprehensible and indeed old-fashioned, though nobody seems to care about the shaded cost that is entailed by such behavior against half of our population. In this paper we undertake an exercise similar to that of Cavalcanti and Tavares (2006) seeking to measure the cost in terms of output that arises from the existence of gender discrimination in the Spanish labor market.

The twentieth century saw a positive change towards equity in the relative wages of women but major efforts are still needed to overcome the remaining discrimination since, according to Lago(2002), women's wages in Spain in 1996 were 75% of men's wages. Research by Ugidos (1997) put the gender wage gap not due to differences in characteristics at 18%.

Active policies to work towards the goal of equality are being pursued by the government and in fact the gender wage gap has tended to decrease[3] year by year. This could be due to a decrease in gender discrimination or to different trends in female and male wages due to differences in occupations or employees characteristics[4].

This paper has two objectives: 1) to build a baseline economy for Spain in order to obtain an estimation of gender wage discrimination and 2) to evaluate the cost in terms of per capita GDP of a reduction in the level of gender wage discrimination in the baseline economy. As in Cavalcanti and Tavares (2006) I measure the cost in terms of GDP for the Spanish economy of reducing gender wage discrimination.

The paper is organized as follows: Section Two develops the economy formed by an OLG model and explains its main characteristics. Section Three calibrates the economy to mimic some Spanish statistics. Section Four presents some numerical experiments and Section Five explains our conclusions and summarizes the relevant research. Two explanatory appendices are included at the end of the paper.

[2] Differences in wage per hour between men and women that are not explained by differences in their characteristics.

[3] INE, Encuesta de Salarios en la Industria y los Servicios.["Survey of Salaries in Industry and Services"].

[4] E.g. a relative increase in female labor market experience.

2-The model

The main characteristics of the model are as follows. This model is taken entirely from Cavalcanti and Tavares (2007) who in turn took it in part from Galor and Weil (1996) though they introduced some innovations with respect to the objective functions.

Basically we are working with an overlapping generations model where agents live for three periods. In the first one they are children and consume a fixed amount of their parents' time endowment. In the second period when they grow up, they are organized in couples and make decisions concerning time worked, time devoted to their children and savings for the future. Finally in the third period the agents (still as couples) consume what they saved in period two.

The model considers that men perform physical tasks better than women. In fact in this setting this idea is taken to the extreme and it is considered that only men are able to offer physical labor (i.e. women have no strength at all).

A) Production sector:

In this economy a single good, which can be consumed or saved, is produced by an indeterminate number of competitive firms, using a constant return to scale technology as follows:

$$Y_t = K_t^{\alpha}(A_t L_t^m)^{1-\alpha} + BA_t L_t^p \qquad (1)$$

Firms in this economy use two kinds of labor. We call these labor inputs "physical labor" and "mental labor". In order to introduce gender wage discrimination it is assumed that women only receive a percentage ϕ<1 of the salary paid to men. This can be understood as a tax on the female labor supply. These characteristics are included firstly to simulate the level of exogenous gender discrimination that leads the economy to an inefficient state, and secondly a progressive reduction in the gender wage gap as long as the economy accumulates capital because men's salary comes from physical labor, which does not interact with capital. A denotes the total factor productivity, $A_t = (1+\mu)^t$ and B is a constant $B \geq 0$.

Finally the first order conditions are:

$$w_t^p = A_t B \qquad (2)$$
$$w_t^m = (1-\alpha)K_t^{\alpha}(A_t L_t^m)^{-\alpha} A_t \qquad (3)$$
$$r_t^k = \alpha K_t^{\alpha-1}(A_t L_t^m)^{1-\alpha} \qquad (4)$$

Therefore, the wage rate per unit of physical labor does not depend on physical capital, but the wage rate per unit of mental labor does. This means that as the physical capital in the economy grows, the wage rate per unit of mental labor increases at a higher rate than the wage rate per unit of physical labor. Since women provide only mental labor whereas men provide both types of labor, the gender wage gap during the transition to

the steady state will be decreasing (due to technological reasons, therefore, in the absence of discrimination).

B) Households problem:

$$U_t = \ln(c_t) + \beta\ln(c_{t+1}) + \gamma \ln(n_t)\,, \beta, \gamma \,\epsilon(0,1).$$

As soon as agents grow up[5], i.e. start the second period, they are organized in couples, so the function written above is faced by every couple during the second period of their lives. Households value their consumption profile and the number of children that they will have.

