A Note On Gender Bias Inefficiency

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Abstract

Gender bias is often mentioned as part to an explanation for both the "missing women mystery" and gender educational gaps unfavorable to girls in developing countries. Since health and education add up to an individual's human capital, this suggests significant inefficiencies ongoing in many places worldwide. Yet, to the extent that gender bias filters through a population sex ratio - to follow on Edlund (J.P.E. 1999), there is a striking evidence of parental gender bias coexisting with high levels of human capital in many economies. This note rationalizes that multiple equilibria arise when gender bias interacts with an economy's macroeconomic features. It develops a stylized two-sector model with home production and shows that depending on a country's labor productivity, parental gender bias might actually be socially beneficial as it raises human capital per capita, or harmful in the sense that it reduces the society's average human capital.

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1 Introduction

Following the seminal work of Nobel price Amertya Sen (1992) on the "Missing Women" mystery gender discrimination has been the focus of an increasing number of contributions to different strands of the literature. A constant in this growing literature is the emphasis on gender discrimination as part of, if not the main explanation for, either the "missing women" mystery, gender educational gaps unfavorable to females in developing countries, earnings differentials, etc.. As health and education add up to an individual's human capital, gender bias might thus be feared to undermine human capital expansion in many societies. Owing to the notion that human capital is the engine of growth, this state of affairs implies that quite important inefficiency might be ongoing in many places all around the world.

Yet, following Edlund (*Journal of Political Economy*, 1999), to the extent that gender bias filters through a population sex ratio, there is some striking evidence of this feature coexisting with high levels of human capital in many countries including Mexico, Singapore, Costa Rica, Kuwait, Oman and the United Arab Emirates.[1] Some other countries including Bangladesh, India, China, Pakistan, and Saudi Arabia are also confronted with the same reality and yet these countries' human development indexes (HDI) assume medium values according to the United Nations Development Program (UNDP). A third group of developing countries experience gender discrimination and in the meantime they exhibit HDI figures below average. Chart 1 summarizes the basic facts using a sample of 111 countries worldwide.[2]

[1]Once gender bias is proxied with the population sex ratio, the demographic norm of 1.05 females per male is used as the frame of reference. Sex ratio below 1.05 is generally viewed as indicative of a pro-male biased society.

[2]The correlation between HDIs and females' enrolment rates is to the order of 0.91 - Data source: United Nations Population Division, and UNDP's 2006 Human Development Report.

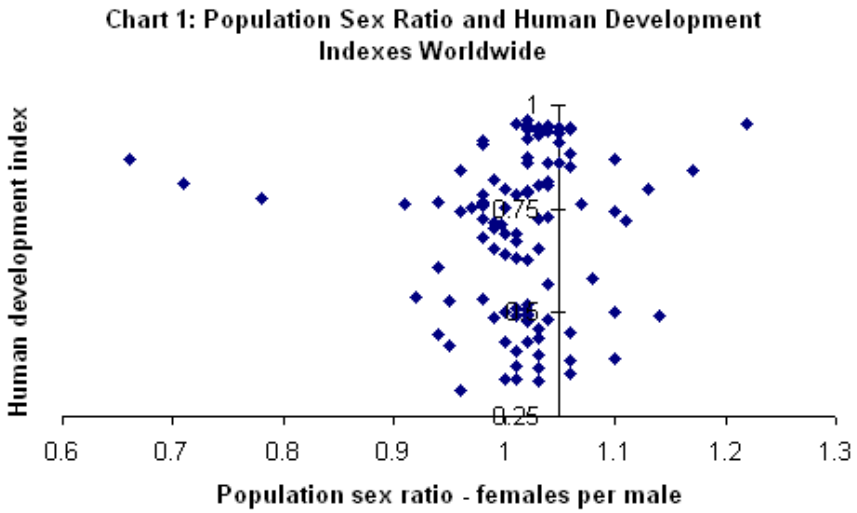


Chart 1 shows that different countries might experience the same magnitude of gender bias and yet follow very different development paths based on their HDIs. This puzzling evidence raises the issue of gender bias (in)efficiency in the context of developing countries and motivates our endeavor. More specifically, we investigate circumstances under which gender bias might be beneficial and those under which it might be detrimental to economic development. Our analysis is consistent with the existence of multiple equilibria regarding the socio-economic consequences of gender bias.

This note rationalizes that multiple equilibria arise when parental gender bias at the household level interacts with macro-economic features pertaining to the market economy. These features refer to a country's labor productivity (which pins down household's labor income), and schooling productivity (which determines schooling effectiveness as a human capital imparting devise).[3] Clearly, when faced with low labor productivity, households feel poor enough that labor income needs to be supplemented with some extra resources potentially involving child labor (Basu, 1999; 2000). We show that gender bias in this case leads the typical parents to claim relatively more on their daughters' time endowment when engaging in home production in their attempt to raise household consumption. However, because schooling productivity is not high enough and there are no human capital externalities

[3]It is worth noticing that these features deal with two of the there HDI's components, namely income per capita and literacy rates.

