The Output Cost of Gender Discrimination: A Model-Based Macroeconomic Estimate*

Tiago V. de V. Cavalcanti† José Tavares‡

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†Faculty of Economics and Fellow of Churchill College, University of Cambridge, Sigwick Avenue, Cambridge CB3 9DD, United Kingdom, Tel.: +44 (0) 1223 335200; email: *tvdvc2@cam.ac.uk.*

‡*Corresponding Author:* José Tavares, Universidade Nova de Lisboa and Center for Economic Policy Research (CEPR). Address: Faculdade de Economia, Universidade Nova de Lisboa, Campus de Campolide, Lisboa, Portugal 1099-032. Tel.: +351-21-380-1669; fax: +351-21-388-6078; email: *jtavares@fe.unl.pt.*

Abstract

This paper seeks to quantify the output cost of gender discrimination based on a growth model where saving, fertility and labor market participation are endogenously determined (*a la* Galor and Weil (1996)), and there is gender barriers to female labor force participation. The model is calibrated to mimic the performance of the U.S. economy, including the gender wage gap and relative female labor force participation. We then compute the output cost of an increase in gender barriers, to find that a 50 percent increase in the gender wage gap leads to a decrease in income per capita of a quarter of the original output. We then compile independent estimates of the female to male earnings ratio for a wide cross-section of countries to construct a new economy, in line with the benchmark U.S. economy, except for the degree of gender barriers. Higher discrimination leads to lower output per capita for two reasons: a direct decrease in female labor market participation and an indirect effect through an increase in fertility. We find that for several countries a large fraction of the actual difference in output per capita between the U.S. and the different economies is due to gender inequality. Moreover, we find that the increase in fertility due to discrimination is responsible for almost half of the decrease in output per capita.

JEL Classification Numbers: E0, J1, O1

Keywords: Economic Development, Gender Inequality, Female Labor Force Participation, Fertility.

1 Introduction

Everywhere females find it more difficulty than males to access market activities, political power, or health and education inputs. Alesina and Lotti (2008), for instance, show that women in Italy pay a higher interest rate than men despite having a slightly better credit history, after controlling for a host of personal characteristics, characteristics of the business and characteristics of local credit markets. As mentioned in Hausmann, Tyson, and Zahidi (2006), "*no country in the world has yet reached equality between women and men in critical areas such economic participation, education, health, and political empowerment.*" Gender discrimination has many guises, probably interrelated in their causes and consequences, as they are part of a complex system of social, cultural and economic determinants. The economics literature has studied the microeconomics of job and wage discrimination in some detail, thus far focusing on the individual cost of discrimination. We believe it is important to provide a model-based macroeconomic estimate of the cost of wage discrimination and that is the goal of this paper.

Providing an estimate of the cost of discrimination to aggregate output is important for several reasons. First, gender discrimination is largely determined by social and cultural characteristics at the national level that hardly change in the short run.[1] Many of the determinants of discrimination are thus exogenous from the perspective of the economy, suggesting the possibility of ascertaining the aggregate costs of discrimination.[2] Second, the pervasiveness of discrimination across economies implies

[1]This is an important argument in Fernández (2007), which states that, "*if culture is, on the whole, evolving slowly, then this variable should also have explanatory power for individual women's labor supply.*" It is of interest to note that Fernández and Fogli (2005) find that cultural proxies are never significant in explaining male labor force participation.

[2]Other authors have argued, convincingly, that the tax rates on second earners (usually the woman) are much higher than those on the first earner. This further discourages female labor force participation. Alesina and Ichino (2007) have suggested going further than equalizing tax rates,

that aggregate costs are sizable and should be easily captured by aggregate models of the economy. Third, an aggregate model will be able to capture costs of gender discrimination related to indirect, but important, effects such as the impact on fertility, and assess the relative importance of the former with the direct cost of the mere lower participation of women.[3] In fact, this is consistent with cross country empirical evidence, as we will discuss below and as is shown in Figure 1. Panel (a) of this figure shows that there is a negative correlation between gender inequality and output per capita and Panel (b) reports a positive correlation between gender inequality and fertility. This last correlation will be a key feature of our model economy.

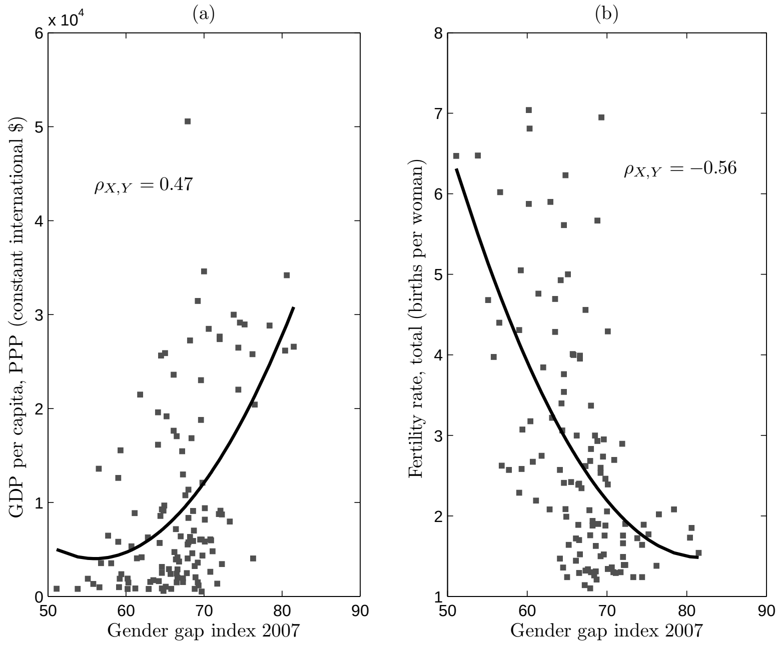
The social sciences literature has uncovered several important relationships between economy, culture, gender discrimination and female labor force participation (FLFP). A branch of this literature shows that income per capita and education levels are associated with lower degrees of discrimination against women (e.g, Dollar and Gatti (1999) and Guiso, Sapienza, and Zingales (2003)). Related research (e.g., Goldin (1990) and Juhn and Murphy (1997)) shows that although the increase in women's wage accounts for a large fraction of the increase in FLFP, there is still a large fraction that is unexplained. Another branch highlights the importance of cultural characteristics, religion, and religiosity as determinants of FLFP.[4] The literature has therefore emphasized that there are important exogenous and persistent barriers

given the higher tax elasticity of women's labor supply.

[3]In this paper participation and fertility are substitutes in women's time. The Economist (2007) presents data for some countries where higher male to female wage gaps are associated with *lower* rather than higher fertility. This is due to a third factor that we ignore here, the availability of child care, present in the model developed by Cavalcanti and Tavares (2006), where women "finance" their time in the market by voting for higher taxes and public services.

[4]See Fernández (2007) and Algan and Cahuc (2007) for the importance of culture and family characteristics on FLFP. For the role of religion on FLFP, see Guiso, Sapienza, and Zingales (2003), Psacharopoulos and Tzannatos (1989), Schmidt (1993), and Siaroff (1994). Religiosity and FLFP is studied in Knudsen and Waerness (1999) and Read (2003).

Figure 1: Gender inequality, GDP per capita, and fertility. Panel (a): Gender inequality index and GDP per capita. Panel (b): Gender inequality index and fertility. Source: Gender Gap Index (0 to 1 scale: 0=inequality, 1=equality), see Hausmann, Tyson, and Zahidi (2006); data for GDP per capita and fertility are from World Bank (2007).



to female labor force participation.

This, however, does not mean that gender discrimination does not change overtime. Antecol (2003), for instance, focuses on male attitudes toward mothers working outside their home as a determinant of participation, an emphasis that proves productive in the work of Fernández, Fogli, and Olivetti (2004), who show that men whose mothers worked while they were growing up tend to marry working women. This is evidence of "preference transmission".[5] In a recent paper, Doepke and Tertilt

[5]Fogli and Veldkamp (2007) propose a subtler mechanism whereby each generation updates beliefs by observing the children of employed women.

(2008) document and develop an interesting model to explain how women's economic and legal rights are extended over the course of the process of development.[6] In our model presented in Section 2 the gender wage gap has two components: (i) one that reflects productivity differences between women and men (see also Appendix C) that decreases over the development process; and (ii) another (gender barriers to FLFP) that is constant over time. In Subsection 6.3 we also allow gender barriers to change with the level of development.