The household's constraints are the following:

1. The first period budget constraint of each household:

$$c_t + s_t = w_t^p + w_t^m + (1 - h_t)\phi w_t^m$$

2. The second period budget constraint of each household:

$$c_{t+1} = (1 + r)s_t$$

3. And the women's time constraint in terms of the childcare cost of having children.

$$h_t = \frac{n_t}{D}$$

where h denotes the cost in terms of time of having children.

The Lagrange problem of households can be written as:

$$L(c_t, c_{t+1}, n_t; \lambda) =$$

$$lnc_t + \beta lnc_{t+1} + \gamma \ln n_t - \lambda(c_t + \frac{c_{t+1}}{(1+r)} - w_t^p - w_t^m - \left(1 - \frac{n_t}{D}\right)\phi w_t^m$$

We obtain the first order conditions as follows:

$$\frac{\mathrm{dL}}{dc_t} = \frac{1}{c_t} - \lambda = 0 \qquad (5)$$

$$\frac{dL}{dc_{t+1}} = \frac{\beta}{c_{t+1}} - \frac{\lambda}{1+r} = 0 \qquad (6)$$

$$\frac{dL}{dn_t} = \frac{\gamma}{n_t} - \frac{\lambda\phi w_t^m}{D} = 0 \qquad (7)$$

$$\frac{dL}{d\lambda} = c_t + \frac{c_{t+1}}{1+r} - w_t^p - w_t^m - \left(1 - \frac{n_t}{D}\right)\phi w_t^m = 0 \qquad (8)$$

[5] Agents live for three periods: in the first they are children and consume time from their mothers while in the second and third periods they are organized as couples.

C) Finally, we have to keep in mind that all markets must be in equilibrium so we have to add them in order to obtain the endogenous prices that will ensure this:

-Labor market:

$$L_t^m = L_t^p + L_t^p(1 - \frac{n_t}{D})$$

$$L_t^m = L_t^p(2 - \frac{n_t}{D}) \quad (9)$$

Such that the amount of mental labor demanded by firms equals the number of households times the time supplied by each household in mental labor.

-Capital market:

$$K_{t+1} = L_t^p s_t \quad (10)$$

Young couples' savings determine the next period's stock of capital.

-Goods market:

$$c_t L_t^p + c_{t+1} L_{t-1}^p + K_{t+1} - (1-\delta)K_t + (1-\phi)(1-h_t)w_t^l L_t^p = Y_t \quad (11)$$

Aggregate consumption plus gross investment plus government consumption must equal GDP. We assume that the amount of the good not received by women due to the wage discrimination that they face is consumed by the government.

In other words, we end up with eleven equations for eleven variables of the model, $c_t, c_{t+1}, n_t, \lambda, w_t^p, w_t^m, r_t^k, K_t, L_t^p\ Y_t\ and\ L_t^m$.

D) In order to solve this model analytically, we write all aggregate and individual variables in terms of efficiency couple. First of all let us define $\widehat{k_t} = \frac{K_t}{A_t L_t^p}$ (*) as the capital level per unit of efficiency couple. Next we can arrange an expression for solving h_t using equations (2),(3),(5),(6),(7) and (8). Firstly we use the households first order conditions in order to obtain an expression relating h_t with the model parameters and wages. By rearranging equations (5),(6) and (7) we obtain solutions for $c_t$and c_{t+1} depending on $h_t$and other parameters.

$$c_t = \frac{h_t \phi w_t^m}{\gamma} \text{ and } c_{t+1} = \frac{h_t \phi w_t^m (1+r^k)\beta}{\gamma}$$

Then by plugging them into (8) we obtain

$$h_t\left(\frac{1}{\gamma} + \frac{\beta}{\gamma} + 1\right) = \frac{w_t^p}{w_t^m \phi} + \frac{1}{\phi} + 1$$

Where we assume that h_t<1, and if $h_t < 1$ only women provide home activities[6]. Finally, after some algebra we obtain

$$h_t = \frac{\gamma}{1+\beta+\gamma}\left(\frac{w_t^p}{w_t^m \phi} + \frac{1+\phi}{\phi}\right) \quad (12)$$

