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# Caste, Female Labor Supply and the Gender Wage Gap in India: Boserup Revisited

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**ABSTRACT**

The gender wage gap is notable not just for its persistence and ubiquity but also for its variation across regions and countries. A natural question is how greater work participation by women matters to female wages and the gender wage gap. Within India, a seeming paradox is that gender differentials in agricultural wage are the largest in southern regions of India that are otherwise favorable to women. Boserup (1970) hypothesized that this is due to greater labor force participation by women in these regions. This is not obvious as greater female labor supply could depress male wage as well. Other factors also need to be accounted for especially since women have fewer opportunities for non-farm employment. This paper undertakes a formal test of the Boserup proposition. We find that differences in female labor supply are able to explain 55 percent of the gender wage gap between northern and southern states of India. The paper also finds thatwomen gain from greater non-farm employment, even if their direct participation in such activity is limited.  This happens because of higher wages.

Key words: Gender wage gap; Agriculture; Labor supply; Caste

JEL Codes:  J16, J21, J22, J31, J43, O15

## 1. Introduction

The gender gap in wages is a persistent feature of labor markets despite laws mandating equal treatment of women at workplace. What is just as notable is the variation in the gender wage gap across regions and countries, and in some cases, over time as well. In a cross-country context, observable differences in characteristics and endowments, explain only a small portion of the wage gap (Hertz et al. 2009). Since the unexplained component is the dominant one, the geographical variation in the wage gap is commonly attributed to discrimination.

However, discrimination may not be the only reason. If female and male labor are imperfect substitutes, then the wage gap would vary with male and female labor supply. In many regions of the United States, female wages fell relative to male wages during the Second World War (Aldrich 1989; Acemoglu, Autor and Lyle 2004). By exploiting cross-sectional variation in the change in female work participation rates that occurred during World War II, Acemoglu et al. (2004) showed that higher female labor supply increased the gender gap in wages in the United States. In a sample of 22 countries drawn mostly from the OECD, Blau and Kahn (2003) also explored the idea that higher female labor supply can exacerbate the gender wage gap.

In a developing country context, the role of female labor supply in influencing the gender gap in wages was highlighted by Boserup (1970)in her influential book, *Women's Role in Economic Development*. She pointed to the geographical variation in the ratio of female to male agricultural wage that existed in India during the 1950s. The gender wage gap was greater in southern states of India relative to the states in north India and Boserup ascribed this to the much higher female participation rates in farming in South India. Figure 1 maps the ratio of female to male agricultural wage across Indian statesfor year 2004. It is easy to observe a systematic regional pattern –of the same kind as Boserup described 50 years ago.

Boserup’s hypothesis is based on raw correlations drawn from wage data across Indian villages in the 1950s. However, the hypothesis is not immediately obvious because variation in female labor supply could affect male wage as well. The extent to which the female and the male labor are substitutes matters. In addition, there are competing explanations. For instance, there could be gender segregation by task where `female’ tasks are possibly paid less than supposedly `male’ tasks. Second, the relative efficiency of female to male labor in agriculture could vary across regions due to differences in agricultural technology, variation in cropping pattern and agro-climatic conditions. Third, factors that affect the supply of male labor to agriculture, such as non-farm employment, could also matter to the wage gap.The impacts of all these factors must be considered in the analysis.This is what is done in this paper.

The goal of this paper is to explain the spatial variation in the gender gap in agricultural wage in India. In particular, the paper asks whether exogenous variations in female as well as male labor supply to agriculture play any part in explaining the gender wage gap.

The effect of male labor supply on gender wage gap is of independent interest as well. It is well known that the labor flow from agriculture to other sectors has been much more marked for males than for females (Eswaran et al. 2009). So if men have greater access to non-farm work opportunities, do women working as agricultural labor gain from growth in the non-farm sector? In trying to understand the impact of economic growth on the economic well being of women, the effect of non-farm employment on the gender wage gap is of immense importance.