The second motivation to study the aggregate cost of gender discrimination is the absence of model-based macroeconomic estimates.[7] In our knowledge we were the first to study quantitatively in a model based economy the long run effects of barriers to female labor force participation on economic development.[8] A model based estimate is important because it allows us to take into consideration how agents and prices respond to different levels of gender discrimination. It also, as we mentioned previously, captures indirect effects of gender discrimination on development such as

[6]See also Hazan and Maoz (2002) who show how social norms regarding women's labor force participation change overtime and with the level of FLFP.

[7]There is an important literature that studies empirically the effects of gender inequality on human capital accumulation and economic development and economic growth (e.g., Blackden and Bhanu (1999), Daly (2007), Dollar and Gatti (1999), Gümbel (2004), Hausmann, Tyson, and Zahidi (2006), and Klasen (1999)). Using growth accounting exercises Young (1995) found that the rise in female labor force participation accounted for between 0.6 and 1.6 percent of annual per capita growth in the four East Asian tiger economies, giving rise to a controversy on the relative role of productivity and factor inputs as explanations for economic growth. We believe that our research is complementary to this literature.

[8]There is also a literature that studies gender issues over the development process in a growth model. The seminal paper by Galor and Weil (1996)) is an example. Another interesting work is Lagerlöf (2003) who focuses on the relationship between gender discrimination and long-run growth. His model is a long-term economy relating gender discrimination with the industrial revolution and the demographic transition, motivated by the European historical experience. See also Greenwood, Seshadri, and Yorukoglu (2005). We built our model based on this literature but we study a different question.

changes in the fertility rate.[9]

As seen above, there is substantial evidence of the influence of "exogenous" factors as determinants of discrimination. The estimates on the macroeconomic cost of discrimination, though generally pointing to a significant cost, are not heretofore based on a macroeconomic model and can thus benefit from an integrated theoretical and empirical approach. Finally, as we pointed above, the lack of a clearer strategy to model the aggregate economy leads to severe problems in assessing the relative impact on output of concurring channels of causation from discrimination to individual behavior. Our paper intends to provide a contribution that is relevant in all three aspects.

2 The Model

In this section we develop a model to study the cost of gender discrimination to output similar to those in Galor and Weil (1996). Our strategy is to use a simple growth model with endogenous fertility and female labor market participation to assess the costs of gender discrimination.

Women and Men

Our economy is made up of men and women who live for three periods. In the first period, as children, women and men are indistinguishable, do not make any specific decision, and "consume" a fraction of their parents' time endowment, our proxy for parental care. In their second period of life, agents become adult men and women, organized as couples, and differ in their labor endowment such that each man is endowed with one unit of physical labor and one unit of mental labor, and

[9] As Lorentzen, McMillan, and Wacziarg (2008) propose, higher fertility rates in developing countries may also stem from higher mortality rates.

each woman with one unit of mental labor only.[10] Both men and women can use one unit of time, divided between time at work and time raising children. During this second period of life, couples decide how many children to have and allocate their time between the labor market and the task of raising children. In the third period, each couple consumes the life savings.

The novelty relative to macroeconomic models of fertility and labor market participation is the introduction of gender discrimination. We consider that there are barriers to female labor market participation in the form of wage discrimination. If we take w_t^m to be the mental labor wage rate, women receive the fraction $\phi < 1$ of this wage rate and a lower ϕ represents a more discriminatory society.[11] Our model delivers two facts that are borne out by available evidence: the existence of a gender wage gap and its tendency to decrease over time as income per capita increases.

[10]We can think that physical labor is substitute to physical capital, while mental labor is complementary to it. The difference in endowments between men and women allows for possible differences in productivity (or, implicitly, preferences) between genders that "explain" part of the different participation in the labor market. As will become clear, we will provide an estimate of the output cost of gender discrimination above and beyond any such gender differences. Its presence in the model simply considers, for the sake of completeness, that discrimination may not be the whole reason for wage inequality. Alternatively we may assume that women are more productive than men in home activities, as presented in Appendix C. In this case, differences in gender inequality still have similar impacts (both qualitatively and quantitatively) on the economy, but the gender pay and the fertility rate are constant over time.

[11]A similar approach is used by Jones, Manuelli, and McGrattan (2003), who argue that the narrowing wage gap alone explains a large part of the recent increase in female labor force participation in the United States. Lagerlöf (2003), instead, sets up a growth model where gender differences arise endogenously in equilibrium through a coordination process. His idea is that girls may need less education because they are expected to marry a man, who in general may be better educated. The decrease in fertility might improve gender equality as women's human capital becomes more equal to that of men. Related to this article is the model presented by Falcao and Soares (2007) where increases in female labor force participation and reductions in the gender wage gap are the output of reductions in fertility and in mortality rates.

Technology

The production technology uses capital, K_t, mental labor, L_t^m, and physical labor, L_t^p, to produce output, Y_t, according to a constant returns to scale production function. More specifically,

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

where $A_t = (1+\mu)^t$, $B > 0$, and $\alpha \in (0,1)$. While physical labor is a substitute for physical capital, mental labor is a complement. Thus, physical labor will lose importance as the economy accumulates physical capital and its compensation will deteriorate in relative terms. Parameter $\mu \geq 0$ corresponds to the rate of technical progress. Given the technology and input prices, the representative firm chooses inputs so that profits are maximized.[12] The first order conditions associated with the representative firm's problem are:

$$w_t^p = A_t B, \tag{2}$$

$$w_t^m = (1-\alpha)K_t^{\alpha}(A_t L_t^m)^{-\alpha} A_t, \tag{3}$$

$$r_t^K = \alpha K_t^{\alpha-1}(A_t L_t^m)^{1-\alpha}. \tag{4}$$

The wage of physical labor does not depend on capital accumulation, while the wage of mental labor increases with capital accumulation. Therefore, female labor force participation increases as the relative wage of mental labor increases and, concomitantly, the gender wage gap decreases. As the economy accumulates capital, the opportunity cost of staying at home increases

Preferences

As suggested above, couples draw utility from consumption in their second and third period of life and from the number of children. Let n_t be the number of children

[12]Output is taken as the numeraire.

born at period t,[13] and c_t and d_{t+1} be the consumption of a couple in their second and third period of life, respectively. Preferences are represented by

$$U_t = \ln c_t + \beta \ln d_{t+1} + \gamma \ln n_t, \;\; \beta, \gamma \in (0, 1), \tag{5}$$

where β is the subjective discount factor and γ represents the relative weight of children in the couple's utility function. Let h_t be the time that parents devote to raising children. In the spirit of Greenwood, Seshadri, and Vandenbroucke (2005), we assume that children are costly because they consume time resources according to the equation

$$n_t = D h_t^{\theta}, \;\; D > 0, \;\; \theta > 0, \tag{6}$$

Parameter $D > 0$ and $\theta > 0$ determine the level and curvature, respectively, of the production function to raise children. Solving (6) for h_t gives the time cost for a couple that decides to have n_t children

$$h_t = (\frac{n_t}{D})^{\frac{1}{\theta}}. \tag{7}$$

Budget Constraints

Notice that the opportunity cost of raising children is greater for a man, $(w_t^p + w_t^m)$, than for a woman, ϕw_t^m, $\phi \in (0, 1)$. Therefore, if $h_t \leq 1$, only the wife will spend time raising children. In the case where $h_t > 1$ both will raise children, but the husband will also work some time in the market.[14] The couple's budget constraints for each of the two cases are:

$$c_t + s_t \leq w_t^p + w_t^m + (1 - h_t)\phi w_t^m, \;\; \text{if} \;\; h_t \leq 1, \tag{8}$$

$$c_t + s_t \leq (w_t^p + w_t^m - (h_t - 1)(w_t^m + w_t^p)), \;\; \text{if} \;\; h_t \geq 1. \tag{9}$$

[13] Since the household is organized as a couple, we could interpret n_t as the number of couples generated by each household.

[14] This is consistent with the empirical fact that male labor force participation rates tend to be higher than their female equivalent, and women do by far the greater part of unpaid work.

where s_t represents savings and the right-hand side shows net income of the couple.