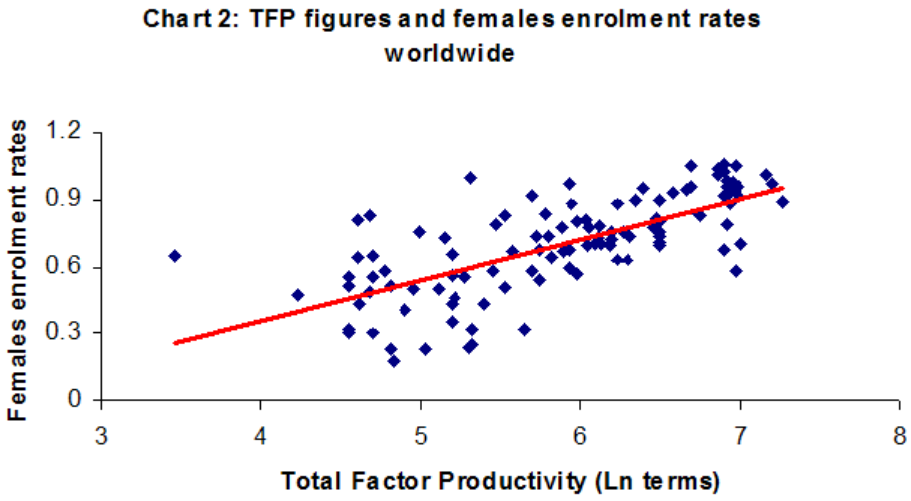
among siblings, gains in boys' education fail to outweigh the losses in girls' human capital and parental gender bias ultimately lowers the average human capital in the society.[4] Thus, gender bias proves detrimental in that the economy remains stuck in an underdevelopment trap with low average human capital.

Conversely, provided labor productivity is high enough, households feel less of a need for home production. In this case gender bias mainly maps into increased human capital investments to boys' benefit without necessarily impeding on the household provision to female offspring. Thus, parental gender bias now proves beneficial as it raises the average human capital of the society. Clearly, the scope of gender bias might be the same as in the previous case and yet cause the economy to converge towards a high-equilibrium profile with more human capital.

Overall, our theory rests on the notion that in the presence of parental gender bias, females' schooling is dependant upon labor market productivity. Based on a sample of 113 countries worldwide Chart 2 documents this association, with a correlation to the order of 0.70 between total factor productivity figures and females combined enrolment rates.[5]

[4]Assuming away intra-household externalities of human capital is a simplifying assumption. Using household survey data for Bangladesh, Basu, Narayan and Ravallion (2002) find evidence of external effects of education on individual earnings within households.

[5]The correlation is as high as 0.91 if based on HDI data. Enrolment rates data source: UNDP's 2006 Human Development Report. TFP data source: Miketa (2004), Technical description on the growth study datasets - http://www.iiasa.ac.at/ECS/data_am/index.html.



Whether there is empirical evidence of parental gender bias is now a settled issues (Masterson, 2008; Dahl and Moretti, 2008; Klassen, 1996). For instance the PROBE survey, a study that covered five Indian states accounting for almost half of India's population in 1996 reveals that: (1) Parents picture that returns to human capital investments are higher for boys; (2) regardless of their socio-economic background and location *i.e.* states, gender, literacy status, occupation and cast, parents consider boys as assets whose education is sensitive to invest in, while girls for their part are expected to leave their natal homes after marriage, hence motivating that boys' education should be given priority.[6]

While numerous contributions have been made to the gender literature, only recently have very few investigated the consequences of gender bias on the aggregate economy. However, this recent strand of research reaches conflicting conclusions as gender inequality is sometimes said to be a drag on growth (Klasen, 2002; Knowles and *al.*, 2002; Lagerlőf, 2003; Chichilnisky, 2008), or a stimulus (Blecker and Seguino, 2002). This note develops a simple unifying theory whereby both scenarios may arise in equilibrium depending on a country's macro-economic features.

Our contribution is best understood with reference to Chichilnisky (2008) who develops a model of the gender gap with home and market production. Chichilnisky shows that high

[6]Center for Development Economics, *The Schools Environment: Public Report on Basic Education in India*, Oxford University Press, 1999, p 22.

levels of output in the market sector can lead to two potential equilibria at the household level. In the first one women receive lower salary than men in the market sector and the household reacts by allocating more housework to women. In the second equilibrium men and women receive the same salary and share housework equally. While the former is shown to be inefficient in the sense that it lowers aggregate output, the latter is deemed riskier in the prisoner's dilemma sense.

Our model also draws a distinction between home and market production. However, it differs from Chichilnisky (2008) in significant ways.

A first fundamental difference pertains to the notion that gender bias bears a univocal relationship to efficiency and hence to economic growth. This note introduces gender-specific parental altruism towards children in a two-sector model economy along with a standard schooling-work trade-off. While only adults are eligible for employment in the market sector, the typical household may claim on the time endowment of its offspring to carry out home production. We normalize parental altruism towards male offspring to one and we introduce a parameter whose values range between zero and one to capture parental altruism towards female offspring. Parental gender bias sharpens as this parameter gets closer to 0 and we use that feature to show that gender bias translates into less schooling for girls relative to boys. Yet, we also show that overall, parental gender bias may raise the average human capital of the economy, especially when labor productivity is high enough that male offspring enjoy extra human capital investments without prejudice to female offspring. Among other major results we find that parental gender bias lowers prospective earnings for females relative to males, whereas a more productive technology in the market sector raises females' schooling and hence their prospective earnings. Whether wage increases in the market sector are driven by endogenous or exogenous technological progress has not effect on the results.