Econometrically, we estimate district level inverse demand functions that relate female and male agricultural wages to exogenous variation in female and male labor supply to agriculture. The conceptual challenge is to identify exogenous variation in female and male labor supply to agriculture. The effect of female labor supply on wages is identified by the variation in cultural and societal norms that regulate female labor supply. In India, the pattern of high female work participation rates in south India relative to north India has persisted over many decades(Nayyar 1987; Chen 1995; Bardhan, K 1984) and Das (2006) suggesting the salience of cultural norms. Boserupobserved that typically, higher caste Hindu women take no part in cultivation activities while tribal and low caste women have traditions of female farming either on their own land or as wage labor. She also points out that tribal and low caste populations are lower in north India relative to other parts of the country. Boserup follows up these observations with its consequences. In her words,

> "The difference between the wages paid to women and to men for the same agricultural tasks is less in many parts of Northern India than is usual in Southern India and it seems reasonable to explain this as a result of the disinclination of North Indian women to leave the domestic sphere and temporarily accept the low status of an agricultural wage laborer." (Boserup 1970, 61).

The plausibility of social norms driving the north-south divide in female work participation is consistent with the well-known finding that women have greater autonomy in the southern states of India (Dyson and Moore 1983). Basu (1992) and Jejeebhoy (2001) also find similar patterns in woman's status indicators across India's north and south.[1]Boserup's association of social group membership with female work participation has been confirmed in later work as well (Chen 1995; Das 2006; Eswaran, Ramaswami and Wadhwa 2013). Taking a cue from these studies, we take the proportion of households that are low-caste as an instrument for female labor supply. The idea that social norms determine women's labor supply decisions is not unique to India (Boserup 1970; Goldin 1995; Mammen and Paxson 2000).What is characteristic of India is the variation of these norms along identifiable social groups.[2] As variation in low-caste population might be correlated with variables that directly affect the demand for agricultural labor, we include them as controls to identify the causal impact. These variables include agro-climatic endowment, cropping patterns and infrastructure.

The proportion of men employed in large-sized non-farm enterprises instruments male labor supply to agriculture. Large enterprises reflect external demand and are therefore a source of exogenous variation in agricultural labor supply. As we argue later, the possible pitfalls in the use of this variable as an instrument are addressed by inclusion of appropriate controls in the estimating equation.

In the next section we relate thispaper to the relevant literature. In section 3, we provide suggestive evidence in support of Boserup hypothesis. Section 4 outlines a theoretical framework which is followed in section 5 by a discussion of the empirical strategy. The data is described in section 6 and section 7 contains the estimation results. To check for robustness, section 8 considers alternative specifications. The estimation results are used in section 9 to quantitatively decompose the proportion of wage gap difference across northern and southern states of India into its various explanatory components.Concluding remarks are gathered in section 10.

## 2. Relation to Literature

Blau and Kahn (2003) analyze the gender wage gap across 22 countries and find evidence that the gender gap in wages is lower when women are in shorter supply relative to their demand. They construct a direct measure of female net supply using data across all occupations and recognize that their estimates might be biased due to reverse causality. Acemoglu et al. (2004)

correct for the endogeneity of female labor supply using male mobilization rates during World War II as an instrument for labor supply of females to the non-farm sector in the United States.They find that an increase in female labor supply lowers female wage relative to male wage. In some specifications, the endogenous variable that is instrumented is the female to male labor supply ratio. In other specifications, the female and the male labor supplyenter as separate explanatory variables but only the female labor supply is instrumented.

In the Indian context, Rosenzweig (1978) was the first paper to estimate labor demand functions for agricultural labor in India to estimate the impact of land reforms on male andfemale wage rates. This exercise is embedded within a general equilibrium market clearing model of wage determination. In the empirical exercise, Rosenzweig estimates inverse demand and supply equations for hired labor of males, females and children in agriculture using wage data on 159 districts in India for the year 1960-61. His results show that an increase in female labor supply has a negative effect on both male and female wage rates. Further, the paper is unable to reject the null hypothesis that both effects are of equal magnitude. Thus, the Boserup hypothesis is not supported.

