Gender Discrimination and Growth: Theory and Evidence from India

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Abstract

Gender inequality is an acute and persistent problem, especially in developing countries. This paper argues that gender discrimination is an inefficient practice. We model gender discrimination as the complete exclusion of females from the labor market or as the exclusion of females from managerial positions. We then analyze the distortions in the allocation of talent between managerial and unskilled positions, and in human capital investment. We find that both types of discrimination hinder economic development; and that the former also implies a reduction in per capita GDP, while the latter distorts the allocation of talent. Both types of discrimination imply lower female-to-male schooling ratios. We present evidence based on panel-data regressions across India's states over 1961-1991 that is consistent with the model's predictions.

Keywords: growth, gender discrimination, labor market, allocation of talent, India

JEL Classification: O10, O15.

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1 Introduction

Gender discrimination against women in the market place reduces the available talent in an economy, which has negative economic consequences. Gender discrimination takes many forms. Many social practices seen as normal from a religious or cultural point of view (which may have deep historical roots) leave women out of the economic mainstream. These social practices may have profound economic consequences because they do not allow society to take advantage of the talent inherent in women. This study investigates these economic consequences.

We develop a theoretical model that allows us to explore the economic implications of gender discrimination in the labor market. In the model, individuals are born with a given endowment of entrepreneurial talent and decide how much human capital to acquire, and whether to become managers or workers. Individuals can also engage in home production. Their choices depend on what everyone else is doing, because other people's decisions affect the returns to investment in human capital and the relative returns to becoming a manager or a worker. We study three possible scenarios. First, we analyze the labor market equilibrium without discrimination. Second, we model gender discrimination as an exogenous exclusion of females from managerial positions.[1] Our model shows how this discriminatory practice affects the labor market, the equilibrium wage rate, the allocation of talent across working and managerial positions, the investment in education by individuals (males and females), and economic growth. We show that discrimination tends to lower equilibrium wages for female and male workers, and to reduce investment in human capital by all females and by male workers. We also show that the average talent of managers is smaller in case of discrimination, which accounts for reduced innovation in the economy, and that the average productivity of workers, which accounts for technology adoption in the economy, is reduced too. Both factors lower economic growth. The fact that the relative average earnings of females relative to males are lower due to occupational segregation matches empirical evidence about the gender wage gap.[2]

Third, we model gender discrimination as a complete exclusion of females from the labor market.[3] That is, women can only engage in home production. In this case,

[1]Several studies report that in many countries it is more difficult for females to have access to human capital, land, and financial or other assets that allow them to be entrepreneurs. Women are underrepresented among top positions in most countries: even in the 30 most developed countries in the world, the average incidence of females among managers is less than 30 percent (World Bank 2001). In Italy and France, respectively, only 3% and 4% of the 50 largest companies' board directors are women (*The Economist,* November 25, 2005). In the US, women made up only 3.4% of the top level management in 1997 (Bertrand and Hallock 1999).

[2]Treiman and Hartman (1981) for instance using U.S. Census data estimated that as much as 35% of the pay gap could be explained by occupational segregation. For more on occupational gender segregation, see Preston (1999), Reskin and Roos (1990), and Strober (1984).

[3]Female labor force participation rates for 2006 according to the World Bank are as low as 25 percent for Oman, 30 percent for Jordan, 22 percent for Egypt, and 36 percent for India (World Bank 2007).

the equilibrium wage rate—and, hence, the average talent and productivity—is the same as in the case of no discrimination. Nevertheless, this type of discrimination is inefficient, because per capita GDP is lower than without discrimination, as home production productivity is lower than that of production outside the home. Economic growth is also lower because, even if the innovation and adoption dimensions are not affected, females optimally decide not to invest in human capital. Finally, we discuss why discrimination in the labor market of either type can be sustainable.

While gender discrimination against women in the labor market in developed countries is usually identified with differential wage rates, it is in developing countries that this discrimination appears to take the form of differential access to wage employment (Collier 1994). To test the implications of the model we take the particular case of India. This is a relevant case for the current study since a number of reasons, such as the observance of *purdah*, are well known to restrict women's access to work (Kumar *et al* 1999). The existence of a great variability in gender sensitivity and customs among Indian states makes it suitable for the sort of econometric analysis that we pursue. Regions in northern India (which tends to be more patriarchal and feudal) have lower female labor force participation rates than southern regions (where generally women have relatively more freedom and a more prominent presence in society). Although the cultural restrictions women face are changing, women are not still as free as men to participate in the formal economy (Drèze and Sen 1995, Dunlop and Velkoff 1999, Nihila 1999).

In order to make use of the variability over time among states, we then use panel data from sixteen of India's states, accounting for about 95% of India's population, over 1961-1991. We find that, as predicted by the model, the ratio of female-to-male managers and the ratio of female-to-male workers are positively and statistically significantly related to per capita output. We find that the effect is large, particularly in the former case: an increase from zero women managers to 50% of managers being female would lead to an increase in real per capita non-agricultural income of about 300%. Our regressions control for female and male literacy rates, socioeconomic controls, political controls, state and year fixed effects, and state-specific trends. We deal with potential endogeneity of the gender composition of the labor force by using the ratios of female-to-male primary and middle school teachers as instruments.

The paper is organized as follows. In the next section we discuss some related literature. Section 3 contains the model. Section 4 presents some background information on India. Section 5 turns to the empirical evidence, and Section 6 concludes and discusses policy implications.

2 Related literature

Even though an extensive literature tries and assesses the equity implications of gender inequality (e.g., the existence of unexplained inequality in wages,[4] potential gender gaps in the intra-household allocation of goods through demand analysis[5]) not much has been said about the efficiency costs of this inequality.

Some studies explore the empirical relationship between different forms of gender inequality and growth. Most of them consist of cross-country analyses that measure gender inequality in terms of schooling, life expectancy,[6] or the gender wage gap, so that the usual problems arise (e.g., unobserved heterogeneity across countries). This paper uses panel data from India's states, and thus constitutes an alternative empirical analysis that might overcome these shortcomings.

In our model, we consider the exclusion of women from (1) managerial positions, and (2) the entire labor force. The latter could be consistent with either a story of taste discrimination (Becker 1957), whereby for instance employers do not like to hire female workers, or a story of statistical discrimination (e.g., Phelps 1972), where employers do not hire female workers because they perceive them to be less productive than male workers. The former type of discrimination, instead, would relate to a social norm: women might not become entrepreneurs, but rather become workers, in the context of religious or traditional beliefs that might operate as social norms. The concept of social norm that we use in order to model discrimination is related to the concept of social stigma in Goldin (1995), and is consistent with issues of identity and occupation as described in Akerlof and Kranton (2000). While we do not endogenize discrimination, the existing empirical evidence based on micro data is consistent with the existence of social norms operating to sustain stigma (a la Goldin 1995) in the case of India (Mammen and Paxson 2000). Here we simply consider discrimination as exogenous, and discuss its sustainability.

Our model is based on a model by Rosen (1982), who analyzed the individual's decision between becoming a manager or a worker in order to match the empirical observation that managers' earnings at the highest hierarchies in large organizations are skewed to the right. As in that paper, we assume that (1) there are multiplicative productivity interactions and (2) the quality of supervision gets congested.[7] This paper argues that inefficiencies arise due to distortions in the choice of whether to become a worker or a manager, leading to distortions in the allocation of talent.

[4] Instances are Blau (1996), Blau and Kahn (1994, 1999) and Horrace and Oaxaca (2001).

[5] Deaton (1997), Burgess and Zhuang (2001).

[6] See Dollar and Gatti (1999), Klasen (1999, 2002), Knowles *et al* (2002), or World Bank (2001a) for a survey. Tzannatos (1992) uses simulation and occupational data from a few Latin American countries to assess what would be the change in the gender composition of the labor force and in output were there wage equality across genders.

[7] Models where the decision between being a manager or a worker is given by latent talent (or alternatively, risk aversion) can also be found in Lucas (1978), Kanbur (1979), and Kihlstrom and Laffont (1979).

The idea that distortions in the allocation of talent across occupations or sectors have negative growth implications is not new (Murphy *et al* 1991, Fershtman *et al* 1996), but to our knowledge this is the first study to use it in order to analyze the consequences of discrimination.

There also exists an extensive literature that investigates a reverse relationship between gender inequality and economic development, i.e., how gender inequality changes along the development process. As described in Forsythe *et al* (2000), some studies find the linear negative relationship that would be predicted by the neoclassical model, a second array of papers seem to find the U-shaped relationship described by Boserup (1970), in the same way as Kuznets (1955) established for income inequality; finally another set of papers finds either no robust relationship or mixed results.

A number of papers use models to study the link between gender and economic growth. Using an overlapping generations framework, Galor and Weil (1996) and Lagerlöf (2003) investigate the relationship between inequality in human capital and earnings and economic growth via the interaction between labor and fertility. In these papers, decreases in gender gaps in earnings lead to reduced fertility and higher economic growth. In the former paper, men and women are equally talented regarding mental input, while men are more endowed regarding raw physical input. In their model, growth in physical capital is assumed to lead to increases in the marginal product of mental input that are proportionally higher than increases in the marginal product of physical input, and thus to reduced fertility given the cost of children. In Lagerlöf (2003), men and women are equally talented at birth, and parents maximize the household income of their children taking other parents' behavior as given. If there gender gaps in education, parents optimally choose to endow daughters (who will likely marry an educated man) with lower human capital than sons (who will in turn marry an relatively uneducated woman). In that context, and if parents coordinate on more gender-equal equilibria over time, whereby gender inequality in human capital is reduced, fertility also declines and growth increases.

In contrast to these studies, our paper does not look into the link between labor and fertility. Given that this has been already captured in other work, here we focus on an allocation of talent argument that can exist beyond fertility and childrearing considerations. In our paper, we find an empirical negative relationship between gender inequality in employment and development. Consistent with this finding, we develop a simple model where men and women are equally talented at birth and where individuals can decide whether to become managers or workers. The model then considers the consequences of exogenous social norms excluding women from certain positions, or from the overall labor force, in terms of the allocation of talent, human capital decisions, and development. While fertility considerations are important for the understanding of gender issues, we provide an alternative, complementary story that is consistent with our results. Furthermore, while our model is used here to derive implications regarding gender discrimination, it could also be applied to other types of discrimination.

This paper can also be related to some studies that explore other types of discrimination or discrimination in a broad sense. Coate and Tennyson (1992) explore what happens when individuals belonging to a group that is discriminated against face higher interest rates in borrowing to enter self-employment. This statistical discrimination is not derived from credit market discrimination, but from labor market discrimination, which spills over to the credit market in the context of asymmetric information regarding borrowers. A related hypothesis could be used to explain the form of partial discrimination that we use in this paper, as we explain later.

3 Model

3.1 The division between managers and workers in the labor market

Following Rosen (1982), we consider an economy where each firm is run by one manager, who employs workers. Workers, in turn, follow the directions that are given by the manager. In our model, however, individuals can alternatively work in home production instead. As in Goldin (1995), home production here refers to productive activity that could be done outside the home (at firms).

Individuals are born with a given endowment of underlying managerial talent, denoted by T.[8] Each individual can optimally choose whether she wants to become a manager or a worker. Each person is described by a vector of skills (r, q, q_H), where r denotes managerial skills, q denotes productivity as a (market) worker, and q_H denotes productivity as a home worker. The type of skill she actually utilizes is determined by her decision to be either a manager, a worker, or a home worker, while the other skill remains latent. Here we also introduce the possibility of investing in human capital to increase the amount of skills. Also differently from Rosen (1982), talent is only useful for managers.[9] In particular, individuals can acquire primary education and/or higher education. We assume that those who want to become workers acquire only primary education, while those who want to be managers can acquire both primary and higher education. An individual cannot acquire higher education without first having completed primary schooling. No education is assumed to be necessary for the home production sector. Productivity of home workers is then constant and equal to one. That is, individuals can decide whether to become managers, workers, or home production workers. If they are workers, they can study and improve their productivity over one by acquiring primary education; however, if they are engaged in the home production sector then their productivity is equal to one. We assume

[8] This concept is similar to the notion of *energy* used in Becker (1985).

[9] In contrast, Rosen (1982) uses a broader concept of talent, ξ, and assumes that skills are given and equal to $q = a_q + b_q\xi$ and $r = a_r + b_r\xi$, for some constants a_k, b_k, $k = \{q, r\}$.

that skills are given by the following:

$$\begin{aligned} r &= cT\overline{H}_p + (1-c)T^{\beta}H_h^{1-\beta} \\ q &= 1 + H_p^{\sigma} \\ q_H &= 1 \end{aligned} \tag{1}$$

with $0 < \beta < 1$ and $0 < \sigma < 1$, for some constant $0 < c < 1$. If a (market) worker does not invest in human capital, he has a skill equal to 1. H_j,for $j = \{p, h\}$ denotes the level of primary and higher schooling acquired by individuals. Complete primary schooling is denoted by $\overline{H}_p$.

Notice that productivity of staying-at-home workers is lower than productivity of outside-home workers for any positive amount of education, implying higher earnings for the latter. Hence, we are in fact assuming that workers outside home will have greater earnings than home workers. We make this assumption for several reasons. First of all, here we want to analyze a social norm that would conflict with economic incentive – in that sense, for the problem to be interesting it has to be true that women can earn more working outside the home – otherwise there is no conflict (Elster 1989a). Secondly, this seems empirically plausible for developing countries, where home workers usually earn lower wages than workers in factories.