Now by plugging (2) and (3) into (12) we find

$$h_t = \frac{\gamma}{1+\beta+\gamma}\left(\frac{A_t B}{\phi(1-\alpha)K_t^{\alpha}(A_t L_t^m)^{-\alpha} A_t} + \frac{1+\phi}{\phi}\right)$$

and, taking into account (*) and (9) we get:

$$h_t = \frac{\gamma}{1+\beta+\gamma}\left(\frac{B}{\phi(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}} + \frac{1+\phi}{\phi}\right). \quad (13)$$

This is an equation that determines h_t as an implicit function of $\hat{k}_t$. It should be noted that as long as capital increases[7] time devoted to children diminishes because they have fewer children and therefore women supply more labor to the market.

We can also rearrange equations (5),(6),(7) and (8) in order to obtain the expression for the endogenous savings:

Plug $h_t = \frac{s_t \gamma}{\beta \phi w_t^m}$ and $c_t = \frac{s_t}{\beta}$ in (8)

and we obtain

$$s_t\left(\frac{1}{\beta} + 1 + \frac{\gamma}{\beta}\right) = w_t^p + (1+\phi)w_t^m$$

and again, after some algebra we get

$$s_t = \left(\frac{\beta}{1+\beta+\gamma}\right)\left[w_t^p + (1+\phi)w_t^m\right] \quad (14)$$

The next step is to get an equation relating $\hat{k}_t$and $\hat{k}_{t+1}$. We are going to use (10), (13), (14) and (*). From (10) we have that $K_{t+1} = L_t^p s_t$, entering (*) in (10) we get $\hat{k}_{t+1} = \frac{s_t}{(1+\mu)A_t n_t}$. Now remember that $n_t = D h_t$ and use (13) and (14) in order to obtain a law of motion[8] of the economy that depends on the current level of capital per unit of efficiency couple, the model parameters and the time spent in raising children.

$$\hat{k}_{t+1} = \frac{\beta}{D\gamma(1+\mu)}\phi(1-\alpha)\hat{k}_t(2-h_t)^{-\alpha} \quad (15)$$

Once the current value of the capital per unit of efficiency couple is obtained, the rest of the endogenous variables of the economy can be calculated.

[6] See Appendix B, where the model is completely developed.

[7] See proof in Appendix B.

[8] Here I show only the results for the case in which women devote some time to work. The shape of the solution is different when women do not work at all. Although, due to the parameter values, we are going to remain in the current caseI offer the complete development of this solution in Appendix B.

3-Calibration

The strategy followed for calibration here differs from the one used by Cavalcanti and Tavares (2007). In this calibration we select one period of time of the Spanish economy, from which we take some statistics (explained below) to be matched with the steady states values of the baseline economy. The mapping between parameter values and targets in the data is multidimensional and we thus solve the parameter values jointly. For expositional reasons, we describe the role of each parameter on a specific target as if the parameter has a first-order impact in the target.