Human capital accumulation underlies the other important difference from Chichilnisky (2008) where the only trade-off is between housework and market production, and productive skills cannot be accumulated. In Chichilnisky's framework, on the one hand women are less productive than men in the market sector because they spend more time on housework,

and on the other hand they spend more time on housework because in the market sector they are less productive than men. In our framework schooling introduces a sequential causality which substitutes for Chichilnisky's circular argument. Clearly, son preference leads the typical parent to invest relatively more in the human capital formation of male offspring, hence reducing women's average human capital in the subsequent period. This channel is overlooked in most models that attempt to connect women's bargaining power within the household to their relative performance in the labor market (see, e.g., Basu, 2006; Chichilnisky, 2008). While allowing for a deeper investigation of productivity differentials across genders in the market place, our inter-temporal approach contributes to fill this gap of the literature.

In accounting for the work-study trade-off while leaving the possibility to claim on a child's time endowment to meet home production needs, the model clearly shares some features with the child labor literature. More specifically the note extends Dessy and Pallage (2005)'s model to include parental gender-specific altruism, hence the main departure from most models of child labor - including Dessy and Knowles (2008), Dessy and Pallage (2001, 2005), Baland and Robinson (2000), Basu and Zarghamee (2009), Basu (1999, 2000), Basu and Van (1998), and Glomm (1997). However, we build upon the standard assumption that a child has no bargaining power and is an instrument to the parent's maximization program (Basu, 1999).

While it is standard in the literature to consider child labor as an homogenous factor input entering the production process, accounting for parental gender bias offers deeper insights into the child labor phenomenon. In fact, the available evidence points to significant educational gaps unfavorable to young females. For all developing countries taken together, in 2004 the female literacy rate was 29% lower than male literacy, women's mean years of schooling was 45% lower than men's, and females' enrollment rates in primary, secondary and postsecondary schools were 9%, 28%, and 49% lower - Todaro and Smith (2006) p. 376. This picture clearly suggests an uneven claim on children's time to meet child labor. The case of Bina Kumani of Baridih village (Ranchi district, Bihar, India), appropriately

illustrates this argument:[7]

The child mothers

> "Her mother works as an agricultural laborer, and her father does construction work. When Bina was in class 3, her mother fell ill and she was made to drop out of school to do the housework. Now she is twelve and works ten hours a day, looking after the house and the younger siblings, and taking the cattle out to graze. In her spare time she sometimes looks at her brothers' textbooks, striving to make sense of them."

The remainder of this note is structured as follows. Section 2 presents the model which we solve in Section 3. Section 4 contains concluding remarks.

2 The model

Consider a two-period economy, $t = 1, 2$, populated by a continium of homogeneous parents of total mass normalized to unity. As the economy starts adults have one period left to live and bear up to n children at the beginning of the first period. To keep matters simple we normalize n to unity. This entails no loss of generality since fertility is exogenous in this framework. For simplicity it is also assumed that there is an equal probability to give birth to either gender, so that $n_m = n_f = .5$, where the subscript f (respectively m) stands for females (males). Each individual, either young or adult, is endowed with one unit of time per period. As this model economy starts, initial adults are also enjoyed h^1 units of human capital.

In this framework altruistic parents care for their children's future as captured through labor income in adulthood. However, because of social norms or else gender bias leads

[7]Center for Development Economics, *The Schools Environment: Public Report on Basic Education in India*, Oxford University Press, 1999, p. 31.

the typical parent to have a preference for male over female offspring. Each parent is a lifetime-utility-maximizer with cardinal utility function over household consumption, c^1, and children's future income, I_m^2 and I_f^2. The utility function is given by:

$$U(c^1, I_m^2, I_f^2) = u\left(c^1\right) + \left(I_m^2 + \gamma I_f^2\right)\bar{\beta}, \tag{1}$$

with $\bar{\beta} = n_f\beta = n_m\beta$, where $0 < \beta < 1$ is the discounting factor and $\gamma \in (0, 1]$ is an exogenous parameter which gives the extent of gender bias in this economy. In clear, $\gamma = 1$ implies that male and female offspring enjoy parental altruism alike. As γ approaches 0 parents increasingly favor male over female offspring. The function u is twice continuously differentiable, strictly increasing, and strictly concave.

An important feature of this model is that parents make time allocation decisions on behalf of their children. A child's time endowment can be allocated to schooling or to household production. The former involves upgrading on parental human capital through formal education whereas the latter does not add significantly to the inherited human capital, h^1. Throughout the analysis it is assumed that male and female offspring are potentially as much productive either at school or when involved in household production. The latter activity generates some output which adds to the household's consumption of the numeraire good.