We assume that entrepreneurial talent at birth is distributed uniformly for males and females. The total population is P, one-half of which is female. The product attributable to a manager with r skills supervising a total quantity of labor skills $Q = \sum_{i=1}^{N_j} q_i$ is,

$$Y_r = sg(r)f(Q) \tag{2}$$

where $f\prime \geq 0$, $f\rfloor < 0$ (diminishing returns), $g\prime > 0$, s is the current state of technology, which is a non-rival, non-excludable good, and N_j denotes the amount of workers hired by firm j's entrepreneur.[10]

The form $g(r)$ can be thought of as the analytical representation of the quality of management decisions, so that greater r implies greater $g(r)$. In other words, higher-quality managers make better management decisions. In particular, the term $g(r)$ gives a representation of the quality of the entrepreneur who is running the firm, so that there are multiplicative productivity interactions.[11] It also captures the idea that the quality of managers is embodied. This formulation implies scale economies since the marginal product of the additional quality of workers is increasing in $g(r)$. However, the diminishing returns to Q imply that this scale economy is congested so that the best manager does not take all the workers.

We assume that Y_r exhibits constant returns to scale and that f and $g(\cdot)$ are a

[10] We therefore add technology to the original specification in Rosen (1982).

[11] This is related to the production function used in Kremer (1993), where the author considers multiple tasks, and explains how failure of one task can have a knock-on effect on other tasks.

Cobb-Douglas function; therefore we can rewrite (2) as

$$Y_r = sr^{\alpha}Q^{1-\alpha} \tag{3}$$

with $0 < \alpha < 1$.

Next we study the occupational decision of individuals. An individual can decide between a managerial position, a working position, and production at home. We assume that an individual who engages in home production does not get any salary—therefore, whatever their level of underlying managerial talent, individuals will prefer being managers or workers in the labor market rather than engaging in the home production sector.[12]

The decision between becoming a manager or a worker does depend on the endowment of managerial talent and is analyzed next.

3.1.1 The managers' problem

A manager with r skills faces a two-stage decision. First, how much education (primary and higher) does she want to acquire as a manager? Second, how many workers is she going to hire? She takes wages (w) as given. We solve the problem by working backward.

Stage 2:

Given skills r, the manager's problem is to choose the size of her company (or the size of her labor force, Q_r) that maximizes gross income:[13]

$$\max_{Q} \pi_r = sr^{\alpha}Q_r^{1-\alpha} - wQ_r$$

where the price of output is normalized to one and w is the market efficiency price for Q_r (which we call the wage), so that the amount Q_r of worker skills that maximizes profits is given by the first-order condition:

$$Q_r = \left[\frac{s(1-\alpha)r^{\alpha}}{w}\right]^{\frac{1}{\alpha}} \tag{4}$$

Equation (4) is the demand function for worker skills for the firm, which determines the size of the firm. The greater the manager's skills (r), the larger is her firm; the higher the wage, the lower the hiring; and the better the technology (s), the more workers are hired by r. We can rewrite managers' gross income as:

$$\pi_r = \left[s^{\frac{1}{\alpha}}w^{\frac{-(1-\alpha)}{\alpha}}\alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}\right]r \tag{5}$$

[12] This assumption is not necessary—it is only necessary that the wage received for home production is lower than the wage from market production (which is true in this model, as market workers invest in human capital and hence they are rewarded by their higher productivity), which is necessary to have a conflict with economic incentive (Elster 1989a).

[13] The manager's gross income is profits, while net income corresponds to profits minus total cost of education; net income is ignored here because it plays a role only in stage 1.

That is, the profit is a linear function of skills, where the factor of proportionality is a combination of wages and technology.

Stage 1:

Given that she knows that she will be rewarded according to (5), the manager chooses a level of human capital that maximizes her net income. We distinguish between primary and higher education, and the manager can only choose her investment in higher education because she needs to acquire $\overline{H}_p$ units of primary education in order to get to higher schooling. Therefore, we can write the manager's problem as:

$$\max_{H_{h,r}} \pi_h^{net} = \pi_r - a_p \overline{H}_p - a_h H_{h,r} \tag{6}$$

where a_j, $j = \{p, h\}$ denotes the cost of each unit of education of primary and higher schooling, respectively.

It makes sense to think that the opportunity cost of education is given by human time and also other inputs, which are combined in the same proportions as in the production of GDP. In particular, it makes sense that a_j and s grow at the same rate. For this reason, we assume that the cost of education evolves according to changes in GDP. That is, $a_j = \lambda_j s$ for positive constants λ_j. The first-order condition for problem (6) implies

$$H_h = \left[(1-c)^{\frac{1}{\beta}} \widetilde{\alpha} s^{\frac{1}{\alpha\beta}} w^{-\frac{(1-\alpha)}{\alpha\beta}} a_h^{-\frac{1}{\beta}} \right] T \tag{7}$$

where $\widetilde{\alpha} \equiv \alpha^{\frac{1}{\beta}} (1-\alpha)^{\frac{1-\alpha}{\alpha\beta}} (1-\beta)^{\frac{1}{\beta}}$.

That is, since $a_p \overline{H}_p$ is a fixed cost to entrepreneurs, it enters their net income function (6) but does not affect their marginal decisions.

Using (1) and (7), we see that a manager's skill is optimally determined as a function of entrepreneurial talent at birth:

$$r = \left[c\overline{H}_p + (1-c)^{\frac{1}{\beta}} s^{\frac{1-\beta}{\alpha\beta}} w^{-\frac{(1-\alpha)(1-\beta)}{\alpha\beta}} a_h^{-\frac{1-\beta}{\beta}} \widehat{\alpha} \right] T \tag{8}$$

where $\widehat{\alpha} \equiv \widetilde{\alpha}^{\frac{1}{\beta}}$.

Notice that there is a linear relationship between the person's underlying entrepreneurial talent, T, and her managerial skills, r. Substituting (7) and (8) into (6) and (5) allows us to write managers' net income as a linear function of talent at birth:

$$\pi_T^{net} = \left[c\overline{\alpha}\overline{H}_p s^{\frac{1}{\alpha}} w^{-\frac{1-\alpha}{\alpha}} + (1-c)^{\frac{1}{\beta}} s^{\frac{1}{\alpha\beta}} w^{-\frac{1-\alpha}{\alpha\beta}} a_h^{-\frac{1-\beta}{\beta}} \right] T - a_p \overline{H}_p \tag{9}$$

where $\overline{\alpha} \equiv \alpha(1-\alpha)^{\frac{1-\alpha}{\alpha}}$. That is,

$$\pi_T^{net} = \Psi(\underset{(-)}{w}, \underset{(+)}{s}, \underset{(-)}{a_p}) \cdot T - a_p \overline{H}_p$$

Managers' net income is depicted as in the profit line in Figure 2.

Since s and a_h are proportional, then Ψ is homogeneous of degree one in s (because the wage rate will also grow at the same rate as s). That is, since s and a_j grow at the same rate, in the steady state profits, wages and, therefore, GDP all grow at the same rate. However, H_h will remain constant over time.

3.1.2 The workers' problem

(Market) workers earn qw as gross income. They can increase their productivity (q) by studying. Education for workers is primary education, with unit cost equal to a_p. Since the maximum amount of primary schooling is $\overline{H}_p$, more schooling does not benefit workers. Using (1), we can write the problem of workers as

$$\begin{aligned} \max_{H_p} I_w^{net} &= wq - a_p H_p \\ s.t.\ H_p &\leq \overline{H}_p \\ q &= 1 + H_p^{\sigma} \end{aligned}$$

The optimal investment in primary education by workers is given by the first-order condition

$$H_{p,w} = \left[\frac{w\sigma}{a_p}\right]^{\frac{1}{1-\sigma}} \tag{10}$$

The optimal decision in (10) is smaller than $\overline{H}_p$ as long as the wage rate is relatively low, in particular, as long as

$$\tag{11}$$

$$w \leq \frac{a_p \overline{H}_p^{1-\sigma}}{\sigma}. \tag{12}$$

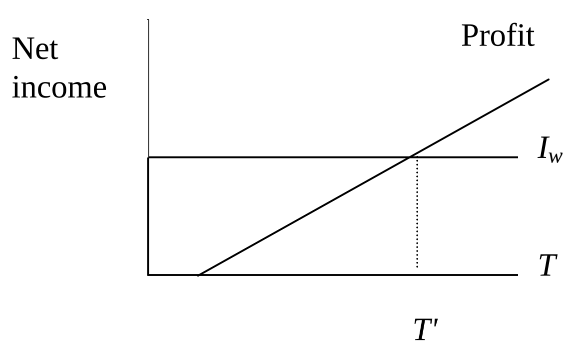


Figure 1 Net income schedules for workers and managers

Also, according to (10), the human capital investment for all workers is the same, regardless of underlying entrepreneurial talent. As long as the cost of schooling is the same, we can write

$$I_w^{net} = w + w^{\frac{1}{1-\sigma}} a_p^{-\frac{\sigma}{1-\sigma}} \widehat{\sigma},$$

where $\widehat{\sigma} \equiv (1-\sigma)\sigma^{\frac{\sigma}{1-\sigma}}$. That is, the workers' net income is increasing in the wage rate and decreasing in the cost of schooling. The net income schedule for workers as a function of T is drawn in Figure 2. It is a horizontal line in T because the underlying managerial talent is only useful for managers.

The determination of workers and managers In Figure 1, we see that individuals with underlying entrepreneurial talent less than T' optimally decide to be workers, while those with more underlying entrepreneurial talent than T' optimally decide to be managers. We call T' the cutoff level of talent since this is the level of underlying talent of the least-talented manager in the economy.[14]

Proposition 1 *A decrease in wages decreases the cutoff level of talent in the economy.*

Proof. see appendix. ■

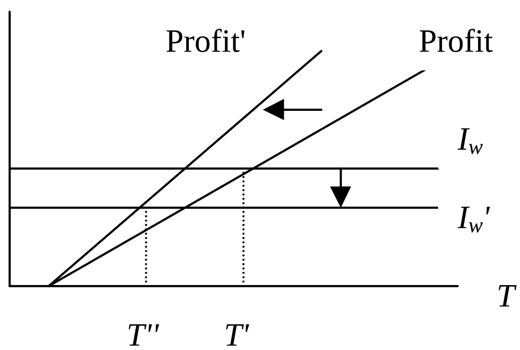


Figure 2 Effects of a decrease in wage rates

The intuition of Proposition 1 is that, when wages fall, the incentive to be a manager increases. Since talent is uniformly distributed, some of those who were previously workers now decide to be managers, so that the least-talented manager is less talented than was the case at the higher level of wages.

As shown in Figure 2, a decline in wages, which entails a decline in workers' net income from to and hence an increase in profits, from $Profit$ to $Profit'$, unambiguously results in a decline in T', the cutoff level of talent of managers, to T''.

[14]The single-crossing property in the model, which determines who will be a manager and who will be a worker according to latent talent, is a simple feature in Rosen (1982) that we get with only assuming that net income schedules have different slopes (see footnote 8). Here we endogenize income schedules for two reasons: first, in order to see how a change in the labor market equilibrium affects occupational decisions of individuals and hence potential distortions, and second, to study the role of human capital.

3.2 Labor market equilibrium without gender discrimination

In order to solve for the equilibrium wage rate w, we need to compute the aggregate supply and demand for worker skills. Notice that in this scenario, no individual engages in home production, because they get higher income from working as either workers or managers.

3.2.1 Aggregate supply of workers' skills without gender discrimination

We assume that the distribution of initial talent is uniform between 0 and 1 (Figure 3).

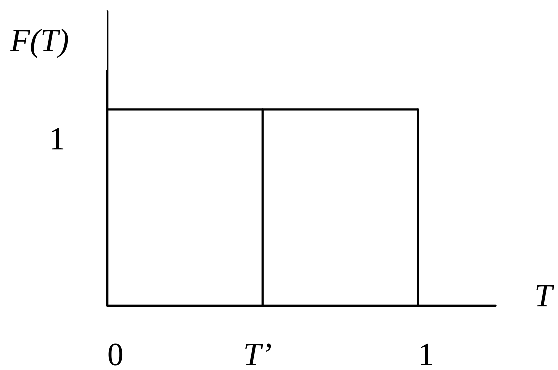


Figure 3 Distribution of underlying managerial talent in population

The fraction of the entire population that becomes workers is the integral between 0 and $T\prime$. From (9) we know that each of them will acquire the same amount of education, so that the skill of each worker is

$$q = 1 + \left[\frac{w\sigma}{a_p}\right]^{\frac{\sigma}{1-\sigma}}.$$

The aggregate supply of worker skills (Q) is, hence, given by

$$Q_S^{ND} = \int^{T(w^{ND})} P\left[1 + \left[\frac{w^{ND}\sigma}{a_p}\right]^{\frac{\sigma}{1-\sigma}}\right] dT = P \cdot T'(w^{ND})\left[1 + \left[\frac{w^{ND}\sigma}{a_p}\right]^{\frac{\sigma}{1-\sigma}}\right], \quad (13)$$

where ND stands for nondiscrimination. As we showed in Proposition 1, the cutoff level of talent is an increasing function of the wage rate. Hence, the supply of workers is an increasing function of the wage rate for two reasons. First, higher wages lead to more workers and fewer managers (this is represented by the $T\prime(w)$ term). Second, higher wages increase the incentive to acquire worker skills. Note than even if we do not allow workers to acquire skills, the labor supply is still upward sloping.