Table.1: Endogenously determined parameters

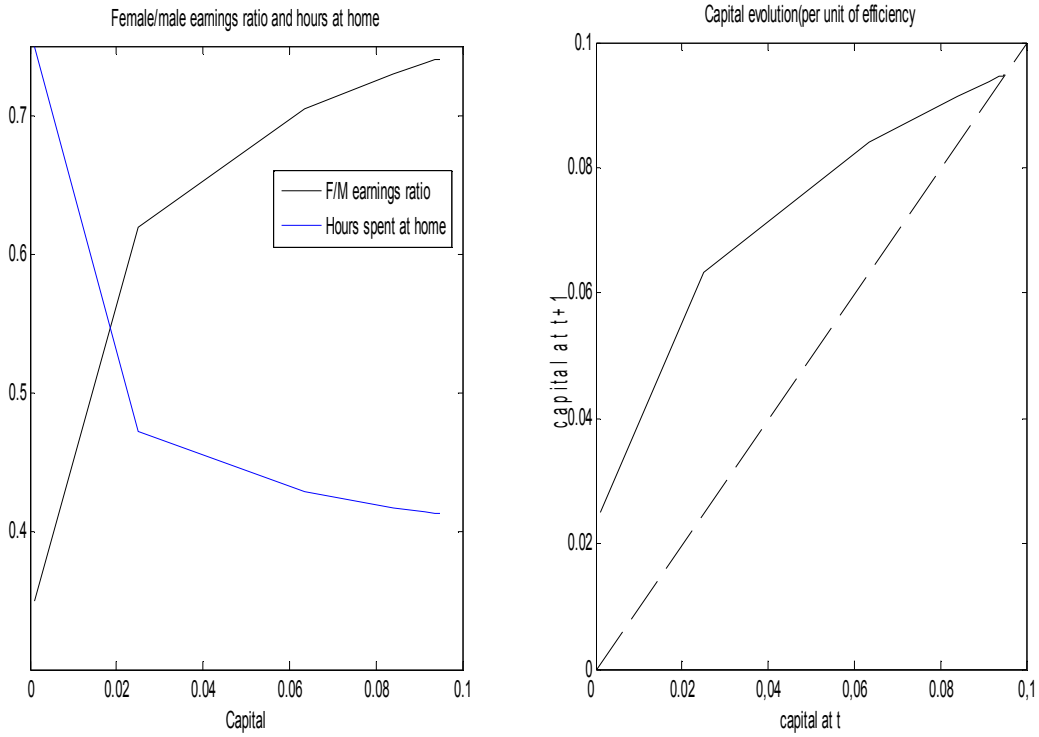
	Value	Target	Data	Model
β	0.36	Annual return on Spanish government bonds	4.25%	4.7%
γ	0.173	Population growth is constant in the steady state		
B	0.189	Spanish high skilled to low skilled earnings ratio (2000)	66.84%	65.85%
D	2.40	Spanish female to male hours worked ratio (2000)	58.29%	58.33%
ϕ	0.616	Spanish female to male earnings ratio (2000)	74.87%	74.28%

Table.2: Exogenously determined parameters

	Value	Source
α	0.31	Conesa-Kehoe (2004)
μ	0.64	Rate of TFP growth based on Conesa-Kehoe (2004)

There are up to seven parameters of the model that need to be properly calibrated $\alpha, \mu, \beta, \gamma, D, B \; and \; \phi$. Parameter α is taken from Conesa and Kehoe (2004)[9], as is the rate of TFP growth. The latter is chosen such that the annual growth rate of per capita GDP is about 2%, but as agents live in periods of 25 years the rate of TFP growth is rearranged to cover such periods[10]. On the other hand β is calibrated in order to match the return of government bonds at 4.25%[11], resulting in a 4.7% return in the model. In order to match Spanish statistics, the steady state values of the model are used.

Figure.1: Baseline economy evolution.



The parameters (ϕ, D, B) of the model are chosen in order to obtain three Spanish statistics. (i)The ratio between the hourly wages of males and females[12]. Data issues concerning the methodology are fully explained in Appendix A. As a summary, the average hourly earnings comes from averaging male/female hourly earnings from the

[9] This value cannot reasonably be taken from another paper as it must be determined so that the model resembles the ratio of capital income to GDP that we observe in the data. If I do so, then the values of the remaining parameters are altered as follows: ϕ decreases to 0.4 when maintaining the female to male earnings ratio while the ratio of skilled/low skilled earnings falls to only 8%. This means that the implied gender wage discrimination is much higher under this strategy. The reason why this model requires such a high gender wage discrimination is that female wages are overestimated in the model related to those of males, as females can only provide mental work(i.e. qualified labor).

[10] Note that if 2% is the annual figure, then $(1 + 0.02)^{25} - 1 = 0.64$ is the correct 25 year measure.

[11] Ley de Presupuestos Generales del Estado["General State Budget Act"] of 1999.

[12] The reader should note that, as the model's male time endowment consists of 2 units of time while women have only 1, male earnings are divided by two to obtain the hourly mean.

CNAE-93 divisions. (ii) The ratio between the wage for physical labor per unit of time and the wage for mental labor per unit of time. I compare the latter ratio with its counterpart in the Spanish economy formed by the ratio between low and high skilled workers. Here I also use the CNAE-93 divisions, distinguishing between divisions in which most workers belong to either the low or the high skilled workforce. (iii)Finally the third statistic is based on the relative hours worked by men compared to women[13].