2.1 Home vs. market production

The unique consumption good is produced either in the market sector or in the non-market one which is referred to as home or household production. Following Dessy and Pallage (2005), and Glomm (1997), there is no loss of generality in assuming that only adults are eligible for employment in the market sector. In that sector firms hire workers to produce output according to the following technology:

$$Y = AH, \quad A > 1, \tag{2}$$

where H denotes efficiency units of labor and A a scale factor capturing the level of technology used. In line with Galdor and Moav (2000), and Dessy and Pallage (2005), it is assumed that

the rate of technological progress between the first and the second periods, $g = (A^2 - A^1)/A^1$, is a function of human capital per capita in the second period, $\bar{h}^2$:

$$g = \psi\left(\bar{h}^2\right), \tag{3}$$

where ψ is a strictly increasing and strictly concave function. This formulation implies an externality *a la* Lucas (1990) in the market sector. In clear, the economy's average human capital raises each worker's productivity.

Profit maximization by perfectly competitive firms in the modern sector implies that each period, workers are paid the value of their marginal product, $\omega^1 = A^1 > 1$, in the first period, and

$$\omega^2 = A^1 + \psi\left(\bar{h}^2\right) \tag{4}$$

in the second period.

Next, to follow the lead of Glomm (1997) and Chichilnisky (2008) home production technology is given by the following:

$$Y^h = L, \tag{5}$$

with

$$L \leqslant n_f l_f + n_m l_m, \tag{6}$$

where l_f (respectively, l_m) denotes the fraction of time claimed on a female's (male's) endowment, and $n_m = n_f = .5$.

The above formulation calls for the important remark that children are the only contributors to home production. Under the maintained assumption that firms hire only adults, and to the extent that the market sector displays a superior technology as postulated above ($A > 1$), it is reasonable to assume that a typical parent inelastically supplies labor in the market sector. Thus, home production is delegated to children, especially as they inherit their parents' human capital at birth and participation into home production activities involves no compensation *per se*.

2.2 Human capital accumulation

In this environment children upgrade on their parents' human capital only through formal schooling. Thus, letting $e_j^1 = 1 - l_j^1$ denote the fraction of a child's time endowment which is devoted to schooling in the first period, with $j = f, m$, and letting the function $\phi(.)$ capture the productivity of schooling, in the second period the average human capital in this economy is given by the following:

$$\bar{h}^2 = h^1 + n_m \phi\left(e_m^1\right) + n_f \phi\left(e_f^1\right), \tag{7}$$

where ϕ is twice differentiable with $\phi' > 0$, $\phi' < 0$ and $\phi(0) = 0$. A concave specification implies that schooling productivity is subject to some form of diminishing returns, say because of fatigue. As schooling time increases it adds fewer units to one's human capital, $h_j^2 = h^1 + \phi\left(e_j^1\right)$.

Substituting (7) back into (4) yields the following expression for wages in the second period:

$$\omega^2 = A^1 + \psi\left[h^1 + n_m \phi\left(e_m^1\right) + n_f \phi\left(e_f^1\right)\right]. \tag{8}$$

Next, devoting a fraction e_j^1 of one's time endowment to schooling in the first period adds $\phi\left(e_j^1\right)$ units to the inherited human capital. Thus, females' (respectively, males') prospective labor incomes in the second period are given by:

$$I_f^2 = \left[h^1 + \phi\left(e_f^1\right)\right]\omega^2, \tag{9}$$

$$I_m^2 = \left[h^1 + \phi\left(e_m^1\right)\right]\omega^2. \tag{10}$$

As evidenced by both equations, an effective schooling system raises labor incomes in the second period. This is because such a system significantly adds to an individual's human capital while maximizing the spill-over effects.

2.3 The problem facing a typical parent

Unlike most models of child labor - including Dessy and Knowles (2008), Dessy and Pallage (2005), Baland and Robinson (2000), and Glomm (1997), this model introduces a gender di-

mension to the child labor phenomenon. The budget constraint facing the typical household is given by:

$$c^1 + \kappa n_m e_m^1 + \kappa n_f e_f^1 \leq A^1 h^1 + n_m l_m^1 + n_f l_f^1, \tag{11}$$

where, following the lead of Dessy and Pallage (2005), κ is a positive factor that converts one unit of the unique consumption good into units of education.

Combining (9), (10) and (1), the typical household seeks to:

$$\max_{c^1, l_f^1, l_m^1} \left\{ u\left(c^1\right) + \left[(1+\gamma) h^1 + \phi\left(1 - l_m^1\right) + \gamma\phi\left(1 - l_f^1\right) \right] \bar{\beta}\omega^2 \right\}, \tag{12}$$

subject to (11), and non negativity constraints on c^1, l_f^1 and l_m^1.

Equations (12) and (8) show that the problem facing a typical parent is subject to the nature of technological progress that drives increases in real wages over time. Yet, it can be shown that parental decision rule is not affected by that feature, hence the focus on exogenous technological change that will be made latter on.