3.2.2 Aggregate demand for worker skills without gender discrimination

Each firm's demand for worker skills is given by (4). There is a one-to-one relationship between managerial skills (r) and underlying entrepreneurial talent (T), given by (8), so that we can write the demand for labor of one firm in terms of T:

$$Q_T = s^{\frac{1}{\alpha}}(1-\alpha)^{\frac{1}{\alpha}} w^{ND\frac{1}{\alpha}} \left[c\overline{H}_p + (1-c)^{\frac{1}{\beta}} s^{\frac{1-\beta}{\alpha\beta}} w^{ND^{-\frac{(1-\alpha)(1-\beta)}{\alpha\beta}}} a_h^{-\frac{1-\beta}{\beta}} \widehat{\alpha} \right] T \equiv \mu(\underset{(-)}{w^{ND}}, \underset{(+)}{s}, \underset{(-)}{a_h})T$$

The aggregate demand for worker skills is the sum of individual demands across all entrepreneurs; this demand can be represented as the individuals from the cutoff level of talent ($T\prime$) to talent equal to 1 (Figure 3), multiplied by P, the total population:

$$Q_D^{ND} = \int_{T'(w^{ND})}^{1} \mu(w^{ND}, s, a_h)T \cdot P \cdot dT = P\mu(w^{ND}, s, a_h) \left[\frac{1}{2} - \frac{T'^2(w^{ND})}{2} \right]. \quad (14)$$

Holding constant $T\prime$, the aggregate demand for worker skills is decreasing in wages, increasing in technology, and decreasing in the unit cost of higher education. Holding these three constant, aggregate demand for worker skills is decreasing in $T\prime$. Since we showed that $T\prime$ is increasing in wages, it follows that the aggregate demand function depends negatively on wages for two reasons. First, as wages increase, each firm will demand fewer workers. Second, when wages rise, the cutoff level of talent increases, that is, fewer people want to be managers and the number of firms demanding workers declines. Hence, the overall effect of wages on labor demand is negative.

The equilibrium wage rate is given by the equalization of (12) and (13), as seen in Figure 4.

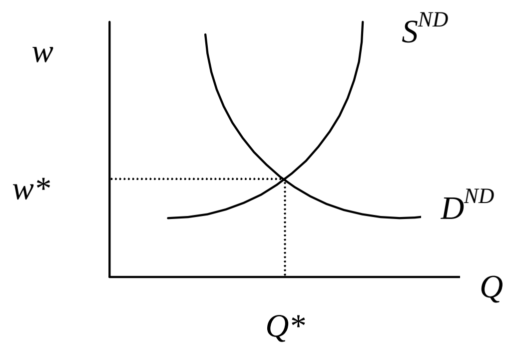


Figure 4 Labor market equilibrium

3.2.3 The number of entrepreneurs

Let the total number of managers be M, which is the sum of male and female entrepreneurs, $M = M_f + M_m$. Since males and females are each one-half of the total population, and both genders are assumed to have the same underlying entrepreneurial talent, the total number of entrepreneurs without discrimination is

$$M^{ND} = M^{f,ND} + M^{m,ND} = \frac{P}{2} \int_{T'(w^{ND})}^{1} 1dT + \frac{P}{2} \int_{T'(w^{ND})}^{1} 1dT = \left[1 - T'(w^{ND})\right] P. \quad (15)$$

3.2.4 Economic growth

How does the allocation of talent determine the growth rate of the economy? We assume that the increase in technology is determined by three factors.

First, we consider that one determinant of growth is the average quality of ideas in the economy, where the quality of ideas can be represented by the underlying entrepreneurial talent of managers (an *innovation* aspect of growth).[15] The reason is that managers are heterogeneous, implying that the average quality of ideas will be a combination of good and bad ideas. Whether an idea is good or bad is apparent only after it has been tried out. If the idea turns out to be good, then it is adopted and the level of technology increases. If it is bad, time and effort are wasted without any benefit. If more talented people tend to have good ideas and less talented people tend to have bad ideas, then people with smaller-than-average talent will tend to hurt the economy. Hence, one important factor is the average talent of managers.

Second, we assume that economic growth also depends positively on the average workers' productivity (*adoption* aspect of growth).[16] The intuition is that more productive workers will be more able to follow the manager's instructions and hence will adopt innovation better.

Finally, we assume that there is a residual dimension to growth that is related to health issues and is basically determined by the education of individuals who engage in home production. The intuition is that, even if some people in the economy may not work in the labor market, increasing their education increases growth because they become more aware of e.g. health issues (this is empirically plausible especially in developing countries).[17]

[15] Other papers in the economic growth literature have modelled this differently. For instance, Murphy *et al* (1991) it is assumed that technology is determined by the underlying entrepreneurial talent of the most talented of the entrepreneurs. Another consideration would be that it is the number of managers that matter, but in that case one would have scale effects; the average talent of managers does not suffer from that shortcoming.

[16] These two factors are related to Acemoglu *et al* (2006), who assume that there is an innovation and adoption or investment dimensions to growth.

[17] Pritchett and Summers (1996) and Martin *et al* (1983) provide empirical evidence for less developed countries that higher levels of education (controlling for income) are associated with lower levels of infant and child mortality. Rajna *et al* (1998) estimate that, even controlling for socioeconomic factors, illiterate women in Uttar Pradesh (India) face a 1.6 times higher risk of later childhood deaths of their children compared with women educated to at least the middle school level. More generally, recent evidence (Topel 1999, Krueger and Lindahl 2001) suggests there is a

In particular,

$$s(t) = s(t-1)\left[1 + f\left(AT(T'(w)), AP(H_p(w)), NE\right)\right],$$

where $f\prime$ is positive in all of its arguments and AT denotes average talent of managers, AP denotes average workers' productivity, and NE denotes average education of individuals who engage in home production.

Then it follows that the rate at which technology, costs of education, wages, and profits grow in this economy is some combination of AT, AP, and NE (in case there are home workers). Therefore, the growth rate of the economy is given by some combination of

$$\begin{aligned} AT &= \frac{1}{2}\left[1 + T'(w)\right] \\ AP &= 1 + H_p(w) \\ NE &= H_p(0). \end{aligned} \tag{16}$$

3.3 Labor market equilibrium with gender discrimination in managerial positions

We now consider the implications of gender discrimination. We analyze two cases. First, gender discrimination can occur in managerial positions (that is, the case in which women are not allowed to be entrepreneurs). In the next section, we look at the stronger case of discrimination in which women cannot take part in the labor force either as managers or as workers. We refer to the former as partial discrimination (PD), and the latter, as total discrimination (TD). Instead, we could model partial discrimination assuming that setting a firm requires a fixed investment, such that the entrepreneur has to borrow some amount of money. Then partial discrimination would for instance consist of women facing higher interest rates in the credit market. For interest rates high enough, no female would decide to be an entrepreneur. That is, this type of discrimination in the labor market could be the result of discrimination in the credit market.[18] A more subtle way to think about this is in the context of a low self-esteem hypothesis: suppose that individuals cannot observe their endowment of T, the underlying managerial talent, and that women believe that they are not talented enough to be managers—this would become self-fulfilling in the sense that women will not invest into higher education and disproportionately fill working positions (Akerlof and Kranton 2000).

positive correlation between education and economic growth (using both the change and initial level of education, even though the latter is appropiate for countries with very low levels of education only).

[18] Coate and Tennyson (1992) show that, under some condition, individuals who are discriminated against in the labour market will face higher interest rates and will hence have less incentive to enter self-employment than those who are not discriminated against, even after allowing for investments in human capital. In both cases though, discrimination in one market spills over to another market.

3.3.1 Aggregate supply of worker skills with partial gender discrimination

Suppose gender discrimination consists of not allowing women to have access to managerial positions. Women, however, may still have access to schooling and worker positions. Notice that since earnings as home worker are zero, women who would be managers without discrimination will still prefer to work in the labor market (even as workers) and earn wages than to engage in home production. Therefore, in this scenario there are no home workers. For every wage, partial discrimination affects the demand and supply of worker skills. The supply of workers will tend to increase because all women are now workers:

$$Q_S^{PD} = \frac{P}{2}T'(w^{PD})\left[1+\left[\frac{w^{PD}\sigma}{a_p}\right]^{\frac{\sigma}{1-\sigma}}\right]+\frac{P}{2}q(w^{PD}) = P\left[1+\left[\frac{w^{PD}\sigma}{a_p}\right]^{\frac{\sigma}{1-\sigma}}\right]\left(\frac{T'(w^{PD})+1}{2}\right). \tag{17}$$

Since $T\prime(w) < 1$, the rightmost term is larger than $T\prime(w)$. Hence, for every wage, the supply curve with partial discrimination is to the right of the curve without discrimination. That is, for every level of employment, workers are willing to work for a lower wage.

3.3.2 Aggregate demand for worker skills with partial gender discrimination

Demand for worker skills will tend to fall because there are no female managers:

$$Q_D^{PD} = \int_{T'(w^{PD})}^{1} \mu(w^{PD}, s, a_h)T\frac{P}{2}dT = \frac{P}{2}\mu(w^{PD}, s, a_h)\left[\frac{1}{2}-\frac{T'^2(w^{PD})}{2}\right].$$

For every wage, demand for worker skills is one-half of what it was without discrimination. In other words, the demand curve with partial discrimination is to the left of the curve without discrimination. Hence, the equilibrium wage unambiguously declines (see Figure 5). The change in the total quantity of worker skills that is hired in equilibrium is ambiguous because, with discrimination, we have higher supply and lower demand.

The intuition is that, for a given wage rate, the human capital investment decisions of men and the cutoff level of talent for men remain unchanged. Hence, discrimination against women in managerial positions has two consequences. First, it increases the supply of workers, as all women become workers. Second, it decreases the demand for workers, as all firms that would have been headed by women no longer exist. Both factors work to lower the wages of workers.

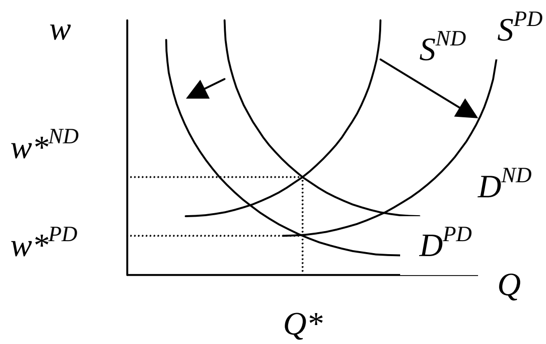


Figure 5 Labor market equilibrium, partial discrimination

3.3.3 The number of entrepreneurs with partial gender discrimination

In this case, the total number of female managers is zero (by definition); at a given wage, therefore, the total number of entrepreneurs will decline. Since the equilibrium wage is lower, the cutoff level of talent for the remaining male managers is lower, so more males are going to become entrepreneurs. Hence, the total number of managers is

$$M^{PD} = M^{m,PD} + M^{f,PD} = \frac{P}{2} \int_{T'(w^{PD})}^{1} 1dT + 0 = \left[1 - T'(w^{PD})\right] \frac{P}{2}.$$

Since $T\prime(w^{PD}) < T\prime(w^{ND})$ while $\frac{P}{2} < P$ (that is, the number of male managers is larger because of lower wages while the number of female managers drops to zero), the overall effect of this type of discrimination on the number of entrepreneurs is ambiguous. Since the fraction of the population who are managers $(1 - T\prime)$ is very small, it is possible that we end up with more managers when there is partial gender discrimination, because a higher proportion of men will decide to become managers; it depends on the sensitivity to wages of the cutoff level of talent for males and the sensitivity of the wage rate to the requirement that all women work as workers. In sum, the change in the number of entrepreneurs is ambiguous, but it is likely that the decrease in the number of managers due to the prohibition of female managers is larger than the increase of male managers due to the lower equilibrium wage.

Proposition 2 *For wages high enough, workers complete primary school even in the case of partial discrimination (which implies a wage cut). In that case, the ratio of female-to-male primary education is the same as without discrimination, that is, equal to one. However, for wages low enough, the ratio of female-to-male primary education is lower in the case of partial discrimination than in the absence of discrimination.*

Proof. see appendix. ■

Corollary 3 *For developed countries, where wages tend to be high, there is no gender inequality in primary education even in the case of partial discrimination. In contrast, for developing countries, where wage rates tend to be low, partial discrimination implies gender inequality in primary education.*

Propositions 3 and 4 establish the implications of the effects of partial discrimination from the first case (developing countries), which is empirically the most plausible:

Proposition 4 *Discrimination against females in managerial positions implies (i) lower female education than without discrimination, (ii) more education for male managers and less education for male workers, and (iii) lower average education for females than for males in both primary and higher education.*

Proof. On the one hand, by (10) lower equilibrium wages imply that workers will optimally invest less in education. Therefore it follows that females (who cannot become managers by definition) will all invest less in education. The same applies for male workers. By (7), lower wages on the other hand imply that male managers will increase their investment in higher education (primary education for managers is fixed). Finally, females have lower average education than males in both primary and higher education, since (1) females who were managers without discrimination will, with partial discrimination, reduce their investment in primary education as workers because the returns are lower, and (2) women who were workers without discrimination reduce their acquirement of primary studies. ■

The change in average male education is however ambiguous because the change in the number of managers is ambiguous.