There are several reasons to revisit this analysis. First, the wage data used by Rosenzweig, is not well-suited for capturing cross-sectional variation.[3] The better data set for this purpose (and which is used in this paper) is the unit level data from the Employment and Unemployment schedule of the National Sample survey (NSS) which was unavailable to researchers at the time Rosenzweig did his study.[4] Second, as a measure of agricultural labor supply, Rosenzweig uses the percentage of male (or female) agricultural labor force to the total labor force. However, after controlling for agricultural labor supply, changes in total labor supply should not matter to wages. Our specification for the labor demand function derives from a production functionthat has land and labor as inputs, and exhibits constant returns to scale. As a result, the relevant labor supply variable is the agricultural employment (male or female) per unit of cultivated land.

Third, Rosenzweig limits the definition of agricultural labor to hired labor alone. This paper, on the other hand, estimates the demand for total labor and not for hired agricultural labor because it is harder to find instruments that are valid for hired labor demand. Suppose $L_s^f$ and $L_s^o$ are the aggregate labor supply to the home farm and to the outside farms respectively. Similarly, let $L_d^f$ and $L_d^h$ be the aggregate demand for family and hired labor respectively. Then equilibrium in the labor market can either be written as $L_s^f + L_s^o = L_d^f + L_d^h$ or as $L_s^o = L_d^h$. However, for econometric estimation, it is preferable to estimate the inverse demand for all agricultural labor than for hired labor alone.This is because the instruments that affect labor supply to outside farms would also affect own farm labor supply and hence potentially affect the demand for hired labor. For instance, higher caste women may refrain from work outside the home and also limit their work on own farms. Similarly, availability of non-farm work opportunities may reduce the family labor supply of landed households to own farms and increase the demand for hired labor. A simple sum of hired and family labor would, however, contradict the accepted notion that family labor is more efficient than hired labor. Moreover, as we shall see later, the implication of using an un-weighted aggregate is that there might be an omitted variable correlated with the aggregate labor supply.  However, we demonstrate that our findings are robust to whichever way the family and the hired labor are weighted to form aggregate labor supply.

Finally, current data allows for more comprehensive controls and better identification strategies than available to Rosenzweig. We are able to employ controls for crop composition, agro-ecological endowments and district infrastructure. For identification, Rosenzweig assumes that the demand for hired labor (whether male, female or child labor) is not affected by proportion of population living in urban areas in the district, indicators of the non-farm economy (factories and workshops per household, percentage of factories and workshops employing five or more workers, percentage of factories and workshops using electricity) and the percentage of population that is Muslim. We do not use urbanization as an instrument because that could be directly correlated with agricultural productivity by determining the access to technology and inputs.We therefore employ urbanization as a control variable in some of our specifications. We improve on the non-farm economy instrument by confining it to traded sectors and large enterprises. Section 5 argues why such an instrument is plausibly exogenous. We replace the percentage Muslim population variable by the proportion of population that is of low-caste. As we argue in Section 5, there is a large literature that has already highlighted caste-specific norms of female labor supply in India.

Other studies that estimate structural demand and supply equations for hired agricultural labor in India are Bardhan (1984) and Kanwar (2004). Bardhan (1984) estimates simultaneous demand and supply equations for hired male laborers at village level in West Bengal. He instruments the village wage rate by village developmental indicators, unemployment rate and seasonal dummies. Kanwar (2004) estimates village level seasonal labor demand and supply equations for hired agricultural labor simultaneously accounting for non-clearing of the labor market using ICRISAT data. Neither of these studies analyze male and female laborers separately and they cover only a few villages in a state. Singh (1996) estimates an inverse demand function for both males and females in agriculture, using state level pooled time series data for 1970 to 1989; however ordinary least squares methods are used and the endogeneity of labor supply is not corrected.