3 Equilibrium Analysis

In deriving the consequences of parental gender bias in this environment we consider the following conceptual framework.

3.1 Characterization

A *competitive equilibrium* in this economy is a collection of endogenous variables $\left\{e_f^1, l_f^1, e_m^1, l_m^1, c^1, \omega^2, h_f^2, h_m^2\right\}$ such that:

(i) Given $(h^1, e_f^1, e_m^1, \omega^1, \omega^2)$, the demand for labor in the market sector is profit maximizing, *i.e.* $\omega^1 = A^1$ and $\omega^2 = A^1 + \psi\left(\bar{h}^2\right)$, where $\bar{h}^2$ is as defined in (7).

(ii) e_j^1 and l_j^1 satisfy $l_j^1 + e_j^1 = 1$, $j = f, m$.

(iii) The human capital market and the consumption good market clear, *i.e* $H^2 = \bar{h}^2$ and $c^1 + \kappa n_f e_f^1 + \kappa n_m e_m^1 = A^1 h^1 + n_f l_f^1 + n_m l_m^1$.

Substituting equation (11) into (12) and using $l_j^1 + e_j^1 = 1$, $j = f, m$, the value accruing to a household engaged in non-market production is given by:

$$\begin{aligned} V(l_f^1, l_m^1; \gamma) &= u\left[A^1 h^1 - \kappa + (1+\kappa) n_f l_f^1 + (1+\kappa) n_m l_m^1\right] + \\ &\quad \left[(1+\gamma) h^1 + \phi\left(1 - l_m^1\right) + \gamma\phi\left(1 - l_f^1\right)\right] \omega^2 \bar{\beta}. \end{aligned} \tag{13}$$

Equation (13) highlights the standard trade-off between having children contribute to the household's income and allowing them to build their human capital through formal schooling. Also important is the fact that parents value schooling quality. In fact, the above value function increases with schooling productivity, $\phi(.)$.

3.2 The social outcomes of parental gender bias

In the absence of human capital externalities technological progress is exogenous in that $\psi(h) = \lambda$, all h, where $\lambda \geq 0$ is an exogenous parameter. Thus the wage rate in the second period reduces to $\omega^2 = A^1 + \lambda$. Solving for the first order conditions with respect to l_f^1 and l_m^1 yields:

$$(1+\kappa) u'\left[A^1 h^1 - \kappa + (1+\kappa) n_f l_f^1 + (1+\kappa) n_m l_m^1\right] = \left(A^1 + \lambda\right) \gamma\beta\phi'\left(e_f^1\right), \tag{14}$$

$$(1+\kappa) u'\left[A^1 h^1 - \kappa + (1+\kappa) n_f l_f^1 + (1+\kappa) n_m l_m^1\right] = \left(A^1 + \lambda\right) \beta\phi'\left(e_m^1\right). \tag{15}$$

The left-hand sides capture the marginal benefits of claiming an additional unit on a child's time to increase current consumption, whereas the right-hand sides give the associated costs in terms of the forgone earning potential for children in the future. Equation (14) carries the important implication that gender bias, *i.e.* $\gamma < 1$, systematically lowers the private opportunity cost of claiming on daughters' time endowment for home production.

In the presence of human capital externalities, *i.e.* endogenous technological progress, and for any given value of γ, it can be shown that the social opportunity cost of claiming on females' time for non market activities is greater than the corresponding private cost. In fact, upon combining equations (8) and (13), the first order condition underlying females'

schooling time from a social perspective, e_f^{1s}, is given by:

$$\begin{aligned} & (1+\kappa)\, u'\left[A^1 h^1 - \kappa + (1+\kappa)\, l_f^{1s} + (1+\kappa)\, l_m^{1s}\right] \\ = \;& \left(A^1+\lambda\right)\omega^2\gamma\beta\phi'\left(e_f^{1s}\right) + \beta n_f \phi'\left(e_f^{1s}\right)\psi'(.)\left[(1+\gamma)\, h^1 + \phi\left(e_m^{1s}\right) + \gamma\phi\left(e_f^{1s}\right)\right], \end{aligned} \tag{16}$$

where the superscript s denotes a social variable. The claim above then follows from $\phi'(.) > 0$ and $\psi'(.) > 0$. Therefore, it must be that $e_f^{1s} > e_f^1$ since a higher cost must be matched with a higher benefit for equality to hold.

Moreover, the right-hand side in (16) shows that the social marginal opportunity cost of a female's time increases with γ, hence the implication that given the range of parameter values, a female's schooling time is the highest when $\gamma = 1$. This partial result provides a frame of reference when assessing the social consequences of parental gender bias.

Because in equilibrium gender bias may also induce parents to increase their human capital investment to the benefit of their male offspring, it is not clear whether overall and relative to a gender bias-free society, more or less units of human capital obtain. This note identifies circumstances under which gender bias might be socially-desirable in that the resulting average human capital in the economy is higher than otherwise.