In the last period of life, consumption by the couple satisfies

$$d_{t+1} = (1 + r_{t+1})s_t. \tag{10}$$

Couples choose the level of consumption when young, c_t, and when old, d_{t+1}, the number of children n_t, and savings, s_t, so as to maximize (5) subject to (7) to (10). The fertility decision satisfies

$$h_t = \frac{n_t}{D} = \frac{\gamma\theta}{1+\beta+\gamma\theta}[\frac{1+\phi}{\phi} + \frac{w_t^p}{\phi w_t^m}], \quad \text{if} \quad h_t \leq 1, \tag{11}$$

$$h_t = \frac{n_t}{D} = \frac{2\gamma\theta}{1+\beta+\gamma\theta}, \quad \text{if} \quad h_t > 1. \tag{12}$$

From the expressions above, a necessary condition for women to participate in the labor market is that

Assumption 1: $\frac{2\gamma\theta}{1+\beta+\gamma\theta} \leq 1$.

This assumption is equivalent to $\gamma\theta \leq (1+\beta)$, which is a restriction on the "altruism factor" that "weighs" the benefits of having children against consumption. If the above condition is satisfied, then the time spent raising children is given by

$$h_t = (\frac{n_t}{D})^{\frac{1}{\theta}} = \min\{1, \frac{\gamma\theta}{1+\beta+\gamma\theta}[\frac{1+\phi}{\phi} + \frac{w_t^p}{\phi w_t^m}]\}, \tag{13}$$

and private savings are given by

$$s_t = \frac{\beta}{1+\beta+\gamma\theta}((1+\phi)w_t^m + w_t^p) \quad \text{if} \quad h_t \leq 1, \tag{14}$$

$$s_t = \frac{\beta}{1+\beta}(w_t^m + w_t^p) \quad \text{if} \quad h_t = 1. \tag{15}$$

Equilibrium

In equilibrium, demand equals supply in all markets. In the market for mental labor this means that $L_t^m = L_t^p(2 - h_t)$, or $m_t = \frac{L_t^m}{L_t^p} = 2 - h_t$. Let $\hat{k}_t$ be the capital level per unit of efficiency couple, i.e., $\hat{k}_t = \frac{K_t}{A_t L_t^p}$. Then, using the input market equilibrium conditions, equations (2) and (3), into (13), yields

$$h_t = \min\{1, \frac{\gamma\theta}{1+\beta+\gamma\theta}[\frac{1+\phi}{\phi} + \frac{B}{\phi(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}}]\}. \quad (16)$$

Proposition 1: *Let assumption 1 be satisfied. Then female hours of work in the market increase with capital accumulation, $\hat{k}_t$, and decrease with labor market discrimination (low ϕ).*

Proof: See Appendix A ∇.

Equation (16) determines h_t as an implicit function of $\hat{k}_t$, $\psi(\hat{k}_t, \phi)$, and a critical value $\hat{k}^*(\phi)$ such that

$$h_t = \begin{cases} 1 & \text{for } \hat{k}_t \leq \hat{k}^*(\phi), \\ \psi(\hat{k}_t, \phi) & \text{for } \hat{k}_t \geq \hat{k}^*(\phi), \end{cases} \quad (17)$$

and $\psi(\hat{k}_t, \phi) \in (0, 1]$ $\forall$ $\hat{k}_t \geq \hat{k}^*(\phi)$, where:

$$\hat{k}^*(\phi) = [\frac{B\gamma\theta}{(1-\alpha)(\phi(1+\beta)-\gamma\theta)}]^{\frac{1}{\alpha}}. \quad (18)$$

As a consequence, time devoted to home activities decreases with capital accumulation. Observe that when barriers to female labor force participation are high (ϕ is low), women work fewer hours in the market. Since fertility is an increasing function of hours at home, the number of children decreases with capital accumulation and increases with gender discrimination in the form of barriers to female labor force participation.[15]

The condition that equilibrates the capital market is

$$K_{t+1} = L_t^p s_t. \quad (19)$$

[15]Interestingly, Del Boca and Locatelli (2006) find that an increase in female wages increases female labor force participation and finds an association between time spent in childcare currently and the decision to have more children in the future. The force relating discrimination and output in Lagerlöf (2003) is also a decrease in the quantity of children as discrimination decreases.

Using equations (13),(14), and (15) yields:

$$\hat{k}_{t+1} = \frac{s_t}{(1+\mu)A_t n_t} = \begin{cases} \frac{\beta[(1-\alpha)\hat{k}_t^{\alpha}+B]}{D(1+\beta)(1+\mu)} & \text{for } \hat{k}_t \leq \hat{k}, \\ \frac{\beta[\phi(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}]^{\theta}[(1+\phi)(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}+B]^{1-\theta}}{D(1+\mu)(\gamma\theta)^{\theta}(1+\beta+\gamma\theta)^{1-\theta}} & \text{for } \hat{k}_t \geq \hat{k}, \end{cases} \tag{20}$$

Using (17) into (20) defines a non-linear difference equation $\hat{k}_{t+1} = \xi(\hat{k}_t, \phi)$.

Proposition 2: *Let assumption 1 be satisfied. Then there exists at least one locally stable positive steady-state equilibrium.*

Proof: See Appendix B ∇.

Proposition 2 states that a positive and locally stable steady-state exists. However, here, as in Galor and Weil (1996), one cannot guarantee that the steady-state equilibrium is unique.

3 Measurement: Replicating a Baseline Economy

In this section we provide a first empirical assessment of the cost of gender discrimination by choosing parameter values for our model economy so that it mimics some key statistics of the United States economy. Table 1, Part I, provides all parameter values as well as a note on how each one was obtained. Below, we describe our calibration in detail.

The model period in our economy is taken to be 25 years. Therefore, each agent lives about 75 years. The capital share α is set to 0.40, consistent with Gollin (2002). According to Greenwood, Seshadri, and Vandenbroucke (2005), the annual growth rate of total factor productivity (TFP) in the United States was 1.41 percent between 1900 and 1948 and jumped to about 1.68 percent between 1948 and 1974.[16] In our

[16] After 1974 there was a productivity slowdown as the TFP growth rate decreased by about 0.57 percent. From 1995 to 2000 the TFP growth rate increased to about 1.2 percent per year.

model, we set the parameter μ such that the rate of TFP growth in the sector where labor is complementary to capital (i.e., *mental labor sector*) is equal to 1.5 percent.[17] We set β such that the agents' subjective discount rate is 4% per year, similar to the risk free yearly real interest rate in the United States in the post war period, as shown in Parente and Prescott (2000). The altruism factor, γ, is calibrated so that the population is constant in the long-run equilibrium. We set the values of the remaining five parameters - $\hat{k}_0$, B, ϕ, D, and θ - so that we approach five empirical observations for the U.S. economy: (i) the ratio of per capita income in 2000 relative to its level in 1900;[18] (ii) the female to male wage earnings in 1900;[19] (iii) the female to male earnings in 2000;[20] (iv) the ratio of female to male hours of work in 2000;[21] and (v) the average private cost of children (ie., the opportunity cost of staying at home) as a share of GDP.[22] Observe that the calibrated model matches the target

[17]This is the weighted average for the period from 1900 to 1974. Observe that the TFP parameter in the mental labor sector is $Z_t = A_t^{\frac{1}{1-\alpha}}$. This implies that $\mu \simeq (1-\alpha) \times 1.5\% = 0.9\%$. Recall also that a model period corresponds to 25 years. Therefore, $A_t = ((1+\mu)^{25})^t$.

[18]According to Maddison (2006), the 2000 real per capita income in the United States was about 7 times higher than its level in 1900.

[19]Goldin (1990) shows that in 1900 the average employed female earned about 48 percent of the average employed male.

[20]Data from the United Nations (2005) show that the female to male earnings ratio is equal to 63 percent in the United States. This dataset uses National Accounts information and estimates the female to male earnings ratio using the the non agricultural wage, the female and male participation rates, and the female and male total populations. Using the Panel Study Income Dynamics (PSID) Olivetti and Petrangolo (2008) show that the gender wage gap is about 67.5 percent. We will make cross-country comparisons and the United Nations (2005) provide estimate of the female to male earnings ratio for a large sample of countries, including developing countries. Therefore, for comparison reasons we let the female to male earnings ratio to be equal to 63 percent in the baseline economy.