## 3.The Gender Gap in Wages and Female Labor Supply: Correlations

Figure 2 cross-plots the state-level average of female to male wage ratio against female labor time in agriculture per unit of cultivable land. The figure is based on data from a national survey in 2004 and is consistent with Boserup's hypothesis that the two variables are inversely related.[5]

If female and male labor are perfect substitutes in agricultural production, then a change in female labor supply, say a decline, would raise both female and male wages proportionately and not affect the gender wage gap (which in a world without discrimination would be solely due to gender differences in marginal product). For the Boserup hypothesis to hold, female and male labor must not be perfect substitutes so that changes in female labor supply affects female wage more than male wage. The lack of perfect substitutability is closely related to the gender division of labor within agriculture that is often found in many countries (Burton and White 1984; Doss 1999). For instance, in many societies, weeding is usually seen as a task mostly performed by females while ploughing is a task done mostly by males. Direct evidence on limited substitutability of female and male labor in agriculture has been found in a number of studies in India and other countries (Jacoby 1992; Laufer 1985; Skoufias 1993;Quisumbing 1996).

If some tasks are better paid than others and if males mostly do the better paid tasks and females do the less paying tasks, then that could result in a gender wage gap. In this case, the geographical variation in the gender wage gap could simply be because of variation in the gender division of labor. It is, in fact, true that the gender division of labor is more pronounced in southern states of India[6]. However, this is not the primary reason for either the gender wage gap or its variation.

In table 1, individual wage rates are regressed on gender, age, age square, education and marital status. With these control variables, column (1) shows that females get a 35 percent lower daily wage than males in agriculture. In column (2) we add the controls for agricultural task for which the daily wage was recorded. The gender wage gap narrows slightly to 33 percent. Thus, the gender wage gap in Indian agriculture is mostly within tasks.

A direct way of accounting for variation across states in the gender division of labor is to hold it constant and to re-do the Boserup plot of figure 2. The female to male wage ratio for state `s' is the weighted mean across tasks given by

$$\frac{\boldsymbol{w_{fs}}}{\boldsymbol{w_{ms}}} = \frac{\sum \boldsymbol{P_{fjs} w_{fjs}}}{\sum \boldsymbol{P_{mjs} w_{mjs}}}$$

where $\boldsymbol{w_{fs}}(\boldsymbol{w_{ms}})$ is the female (male) wage in state `*s*', $\boldsymbol{P_{fjs}}$ $(\boldsymbol{P_{mjs}})$ is the proportion of females (males) working in task '*j*' in state '*s*' and $\boldsymbol{w_{fjs}}(\boldsymbol{w_{mjs}})$ is the female (male) wage in task `*j*' in state `*s*'. Suppose we replace the state proportions in tasks by females and males by the proportions observed for the southern state of Tamil Nadu (arbitrarily chosen), then the wage ratio in state `*s*' becomes

$$\frac{\boldsymbol{w'_{fs}}}{\boldsymbol{w'_{ms}}} = \frac{\sum \boldsymbol{P_{fj,TN} w_{fjs}}}{\sum \boldsymbol{P_{mj,TN} w_{mjs}}}$$

Figure 3 plots this measure of wage ratio, which is devoid of variation in gender division of labor across states, against the female employment in agriculture. The negative relationship between female to male wage ratio and female employment still persists, even when we account for differential participation in tasks by males and females across states in India. As shown earlier, this is because the wage difference across males and females in Indian agriculture is mostly within the same task.

## 4. Theoretical Framework

Before proceeding with the empirical strategy it is useful to discuss the theoretical implications of exogenous changes in male and female labor supply on male and female wages. When male and female labor supply changes are exogenous, the resulting impact on wages can be determined by reading off the labor demand curve. Identification of such exogenous changes and the estimation of the demand curve is the subject of later sections.