Combining equations (14) and (15) yields the following auxiliary equation which underlies proposition 1:[8]

$$\frac{\phi'\left(e_f^1\right)}{\phi'\left(e_m^1\right)} = \frac{1}{\gamma}, \tag{17}$$

hence the result:

Proposition 1 *(Part one) In the absence of gender bias, schooling time is identical across genders.*

(Part two) *Whenever parental preferences are biased against female offspring girls spend relatively more time on home production compared to boys.*

Proof. (Exogenous technological change) It suffices to observe that for $\gamma = 1$, $\phi'\left(e_f^1\right) = \phi'\left(e_m^1\right)$, which implies $e_f^{*1} = e_m^{*1}$.

[8]Whether technological progress is endogenous or exogenous is irrelevant for the stated relation to hold.

To prove part two, assume $\gamma < 1$. Then, (17) implies that $\phi'\left(e_f^1\right) > \phi'\left(e_m^1\right)$, and by the concavity assumption of the function ϕ, this in turn implies that $e_f^{*1} < e_m^{*1}$.

(Endogenous technological change) In the Presence of spill over effects, $\omega^2 = A^1 + \psi\left[h^1 + n_m\phi\left(e_m^{1s}\right) + n_f\phi\left(e_f^{1s}\right)\right]$. Engaging in non market production yields the following value to the household:

$$\begin{aligned} V(l_f^{1s}, l_m^{1s}; \gamma) &= u\left[A^1h^1 - \kappa + (1+\kappa)\, n_f l_f^{1s} + (1+\kappa)\, n_m l_m^{1s}\right] + \\ &\quad \left[(1+\gamma)\, h^1 + \phi\left(1 - l_m^{1s}\right) + \gamma\phi\left(1 - l_f^{1s}\right)\right] * \\ &\quad \left(A^1 + \psi\left[h^1 + n_m\phi\left(1 - l_m^{1s}\right) + n_f\phi\left(1 - l_f^{1s}\right)\right]\right)\bar{\beta}. \end{aligned} \tag{18}$$

Differentiating (18) with respect to l_f^{1s} and l_m^{1s}, and combining the resulting equations yield:

$$\frac{\omega^2\gamma + \left[(1+\gamma)\, h^1 + \phi\left(1 - l_m^{1s}\right) + \gamma\phi\left(1 - l_f^{1s}\right)\right] n_f\psi'}{\omega^2 + \left[(1+\gamma)\, h^1 + \phi\left(1 - l_m^{1s}\right) + \gamma\phi\left(1 - l_f^{1s}\right)\right] n_m\psi'} = \frac{\phi'\left(e_m^{1s}\right)}{\phi'\left(e_f^{1s}\right)}.$$

Since $n_f = n_m$, it is easy to see that $\phi'\left(e_m^{1s}\right)/\phi'\left(e_f^{1s}\right) = 1$ whenever $\gamma = 1$, whereas $\phi'\left(e_m^{1s}\right)/\phi'\left(e_f^{1s}\right) < 1$ whenever $\gamma < 1$.Following the same steps as above then leads to the results.

This ends the proof. ■

Part 2 in proposition one also underlies another important result which we emphasize below:

Proposition 1 - Corollary *(Part one) In the absence of gender bias, prospective earnings are similar across genders.*

(Part two) In the presence of gender bias, females' prospective labor income is lower compared to that of males.

Proof. Using equations (9) and (10) male to female income differential is given by

$$I_m^{*2} - I_f^{*2} = \left[\phi\left(e_m^{*1}\right) - \phi\left(e_f^{*1}\right)\right]\omega^2. \tag{19}$$

Owing to the properties of the function ϕ, the results obtain as $e_f^{*1} = e_m^{*1}$ whenever $\gamma = 1$, whereas $e_m^{*1} > e_f^{*1}$ whenever $\gamma < 1$.

This ends the proof. ■

While income differentials may clearly stem from other sources - including gender-based discrimination inherent to the labor market *per se*, the result above points to parental gender bias in childhood as another important factor. In clear, by creating schooling time differentials, parental gender bias shifts the distribution of human capital towards males. This feature then translates into income differentials as both genders face the same market wage rate.

Notwithstanding the above, one may wonder why different countries facing similar gender bias norm would experience different females' schooling rates. We investigate this issue next. To that goal, let $0 < \varepsilon < 1$ denote the elasticity of schooling productivity, ϕ, with respect to schooling time, e, *i.e.* let $\phi(e) = e^{\varepsilon}$. This elasticity shows how schooling contributes to building one's human capital. Equation (17) implies that

$$e_f^{*1} = \gamma^{1/(1-\varepsilon)} e_m^{*1}. \tag{20}$$

Next, we substitute equation (20) back into (14) using $n_m = n_f$ and $l_j^{*1} = 1 - e_j^{*1}$, $j = m, f$. The first order condition for l_c^f, which we denote $\Gamma\left(l_c^f\right) = 0$, can now be written as follows:

$$\Gamma\left(l_c^f\right) = (1+\kappa)\, u'\left[(1+\kappa)\left(1+\gamma^{-1/(1-\varepsilon)}\right) n_f l_f^1 - (1+\kappa)\, n_f \gamma^{-1/(1-\varepsilon)} + Z\right] - \phi'\left(1-l_f^1\right)\gamma\beta\omega^2, \tag{21}$$

where $Z \equiv A^1 h^1 - \kappa + (1+\kappa)\, n_m$ is a constant. Equation (21) allows for a full characterization of females schooling time, e_f^{*1}, as affected by parental gender bias and more importantly, by some features that might be specific to each economy. Proposition 2 below connects labor productivity and females' schooling and sets the tone for our analysis.