Proposition 5 *Discrimination against females in managerial positions implies lower economic growth.*

Proof. Lower equilibrium wages in the case of partial discrimination implies, according to Proposition 1, a lower cutoff level of talent. On the one hand, according to (15), the latter in turn implies that the average talent of entrepreneurs is smaller (which leads to less innovation). On the other hand, workers' productivity depends on their primary education, which in turn depends on wages. By Proposition 3 we know that male workers optimally decide to study less than without discrimination, so average workers' productivity is lower (leading to less adoption). Both factors imply a lower rate of economic growth. ■

Therefore discrimination in the form of a social norm that does not allow women to be managers has negative implications for growth.

3.3.4 Discrimination in higher education

A similar conclusion might be reached through an alternative type of discrimination. Suppose that girls face a larger cost of higher schooling than boys, that is, $a_{h,f} > a_{h,m}$.

This could be the result of a social norm according to which women are not expected to enter the labor force in the future. In that case parents pay for their daughter's primary education if they have the means but not the extra amount needed for higher education, because there are no private gains from girls' higher education. Then it can be shown that since women face lower incentives to be managers, in equilibrium wages are lower than without discrimination, and a larger proportion of men than of women become managers—nevertheless those women who become managers are in average more talented than male managers, even though their average education will be lower than their male counterpart. Furthermore, under a certain condition it can be shown that this situation lowers the average cutoff level of talent and hence economic growth.

3.4 Labor market equilibrium with total gender discrimination in the labor market

3.4.1 Aggregate supply of worker skills with total gender discrimination

Suppose gender discrimination consists of not allowing women to have access to managerial positions or to become workers. We interpret this as a social norm that is enforced by the existence of social stigma, in the same spirit as Goldin (1995) and Mammen and Paxson (2000) describe social stigma as a deterrent to women's participation in the labor market.[19] In particular, Goldin (1995) models this social stigma as a cost to the household: each family has a value S giving the utility that would be lost from the social stigma of having a wife work for wages ("only a husband who is lazy, indolent, and entirely negligent of his family would allow his wife to do such labor"). This cost is not a function of the number of hours at work but is "all or none". In this study, in order to see the aggregate costs of such social stigma, we assume that the cost that this social norm or stigma represents is large enough for women to turn to the home production sector. This could be modeled in an intra-household context, as in Goldin (1995), and the result would be the same.

In this case, females' human capital is zero because, in this model, education is only useful to individuals who take part in the labor market. For every wage, this affects the demand and supply of worker skills. Supply in this case is

$$Q_S^{TD} = \frac{P}{2} T'(w^{TD}) \left[1 + \left[\frac{w^{TD}\sigma}{a_p} \right]^{\frac{\sigma}{1-\sigma}} \right]. \qquad (18)$$

Hence, for a given wage, the supply of worker skills is one-half of the supply without gender discrimination.

[19] More precisely she associates social stigma to having a wife work as a manufacturing operative or manual labourer.

3.4.2 Aggregate demand for worker skills with total gender discrimination

As in the case of gender discrimination in managerial positions, demand for worker skills is simply one-half of what it was without discrimination:

$$Q_D^{TD} = \int_{T'(w^{TD})}^{1} \mu(w^{TD}, s, a_h) T \frac{P}{2} dT = \frac{P}{2} \mu(w^{TD}, s, a_h) \left[\frac{1}{2} - \frac{T'^2(w^{TD})}{2} \right].$$

Hence, relative to the situation of discrimination in managerial positions, the equilibrium wage unambiguously increases, while the amount of worker skills hired in equilibrium decreases (see Figure 6). Unlike in the nondiscrimination case, since both aggregate supply of, and demand for, worker skills change in the same proportion, the wage rate is the same, although in the total discrimination equilibrium less worker skills are hired.

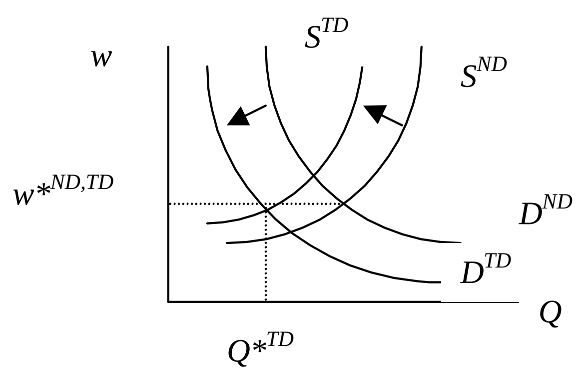


Figure 6 Labor market equilibrium, total discrimination

3.4.3 The number of managers with total gender discrimination

The total number of managers is

$$M^{TD} = M^{m,TD} + M^{f,TD} = \frac{P}{2} \int_{T'(w^{TD})}^{1} 1 dT + 0 = \left[1 - T'(w^{TD})\right] \frac{P}{2}. \tag{19}$$

Since the equilibrium wage rate increases, the number of managers is unambiguously smaller than in the case of discrimination in managerial positions. By (14)

and (18), and given that the cutoff level of talent with total discrimination is the same as without discrimination, the number of managers with total discrimination is one-half of the number without discrimination. Propositions 5 and 6 summarize the effects of total gender discrimination.

Proposition 6 *Gender discrimination in the overall labor market implies that (i) average female education is lower, for both primary and higher education, (ii) male education is the same as without discrimination, and (iii) average female education is lower than male education.*

Proof. (i) follows from the fact that in the model, education is only useful if in the labor market, while (ii) follows from (7) and (10). Finally, (iii) follows from (i) and (ii). ■

Proposition 7 *Gender discrimination in the overall labor market implies (i) lower economic growth, and (ii) lower per capita GDP.*[20,21]

Proof. (i) follows from the residual determinant of economic growth, as some individuals (half the population—all females in the economy) who were previously working outside the home and hence investing in some positive level of education in the existence of discrimination optimally decide not to get any education. Part (ii) follows from the fact that population is the same as without discrimination while women who were managers or workers without discrimination have to engage in home production with discrimination, which is less productive than production outside the home; hence per capita GDP decreases. ■

3.5 Discussion: sustainability of gender discrimination

As seen in the previous section, discrimination in the forms considered here can have substantial costs. In terms of our model, there are cases where the total household income, i.e. of husband and wife, is lower as a consequence of discrimination.

For instance, a man who is married to a woman who is a manager in a situation of no discrimination may be worse off in terms of per capita household income by the introduction of partial discrimination (where she can only be a worker) or total discrimination (where she cannot participate in the labor market), due to the fact that her income decreases. However, in the case of partial discrimination, this also depends on whether the husband's own working status (and hence his income) changes due to discrimination.

Why can discrimination persist? In the context of the unitary model of the household, discrimination should not persist. There are two alternative approaches that could explain the persistence of discrimination.

[20] Hence this prediction of total gender discrimination is similar to the one from the model in Galor and Weil (1996) where, taking into account fertility and assuming two different types of skills among individuals, when women do not participate in the labor force the rate of economic growth declines over time.

[21] This is consistent with no scale effects in the sense that the average talent of managers and the average productivity of (market) workers are the same as without discrimination.

First, a bargaining approach.[22] From the point of view of a cooperative bargaining framework, where the threat point is divorce, the individuals' bargaining strength depends positively on their own outside option and negatively on their partners' outside option. That is, everything else equal, if the wife's earnings increase without discrimination, her outside option is stronger (as she would still be able to earn a wage in the case of divorce), which would decrease the husband's utility.[23] While the woman's participation in the labor market may increase the size of the cake too, this represents lower bargaining power for the husband in the case that his income share is lower as a result. Additionally, men who are workers in the case of no discrimination and would become managers under partial discrimination unambiguously enjoy a higher share in total income under the latter situation.[24]

The type of discrimination in this paper may be more consistent with the predictions of a model of (noncooperative) separate spheres bargaining, as introduced by Lundberg and Pollak (1993), for several reasons. A perhaps subtle reason is that cooperative bargaining requires the threat point to depend on divorce, while in developing countries with very unequal gender relations, such as India and other countries relevant for this analysis, divorce either involves substantial transaction costs or can be dominated by sharing public goods within an intact but noncooperative marriage, where a division of labor based on socially recognized and sanctioned gender roles emerges without explicit bargaining. In this case, the relevant threat point is not divorce but the noncooperative, voluntary equilibrium within marriage. Cooperative bargaining is distinguished by the ability of players to make binding agreements within marriage. Then, as shown by Lundberg and Pollak (1993), it will be optimal for couples with high transaction costs (which arise because of the negotiation, monitoring, and enforcement of such agreements) or low expected gains from cooperation to remain at the stereotypical noncooperative solution, where the division of labor is based on socially recognized gender roles. More importantly, the argument that cooperation does break down seems especially appropriate in the case of India, where borrowing constraints are severe and therefore agents have low discount rates. In our model, we could think of the surplus from cooperation as being positively given by total income and negatively given by the male disutility from his wife's higher occupation (this could be some sort of stigma) or the fact that she is working. We can think of some sort of distribution of this disutility among males—for some males it may be equal to zero, for others, infinite—so as long as the disutility is larger than

[22] Additionally, empirical evidence seems to reject the unitary model, in particular, income pooling is rejected (Mansen 1993, Thomas 1993).

[23] In a cooperative bargaining framework the increase in the wife's earnings can be either represented by an increase in her outside option or an increase in her weight in the maximization problem.

[24] In the case of men who are workers even without discrimination, if their wife's outside option increases in the same proportion as the total cake, then they are not better off by the removal of discrimination. Notice that this is the relevant comparison if there is assortative matching. The analysis is the same in the case of the suppression of total discrimination.

income, cooperation can break down.

Second, an identity approach. As modeled in Akerlof and Kranton (2000), individual utility might also be guided by identity considerations. In their paper, individual j's utility is given by $U_j = U_j(a_j, a_{-j}, I_j)$, where $I_j = I_j(a_j, a_{-j}; c_j, \varepsilon_j, P)$, where a denotes actions, c denotes social categories, ε denotes characteristics and P denotes prescriptions (i.e., social norms). Thus, individual i's identity depends on individual i's actions as well as on his peers' actions, which govern certain social norms, characteristics and social categories. More generally, if there are gender-jobs associations (that is, some jobs perceived as 'man's jobs' and some other jobs perceived as 'woman's jobs') that are sectorwide or economywide, these might persist—which is consistent with the empirical evidence of persistent occupational segregation (e.g., Jacobs 2003)—, as perfectly competitive firms will underinvest in new job categories. Hence in the absence of market power or technological change, a shift in social attitudes and legal intervention might be necessary for changes in employment patterns. If social norms prescribe that women's work outside the house is not appropriate behavior, then a husband's utility might overall decrease due to his lower identity, even in the case where his income is larger when his wife participates in economic activity.[25]

Finally, there are a number of reasons why discrimination could be efficient. First, it could be that there exists assortative matching across households. In particular, if the most talented man marries the most talented woman, it is efficient for women to work at home (or hold unskilled—less demanding— positions) as long as there is some comparative advantage of men over women in working outside home, and the cost of providing household goods and services is lower than the external market rate (Becker 1985).[26] Second, the analysis ignores the role of fertility. Introducing fertility in the analysis might create a female comparative advantage as home workers. Introducing fertility in the analysis would similarly create a trade-off between the comparative advantage and the misallocation of talent. Third, there might exist statistical discrimination, perhaps because of a potential lower female productivity due to fertility and childrearing duties. In that case, discrimination could be efficient. Therefore, whether discrimination is efficient or not is ultimately an empirical

[25] A social scientist with a large body of work on the topic, Jon Elster defines social norms as injunctions to behaviour that (1) are non-outcome oriented, (2) apply to others as well as oneself, (3) are sustained by the sanctions of others, and (4) are sustained by internalized emotions (Elster 1989a,b). Social norms constitute guides to behavior in everyday life, outside the formal legal system; as opposed to legal norms, they are enforced by members of the general community, and not always out of self-interest. Social norms are in contrast with economic incentives: when economic incentives exist, individuals do not need guides to behave in a particular way. However, as argued by Lindbeck et al (1999), both social norms and economic incentives can lead to rational behavior, in the sense that individuals act in accordance with expected reward or punishment, even though the form these take differs substantially in the two cases.

[26] The model is in this feature similar to the one in Francois (1998), where gender discrimination is inefficient (in particular, there are gains from trading occupations within the household) only when members in the household differ.

issue. It makes sense to think that a potential female comparative advantage in home production might have more weight against the misallocation argument in particular sectors such as agriculture. The empirical analysis will exploit differences by sector to shed some light onto these issues.

4 Women and the labor market in India

Figures of female labor participation in India are still low: 22 percent according to the Census of India of 1991, and 28 percent according to the National Sample Survey (Kundu 1999). The evolution of female labor force participation rates in modern India has differed by state, and it is this heterogeneity that we exploit in this paper. Female labor participation in India as measured by the percentage share of women workers to total female population was lower in 1991 (16 percent) than in 1901-1951, when the participation rate ranged between 23 and 32 percent.[27]

While women in the middle classes do not tend to participate in the labor force, women from poorer households cannot afford not to engage in productive activity outside the home (Mammen and Paxson 2000). However, women in the upper classes are increasingly free to participate in the labor force, especially in the cities.[28] This suggests the existence of a U-shaped relationship between female labor participation and development as documented in Goldin (1995) and Mammen and Paxson (2000). Goldin (1995) argues that the initial decline in female participation is due to an income effect—due to the change from home production to manual work market production, against which a social stigma exists—while, as economies develop, women enter the labor force through white-collar work, against which no social stigma exists.[29] Therefore female labor force participation in India might be the result of the interaction between social norms (enforced by social stigma that obliges men to provide for their families) and economic conditions: as Goldin (1995) shows with a simple model, the probability that the stigma will be binding will be greater the larger the family income. In this study we measure the aggregate consequences of this so-called social stigma (or the social norm that it enforces), whereby women do not participate in the labor market at certain stages of the development process.