Assume ahomogenous, continuous and differentiable agricultural production function with three factors of production – Land (A), Male labor ($L_m$) and Female labor ($L_f$). Returns to each factor are diminishing and land is fixed in the short run. The profit function is given by:

$$\pi = F\left(A, L_m, L_f\right) - w_m L_m - w_f L_f$$

Let $F_{L_m}$ and $F_{L_f}$ denote the marginal product of male and female labor respectively. For given wages, the first order conditions for labor demand satisfy

$$\ln(w_m) = \ln(F_{L_m}) \quad (1)$$

$$\ln(w_f) = \ln(F_{L_f}) \quad (2)$$

If labor supply were to, say, increase for a reason exogenous to wages, then wages must adjust to increase demand. We derive the own and cross-price elasticities of male labor demandas

$$\frac{\partial \ln(w_m)}{\partial \ln(L_m)} = \frac{\partial \ln(F_{L_m})}{\partial L_m} \frac{\partial L_m}{\partial \ln(L_m)} = \frac{F_{L_m L_m}}{F_{L_m}} L_m \quad (3)$$

$$\frac{\partial \ln(w_m)}{\partial \ln(L_f)} = \frac{\partial \ln(F_{L_m})}{\partial L_f}\frac{\partial L_f}{\partial \ln(L_f)} = \frac{F_{L_m L_f}}{F_{L_m}} L_f \qquad (4)$$

Similarly, expressions for own and cross-price elasticity of female labor demand are given by

$$\frac{\partial \ln(w_f)}{\partial \ln(L_f)} = \frac{F_{L_f L_f}}{F_{L_f}} L_f \qquad (5)$$

$$\frac{\partial \ln(w_f)}{\partial \ln(L_m)} = \frac{F_{L_f L_m}}{F_{L_f}} L_m \qquad (6)$$

The diminishing return to factor inputs implies that own-price elasticities, (3) and (5) are negative. To sign the cross-price elasticity we need to know whether male and female labor are substitutes or complements in the production process. If they are imperfect substitutes then (4) and (6) will also be negative since the marginal product of male labor will decline if female labor increases and vice versa. If they are complements then (4) and (6) will be positive.

The effect of female employment on the gender wage gap is given by $\frac{\partial \ln(w_f/w_m)}{\partial \ln(L_f)} = \frac{\partial \ln(w_f)}{\partial \ln(L_f)} - \frac{\partial \ln(w_m)}{\partial \ln(L_f)}$. If male and female labor are imperfect substitutes, this expression cannot be signed without further restrictions. If the two kinds of labor are complements, then increase in female labor employment will decrease the female to male wage ratio (or increase the gender wage gap). Similarly, the effect of male labor employment on the gender wage gap is given by $\frac{\partial \ln(w_f/w_m)}{\partial \ln(L_m)}$. Again, this expression cannot be signed when male and female labor are imperfect substitutes. If they are complements, then an increase in the male labor employment will increase the female to male wage ratio (or reduce the gender wage gap).Note that the relative magnitude of the cross-price elasticities can be obtained from (4) and (6). This is given by

$$\frac{\partial \ln(w_f)}{\partial \ln(L_m)} \Big/ \frac{\partial \ln(w_m)}{\partial \ln(L_f)} = \frac{L_m}{F_{L_f}} \frac{F_{L_m}}{L_f} = \frac{L_m}{w_f} \frac{w_m}{L_f} = \frac{L_m}{L_f} \frac{w_m}{w_f} \qquad (7)$$

The relative magnitude of cross-price elasticities can, thus, be expressed as a product of male to female labor employment and male to female wage ratio. In the Indian agricultural labor market, it is seen that the labor supply of males is greater than that of females and the male wage is also greater than female wage. Therefore, the above expression will be greater than unity which implies that the effect of male labor employment on female wage will be greater than the effect of female labor employment on male wage. Later, in the paper we see if the estimate of the relative cross-price elasticities, implied by the above theoretical model, holds ground empirically.