Proposition 2 *Females' schooling time increases as technology in the market sector of the economy improves.*

Proof. The proof proceeds by way of differentiation of (21) with respect to l_f^1 and A, *i.e.*

$$\Gamma_{l_f^1} = (1+\kappa)(1+\kappa)\left(1+\gamma^{-1/(1-\varepsilon)}\right) n_f u''(.) + \phi''\left(1-l_f^1\right)\omega^2\gamma\beta < 0, \tag{22}$$

$$\Gamma_A = (1+\kappa)\, h^1 u''\left(c^1\right) - \phi'\left(1-l_f^1\right)\gamma\beta < 0. \tag{23}$$

Next, since $\Gamma_{l_f^1} \neq 0$ the Implicit function theorem applies to $\Gamma\left(l_f^{*1};\gamma,A\right)$ and there exists a function $l_f^{*1} \equiv \bar{\varphi}\left(A\right)$ such that $\bar{\varphi}' < 0$, where

$$\bar{\varphi}' = -\Gamma_A/\Gamma_{l_f^{*1}}. \tag{24}$$

The result follows from $l_j^{*1} = 1 - e_j^{*1}$.

This ends the proof. ■

Regarding the impact of parental gender bias on females' schooling time, notice that Part 2 in Proposition 1 can now be derived from equation (21) in a very similar manner as proposition 3. In clear, by applying the Implicit functions theorem to (21) it is easy to show that there exists a function $l_f^{*1} \equiv \varphi\left(\gamma\right)$ such that $\varphi' < 0$, where $\varphi' = -\Gamma_\gamma/\Gamma_{l_f^{*1}}$ and $l_j^{*1} = 1 - e_j^{*1}$.

Proposition 2 clearly sheds light on the role of economic factors when it comes to assessing females' schooling in gender-biased societies. Provided the market sector's technology is high enough that it generates decent labor incomes to working parents, there might be less of a need to rely on home production whose burden has been shown to fall mainly on females. This result aligns with Basu (1999)'s luxury axiom which states that households would not rely on child labor if their income from non-child labor sources is sufficiently high. Propositions 1 and 2 together show that different countries may share the same value of γ and yet follow very different human capital or development paths depending on the productivity of their respective market sectors.

The results above suggest that the socio-economic consequences of parental gender bias are not clear cut. The elusiveness of this situation arises from the fact that while impeding females' education, *i.e.* $\varphi' < 0$ or $\left(de_f^{*1}/d\gamma\right) > 0$, gender bias may foster males' schooling at the same time. In fact, from equation (20) it is easy to see that $de_m^{*1}/d\gamma = \left[\left(de_f^{*1}/d\gamma\right) - e_f^{*1}/\left(1-\varepsilon\right)\gamma\right]\gamma^{-1/(1-\varepsilon)}$. In clear, if females' schooling time is not that sensitive to parental gender bias, *i.e.* $\left(\gamma de_f^{*1}/e_f^{*1}d\gamma\right) < \left(1-\varepsilon\right)^{-1}$, then the latter feature mainly maps into increased human capital investments to the benefit of male offspring.[9] Therefore, working out the aforementioned elusiveness might provide deeper insights into the actual

[9]This might take the form of private tutoring for sons adding to regular schooling.

socio-economic consequences of gender bias. Below is a formal investigation of how parental gender bias ultimately impacts human capital per capita.

Since $n_m = n_f$, using equations (20) and $l_f^{*1} + e_f^{*1} = 1$ to substitute $l_f^{*1} \equiv \varphi(\gamma)$ back into (7) yields the following expression for human capital per capita in the second period:

$$H^2 \equiv \bar{h}^2(\gamma) = h^1 + \left(1 + \gamma^{-\varepsilon/(1-\varepsilon)}\right) n_f \phi \left[1 - \varphi(\gamma)\right]. \tag{25}$$

Next, based on equation (25), we first define the following elasticity:

$$\sigma = -\frac{\gamma \phi'\left(e_f^{*1}\right) \varphi'(\gamma)}{\phi\left(e_f^{*1}\right)}. \tag{26}$$

The elasticity in (26) captures the extent to which gender bias alters the human capital building potential of schooling in aggregate. Thus, this elasticity controls for the effects on both females' and males' schooling.

Proposition 3 *Let*

$$\bar{\sigma} \equiv \varepsilon/(1-\varepsilon)\left(1 + \gamma^{\varepsilon/(1-\varepsilon)}\right).$$

Then:

(Part one) Gender bias is socially harmful provided that $\sigma > \bar{\sigma}$.

(Part two) Gender bias is socially beneficial provided that $\sigma < \bar{\sigma}$.