The female labor force participation rate used here comes from the Census of India and contains female employers, employees, single workers, and family workers (see the data appendix for more details and definitions). This figure excludes agricultural

[27] Source: Statistical Profile of Women Labour, Ministry of Labour, 1990, Census of India, as tabulated by Kak (1999).

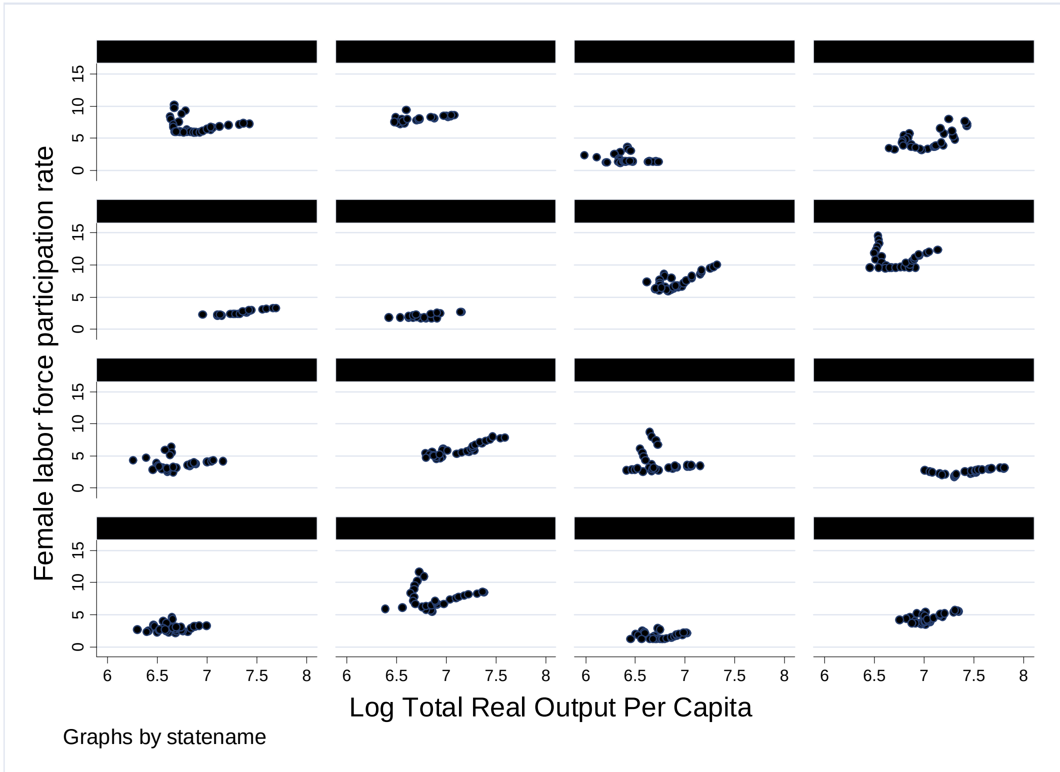
[28] In India, not until women receive specialized post-secondary education do they see significant improvements in their employment rates (Dunlop and Velkoff 1999).

[29] "The social stigma against wives working in paid manual labor outside the home is apparently widespread and strong (. . .). The prohibition is so ubiquitous that it seems likely to be connected with many of the most basic norms in society—those which bind the family together as a productive unit." (Goldin 1995).

laborers and household workers, which belong to the informal labor market. As in Besley and Burgess (2002, 2004), due to data availability we use data on the sixteen main states in India, covering about 95% of the population (see Table 1 for a list of the states used in this paper).

Examined by group, the proportions of females as both employees and employers have been increasing with respect to development (only slightly for Northwestern states), while the proportion of women as single workers has decreased. The proportion of women as family workers has changed little for most states.

Figure 7 displays the female formal labor participation rate as a function of logged per capita real output, by Indian state . Northwestern states (Bihar, Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, and Rajasthan) not only have lower female labor participation rates for a given level of development but also are the only states which do not display the increasing part of the U-shape relationship. That is, in these states, development is not easing female access to the formal labor market—these states are characterized by highly unequal gender relations (large literacy gap by gender, strictly restricted female property rights, strong boy preference, and neglect of female children. For instance, in much of northern and central India, particularly in rural areas, Hindu and Muslim women follow *purdah*, a set of complex rules of veiling the body and avoidance of public appearance, especially in the presence of men who are not blood relatives (Dyson and Moore 1983). The observance of purdah thus limits the participation of women in the labor market. In contrast, in South India, where gender relations are less patriarchal and for instance female education has spread relatively rapidly (Drèze and Sen 1995), states are in the increasing part of the U-shape relationship.



Source - author's calculations using Census data, Ozler et al (1996) and successive updates

Figure 7 Female labor force participation as a function of development

The Government of India has attempted to improve the status of women workers through legislation directly targeting women (Maternity Benefits Act (1961), Equal Remuneration Act (1976)), or indirectly (Plantations Labour Act (1951), Contract Labour (1970), Inter-State Migrant Workers Act (1979), Factories Act (1948), and Mines Act (1952)).

Despite the Government's attempts at improving women's working conditions, inequalities remain. According to reports, men are more likely to get promotions than women—besides, for men the nature of their jobs would often change with these promotions, unlike women, who would usually only get increased responsibility and higher workload. Promotion policies are better in the public sector and unionized companies, but the provision for facilities at the workplace is inadequate, even in unionized companies (Kumar *et al* 1999).

5 Empirical analysis

The theoretical section provides motivation for the hypothesis that a lower number of females relative to males in (1) managerial positions and (2) worker positions as a whole has two sets of implications: in terms of lower economic growth and GDP (Propositions 4 and 6), and in terms of lower female-to-male human capital (Propositions 3 and 5). In particular, the theoretical section argues that gender discrimination in managerial positions implies a misallocation of talent that leads to lower economic growth through the innovation and adoption dimensions of economic growth, while gender discrimination in the overall labor market has negative economic consequences through the education dimension of growth. We test the implications of the theoretical section using data from sixteen Indian states that cover 95% of India's population over 1961-1991. While it would have been interesting to include the 2001 Census information, this is not possible because it does not include information by class of work by state.

Measuring gender discrimination is often not feasible. The measures we use to proxy for gender discrimination are based on the number of female and male (1) managers and (2) workers.[30] While these measures might capture discrimination and other factors too, just as preferences, in the context of India particularly, and based on existing microevidence (e.g. Mammen and Paxson 2000), we generally call them social norms. Moreover, there exist issues with the data on women's labor participation in developing countries (Anker 1983, Kak 1999).

We do not expect that the argument in the theoretical section can apply to agricultural workers: in the case of agricultural jobs, it makes sense to think that there exists comparative advantage reasons favoring men, who tend to enjoy a physical advantage in carrying out agricultural tasks. For that reason, the measure of workers that we use does not include agricultural workers. However, we do use information on the number of agricultural workers by gender for robustness checks.

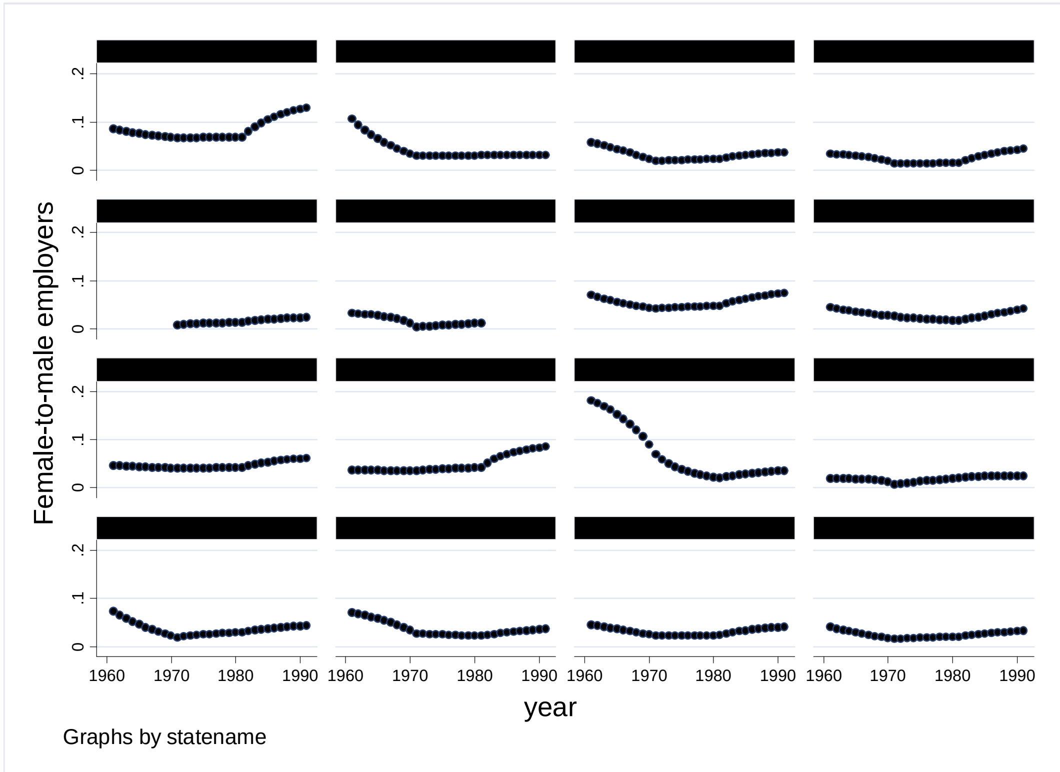
We expect the ratio of female-to-male managers or workers to partly reflect gender inequality that is driven by gender discrimination, as of the types described in the theoretical section.[31] In constructing the ratios, we divide by the respective populations.

Figures 8 and 9 show the evolution of these variables over time. They are basically

[30] The variable we call *managers* corresponds to the variable that is called *employers* in the Census of India and is described as "a person who had necessarily to employ other persons in order to carry on the business from which he served his likelihood." See the data appendix for definitions and sources of the data.

[31] Indeed, even in states where agriculture is the predominant activity, there is no reason for female-to-male ratios to be biased. Moreover, the fact that agriculture-related jobs are usually more unsecure and lower paid points towards a situation which could be discriminatory in origin.

U-shaped but in a few states, notably Punjab, Haryana and West Bengal.



Source - author's calculations using Census data, Ozler et al (1996) and successive updates

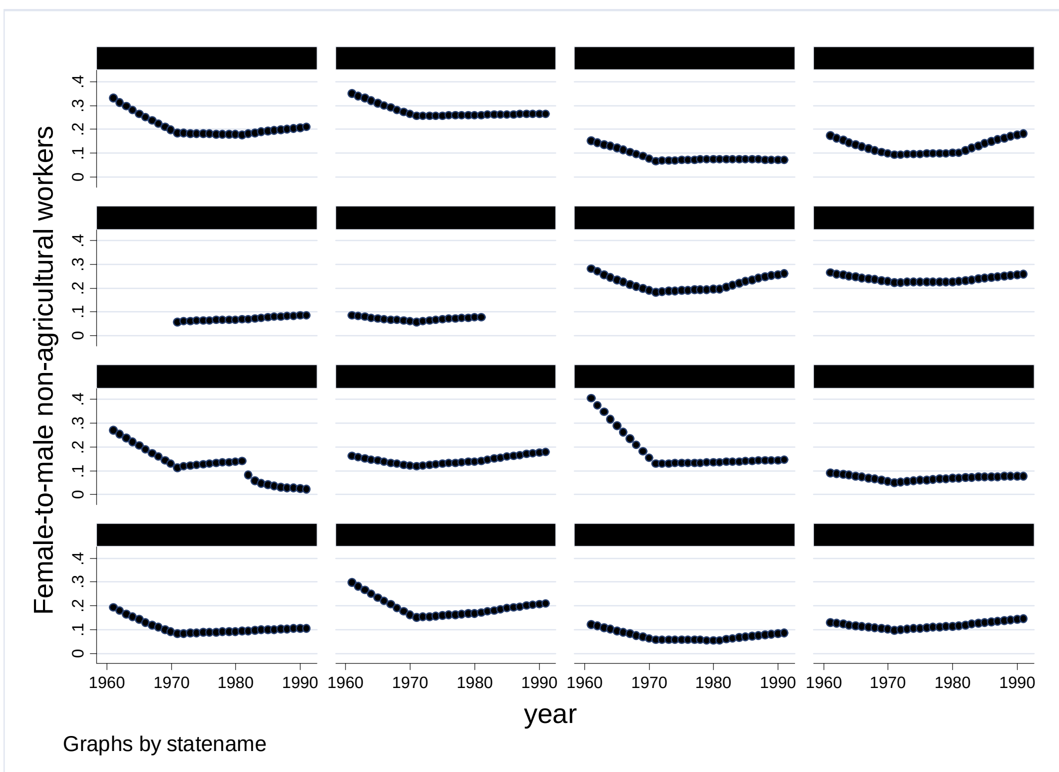
Figure 8 Ratio of female-to-male managers, 1961-1991

In Table 1 we present means and standard deviations for the output and human capital variables used in the empirical analysis, by state, averaged for the period 1961-1991. In columns (1)-(3) we display statistics regarding total, agricultural and non-agricultural output respectively, all in per capita real terms. Output measures have been deflated using the CPIIW (consumer price index for industrial workers) and the CPIAL (consumer price index for agricultural laborers) when appropriate, as calculated by the National Sample Survey Organisation (NSSO), and following Besley and Burgess (2002, 2004) using data from Özler *et al* (1996) and successive updates.