[21]According to Erosa, Fuster, and Restuccia (2005), women worked 40 percent fewer hours than men.

[22]According to Haveman and Wolfe (1995) this ratio is equal to 40 percent in the United States. See also Doepke, Hazan, and Maoz (2007).

values well[23] (see Table 1, Part II).

Our model, however, suggests that women spend 17 percent less hours in home activities in 2000 than in 1900.[24] Estimates from Ramey and Francis (2006) suggest that the number of hours per woman in home production decreased by 40 percent from 1900 to 2000.[25] Our model thus underestimates the reduction in the number of hours spent by women in home activities over the development process. However, we highlight that in our model, as in Galor and Weil (1996), the driving force in the reduction of time spent in home activities is the decrease in the gender wage gap. As argued by Greenwood, Seshadri, and Yorukoglu (2005), there are other factors, such as technical progress in the home sector, that are important in accounting for the reduction in hours of housework.[26] Following Greenwood, Seshadri, and Vandenbroucke (2005), we could have increased parameter D in 1950 to mimic the technical progress that occurred in the home sector. This, however, would not have added any new insight to our analysis.

Figure 2 shows the evolution of the baseline economy, represented by the solid line. The graph on the left describes the evolution of the capital stock, with $\hat{k}_{t+1}$ on the y axis and $\hat{k}_t$ on the x axis, and the steady state is found where this line is crossed by the 45 degree line. Simulations with the baseline parameter values show that there

[23] In our calibration $\hat{k}_0 = 0.00495 > 0.00003 = \hat{k}^*$. This implies that only women work at home in our calibrated model and the number of hours in home activities decrease with capital accumulation.

[24] More specifically, $h_{2000}/h_{1900} = 0.83$.

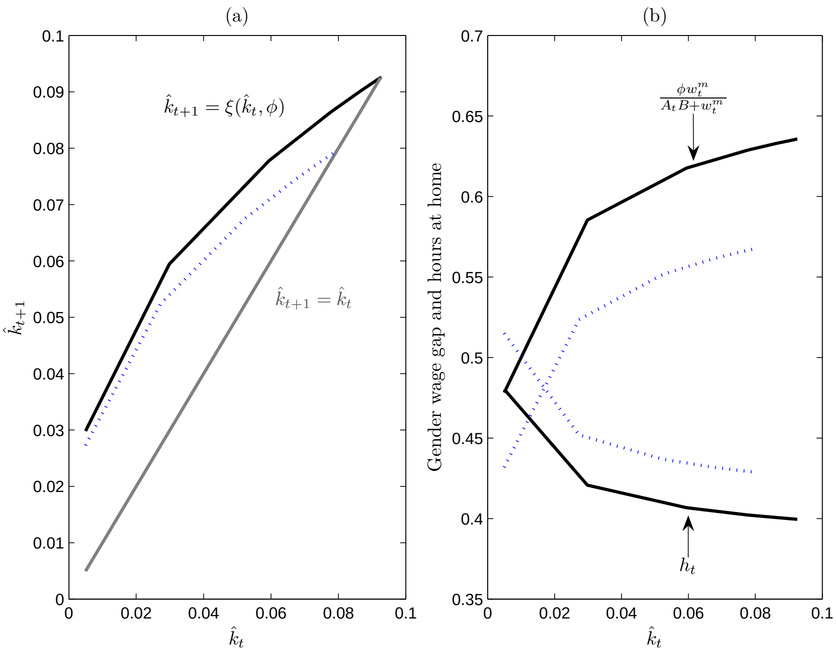
[25] According to Ramey and Francis (2006), women spent on average about 50 hours per week in home activities in 1900, compared with about 30 hours per week in 2000.

[26] See also Lord and Rangazas (2006). In fact, Cavalcanti and Tavares (2008) show that a decrease in the relative price of home appliances has a first order effect in female labor force participation. Albanesi and Olivetti (2007) argue that improved medical knowledge and the provision of an effective breast-milk substitute favored women's participation in the market. In the current paper we abstract from technical progress in the home sector, so we underestimate the reduction of hours in home production.

Table 1: Parameter values, basic statistics, baseline economy. Sources: Goldin (1990), Goldin (2006), Maddison (2006), Erosa, Fuster, and Restuccia (2005), and Haveman and Wolfe (1995).

Part I: Parameter Values		
Parameters	*Values*	*Comment/Observations*
α	0.4	Capital share based on Gollin (2002)
μ	0.009	Rate of TFP growth based on Greenwood, Seshadri, and Vandenbroucke (2005)
β	0.3604	Calibrated to match the U.S. historical post-war return on government bonds (about 4%)
γ	0.2525	Population growth rate is constant in the steady-state
D	2.3	Calibrated to match the average private cost of children as a share of GDP
θ	0.9	Calibrated to match hours worked by women relative to hours worked by men in 2000
B	0.0345	Calibrated to match the U.S. female to male earnings ratio in 1900
ϕ	0.75	Calibrated to match the U.S. female to male earnings ratio in 2000
$\hat{k}_0$	0.00495	Calibrated to match the U.S. per capita output in 2000 relative to its level in 1900 (Maddison (2006))
Part II: Basic Statistics		
	U.S. economy	*Baseline economy*
$\phi w^m_{1900}/(w^p_{1900} + w^m_{1900})$	48%	48%
$\phi w^m_{2000}/(w^p_{2000} + w^m_{2000})$	63%	63%
y_{2000}/y_{1900}	7.0	7.0
$1 - h^{women}_{2000}/1 - h^{men}_{2000}$	60%	60%
$\phi w^m_{2000} h_{2000}/y_{2000}$	40%	40%

Figure 2: Baseline Economy. Panel (a): Evolution of capital per unit of efficiency couple. Panel (b): the gender wage gap and hours worked versus capital per unit of efficiency couple. Black solid line: Baseline economy; dotted blue line: economy with 10 percent more gender inequality in 2000.



is a unique steady-state equilibrium for $\hat{k}_t > \hat{k}^*$. The graph on the right shows the mechanics of the increase in women's hours worked: as capital is accumulated, the gender wage gap narrows; this increases the opportunity cost of staying at home, decreases fertility, and increases female labor market participation. The dotted line in both graphs describes an economy with a female to male earnings ratio in 2000 of 56 percent instead of 63 percent, as in the baseline economy. Observe that, in this case, the capital per unit of efficiency couple is lower and women work fewer hours in the market. In the following section we exploit these "cross-section" changes further.

Table 2: Gender inequality and development: Quantitative properties of the model

	Output per capita, % baseline	Female to male earnings ratio	Hours at home, % baseline	Output per capita, % baseline (constant fertility)
Baseline	100.00	63	100	100
$\phi = \frac{1}{1.5} \times \phi_{\text{base}}$	76	41	133	89
$\phi = \frac{1}{2} \times \phi_{\text{base}}$	60	30	167	83
$\phi = \frac{1}{3} \times \phi_{\text{base}}$	40	20	235	73
$\phi = \frac{1}{4} \times \phi_{\text{base}}$	28	15	300	64

4 Measurement: The Output Cost of Gender Discrimination

We now explore how the equilibrium properties of the model calibrated in the previous section change with gender discrimination, measured by the female to male earnings ratio. We vary parameter ϕ and examine the model's predictions along three dimensions: output per capita as a fraction of U.S. output per capita; female to male earnings ratio; and women's hours worked in the market. All statistics correspond to what would be observed in 2000.

Table 2 shows that as gender discrimination in labor market activities increases, the level of per capita output decreases, and both the gender wage gap and hours spent by women in home activities increase. The effect of ϕ on output per capita is sizeable: a decrease in ϕ by a factor of two decreases output per capita by approximately 40 percent, while hours at home increases by approximately 67 percent.[27]

It is very important to highlight that as barriers to female labor market participation increase (that is, ϕ decreases), there are two channels through which per capita

[27] $1 - h_t$ can be interpreted as the fraction of the female population that participates in labor market activities in a homogeneous couple setup.

output decreases.[28] First, output per capita decreases because women work fewer hours in the market (h_t decreases), and so output decreases for the same population. Second, output per capita also decreases because discrimination discourages female labor market participation and decreases the couple's total income, leading couples to choose to have more children, that is, increase n_t.[29] What is the relative quantitative importance of the two effects in the overall impact of discrimination.