Proof. The proof proceeds by differentiating equation (25) with respect to γ and then arranging terms:

$$\frac{d\bar{h}^2}{d\gamma} = -\left[\frac{\varepsilon}{1-\varepsilon}\gamma^{-\varepsilon/(1-\varepsilon)} - \left(1 + \gamma^{-\varepsilon/(1-\varepsilon)}\right)\sigma\right] \phi\left[1 - \varphi(\gamma)\right] \frac{n_f}{\gamma}.$$

The results follow from $\left(d\bar{h}^2/d\gamma\right) > 0$ if $\sigma > \bar{\sigma}$, and $\left(d\bar{h}^2/d\gamma\right) < 0$ if $\sigma < \bar{\sigma}$.

This ends the proof. ■

Part 1 in Proposition 3 states that parental gender bias is detrimental to the whole economy whenever it is strong enough that it prevents the human capital imparting potential of schooling to unfold for a significant fraction of the population. One might think of this case as referring to countries where basic literacy is still at stake. The result arises as gender

bias reduces enrollment or attendance rates among females, whereas the gains in males' education fail to outweigh the losses in females' human capital.

Conversely, part 2 points to the fact that some efficiency gains might derive from parental gender bias provided that it only has a negligible effect on females' schooling. The result unfolds as the losses (if any) in females' human capital are more than outbalanced by the gains in males' education. One might think of this case as applying to countries where post-primary education is at issue.

Moreover, with regards to part 2 in Proposition 3 the underlying micro behavior can be interpreted as a resource-targeting strategy. Under this interpretation a typical parent perceives that strategy as the only way to guarantee meaningful outcomes for school-goers, especially when confronted with limited resources or ineffective educational systems. This analysis is consistent with the "discouragement effect" as evidenced by the PROBE survey and summarized by Rukmini's story. While Rukmini is the only daughter of a four-child family, she never went to school as her forty-year mother claims "if we send the girl to school, we have to pay a laborer to replace her, and the girl learns nothing. What do we gain?"[10]

With these results in hand we can formally rationalize how proposition 3 combines with proposition 2 to explain the puzzling evidence of gender bias coexisting with high levels of human capital in some countries and not in others. To that goal, it is worth noticing that market sector's productivity affects σ through schooling time. In clear, the extent to which human capital per capita is affected by gender bias depends on households' labor income. In fact, owing to the concavity property of the function ϕ, it can been shown that σ is inversely related to a country's market sector's productivity, *i.e.*

$$\frac{d\sigma}{dA} = \gamma\varphi'(\gamma)\,\bar{\varphi}'(A)\,\frac{\phi\left(e_f^{*1}\right)\phi''\left(e_f^{*1}\right) - \left[\phi'\left(e_f^{*1}\right)\right]^2}{\left[\phi\left(e_f^{*1}\right)\right]^2} < 0. \tag{27}$$

Equation (27) is the cornerstone in explaining why for a given value of γ an economy might be caught in an underdevelopment trap with low average human capital or converge to a better high-profile equilibrium with significant human capital per capita. The intuition is as

[10]Center for Development Economics, *The Schools Environment: Public Report on Basic Education in India*, Oxford University Press, 1999, p 27.

follows. For a given value of γ, *i.e.* gender bias, low labor productivity in the market sector leads households to claim on their children's time endowment to meet home production needs. In the presence of gender bias we have shown that the burden of home production falls mainly on female offspring, with the implication that their schooling rates decrease. As labor productivity falls, the social effect of parental gender bias becomes increasingly apparent through females' schooling rates, hence increasing the sensitivity of $\bar{h}^2$ to γ. In clear, the configuration gradually aligns with $\sigma > \bar{\sigma}$, and parental gender bias indeed undermines human capital expansion, and hence, economic development.

However, for the very same value of γ as above, high labor productivity in the market sector translates into more females' schooling. The human capital per capita then shows less sensitivity to parental gender bias, and the configuration gradually aligns with $\sigma < \bar{\sigma}$ as labor productivity rises. As shown in Proposition 3, Part 2, gender bias then fosters human capital expansion and hence, promote economic development.

4 Concluding remarks

This note develops a two-sector model economy with home production to explain the puzzling evidence of gender bias coexisting with high levels of human capital in a significant subset of countries, whereas the same feature is often mentioned in explaining low females' schooling rates and the "missing women" mystery. The results show that whether gender bias is detrimental to economic development depends on TFP in the market sector of the economy. We first show that schooling and earning differentials unambiguously emerge as an equilibrium outcome whenever parental preferences are gender-biased.

However, we also show that the same feature does not necessarily lower human capital per capita in the economy. Low TFP in the market sector leads households to restrain their daughters' schooling so as to engage into home production. Parental gender bias then hinders development as it ultimately lowers the average human capital in the society. On the other hand, high labor productivity in the market sector raises human capital investments to the benefit of male offspring, without necessarily reducing that of female offspring, so that

parental gender bias benefits the economy through increased human capital per capita. Our analysis is consistent with the existence of multiple equilibria and suggests that raising TFP in a gender-biased society can actually allow the economy to turn a morally-embarrassing practice into an economic stimulus.

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