The left-hand figure above shows the trends in time devoted to child care by women and the female/male earnings ratio as long as the economy accumulates capital. It is remarkable, though completely logical, how the ratio tends to increase its value (i.e. decrease the gender wage gap) while women spend less time at home as the economy develops and accumulates capital, as occurred in Spain at the end of the 20th century. The right-hand figure proves the convergence of the model to a steady state reached when the solid line meets the broken line.

Figure.2: Baseline economy hourly wages.

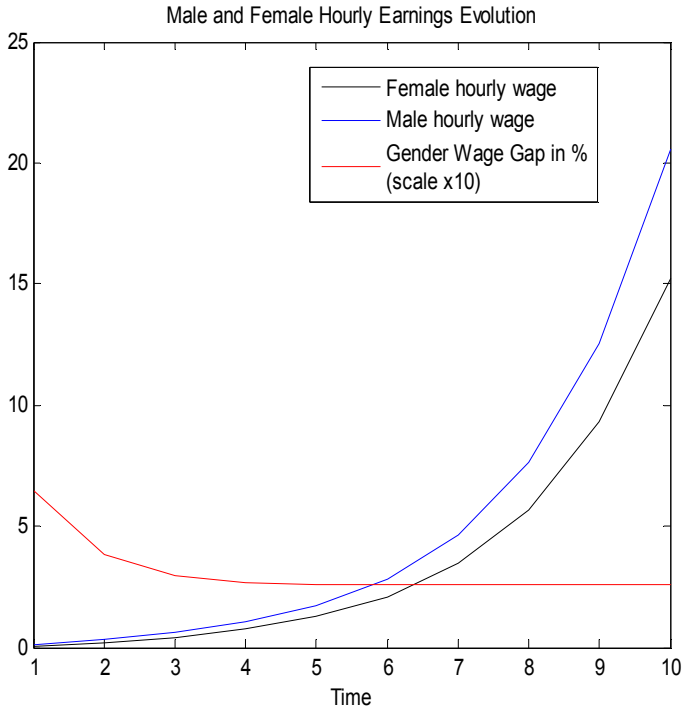


Figure 2 confirms the above graphs, and shows that the gender wage gap decreases as long as the relative difference between hourly wages diminishes. In fact that is what happened in Spain. The hourly gender wage gap decreased from 27.5% to 25.14% in the period[14] 1991-2000[15].

[13] I use the average female/male hours worked by those people who belong to the active population, that is, only women/men aged between 16 and 64.

[14] Although we found data on male and female earnings from 1963, the incompleteness of the information meant that it was unreliable and not comparable with the 1991-2000 period, so long run assessments must be postponed until a new source is found or the current ones achieve an optimal length.

[15] INE, Encuesta de salarios en la Industria y los servicios.

4-Results

In this section we conduct a numerical analysis to evaluate the gain in terms of output per capita that results from reducing gender wage discrimination. Basically in our new economy ϕ is raised (i.e. gender wage discrimination is decreased) to different levels in order to measure its cost in output per capita[16]. It is important to know that our baseline economy has a certain level of wage discrimination against women[17] which is progressively reduced in order to learn how much better the new economy performs compared to the baseline in terms of GDP per capita and how they differ in terms of the time spent by women in the labor market. For comparison purposes I carried out four experiments consisting of a reduction of gender wage discrimination of 25%, 50%, 75% and 100% (i.e. there is no gender discrimination in the economy). Full results are provided in Table 3 along with the percentage differences between the set of economies.

Table.3:

Measurement % Reduction in the discrimination level	ϕ **level**	**GDP pc**	**GDPpc % gain from baseline**	**Ratio hours worked** $1-h_t$	**Ratio hours worked % gain from baseline**
Baseline	0.616	12.12	Not applicable	0.594	Not applicable
25%	0.712	12.85	6.02%	0.629	5.89%
50%	0.808	13.43	10.8%	0.664	11.78%
75%	0.904	13.89	14.6%	0.691	16.33%
100%	1.000	14.26	17.6%	0.712	19.86%

As long as ϕ increases (gender discrimination decreases) GDP per capita rises. This comes about through two channels. On the one hand output per capita increases because women work more time ($h_t$decreases) so GDP obviously becomes higher, while the population remains constant. On the other hand it is not true that population of the economy remains constant, in fact it decreases because the opportunity cost of having children increases when wage discrimination against women disappears and $n_t$will therefore be lower. The underlying idea in the above arguments is the following: When women are better paid couples achieve (relatively) more utility from consumption than from children so women spend more time working and consequently have fewer children.