## 5. Empirical strategy

For observed levels of female and male employment in agriculture, the inverse demand functions can be written as

$$\boldsymbol{W_{Mi} = \alpha_0 L_{F,i} + \beta_0 L_{M,i} + \gamma_0 X_i + \varepsilon_{M,i}} \qquad \mathbf{8(\boldsymbol{a})}$$

$$\boldsymbol{W_{Fi} = \alpha_1 L_{F,i} + \beta_1 L_{M,i} + \gamma_1 X_i + \varepsilon_{F,i}} \qquad \mathbf{8(\boldsymbol{b})}$$

where '*i*' indexes district, *W* is log of real wage, *L* is log of labor employed in agriculture, *X* are other control variables. The inverse demand functions are estimated at the level of a district. This requires Indian districts to approximate separate agricultural labor markets. This has also been assumed inprevious studies on Indian rural labor markets (Jayachandran, 2006; Rosenzweig,

1978) and is supported by the conventional wisdom that inter-district permanent migration rates are low in India (Mitra and Murayama, 2008; Munshi and Rosenzweig, 2009, Parida and Madheswaran, 2010). While some recent work has questioned this, the evidence here points to rural-urban and out-country migration rather than rural-rural migration (Tumbe, 2014). If rural-rural labor mobility across districts is large in India, then, the district level effect oflabor supply changes on agricultural wages will be insignificant.

From (8a) and (8b), it can be seen that the effect of female labor supply on female to male wage ratio is given by $(\alpha_1 - \alpha_0)$. As $\alpha_1$ is expected to be negative, an increase in female labor supply leads to a greater gender gap in agricultural wages (i.e., the Boserup hypothesis) if $(\alpha_1 - \alpha_0) < 0$. Similarly, the effect of male labor supply on the gender gap in agricultural wages is $(\beta_1 - \beta_0)$. A decline in male labor supply to agriculture due to greater non-farm employment opportunities would increase the gender gap in agricultural wages if $(\beta_1 - \beta_0) > 0$. Identification requires that we relate wages to exogenous variation in female and male labor supply to agriculture.

*Identification of the Impact of Female Labor Supply*

For female labor supply, this paper uses the proportion of district population that is low caste as an instrument.[7] The relation betweendistrict level female employment in agriculture and the instrument is plotted in figure 4. The positive association between the two is consistent with earlier work that has established the effect of caste on female labor supply. These studiesobserve that high caste women refrain from work participation because of `status’ considerations (Aggarwal 1994; Bagchi and Raju 1993;Beteille 1969; Boserup 1970; Chen 1995).Correlations from village level and local studies have been confirmed by statistical analysis of large data sets.

Using nationally representative employment data, Das (2006) shows that castes ranking higher in the traditional caste hierarchy have consistently lower participation rates for women. The `high' castes also have higher wealth, income and greater levels of education. So could the observed effect be due to only the income effect? In an empirical model of household labor supply, Eswaran et al. (2012) show that `higher' caste households have lower female labor supply even when there are controls for male labor supply, female and male education, family wealth, family composition, and village level fixed effects that control for local labor market conditions (male and female wages) as well as local infrastructure.

The exclusion restriction for identification of the impact of female labor supply on wage rates is that caste composition affects wages only through its affect on labor supply of women to agriculture. Could the caste composition of a district directly affect the demand for agricultural labor?Das and Dutta (2007) find no evidence of wage discrimination against low castes in the casual rural labor market in India.An earlier village level study by Rajaraman (1986) also did not find any effect of caste on offered wage in Indian agriculture.