In the last column of Table 2 we present results for output per capita in the baseline economy when fertility is kept constant. We have solved a standard overlapping generations economy without fertility in which we feed exogenous values of h_t into the model as observed in each previous experiment. In this case, we are isolating the first channel through which gender discrimination affects output per capita, that is, the effect working solely though number of hours worked by women.[30] When the female to male earnings ratio decreases by a factor of two, output per capita, in the constant fertility case, decreases by 17 percentage points, compared to 40 percentage points in the first column. The effect of discrimination through women' s hours at work accounts for about 57.5 percent of the total reduction in output observed in the model with endogenous fertility.

[28]Per capita output in this model is given by: $y_t = \frac{Y_t}{n_t L_t^p + L_t^p + \frac{L_t^p}{n_{t-1}}}$. The first term in the denominator corresponds to the number of existing children, the second term is the number of young couples, and the third term is the number of elderly couples.

[29]In our model, as discrimination limits utility gains through female participation and higher consumption, couples opt for increases in utility through fertility. This effect also accounts, in a larger model, for the lower opportunity cost of time spent at home, which is reflected in the decision to have more children.

[30]We can infer the role of fertility in the output decrease as the difference between the first and the last column.

5 Measurement: Counterfactual Analysis

The exercises in the previous section describe the quantitative properties of the model for systematic variations in gender discrimination through wage inequality. We now feed the model with independent estimates of the female to male earnings ratio for several economies, keeping the other parameters, as in the baseline economy, at the U.S. level. The purpose of this counterfactual exercise is to assess how much the level of U.S. output per capita would decrease if gender discrimination were the same as in, say, Egypt. This will provide us with a first-ever macroeconomic estimate of how much of the existing difference in output per capita between Egypt and the United States can be accounted for by differences in gender inequality in pay. In effect, we conduct this exercise for a large sample of countries. For each country, we feed in an independent estimate of gender wage inequality and compare the model's predictions with the relevant country data. We keep all parameters at their baseline values, except parameter ϕ, which we adjust until the female to male earnings ratio is similar to what is observed in the data. Table 3 reports results for selected economies.

We find that when fertility is endogenous, gender wage discrimination explains a large fraction of the difference in output per capita between some countries (see Table 3, Part I) and the United States. In the case of Saudi Arabia and Ireland, barriers to female labor force participation explain the entire gap in relative output per capita. Notice that, were the United States to have the level of gender pay inequality observed in Egypt, output per capita would be 46 percent below its actual level. Since output per capita in Egypt is about 10 percent that of the United States, gender discrimination explains about 60 percent of the difference in output per capita between the two countries. When fertility is constant the model explains about 27 of the difference, still a sizeable fraction.[31]

[31] Instead of using the female to male earnings ratio to estimate ϕ, we could have used the gender gap index (see Hausmann, Tyson, and Zahidi (2006)), which is the synthesis of gender discrimination

Table 3: Gender inequality and development: Empirical data and model predictions for reference economies. Source: United Nations (2005).

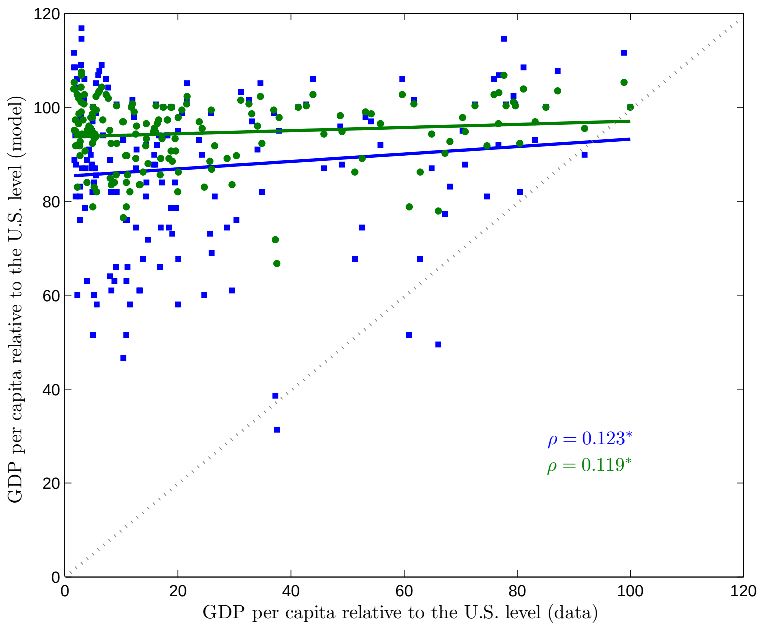
Countries	**Data**		**Model**		
	Output per capita, % baseline	Female to male earnings ratio	Output per capita, % baseline	Female to male earnings ratio	Output per capita, % baseline (constant fertility)
Baseline$_{\phi_{US}=0.75}$	100	63	100	63	100
Part I					
Ireland$_{\phi_{IRL}=0.6356}$	91	53	90	53	95.5
Greece$_{\phi_{GRC}=0.6591}$	56	55	92	55	96
Singapore$_{\phi_{SGP}=0.6148}$	71	51	87.8	51	95
Saudi Arabia$_{\phi_{SAU}=0.2027}$	37	16	31	16	67
Iran$_{\phi_{IRN}=0.4777}$	19	39	73	39	88
Egypt$_{\phi_{EGY}=0.2885}$	10	23	46	23	76
India$_{\phi_{IND}=0.3866}$	8	31	61	31	83
Part II					
Finland$_{\phi_{FIN}=0.8352}$	77	71	107	71	103
Norway$_{\phi_{NOR}=0.9004}$	99	77	111	77	105
Sweden$_{\phi_{SWD}=0.9434}$	77	81	114	81	107

Table 3, Part II, shows what would output per capita in the United States be if gender barriers were similar to what is observed in Finland, Norway, and Sweden. Scandinavian countries are particular interesting because gender inequality in earnings is lower in these countries than in the United States (see Table 3, part II), but output per capita is slightly lower than in the United States. Our exercises show that the United States can increase output per capita significantly if gender inequality decreased to the level observed in Scandinavian countries. For instance, if gender inequality in the US was similar to the one in Sweden, output per capita would be 14 percent higher than the actual level.

Figure 3 summarizes the performance of our model for 118 countries, for the baseline model and for the model with constant fertility. The figure plots, on the y axis, the value of country output per capita relative to the U.S. level, as predicted by the model. On the x axis, we plot the value of the exact same variable, as observed in the data. If gender discrimination explained all of the difference in per capita output between a country and the U.S., the corresponding point would lie on the 45 degree line. The graphs reveal three extremely important features. First, the model tends to predict values of per capita output that are higher than those observed in the data. This is expected given that we focus only on barriers to female labor force participation and abstract from all other differences among countries, such as TFP differences, labor market institutions, and government policies. We also abstract from the effects of gender discrimination on human capital, working through a decrease in young girls'access to education, which is also expected to be considerable. Second,

indices in health, education, political and economic empowerment. To determine the parameter estimate for ϕ for each country we could have multiplied the ratio of the gender gap index of a country to the U.S. value by the baseline $\phi = 0.75$. This is what we did in Appendix D. Notice that in this case, the experiments underestimate the gender wage gap and gender barriers explain a smaller fraction of international income differences (see Table 7 in Appendix D). However, these experiments would require that the mapping of differences in the gender gap index would translate in the observed differences in ϕ.

Figure 3: Empirical Data and Model Predictions for Selected Economies. Blue squares represent model predictions with endogenous fertility and the blue solid line is the best linear fit. Green balls and the accompanying green solid line correspond to the constant fertility model. Dotted gray line: 45 degree line.



for some countries, gender discrimination explains all of the difference in relative output levels, as shown by the cases where the point lies very close to the 45 degree line. Third, the model with endogenous fertility shows a stronger positive correlation between predicted and actual values, when compared to the exogenous fertility model.