In columns (4)-(7) we show descriptive statistics for human capital. There is wide variability in literacy rates across states as can be seen in columns (4) and (5), from Jammu and Kashmir with the lowest rates (10% and 31% for women and men respectively), to Kerala with the highest literacy rates (65% and 83%). In columns (6) and (7), female-to-male teachers in primary and middle school also show variability: only Kerala displays ratios higher than one; in the rest of states, there are more male than female teachers, while most teachers are male in Orissa at both levels. Other states with high numbers of female relative to male teachers are Punjab and Tamil

Nadu, while states with relatively low ratios include many northwestern states (e.g., Rajasthan, Uttar Pradesh).

In Table 2 we present descriptive statistics on laborers in India. In columns (1)-(3) we display the female-to-male ratios of (1) agricultural workers, (2) non-agricultural workers, and (3) managers (where (3) is a subset of (2)). Typically, states with the highest ratios of female-to-male managers and non-agricultural workers are southern states (Karnataka, Kerala, Andhra Pradesh) while states with the lowest ratios are usually in North India (Haryana, Jammu and Kashmir, Punjab). Interestingly, there is no strong direct relationship between these variables and income. For instance, Haryana and Punjab are relatively rich, while Jammu and Kashmir is at about the all-India average income. There is also diversity among states with higher female-to-male worker ratios: Kerala and Orissa have lower-than-average income, while Andhra Pradesh and Karnataka have approximately average income. In fact, it seems that as explained in the background section, these statistics would in fact tend to suggest that female labor participation relative to male in the non-agricultural sector is higher in poorer states (simple correlations with per capita GDP are indeed negative: -7% with respect to female-to-male managers and -15% with respect to female-to-male workers).



Source - author's calculations using Census data, Ozler et al (1996) and successive updates

Figure 9 Ratio of female-to-male (non-agricultural) workers, 1961-1991

If we look at the shares of workers by sector (Table 2, columns (4)-(9)), a majority of women work in agriculture in every state. However, there is not a strong correlation between the share of female workers in agriculture and its male counterpart: for instance in Maharashtra 86% of women workers work in agriculture, while 55% of men do the same. For Kerala numbers are more similar: the female share is 58% while the male share is 42%. Consequently, the correlation coefficient between those two variables is positive but below 15%.

In order to investigate the predictions from the theoretical section we take advantage of the panel nature of the data and run regressions of the type:

$$y_{st} = \alpha_s + \gamma_t + \delta r_{st} + X_{st}\xi + \varepsilon_{it} \tag{20}$$

where y is either the logarithm of per capita real net state domestic product, or the female-to-male literacy ratio, depending on whether we focus on the output analysis, or the human capital analysis, r denotes the ratio of the number of females to males in a certain class of the labor force (namely managers and workers), X denotes controls (human capital, and other socioeconomic controls such as population growth, the ratio of urban to total population, and the ratio of capital to labor), α is a state effect, and γ is a year fixed-effect. State effects pick up effects that vary among states but are constant over time, as well as heterogeneous initial conditions; year effects pick up shocks that are common to all states but differ over time.

In light of recent research about fixed-effects panel models estimation (Bertrand *et al* 2003, Kézdi 2002) showing that the cluster estimator behaves well with finite samples, we cluster our standard errors by state to deal with serial correlation concerns.

5.1 Output

First we would like to investigate whether the low participation of women in managerial positions (Proposition 4), or working positions in general (Proposition 6), has negative implications for economic development.

The main output measure we use is the log of per capita real net state domestic product.[32] We also use measures of output per sector.

5.1.1 Basic results

In Tables 3 and 4 we present the results of estimating (20) for the ratio of female-to-male managers and workers respectively. Column (1) in both tables represent the key basic results in the paper: in line with the theory, the estimates show that our labor measures by gender are negatively correlated with economic development. As explained above we use non-agriculture worker ratios therefore the dependent variable

[32] Therefore differences in prices across states are controlled for. The deflator that we use takes into account rural and urban prices (Besley and Burgess 2002, 2004).

we use here is the log of non-agricultural per capita output in real terms.[33] In column (1) in Table 3, the ratio of female-to-male managers is positively related to output, and this relationship is significant at the one percent level, controlling for female and male literacy rates, population growth, the ratio of urban to total population, and the ratio of capital to labor (the latter is introduced as a proxy for technology). In column (2) we add some controls for policy/institutional quality. There exists the possibility that our variable of interest might be capturing some other sort of policy that is undertaken at the state level, hence simply reflecting omitted policy bias. Even though gender sensitive legislation and policy-making exist only at the national level, some other type of policy at the state level might happen to be related to gender-wise work participation. We cannot possibly control for any state-level policy but we can follow the strategy in Besley and Burgess (2002) and control for government responsiveness using the following political controls: electoral turnout lagged one period, a measure of political competition (the absolute difference in the share of seats occupied by the main political party and its main competitor), and a dummy for election years. Results, in column (2), are unchanged. Therefore our results are robust to the inclusion of proxies for government and institutional quality. In column (3), we additionally control for caste (introducing the percentage of the population that belongs to scheduled castes or scheduled tribes) and the size of the (non-agricultural) labor force, logged. The estimated coefficients for our variables of interest are similar and still significant at the one percent level. Finally in column (4) we introduce religious affiliation controls, in particular the percentage of the population who is Muslim and the percentage who is Hindu, to discard the possibility that our variables are picking up any omitted religion bias. Results remain basically the same.

Results for the ratio of female-to-male workers, in Table 4, are similar. The estimated coefficient is lower but also positive and statistically significant.

What is the magnitude of the effect? Looking at results in column (4) in Tables 3 and 4, an increase in the ratio of female-to-male managers in one unit (e.g., from 100% men managers to women becoming half of them would lead to a 319% increase in per capita income. Analogously, an increase in the ratio of female-to-male workers in one unit (e.g., from women being half of the employed to there being twice as many women employed as men) is associated with a 153% increase in per capita income.

A remark should be made regarding home production. In particular, if women's participation in the labor force relative to men's has been increasing (which may have therefore decreased their—officially not accounted for—home production) along with per capita GDP, as predicted by the model, the positive effect that we find might appear because of this accounting fact rather than because of discrimination itself. However, a quick look at Figures 8 and 9 above suggests that this is not the case, as female-to-male ratios of managers and workers have evolved differently by state over time.

[33] Deflated using the consumer price index for agricultural labourers (CPIAL).

In Table 5 we look at effects by sector, controlling for political and socioeconomic controls, and state and year fixed-effects. In column (1), we regress agricultural output on the ratio of female-to-male agricultural laborers: we find no effect. This makes sense from a point of view of male physical comparative advantage as explained above. However, in column (2), we do find that more female-to-male household workers are positively associated with greater non-agriculture output. This suggests that even as household workers, women contribute to the economy. In columns (3) and (4) we look at the secondary and tertiary sectors respectively. The secondary sector includes manufacturing, while the tertiary sector includes banking, public administration, trade, construction, electricity, transport, and storage. We find no relationship with regards to the secondary sector, which again could be explained due to physical ability perhaps being more important than other ability in that sector, but we do find a strong effect regarding the tertiary sector. This makes sense, as it is in this sector that we expect talent, or non-physical ability, to be more important than physical ability.

In Table 6 we look at the effect of female-to-male managers and workers on tertiary sector output. We find that both have a positive significant effect (columns (1) and (2)). This is consistent with the results in Tables 3 and 4 with non-agricultural output.

5.1.2 Robustness checks

In Table 7 we show results from performing some robustness checks. In columns (1)-(2) we run the same regressions as in column (4) in Tables 3 and 4, but now using the log of per worker real output as opposed to per capita real output. Results are similar.

In columns (3) and (4), we run regression (4) in Table 3, now with the share of managers who are female as independent variable (as opposed to the ratio of female-to-male managers). Results remain unchanged.

Finally in columns (5) and (6) we introduce state-specific trends to the specification in column (4) in Tables 3 and 4 respectively. In this case, the identification of the effects of female-to-male workers comes from whether changes in that ratio lead to deviations from pre-existing state specific trends. The female-to-male ratio of managers still has a positive significant effect on non-agricultural output, and the effect is even bigger than in Table 3, however the female-to-male ratio of workers has no statistically significant effect once state-specific trends are included. Thus, states with similar patterns of female-to-male workers also have similar long-term trends. Differences in workers by gender would be therefore driving differences in these trends.[34]

[34] To make sure it is not the interpolated data that generates our results, we run two respective basic regressions with only the non-interpolated employment data, state fixed-effects and a year trend, and cluster standard errors at the state level. Female-to-male managers and workers are still positive and significant (at the five and one percent level respectively).

5.1.3 Instrumental Variables results

An obvious concern is causality. In particular, we might worry that the statistical positive relationship we are estimating is arising due to the possibility that richer states have higher female-to-male employment ratios. The standard strategy is to find an appropriate instrument for the ratios of female-to-male workers.

We try and control for potential endogeneity using the ratio of female-to-male primary and middle school teachers. This is a proper instrument as long as the determinants of the number of female-to-male teachers are not a direct determinant of per capita output. In other words, the exclusion restriction is met if the ratio of female-to-male teachers is only affecting output through female-to-male workers. Indeed, we can expect issues regarding education and gender to be affecting development mainly through gender and work channels, in limiting differential access to work by gender. We expect differences in the ratio of female-to-male teachers to proxy for variation in cultural values that promote female labor force participation, hence being fairly exogenous. Indeed, it has been argued that potential reasons for low numbers of women amongst teachers particularly include barriers and discouragements such as the belief that it is men who should teach and run schools (UNESCO 2006).

We present the instrumented results in Tables 8 and 9. In Table 8 (columns (1) and (2)) we present the instrumented version of column (4) in Tables 3 and 4 respectively. Our results are robust to this instrumentation: the estimated coefficients for the female-to-male ratios of managers and workers (columns (1) and (2) respectively) are positively significant at the one percent level. Interestingly, the coefficient estimates for the instrumented variables are higher than the OLS estimates in Tables 3 and 4, suggesting that the relationship from income to female labor participation might actually be negative. This is consistent with the hypothesis that it is poorer women who engage in working activity, and that the social norm is binding. That is, if anything, endogeneity might be biasing our coefficients downwards. an increase in the ratio of female-to-male managers in one unit (e.g., from 100% men managers to women becoming half of them would lead to a 582% increase in per capita income. Analogously, an increase in the ratio of female-to-male workers in one unit (e.g., from women being half of the employed to there being twice as many women employed as men) is associated with a 464% increase in per capita income. As in the case of OLS results, these results suggest that gender inequality in the access to working positions is a bigger brake on development than gender inequality in the access to managerial positions.

Results from the first-stage regressions are also presented in Table 7 (columns (3) and (4)). The ratio of female-to-male (primary and middle) school teachers is positively correlated with female-to-male managers and total workers, suggesting that states where there are relatively more women teachers have better conditions for female labor force participation. The first-stage F-statistic for joint significance of the instruments is above 14 in both cases, which rules out issues of weak instruments under standard rules of thumb (Stock and Yogo 2003).[35]

We perform a test of overidentifying restrictions due to Sargan (1958). The joint null hypothesis is that the excluded instruments are valid instruments, i.e., uncorrelated with the error term, and that they are correctly excluded from the estimated equation. Columns (3) and (4) show p-values of 0.67 and 0.78 for female-to-male managers and workers respectively, hence the instruments are valid at standard levels.

In Table 9 (columns (1) and (2)), we present the instrumental variable counterparts of columns (1) and (2) in Table 6. Again, we find that our variables of interest are positive and significant, and of greater magnitude than their non-instrumented counterparts. The F-test statistics for the first stage regressions are in accord with Stock and Yogo's rule of thumb, and the Sargan tests of overidentification are passed at standard levels.

The bottom line is that our main result, that gender inequality in labor employment hinders development, goes through in the instrumented regressions.

In the theoretical section we have raised the issue of how the existence of assortative matching and comparative advantage might prove discrimination efficient, since the person (usually the husband) who works more hours outside the home is also the person who works less hours at home (Becker 1965). Although this is theoretically plausible, in light of the empirical evidence that we have just examined—whereby ceteris paribus states that have larger numbers of women at work have experienced larger per capita GDP—we conclude that this theoretical possibility is not empirically relevant, but rather, that there exist substantial transaction costs in intra-household bargaining so that the suboptimal, non-cooperative equilibrium can be sustained. Moreover, the efficiency costs of gender discrimination are big. This evidence can also be added to previous evidence that the comparative advantage theory of labor division in the household does not work (Akerlof and Kranton 2000 find that women who work more hours outside the home than their husbands also work more hours at home than their husbands).[36]

5.2 Human capital

Now we want to check whether states that have fewer women managers or workers also have lower human capital as predicted by Propositions 3 and 5 respectively in the theoretical section.

[35] Stock and Yogo (2003) provide a threshold of 11.59 in the case of two instruments and 5% critical value.

[36] To make sure it is not the interpolated data that generates our results, we run two respective basic regressions with only the non-interpolated employment data, state fixed-effects and a year trend, and cluster standard errors at the state level, instrumented by female-to-male primary and middle school teachers as before. Female-to-male managers and workers are still positive and significant; at the ten and five percent level respectively.