[16] Output per capita is measured as follows: $y_t = \frac{Y_t}{n_t L_t^p + L_t^p + {L_t^p}/{n_{t-1}}}$.Where we can find the total output divided by the young people, the workforce and the retired.

[17] Properly speaking $\phi = 0.616$ which means women earn 38.4% less than men (per hour).

From the results in Table Three the male to female ratio of hours worked (i.e. the economy activity rate) can be seen, taking into account that males use their entire time endowment for work.

Thus, without gender discrimination women's activity rate would rise by twenty percentage points. Finally the results allow us to quantify the effect of gender discrimination on output. What we see is the following: if gender discrimination completely disappears, GDP per capita will increase by approximately 17.6%.

5-Conclusions

In this paper we present a simple model of growth where fertility decisions are allowed and women suffer discrimination in the labor market. Results from this model should be taken cautiously because of the restrictive shape of the production function. In fact there might be a positive bias in the estimation of the gender discrimination level because women's hourly wage is higher than men's hourly wage. This stems from the following: Only men are able to perform physical tasks (low paid) while women are able to offer only skilled work. Insofar as women actually also perform low-skilled tasks, part of the gender wage gap is assigned to discrimination. By contrast, the wage gap created by the latter issue can be explained by the fact that women also provide low-skilled work. We go on to calibrate the model in order to mimic some key statistics of the Spanish economy and then we carry out some numerical experiments by changing the level of gender wage discrimination represented by ϕ. The exercise presented shows a measure of how much damage might be caused to an economy by the gender wage discrimination. In other words the paper presents the price that our society might be paying for gender wage discrimination. In fact our numerical exercise shows that an improvement in per capita GDP of between 6% and 17% depending on the level of the reduction in gender wage discrimination. This highly positive gain in per capita income is accompanied by a quantitatively important rise in women's activity rate (about 20% when discrimination disappears).

References:

[1] Cavalcanti, Tiago and Tavares, José (2007). *The Output Cost of Gender Discrimination: A Model-Based Macroeconomic Estimate.* CEPR Discussion Papers 6477.

[2] Conesa, Juan C. and Kehoe, Timothy J. (2004). *Productivity, Taxes and Hours worked in Spain: 1970-2000.* Mimeo.

[3] Eurostat, http://ec.europa.eu/**eurostat**.

[4] Galor O. and D. N. Weil (1996). *The gender gap, Fertility and Growth.* American Economic Review, 85(3), 374-387.

[5] Global gender gap report, published by the World Economic Forum.

[6] Instituto de la mujer (2007).*Diferencia y discriminación salarial por razón de sexo*.

[7] Instituto Nacional de Estadística, www.ine.es.

[8] Instituto Nacional de Estadística, (Tablas anuales 2000).*Encuesta de Población Activa*.

[9] Jones L., R. E. Manuelli and E. R. McGrattan (2003). *Why Are Married Women Working So Much?*. Federal Reserve Bank of Minneapolis, Staff Report.

[10] Lago Peñas, Ignacio (2002). *La discriminación salarial por razones de género: Un análisis empírico del sector privado en España.* Revista Española de Investigaciones Sociológicas 98: 171-196.

[11] Ugidos, A. (1997). *Diferencias salariales entre hombres y mujeres en el sector público y en el sector privado*. Información comercial española, Revista de economía 760: 61-74.

Appendix A: Data sources

The data used to calculate the Spanish statistics comes from two surveys undertaken by the Spanish Statistics Institute (in Spanish I.N.E.) called "Encuesta de Salarios en la Industria y los Servicios" ["Survey of Salaries in Industry and Services"] and "Encuesta de Población Activa" ["Active Population Survey"]. The full methodology can be found in the publication although I provide some insights that show the validity of the source.

1-About the "Encuesta de Poblacion Activa":

I take the activity rate from this survey which excludes less than one percent of the total population and the annual mean results from the aggregation of the quarterly data. The survey defines the Active Population as everyone who, in a given period, either supplies labor to the goods and service markets or is willing to provide such labor in order to join the production process. Furthermore the survey covers those persons aged 16 and over who meet the above conditions during the reference week and therefore, are included in either the unemployed or the employed group.