A final feature to notice is that for very poor countries gender barriers explain a low fraction of the difference in income level between these countries and the United States. Very poor countries have a low level of gender inequality in earnings and in fact Goldin (1995) and Galor and Weil (1996) emphasize that female labor force participation has a U-shaped pattern. This is because female labor force participation is high and gender inequality is low in the traditional agriculture sector. Therefore, as in Galor and Weil (1996) our model is more appropriated to analyze economies that are consistent with the modern growth regime with a negative relationship between income and population growth (e.g., Galor and Weil (2000)). Figure 5 in appendix E shows that the model does a better fit when we exclude from our simulations countries with output per capita that is below 10 percent of the U.S. level.[32]

6 Issues and Robustness

6.1 Measuring gender discrimination

Total wage inequality between men and women can be decomposed in two distinct parts: the first stems from differences in gender attributes - education, skills, among others - and the second from differences in the return to those attributes or the effects due, among other things, to gender discrimination.[33] In this paper we use the raw differences in gender pay for several reasons:

1. Measures of gender wage discrimination are not readily available for a sufficiently high and diverse number of countries. An important source is Blau and Kahn (2003) who estimates the "unexplained" gender wage gap for the United States and OECD countries only. Weichselbaumer and Winter-Ebmer (2005) provide a quantitative review of the vast empirical literature on the gender wage gap for a large sample of countries but the examined period changes considerably across countries, which is a problem to make country comparisons. Moreover, almost all Middle-Eastern economies, some well-known for high levels of gender discrimination, are absent from the sample.

2. Weichselbaumer and Winter-Ebmer (2005) unveil a strong positive correlation

[32] The correlation between model predictions and data is almost three times higher than when the whole sample is included.

[33] See Blinder (1973) and Oaxaca (1973).

between the gender wage gap and the unexplained residual, suggesting that the relative cost of discrimination across countries would remain substantially unaltered were we to obtain information on the gender wage residual across countries.[34]

3. Much of the difference in endowments between women and men is explained by gender barriers to the participation of women in the labor market. In a long-run model like ours, where education and work experience are not explicitly considered, it makes sense to estimate the effects of discrimination by using the raw gender wage inequality rather than a measure of statistical discrimination since the women's incentive to obtain education and the experience they accumulate in the market is likely influenced by discrimination.

4. Finally, as reported by Blau and Kahn (2000) and Goldin (2006), there is a higher fraction of women than men in relative low-paying jobs and at lower levels of the managerial hierarchy. This can explain why returns on human capital characteristics, such as years of schooling and experience, are different for men and women. But these gender occupational differences might be driven by discrimination.

The reasons above suggest the use of a broad measure of discrimination rather than just the gender wage residual.

[34]Figure 2 of Weichselbaumer and Winter-Ebmer (2005) plots the reported gender wage gap versus the reported wage residual. For countries above the 45^0 line (e.g., Cote d'Ivoire, Tanzania, and Korea) women have lower endowments than men. Part of the total wage gap, therefore, can be attributed to differences in human capital. In countries below the 45^0 line (e.g., Singapore, Guinea, and Costa Rica) the contrary is true and women have higher endowments than men, though still receiving less pay. The majority of countries, however, lies close to the 45^0 line.

6.2 Selection bias in female labor force participation

There is evidence showing that gender wage inequality might be affected by gender-based selection bias. The rationale suggests that employed women tend to have relatively high levels of human capital and cognitive ability, which would affect the raw gender wage gap.[35] Gender inequality in earnings would be higher than observed were this selection bias to be taken into account. On the other hand, since highly productive women have a higher reservation wage than low skilled women, when gender barriers are large, then highly productive women are less likely to work, the observed gender wage gap would be higher than if the selection bias was not present. Using United States data, Mulligan and Rubinstein (2005) show that, in the 1980's and 1990's, working women typically had better backgrounds than women not working, but women not working in the 1970's had better backgrounds than women working. In sum, selection bias changed signs, from negative to positive.

How would sample selection in female labor force participation affect our counterfactual estimates? In the case in which women not working have lower potential wages (productivity) than women working, a decrease in gender barriers to female labor participation (decrease in ϕ) would decrease female labor participation, going from the left to the right of the productivity distribution. In this case, our estimates in Section 5 overestimate the true effect of barriers to female labor force participation on income levels since it is the low productivity women that are abandoning the market first. However, notice that the change in ϕ to match the new female to male earnings ratio would have to be higher, which suggests an underestimation of the true effect of gender barriers on development. On the other hand, if women not working have better skills than those in the labor market, the opposite is true. In sum, the overall quantitative implications of selection bias on our results would depend on the type of sample selection in each country and the implied change in ϕ.

[35] As in Olivetti and Petrangolo (2008).

Though we recognize that selection bias is an important issue in the study of gender barriers on economic development, it is unclear how it would change, qualitatively and quantitatively, our results.

6.3 Causality in gender barriers

In our benchmark model the gender wage gap has two components: the first reflects productivity differences between women and men and decreases over the development process with the accumulation of capital;[36] the second derives from the existence of gender barriers to female participation in the labor market and is constant over time. Although there is empirical evidence showing that gender inequality is largely determined by social and cultural norms at the national level that hardly change in the short run,[37] it does not mean that economic forces, such as technical changes which raise women's relative wage, do not have an impact on those norms.[38]

In this section we alter our benchmark model and let the relative wage of women affect the extent of barriers to female labor force participation. Our aim is to investigate the robustness of our quantitative results with endogenous barriers to female participation in the market. We assume that $\phi_t = \phi(\frac{w^m_{t-1}}{w^p_{t-1}})$ with $\phi'(\cdot) > 0$ so that higher relative wages for women imply less discrimination.[39] Since $\frac{w^m_{t-1}}{w^p_{t-1}}$ increases with capital accumulation per effective unit of couple, this implies that gender barriers decrease as the economy develops so that we can write $\phi_t = \phi(\hat{k}_{t-1})$. In particular, we let

[36] See also appendix C

[37] See, for instance, Fernández (2007).

[38] Hazan and Maoz (2002) provides an interesting model of the dynamics of female labor force participation based on endogenous changes of social norms. Doepke and Tertilt (2008) show how technical progress can lead men to choose the extension of women's rights.

[39] Notice that current gender barriers depend on the lagged relative wage of women. Such assumption does not change the main analytical results and it captures the dynamic effects of relative wages on gender barriers.

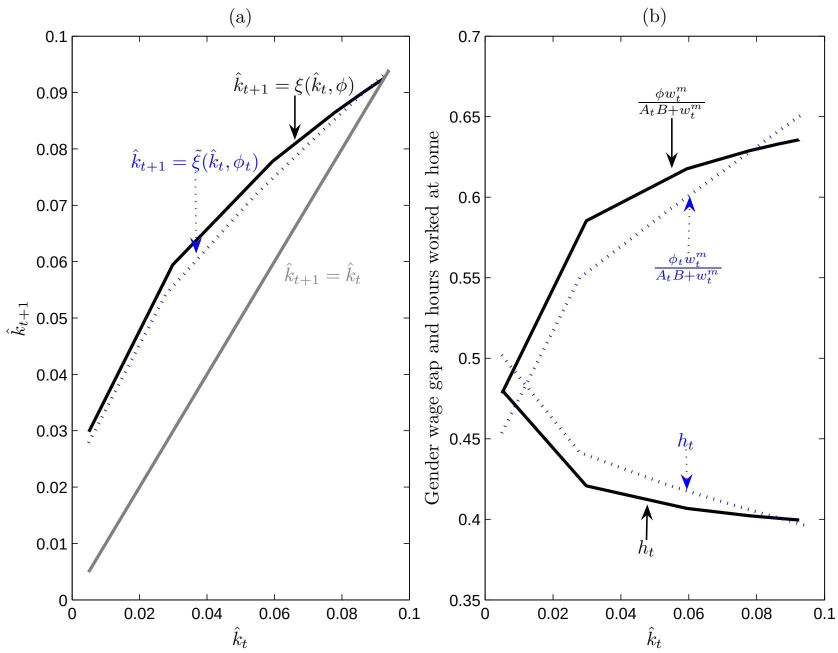
$$\phi_t = \phi(\hat{k}_{t-1}) = \begin{cases} \phi_1 \times (1 + \hat{k}_{t-1}), \quad \phi_1 > 0 & \text{if } \hat{k}_{t-1} \leq \frac{1}{\phi_1} - 1, \\ 1 & \text{if } \hat{k}_{t-1} \geq \frac{1}{\phi_1} - 1. \end{cases} \tag{21}$$

The rest of the framework is identical to that presented in Section 2. We calibrate the model to match the same statistics reported in Table 1.[40] In this case, the gender wage gap decreases over time for two reasons: both gender productive differences and gender barriers decrease as the economy accumulates capital and develops. Figure 4 shows that the two economies - with ϕ exogenous and ϕ endogenous - behave similarly in terms of capital per effective unit of couple (panel (a)), even if the curve describing the evolution of the wage gap is now steeper (panel (b)), as expected.