In Table 10 we show results from running regression (19) using female-to-male literacy rates. While we would have liked to use more disaggregated measures of human capital, primary and secondary schooling rates are so low in many states in India that variability is very low. Thus we use literacy rates, for which there is enormous variability across India's states (see Table 2).

In columns (1) and (2) we show OLS results. In columns (3)-(6) we show instrumental variable results.

OLS results suggest a positive, not significant relationship between female-to-male literacy and female-to-male managers and workers. However, endogeneity is also here an issue—using the same instruments as before, columns (3) and (4) show that, once we try and control for endogeneity, the effect of gender inequality in the labor force on human capital by gender is positive and significant at the one percent level. Results in columns (5) and (6) show that the F-statistics are larger than ten, and that Sargan overidentification tests are passed comfortably, with p-values of 0.52 and 0.83 respectively. Thus, the evidence from India's states is consistent with inequality in employment having a negative effect on female-to-male human capital.[37]

6 Conclusion

This paper provides theoretical and empirical support for the view that social norms that restrict women's employment act as a brake on economic development. Using panel data from India's states, we find that increases in the female-to-male managers ratio are associated with substantial increases in non-agricultural output per capita. Increases in the female-to-male (non-agricultural) workers ratio are also associated with increases in non-agricultural output per capita, but this affects via long-term trends. This positive relationship is in accord with the theoretical predictions of our model, according to which the exclusion of women from either managerial positions or the labor market has negative economic consequences. The intuition is as follows. If women cannot gain access to managerial positions, the equilibrium wage rate declines, and the cutoff level of talent of managers declines as well, so that the average talent of entrepreneurs and economic growth both decline. If females cannot participate in the labor market, but have to engage in home production, the wage rate is the same as without discrimination, so that the cutoff level of talent is the same and, therefore, there are no innovation or adoption implications. Nevertheless, growth decreases due to the fact that half the population acquires zero education. Moreover, the theory predicts that per capita output is lower than it is without discrimination.

[37] We run four respective basic regressions for Table 10, with only the non-interpolated employment data, state fixed-effects and a year trend, and cluster standard errors at the state level, and instrumented by female-to-male primary and middle school teachers when appropriate. OLS regressions as before do not show any effect; instrumented results are significant at the 20 percent level and nine percent level respectively.

These effects are more serious in particular sectors of the economy, as we find the effects to be stronger if we only consider the tertiary sector. However, we do not find that higher ratios of female-to-male agricultural workers are related to higher agricultural per capita output. This is in line with the model in this paper in that distortions in the allocation of managerial talent play a larger role in sectors where more skills are needed—as opposed to sectors that require more physical ability, as agriculture. Therefore, these results can be matched to the model's predictions in the sense that while gender discrimination in the form of restricting women's access to work lowers output in all sectors, gender discrimination in managerial positions that distorts the allocation of talent between managerial and unskilled positions lowers output in sectors where managerial talent is relatively more important than physical talent.

We also find that states with higher ratios of female-to-male managers and workers also have lower female-to-male literacy rates. This result is consistent with the model, which predicts that if women's participation in the labor market is restricted, then on average women have lower incentives to invest in human capital.

The fact that our results are robust to the inclusion of various controls for omitted variables and to potential endogeneity make us more confident that women's lower labor employment, as managers and as workers, has a detrimental effect on economic development, and that this effect is large. In particular, we find the lack of women among managers to be more associated with development than the lack of women among workers in the nonagricultural sector overall. At the same time, while we find that female-to-male managers are associated with per capita output within a state in a given year, differences in workers by gender are only driving differences in long-term trends.

The evidence in this paper suggests that women's lower participation in the nonagricultural labor market has detrimental effects on economic development. In that sense, policy that encourages greater participation of women in the labor market will tend to make an economy grow. While participation in the labor market is partly determined by preferences, empirical evidence (e.g., Mammen and Paxson 2000) suggests that social norms operating in societies like India imply that female labor supply decisions are not optimal from an aggregate point of view, and thus policy should be targeted towards changing these social norms. Therefore for economic development it is crucial to try and erode this discriminatory social norm by encouraging policies and education that underline the value of women in society and in particular in the labor market. We need to think about targeted policies that change social norms and society's perceptions of what women are capable of. In that sense, our understanding of what policies are effective in shifting deeply embedded cultural norms like gender discrimination is extremely limited. Nevertheless, there is a role for the government in financing projects like Mahila Samakhya, a women's empowerment project launched in 1986 by the Ministry of Human Resource Development which, through the building of village level collectives, seeks to bring about a change in women's perception about themselves and that of society regarding women's traditional roles.

7 Appendix: Proofs of some results

Proof of Proposition 1. The particular function for the cutoff level of talent is as follows:

$$T'(w) = \frac{w + w^{\frac{1}{1-\sigma}} a_p^{-\frac{1}{1-\sigma}} \widehat{\sigma} + a_p \overline{H}_p}{c\overline{\alpha}\overline{H}_p s^{\frac{1}{\alpha}} w^{-\frac{1-\alpha}{\alpha}} + (1-c)^{\frac{1}{\beta}} s^{\frac{1}{\alpha\beta}} w^{-\frac{1-\alpha}{\alpha\beta}} a_h^{-\frac{1-\beta}{\beta}} \overline{\alpha}\beta(1-\beta)^{\frac{1-\beta}{\beta}}}.$$

All the important endogenous variables depend on the wage rate, w. After solving for the equilibrium wage rate, the remaining variables are endogenously determined. In particular, it can be checked that $\frac{\partial T'(w)}{\partial w} > 0$. ■

Proof of Proposition 2. Recall by (10) that $H_{p,w} \leq \overline{H}_p$, as long as $w \leq \frac{a_p \overline{H}_p^{1-\sigma}}{\sigma}$, because higher wages mean incentives for the worker to invest more in primary education. There are two possibilities:

In the first case, workers are in the range where $H_{p,w} < \overline{H}_p$. In this case, discrimination lowers the primary human capital of workers. Since some males are entrepreneurs, they will still go through the whole primary schooling process; as a result, the average primary education for males compared to females is

$$AH_p^{males} = \frac{NH_{p,w} + M\overline{H}_p}{P} > H_{p,w} = AH_p^{females},$$

where AH denotes average human capital and N denotes the number of workers. In this case, therefore, the ratio of female-to-male primary education decreases with partial discrimination.

The second possibility is that $H_{p,w} = \overline{H}_p$, which was also true before discrimination because wages were higher. In this case, gender discrimination does not reduce the human capital of workers. Moreover, workers and entrepreneurs, males and females, all go to primary school, so discrimination does not show up in the female-to-male ratio of primary education, but only in the ratio of higher education. ■

8 Data appendix

We use data from sixteen Indian states over the period 1961-1991. Data availability prevents us to extend the analysis to 2001 (there is no information by class of work by state in the Census of India 2001). Our data base builds on Özler *et al* (1996) and Besley and Burgess (2002, 2004). In particular, state per capita **net domestic product** at current prices comes from *Estimates of State Domestic Product* [Department of Statistics, Department of Statistics, Ministry of Planning, Government of

India]. **Education** (female and male literacy rates) and **population** (population growth, and the percentage of urban population to total population) measures come from *Education in India* [Ministry of Education, Government of India] and *Selected educational statistics* [Ministry of Education, Government of India] and from the *Census of India* (*General Economic Tables*, *Socio-Cultural Tables*). Both education and population measures correspond to census issues for 1961, 1971, 1981 and 1991, and have been interpolated between census years. Data on **capital** stock (productive capital) come from the *Annual Survey of Industries* [Central Statistical Office, Industrial Planning Wing, Department of Statistics, Ministry of Planning and Programme Implementation, Government of India]. Data on **politics**— political competition (the absolute difference between the percentage of seats occupied by the Congress party and its main competitor), election turnout (percentage of electors who voted), and information on election years, are calculated from figures in Butler *et al* (1995).

The gender composition of the **labor force** figures come from the *Census of India* 1961, 1971, 1981 and 1991 (*General Economic Tables*), where we find data on four classes of worker: *employers*, *employees*, *single workers*, and *family workers*, which we interpolate between census years. We use the first category as it is and then define *total workers* as the sum of the four. There are however some changes of definitions in the census over the years, which are explained next. Also from the Census are the variables of employment by sector.

In the census issues of 1961 and 1971, the population was divided into either *workers* or *non-workers*. A *worker* is defined as "a person whose main activity was participation in any economically productive work by his physical or mental activity". In the case of regular employment in any trade, profession, service, business or commerce, the criterion of work was satisfied if the person had been employed during any 15 days preceding the day on which he was enumerated. This is somewhat different in the census of 1971 since the reference period is a week.

In the census issues of 1981 and 1991, population is instead divided into *main workers*, *marginal workers, and non-workers*. A *main* (*marginal*) *worker* is defined as "a person whose main activity was participation in any economically productive work by his physical or mental activities and who had worked for 183 days or more (less than 183 days)". For the 1991 issue, we then use the sum of main and marginal workers, so that the same information as in census 1961 and 1971 is used. However, information on the class of worker is only available in the 1981 issue for main workers. Marginal workers typically reflect a very small percentage of total workers, so we do not expect this to affect results in a significant way.

Definitions of every class of worker are as follows. An *employer* is "a person who had necessarily to employ other persons in order to carry on the business from which he served his likelihood." In that sense, "if a person employed a cook or other person for domestic service, he was not to be recorded as employer merely for that reason." An *employee* is "a person who ordinarily worked under some other person for a salary or a wage in cash or in kind as a means of earning a likelihood." A *single worker* is "a person who is doing her/his job without employing others except casually, and without the help of other members of the family except casually and a participant in work as member of co-operative." Finally, a *family worker* is "a person who is doing her/his work in a family enterprise along with the other members of the family without wages or salary in cash or kind."

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Table 1: Descriptive statistics: output and human capital

State	Net per capita real product	Net per capita real agricultural product	Net per capita real non-agricultural product	Female literacy rate	Male literacy rate	Female-to-male primary school teachers	Female-to-male middle school teachers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Andhra	998	455	543	0.19	0.43	0.31	0.37
Pradesh	(251)	(57.4)	(224)	(0.04)	(0.04)	(0.05)	(0.06)
Assam	891	410	481	0.20	0.60	0.23	0.16
	(192)	(33.9)	(172)	(0.06)	(0.08)	(0.05)	(0.03)
Bihar	630	298	332	0.12	0.42	0.15	0.16
	(111)	(36.5)	(90.7)	(0.04)	(0.05)	(0.04)	(0.05)
Gujarat	1173	415	759	0.30	0.60	0.46	0.60
	(265)	(78.4)	(236)	(0.07)	(0.06)	(0.11)	(0.14)
Haryana	1444	757	687	0.22	0.54	0.49	0.48
	(357)	(99.7)	(286)	(0.05)	(0.07)	(0.14)	(0.11)
Jammu &	1021	440	581	0.10	0.31	0.24	0.43
Kashmir	(228)	(41.9)	(212)	(0.04)	(0.07)	(0.08)	(0.17)
Karnataka	1029	458	571	0.25	0.54	0.24	0.43
	(204)	(48.7)	(202)	(0.07)	(0.06)	(0.08)	(0.17)
Kerala	857	342	515	0.65	0.83	1.12	1.05
	(169)	(29.5)	(170)	(0.11)	(0.07)	(0.30)	(0.27)
Madhya	834	392	443	0.14	0.44	0.21	0.23
Pradesh	(185)	(50.9)	(157)	(0.05)	(0.07)	(0.06)	(0.06)
Maharashtra	1274	328	946	0.31	0.64	0.44	0.41
	(315)	(44.8)	(296)	(0.08)	(0.07)	(0.12)	(0.09)
Orissa	867	427	440	0.18	0.52	0.10	0.09
	(183)	(89.1)	(179)	(0.07)	(0.06)	(0.08)	(0.04)
Punjab	1732	871	861	0.29	0.49	0.82	0.71
	(384)	(112)	(286)	(0.09)	(0.07)	(0.29)	(0.13)
Rajasthan	779	403	375	0.11	0.39	0.22	0.24
	(128)	(61.3)	(98.9)	(0.03)	(0.08)	(0.08)	(0.05)
Tamil	1001	303	698	0.30	0.62	0.57	0.85
Nadu	(256)	(50.4)	(265)	(0.08)	(0.05)	(0.06)	(0.08)
Uttar	868	439	429	0.13	0.42	0.20	0.25
Pradesh	(146)	(32.1)	(129)	(0.04)	(0.07)	(0.04)	(.03)
West	1160	402	758	0.30	0.58	0.18	0.30
Bengal	(179)	(37.3)	(170)	(0.07)	(0.06)	(0.06)	(0.04)
N	479	479	479	457	457	395	395

Note: standard deviation in parentheses.