2-About the "Encuesta de Salarios en la Industria y los Servicios".

This is an ongoing quarterly survey which contains data about hourly average earnings, average earnings per worker and average hours worked per worker and month. This survey covers the whole country, with more than 11.800 units (firms). It also includes all workers who come from the private sector and work for companies with more than 5 workers. Salary earnings are formed by all earnings from brick and mortar sources and money alone. When considering the time worked by workers, we consider both the standard working day and overtime.

Specifically we use used hourly average earnings for females and males to compute the male/female earnings ratio and the average hours worked per worker to compute (jointly with the activity rate) the actual hours worked ratio between males and females aged between 16 and 64.

Appendix B: Further information relating to the model

This appendix shows some special features of the model which have to do with possible solutions and proofs mentioned above.

1-Proof: Time spent rising children decreases as long as capital increases.

Working out the first derivative of (12) and observing its sign suffices to confirm whether the model acts in this way or not.

$$\frac{\delta h_t}{\delta \hat{k}_t} = -\frac{\mu_t \gamma A_t B}{\kappa_t^2} - \frac{\mu_t \beta \gamma A_t B}{(\beta \kappa_t)^2} - \frac{\mu_t \gamma^2 A_t B}{(\gamma \kappa_t)^2} < 0$$

where μ_t stands for the first derivative of κ_t such that $\kappa_t = \phi(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}$ while $\mu_t = \alpha\phi(1-\alpha)\hat{k}_t^{\alpha-1}(2-h_t)^{-\alpha}$. So it is proved that as long as capital per unit of efficiency couple increases the time spent rising children decreases.

2-Complete development of the model

In section 2 the model is developed in order to obtain a solution for our particular case, but we are looking a situation in which only women take care of children. If the amount of childcare needed exceeds the endowment available to women[18] their male counterpart are going to start spending some time at home. Mathematically this can be expressed by changing the budget constraint of the couple maximization problem.

$$c_t + s_t = (w_t^p + w_t^m - (h_t - 1)(w_t^m + w_t^p))$$

And the new first order conditions become

$$\frac{\delta \mathrm{L}}{\delta \mathrm{c_t}} = \frac{1}{\mathrm{c_t}} - \lambda = 0 \qquad (5')$$

$$\frac{\delta L}{\delta c_{t+1}} = \frac{\beta}{c_{t+1}} - \frac{\lambda}{1+r^k} = 0 \qquad (6')$$

[18] Remember that women will be the first agents to offer their time for childcare whenever $\phi < 1$. In other words, women face a lower cost in raising children than men. It should be noted that this has been imposed for the correct development of the research.

$$\frac{\delta L}{\delta n_t} = \frac{\gamma}{n_t} - \frac{\lambda(w_t^m + w_t^p)}{D} = 0 \qquad (7')$$

$$\frac{\delta L}{\delta \lambda} = c_t + \frac{c_{t+1}}{1+r^k} - w_t^p - w_t^m + \left(\frac{n_t}{D} - 1\right)\left(w_t^m + w_t^p\right) = 0 \qquad (8')$$

Again we can arrange the above equations to get an expression for time spent raising children. Use (5') and (6') into (7') to obtain:

$$c_t = \frac{h_t(w_t^m + w_t^p)}{\gamma} \quad \text{and} \quad \frac{c_{t+1}}{1+r^k} = \frac{\beta h_t(w_t^m + w_t^p)}{\gamma}$$

Now, by plugging the latter into (8') we get:

$$h_t\left(w_t^m + w_t^p\right)\left(\frac{1}{\gamma} + \frac{\beta}{\gamma} + 1\right) = 2(w_t^m + w_t^p)$$

And by rearranging terms we arrive at:

$$h_t = \frac{2\gamma}{1+\beta+\gamma}$$

Finally we implicitly obtain the necessary condition for women to participate in the labor market, that is $\frac{2\gamma}{1+\beta+\gamma} < 1$or simply[19] $\gamma < 1 + \beta$, which is, as Cavalcanti and Tavares noted in their paper, a restriction in a couple's desire to have children.

[19] In our baseline economy clearly $\gamma = 0.163 < 1 + 0.3 = 1 + \beta$.