We can investigate the robustness of our quantitative experiments to feedbacks from development to gender barriers (see Table 4). First, we will vary the exogenous parameter ϕ_1 and examine the model's predictions along the same dimensions described in Table 2. Again, all statistics correspond to what would be observed in 2000. Observe that results are very similar to those in Table 2. For instance, when ϕ_1 decreases by a factor of 2 output per capita decreases by 42 percent, while in the baseline case it decreased by 40 percent. Notice, however, that now the gender wage gap increases further. The female to male earnings ratio decreases from 63 percent to 28 percent, while in the baseline case it decreased to 30 percent. Therefore, to make cross country analysis we would need a smaller variation in ϕ than in our benchmark model. For instance, if we decrease ϕ_1 such that the female to male earnings ratio is the same as in the baseline case (say 30 percent), then the decrease in output per capita is roughly the same as when gender barriers are exogenous (ϕ constant). This implies that the counterfactual analysis similar to the one implemented in Section 5 yields similar results for this case when gender barriers depend on the level of capital per effective unit of couple.

[40]The calibrated parameter values are: $\alpha = 0.4$, $\mu = 0.009$, $\beta = 0.3604$, $\gamma = 0.255$, $D = 2.3$, $\theta = 0.9$, $B = 0.0335$, $\hat{k}_0 = 0.0049$, and $\phi_1 = 0.6836$. Since barriers to female labor force participation decreases with capital accumulation, then $\phi_{1900} = 0.6870$ and $\phi_{2000} = 0.75$.

Figure 4: Baseline Economy. Panel (a): Evolution of capital per unit of efficiency couple. Panel (b): the gender wage gap and hours worked versus capital per unit of efficiency couple. Black solid line: ϕ constant; dotted blue line: ϕ increases with $\hat{k}_t$.



7 Concluding Remarks

The purpose of this paper is straightforward. We present a simple model of growth with endogenous fertility and endogenous labor market participation that allows us to provide a macroeconomic estimate of the output costs of gender discrimination. By choosing parameter values that bring our baseline economy close to the actual U.S. economy we find that the output cost of gender discrimination is sizeable. This decrease in output per capita can reach 54 percent of the current U.S. level, were the U.S. to approach the level of gender wage inequality present in, say, Egypt. This estimate is reached changing *only* the level of gender wage inequality in the U.S. to match the value in Egypt, and maintaining *all* other parameters constant, including productivity.

Table 4: Gender inequality and development: Quantitative properties of the model

	Output per capita, % baseline	Female to male earnings ratio	Hours at home, % baseline	Output per capita, % baseline (constant fertility)
Baseline	100.00	63	100	100
$\phi_1 = \frac{1}{1.5} \times \phi_{1,\text{base}}$	74	40	136	89
$\phi_1 = \frac{1}{2} \times \phi_{1,\text{base}}$	58	28	173	82
$\phi_1 = \frac{1}{3} \times \phi_{1,\text{base}}$	38	18	245	72
$\phi_1 = \frac{1}{4} \times \phi_{1,\text{base}}$	27	13	312	62

The decrease in output per capita due to wage discrimination stems from both a decrease in female labor market participation and an increase in fertility, with the first channel slightly more important in quantitative terms. A counterfactual exercise using 118 developing and developed countries shows that, as expected, our simple model underestimates the difference in output per capita with the U.S. economy. However, as is clearly demonstrated, our very parsimonious model shows that a large fraction of country differences in output per capita can be attributed to gender inequality. For countries such as Ireland and Saudi Arabia, wage discrimination may explain all of the output difference.

Our conclusion is that many countries can make substantially better use of their workforce and significantly increase output per capita by discouraging gender barriers in the labor market. This is also valid for the United States: output per capita would increase by 14 percent if gender inequality were reduced to the level observed in, say, the country of Sweden. Further research should concentrate on two issues. The first is how distinct mechanisms of gender discrimination - bias against participation versus wage discrimination - affect output. The second is the relationship between gender discrimination and the accumulation of human capital, in particular how curtailment of girl education affects overall human capital and output in a dynamic setting.[41] The

[41]See, for instance, Lagerlöf (2003).

paper is suggestive of the importance that macroeconomic models should ascribe to gender discrimination, a variable that is notably absent from most analysis.

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A Proof of Proposition 1

Equation (16) defines $h_t = \psi(\hat{k}_t, \phi)$. When $h_t = 1$, we have that $\psi_i(\hat{k}_t, \phi) = 0$. For $h_t < 1$, and using the implicit function theorem, yields:

$$\frac{\partial h_t}{\partial \hat{k}_t} = \psi_1(\hat{k}_t, \phi) = \frac{-B\gamma\theta\alpha\hat{k}_t^{-1}(2-h_t)}{(1+\beta+\gamma\theta)\phi(1-\alpha)k_t^{\alpha}(2-h_t)^{1-\alpha} + B\gamma\theta\alpha} < 0. \tag{22}$$

Clearly, $\psi_2(\hat{k}_t, \phi) < 0$.

B Proof of Proposition 2

Equation (20) defines a non-linear difference equation $\hat{k}_{t+1} = \xi(\hat{k}_t, \phi)$. As in Galor and Weil (1996), it is clear that $\xi(\cdot, \phi)$ is continuous, and when $\hat{k}_t < \hat{k}^*$, we have that

$$\hat{k}_{t+1} = \xi(\hat{k}_t, \phi) = \frac{\beta}{D(1+\beta)(1+\mu)}[(1-\alpha)\hat{k}_t^{\alpha} + B].$$

Therefore,

$$\xi_1(\hat{k}_t, \phi) = \frac{\beta}{D(1+\beta)(1+\mu)}[(1-\alpha)\alpha\hat{k}_t^{\alpha-1}],$$

and

$$\xi_{11}(\hat{k}_t, \phi) = \frac{\beta}{D(1+\beta)(1+\mu)}[-(1-\alpha)^2\alpha\hat{k}_t^{\alpha-1}] < 0.$$

Moreover, clearly $\lim_{k_t \to 0} \xi_1(k_t, \phi) = \infty$.

When $k_t > k^*$, then

$$\xi(\hat{k}_t, \phi) = \Delta[\phi(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha}]^{\theta}[(1+\phi)(1-\alpha)\hat{k}_t^{\alpha}(2-h_t)^{-\alpha} + B]^{1-\theta},$$

where $\Delta = \frac{\beta}{D(1+\mu)(\gamma\theta)^{\theta}(1+\beta+\gamma\theta)^{1-\theta}}$. We will first prove the proposition for $\theta = 1$, since the algebra is simpler and sketch the proof for $\theta > 0$. When $\theta = 1$, then

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

Therefore,

$$\xi_1(\hat{k}_t, \phi) = \frac{\beta}{D\gamma(1+\mu)}\phi(1-\alpha)\alpha\hat{k}_t^{\alpha-1}(2-h_t)^{-\alpha-1}[(2-h_t) + \hat{k}_t\frac{\partial h_t}{\partial \hat{k}_t}].$$

From (22), we have that $|\hat{k}_t\frac{\partial h_t}{\partial \hat{k}_t}| < (2-h_t)$, which implies that $\xi_1(k_t, \phi) > 0$ for $k_t > k^*$. In addition, observe that h_t goes to one as $\hat{k}_t$ increases. Therefore, $\lim_{\hat{k}_t \to \infty} \xi_1(\hat{k}_t, \phi) = 0$. A positive and locally stable steady-state $\bar{\hat{k}} = \xi(\bar{\hat{k}}, \phi)$ exists.