Table 2: Descriptive statistics: female and male workers by sector

State	Female-to-male agricultural workers	Female-to-male non-agricultural workers	Female-to-male managers	Share of female agricultural workers	Share of female household workers	Share of female other workers	Share of male agricultural workers	Share of male household workers	Share of male other workers
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Andhra	0.69	0.21	0.08	82.0	5.57	11.7	63.5	5.32	31.1
Pradesh	(0.09)	(0.04)	(0.02)	(1.92)	(1.37)	(1.40)	(1.11)	(2.02)	(2.59)
Assam	0.29	0.27	0.04	64.5	5.54	29.5	67.1	0.86	31.9
	(0.13)	(0.03)	(0.02)	(10.6)	(4.91)	(10.8)	(2.08)	(0.16)	(2.13)
Bihar	0.31	0.09	0.03	89.5	3.56	6.01	78.1	2.65	19.1
	(0.09)	(0.03)	(0.01)	(2.67)	(1.74)	(0.80)	(1.70)	(0.80)	(1.23)
Gujarat	0.49	0.13	0.02	81.7	3.37	12.1	58.5	2.99	38.4
	(0.14)	(0.03)	(0.01)	(0.37)	(1.90)	(1.38)	(3.66)	(1.28)	(4.65)
Haryana	0.22	0.07	0.02	81.3	1.89	15.6	60.5	2.57	36.8
	(0.08)	(0.01)	(0.01)	(5.35)	(0.72)	(5.07)	(2.74)	(0.54)	(3.25)
Jammu &	0.35	0.07	0.02	84.1	7.71	7.95	67.7	4.06	28.2
Kashmir	(0.19)	(0.01)	(0.01)	(5.52)	(3.57)	(4.49)	(3.83)	(0.24)	(3.57)
Karna-	0.64	0.22	0.05	78.5	3.74	16.0	60.0	2.49	37.2
taka	(0.05)	(0.03)	(0.01)	(0.31)	(1.24)	(1.05)	(1.20)	(0.50)	(1.74)
Kerala	0.51	0.24	0.03	57.7	9.57	37.5	41.3	2.87	54.2
	(0.14)	(0.01)	(0.01)	(13.3)	(3.37)	(2.15)	(2.98)	(0.91)	(2.64)
Madhya	0.62	0.12	0.05	89.1	3.82	6.49	73.1	3.56	23.3
Pradesh	(0.12)	(0.07)	(0.01)	(0.63)	(0.40)	(0.64)	(1.94)	(0.83)	(5.15)
Maha-	0.80	0.14	0.05	85.9	2.65	10.9	54.5	2.97	42.2
rashtra	(0.15)	(0.02)	(0.02)	(0.80)	(0.64)	(1.02)	(3.43)	(0.87)	(4.02)
Orissa	0.32	0.18	0.07	78.8	7.03	12.8	75.0	3.32	21.5
	(0.11)	(0.08)	(0.05)	(5.76)	(2.13)	(4.69)	(1.99)	(0.79)	(2.29)
Punjab	0.11	0.07	0.02	41.9	7.08	43.9	54.6	3.16	32.9
	(0.08)	(0.01)	(0.01)	(4.58)	(2.16)	(21.6)	(6.52)	(1.94)	(3.45)
Rajasthan	0.47	0.11	0.04	88.6	3.03	7.42	69.2	3.67	27.0
	(0.17)	(0.03)	(0.01)	(2.17)	(1.55)	(1.82)	(3.05)	(1.17)	(3.97)
Tamil	0.57	0.19	0.04	73.3	5.40	16.6	55.3	3.75	40.6
Nadu	(0.13)	(0.04)	(0.02)	(1.91)	(0.26)	(1.54)	(1.78)	(0.46)	(2.16)
Uttar	0.17	0.07	0.03	76.8	4.88	8.19	73.8	3.74	22.4
Pradesh	(0.04)	(0.03)	(0.01)	(16.0)	(1.31)	(0.46)	(1.58)	(0.94)	(2.10)
West	0.15	0.12	0.02	58.3	8.99	30.2	55.6	2.85	41.2
Bengal	(0.04)	(0.01)	(0.01)	(1.15)	(1.92)	(4.14)	(1.68)	(0.15)	(1.53)
N	446	476	476	446	446	446	446	446	446

Note: standard deviation in parentheses.

Table 3: Non-agricultural output and gender composition of the labor force, by class - Managers

Dependent variable: log per capita non-agricultural output				
OLS	(1)	(2)	(3)	(4)
Female-to-male managers	2.56***	2.42***	2.95***	3.19***
	(0.41)	(0.37)	(0.37)	(0.37)
Female literacy rate	1.83***	1.81**	1.34*	1.41*
	(0.68)	(0.72)	(0.76)	(0.75)
Male literacy rate	0.30	0.23	-1.45	-1.26
	(1.68)	(1.64)	(1.14)	(1.07)
Population growth	-0.01	0.02	0.21*	0.19
	(0.13)	(0.13)	(0.12)	(0.10)
Ratio of urban to total population	3.52	4.04	4.57*	5.06
	(3.20)	(3.16)	(2.66)	(3.22)
Ratio of capital to labor	-23.4	-28.5	-159	-177
	(99.6)	(109)	(111)	(157)
Election dummy		-0.01	-0.01	-0.01
		(0.02)	(0.02)	(0.02)
Election turnout		-0.003*	-0.002	-0.002
		(0.001)	(0.002)	(0.002)
Political competition		0.0005	0.0004	0.0004
		(0.0003)	(0.0003)	(0.0003)
Scheduled tribes and castes population (%)			-0.03***	-0.02***
			(0.01)	(0.006)
Log non-agricultural work force			0.24**	0.18**
			(0.18)	(0.16)
Muslim population (%)				-0.03
				(0.03)
Hindu population (%)				-0.03
				(0.02)
State effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Adjusted R^2	0.93	0.93	0.93	0.93
Number of observations	289	288	261	261

Notes: robust standard errors clustered at the state level in parentheses.
*significant at 10%; **significant at 5%; ***significant at 1%.

Table 4: Non-agricultural output and gender composition of the labor force, by class - Workers

Dependent variable: log per capita non-agricultural output				
OLS	(1)	(2)	(3)	(4)
Female-to-male workers	1.38***	1.18**	1.49***	1.53***
	(0.61)	(0.53)	(0.47)	(0.51)
Female literacy rate	1.49*	1.47*	1.70**	1.59**
	(0.77)	(0.78)	(0.68)	(0.72)
Male literacy rate	-0.17	-0.17	-2.02	-1.95
	(1.68)	(1.65)	(1.41)	(1.36)
Population growth	-0.02	0.01	0.12	0.11
	(0.13)	(0.13)	(0.11)	(0.10)
Ratio of urban to total population	5.70*	5.95	5.81**	6.15*
	(3.21)	(3.16)	(2.45)	(3.51)
Ratio of capital to labor	-29.7	-33.3	-73.3	-90.8
	(114)	(120)	(116)	(169)
Election dummy		-0.02	-0.01	-0.02
		(0.80)	(0.02)	(0.02)
Election turnout		-0.003**	-0.001	-0.002
		(0.002)	(0.002)	(0.002)
Political competition		0.001	0.003	0.001
		(0.001)	(0.003)	(0.001)
Scheduled tribes and castes population (%)			-0.02**	-0.02***
			(0.09)	(0.01)
Log non-agricultural work force			0.33**	0.31**
			(0.16)	(0.15)
Muslim population (%)				-0.02
				(0.05)
Hindu population (%)				-0.02
				(0.04)
State effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Adjusted R^2	0.92	0.92	0.93	0.93
Number of observations	289	288	288	270

Notes: robust standard errors clustered at the state level in parentheses.
*significant at 10%; **significant at 5%; ***significant at 1%.

Table 5: Non-agricultural output and gender composition of the labor force, by class - Workers

Dependent variable:	log per capita agricultural output	log per capita non-agricultural output	log per capita secondary output	log per capita tertiary output
OLS	(1)	(2)	(3)	(4)
Female-to-male agricultural workers	0.39			
	(0.35)			
Female-to-male household workers		0.12***		
		(0.04)		
Female-to-male secondary sector workers			-0.42	
			(0.57)	
Female-to-male tertiary sector workers				1.15***
				(0.27)
Political controls	yes	yes	yes	yes
Socioeconomic controls	yes	yes	yes	yes
State effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Adjusted R^2	0.70	0.93	0.77	0.94
Number of observations	261	261	258	257

Notes: robust standard errors clustered at the state level in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%.

Table 6: Output and gender composition of the labor force, tertiary sector

Dependent variable: log per capita tertiary sector output		
OLS	(1)	(2)
Female-to-male employers	2.86***	
	(0.47)	
Female-to-male workers		1.42***
		(0.50)
Political controls	yes	yes
Socioeconomic controls	yes	yes
State effects	yes	yes
Year effects	yes	yes
Adjusted R^2	0.93	0.93
Number of observations	257	257

Notes: robust standard errors clustered at the state level in parentheses. *significant at 10%; **significant at 5%; ***significant at 1%.

Table 7: Non-agricultural output and gender composition of the labor force, Robustness checks

Dependent variable:	log per worker non-agricultural output		log per capita non-agricultural output	log per capita tertiary sector output	log per capita non-agricultural output	
OLS	(1)	(2)	(3)	(4)	(5)	(6)
Female-to-male managers	2.34***				7.08**	
	(0.60)				(3.57)	
Female-to-male workers		1.25*				0.10
		(0.69)				(0.35)
Share of female managers			3.80***	2.36***		
			(0.48)	(0.50)		
Political controls	yes	yes	yes	yes	yes	yes
Socioeconomic controls	yes	yes	yes	yes	yes	yes
State effects	yes	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes	yes
State-specific linear trends	no	no	no	no	yes	yes
Adjusted R^2	0.99	0.99	0.93	0.94	0.94	0.94
Number of observations	261	261	261	257	261	261

Notes: robust standard errors clustered at the state level in parentheses. Socioeconomic controls are female and male literacy rates, population growth, the ratio of urban to total population, the ratio of capital to labor, the log number of workers, caste andreligious affiliation. Political controls are the absolute difference between the percentage of seats of the Congress party and its party and its main competitor, lagged election turnout, and a dummy for an election year. *significant at 10%; **significant at 5%; ***significant at 1%.

Table 8: Non-agricultural output and instrumented gender composition of the labor force, by class

	Dependent variable			
	Log per capita non-agricultural output	Log per capita non-agricultural output	Female-to-male managers	Female-to-male workers
	(1)	(2)	(3)	(4)
Female-to-male managers	5.82***			
	(1.57)			
Female-to-male workers		4.64***		
		(1.32)		
Socioeconomic controls	yes	yes	yes	yes
Political controls	yes	yes	yes	yes
State effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Female-to-male primary school teachers			0.092***	0.10***
			(0.020)	(0.026)
Female-to-male middle school teachers			0.040*	0.075**
			(0.023)	(0.03)
First stage F test statistic			14.9	14.2
Sargan overidentification test p-value			0.67	0.78
Adjusted/Centered R^2	0.94	0.93	0.81	0.95
Number of observations	233	233	233	233

Notes: robust standard errors clustered at the state level in parentheses. Socioeconomic controls are female and male literacy rates, population growth, the ratio of urban to total population, the ratio of capital to labor, caste and religious affiliation. Political controls are the absolute difference between the percentage of seats of the Congress party and its main competitor, lagged election turnout, and a dummy for an election year. The ratio of female-to-male managers/workers is instrumented with the ratio of female-to-male primary and middle school teachers.*significant at 10%; **significant at 5%;***significant at 1%.

Table 9: Tertiary sector output and instrumented gender composition of the labor force, by class

	Dependent variable			
	Log per capita tertiary output	Log per capita tertiary output	Female-to-male managers	Female-to-male workers
	(1)	(2)	(3)	(4)
Female-to-male managers	2.74**			
	(1.39)			
Female-to-male workers		2.50*		
		(1.40)		
Socioeconomic controls	yes	yes	yes	yes
Political controls	yes	yes	yes	yes
State effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
Female-to-male primary school teachers			0.090***	0.093***
			(0.018)	(0.023)
Female-to-male middle school teachers			0.028	0.036
			(0.023)	(0.029)
First stage F test statistic			15.7	11.6
Sargan overidentification test p-value			0.19	0.17
Adjusted/Centered R^2	0.96	0.95	0.83	0.95
Number of observations	229	229	229	229

Notes: robust standard errors clustered at the state level in parentheses. Socioeconomic controls are female and male literacy rates, population growth, the ratio of urban to total population, and the ratio of capital to labor. Political controls are the absolute difference between the percentage of seats of the Congress party and its main competitor, lagged election turnout, and a dummy for an election year. The ratio of female-to-male managers/workers is instrumented with the ratio of female-to-male primary and middle school teachers. *significant at 10%; **significant at 5%; ***significant at 1%.

Table 10: Human capital and gender composition of the labor force, by class

	Dependent variable:					
	Female-to-male literacy		Female-to-male literacy		Female-to-male managers	Female-to-male workers
	OLS		IV			
	(1)	(2)	(3)	(4)	(5)	(6)
Female-to-male managers	0.075		0.95***			
	(0.097)		(0.27)			
Female-to-male workers		0.14		0.61***		
		(0.09)		(0.15)		
Socioeconomic controls	yes	yes	yes	yes	yes	yes
Political controls	yes	yes	yes	yes	yes	yes
State effects	yes	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes	yes
Female-to-male primary school teachers					0.077***	0.13***
					(0.017)	(0.02)
Female-to-male middle school teachers					0.066***	0.08***
					(0.022)	(0.03)
First stage F test statistic					27.2	40.8
Sargan overidentifaction test p-value					0.52	0.83
Adjusted/Centered R^2	0.99	0.99	0.99	0.99	0.78	0.95
Number of observations	279	279	251	251	251	251

Notes: robust standard errors clustered at the state level in parentheses. Socioeconomic controls are female and male literacy rates, population growth, the ratio of urban to total population, the ratio of capital to labor, caste and religious affiliation. Political controls are the absolute difference between the percentage of seats of the Congress party and its main competitor, lagged election turnout, and a dummy for an election year. The ratio of female-to-male managers/workers is instrumented with the ratio of female-to-male primary and middle school teachers.*significant at 10%; **significant at 5% ;***significant at 1%.