For any $\theta > 0$ but $\theta \neq 1$, then we also have that $\xi_1(\hat{k}_t, \phi) > 0$, since $|\hat{k}_t\frac{\partial h_t}{\partial \hat{k}_t}| < (2-h_t)$. Moreover, $\lim_{\hat{k}_t \to \infty} \xi_1(\hat{k}_t, \phi) = 0$.

C Model with gender productivity difference in child raising activities

The model presented in Section 2 relies on the assumption that men are more productive than women in physical labor, but they have an equal productivity in mental labor. Here we present an alternative framework in which there is only one type of labor, which is complementary to capital, but women are more productive than men in raising children. The preferences of the couple are still represented by the same utility function, but both the child raising and the production functions are changed.

In particular, we assume that each man and each woman have one unit of time that can be used to raise children or in market production. Let h_t^w and h_t^h denote the time of the wife and the husband spent in raising children. The child raising production function is given by

$$n_t = D(h_t^w + \eta h_t^h)^\theta, \; D > 0, \; \theta > 0. \tag{23}$$

We assume that $\eta \in (0, 1)$, which implies that women are more productive than men in household chores. For instance, women's ability to breastfeed, as emphasized by Albanesi and Olivetti (2007). The couple's budget constraints are:

$$c_t + s_t \leq w_t(1 - h_t^h) + \phi w_t(1 - h_t^w), \tag{24}$$

$$d_{t+1} \leq (1 + r_{t+1})s_t. \tag{25}$$

It can be shown that only the woman spends time raising children,[42] i.e., $h_t^h = 0$, and

$$h_t^w = \frac{\gamma\theta}{(1 + \beta + \gamma\theta)} \frac{1 + \phi}{\phi}, \tag{26}$$

which is increasing in gender inequality (lower ϕ). The time endowment of women requires that $h_t^w \leq 1$. Therefore, for given (γ, θ, β), there is a limit on gender wage inequality.

[42]Observe that $h_t^h > 0$ requires $\eta \geq 1/\phi$. But this cannot be the case, since $\phi < 1$ and $\eta < 1$.

The market production function is represented by a standard Cobb-Douglas function

$$Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}, \tag{27}$$

where L_t represents the labor input in production, $A_t = (1+\mu)^t$, and $\alpha \in (0,1)$.

In equilibrium, we have that capital evolves according to:

$$\hat{k}_{t+1} = \frac{\beta\phi^{\theta}(1+\phi)^{1-\theta}}{D(1+\mu)(\gamma\theta)^{\theta}(1+\beta+\gamma\theta)^{1-\theta}}(1-\alpha)\hat{k}_t^{\alpha}(2-h_t^w)^{-\alpha}. \tag{28}$$

In this case there exists a unique and globally stable steady-state level of capital per unit of efficient couple. Again cross-country differences in gender inequality will have two effects on long-run output: (i) one through its direct effect on labor participation; and (ii) another through its impact on fertility. Observe, however, that contrary to the model of Section 2, the present model generates gender wage inequality and fertility rates that are constant over time.

Table 5, Part I, provides all parameter values as well as a note on how each one was obtained. The calibration exercises use the same statistics that were used in the previous model. Now, we do not have to calibrate parameter B, but we have to calibrate parameter η, which is the relative productivity of men in child raising activities. Observe, however, that for any $\eta \in (0,1)$, only women will spend some time at home. Therefore η can take any value in the $(0,1)$ interval.

We again explore how the equilibrium properties of the model change with gender barriers, measured by the female to male earnings ratio. Table 6 shows that results are qualitatively and quantitatively similar to those presented in Table 2. A decrease in ϕ by a factor of two decreases output per capita by approximately 39 when fertility is endogenous, and by roughly 20 percent when fertility is exogenous. Recall that this same exercise using the model of Section 2 yielded the following reductions in output per capita (see Table 2): 40 and 17 percent for the case of endogenous and exogenous fertility, respectively.

Table 5: Parameter values, basic statistics, baseline economy. Sources: Goldin (1990), Goldin (2006), Maddison (2006), and Erosa, Fuster, and Restuccia (2005).

Part I: Parameter Values		
Parameters	*Values*	*Comment/Observations*
α	0.4	Capital share based on Gollin (2002)
μ	0.009	Rate of TFP growth based on Greenwood, Seshadri, and Vandenbroucke (2005)
β	0.3604	Calibrated to match the U.S. historical post-war return on government bonds (about 4%)
γ	0.445	Population growth rate is constant in the steady-state
D	2.5	Calibrated to match hours the average private cost of childre as a share of GDP
θ	0.9	Calibrated to match hours worked by women relative to hours worked by men in 2000
η	$\eta \in (0,1)$	Any number in the interval $(0,1)$
ϕ	0.63	Calibrated to match the U.S. female to male earnings ratio in 2000
$\hat{k}_0$	0.0085	Calibrated to match U.S. per capita output in 2000 relative to its level in 1900 (Maddison (2006))
Part II: Basic Statistics		
	U.S. economy	*Baseline economy*
$\phi w_{1900}/w_{1900}$	48%	48%
$\phi w_{2000}/w_{2000}$	63%	63%
y_{2000}/y_{1900}	7.0	7.0
$1-h_{2000}^{women}/1-h_{2000}^{men}$	60%	60%
$\phi w_{2000}^{m} h_{2000}/y_{2000}$	40%	40%

Table 6: Gender inequality and development: Quantitative properties of the model

	Output per capita, % baseline	Female to male earnings ratio	Hours at home, % baseline	Output per capita, % baseline (constant fertility)
Baseline	100	75	100	100
$\phi = \frac{1}{1.5} \times \phi_{\text{base}}$	75	50	128	87
$\phi = \frac{1}{2} \times \phi_{\text{base}}$	61	37	157	80
$\phi = \frac{1}{3} \times \phi_{\text{base}}$	47	25	214	70

D Gender inequality (ϕ) based on the gender gap index

In this appendix we use the gender gap index (see Hausmann, Tyson, and Zahidi (2006)) to estimate ϕ, instead of the female to male earnings ratio. This index is a composition of gender discrimination indices in health, education, political and economic empowerment. To determine the parameter estimate for ϕ for each country we multiplied the ratio of the gender gap index of a country to the U.S. value by the baseline $\phi = 0.75$. For instance, the gender gap index in the United States and in Egypt are 70 and 58.1, respectively. The estimated value of ϕ for Egypt is $\phi_{Egypt} = \frac{58.1}{70} \times \phi_{US} = \frac{58.1}{70} \times 0.75$=0.6225. Table 7 reports results using this approach. Observe that in almost all cases the female to male earnings ratio in the data than in model simulations.

E Economies with output per capita $\geq$ 10% of the U.S. level

In this appendix we run the same simulations that we did in Figure 3 in Section 5, but we consider only countries with the level of income per capita that is greater or equal to 10 percent of what is observed in the United States.

Table 7: Gender inequality and development: Empirical data and model predictions for reference economies. Source: United Nations (2005).

Countries	**Data**		**Model**		
	Output per capita, % baseline	Female to male earnings ratio	Output per capita, % baseline	Female to male earnings ratio	Output per capita, % baseline (constant fertility)
Baseline$_{\phi_{US}=0.75}$	100	63	100	63	100
Part (a)					
Ireland$_{\phi_{IRL}=0.7993}$	91	53	104	68	102
Greece$_{\phi_{GRC}=0.7125}$	56	55	96.8	60	98.5
Singapore$_{\phi_{SGP}=0.7082}$	71	51	96.4	59	98.4
Saudi Arabia$_{\phi_{SAU}=0.6054}$	37	16	87	50	94
Iran$_{\phi_{IRN}=0.6321}$	19	39	89.5	52	95
Egypt$_{\phi_{EGY}=0.6225}$	10	23	88.6	52	95
India$_{\phi_{IND}=0.6364}$	8	31	90	53	95.6
Part (b)					
Finland$_{\phi_{FIN}=0.8614}$	77	71	108.7	73	104
Norway$_{\phi_{NOR}=0.8636}$	99	77	109	73	104
Sweden$_{\phi_{SWD}=0.8732}$	77	81	109	74	104

Figure 5: Empirical Data and Model Predictions for Selected Economies. Blue squares represent model predictions with endogenous fertility and the blue solid line is the best linear fit. Green balls and the accompanying green solid line correspond to the constant fertility model. Dotted gray line: 45 degree line.