However, the disinclination of higher-caste women to work suggests that their reservation wage ought to be higher. Table 2 shows the results forthe regression of individual female wages on a dummy for lowcaste and other controls.The low caste dummy is insignificant controlling for age, education, marital status, type of agricultural operation and district fixed effects. If the district fixed effects are dropped, then the low caste dummy is negative and significant even with other district controls. These controls do not, however, capture the across district variation in male and female labor supply all of which are impounded in the district fixed effects. Thus, within a district, differential selection into the labor force does not matter across castes.[8]

The second concern with caste composition as an instrument is that areas with greater low-caste households may have lower access to inputs, public goods and infrastructure. Such areas may also have agro-ecological endowments which are unfavorable to agriculture. For these reasons, we include a comprehensive set of controls for irrigation, education, infrastructure (roads, electrification, banks), urbanization and agro-climatic endowments.

While there is no ex-ante way of knowing whether our controls are good enough, we can perform the following consistency check. Suppose conditional on our controls, the instrument is still correlated with omitted variables that affect the demand for agricultural labor.Thenthe caste composition also ought to have an effect on the demand for male labor.This can be easily checked from the first-stage regressions of the instrument variable procedure. As will be shown later, conditional on controls for agro-climatic endowments and infrastructure, caste composition does not have a statistically significant effect on the employment of male labor in agriculture.

A third possibility is that the caste composition in a district reflects long run development possibilities. In this story, the `higher' castes used their dominance to settle in better endowed regions. Once again, this would require adequate controls for agro-ecological conditions. Finally, could caste composition itself be influenced by wages? Anderson (2011) argues that village level caste composition in India has remained unchanged for centuries and location of castes is exogenous to current economic outcomes. This is, of course, entirely consistent with the low levels of mobility in India noted earlier.

*Identification of the Impact of Male Labor Supply*

For male labor supply, this paper uses, as instrument, the district proportion of men (in the age group 15-59) employed in non-farm manufacturing and mining units with a workforce of at least 20.The relation between this instrument and district level male employment in agriculture is plotted in figure 5.The negative association visible in the graph is consistent with the proposition that competition from non-farm jobs reduces labor supply to agriculture and increases wages (Lanjouw and Murgai, 2009).Rosenzweig's (1978) study of agricultural labor markets also uses indicators of non-farm economy as an instrument for labor supply to agriculture.[9] However, not all non-farm activity can be considered to be exogenous to agriculture. We define our instrument to include employment in manufacturing and mining sectors, and further restrict it to only large scale units.Our case, elaborated below, is that employment in the non-traded sectors and in small enterprises is endogenous to agricultural development but that is not so for large enterprises in traded sectors.

The rural non-farm sector is known to be heterogeneous. Some non-farm activity is of very low productivity and "functions as a safety net – acting to absorb labor in those regions where agricultural productivity has been declining – rather than being promoted by growth in the agricultural sector" (Lanjouw and Murgai, 2009). These are typically service occupations with self-employment and limited capital. It is clear that such non-farm activity is endogenous to agricultural wages.

The other case is when a prosperous agriculture stimulates demand for non-farm activity. This type of non-farm employment tends to be concentrated in the non-traded sector of retail trade and services and mostly in small enterprises.Using a village level panel data set across India, Foster and Rosenzweig (2003) argue that non-traded sectors are family businesses with few employees while factories are large employers and frequently employ workers from outside the village in which they are located. In a companion paper, they state that on an average non-traded service enterprises consist of 2-3 workers. This is no different from the international experience of developing countries (Chapter 9 of the World Development Report 2008).

Column 1 in table 3 presents the sectoral distribution of non-farm employment in production units with workforce of size 20 or more. This can be compared to the sectoral distribution of non-farm employment in production units with workforce of size nine or less in column 2 of table 3. It can be seen that, manufacturing and mining account for a substantially larger proportion of large work units while non-tradable sectors such as trade and hotels, transport and construction are less important.These considerations dictate that a valid instrument that captures withdrawal of labor from farm sector would measure non-farm employment in large units and in the traded sectors.

Even though the tradable non-farm goods and services do not depend on local demand, this variable could still be invalid if large non-farm enterprises locate in areas of low agricultural wages. This possibility is suggested in the work of Foster and Rosenzweig (2004). Theyanalyze a panel data set over the period 1971-1999 collected by the National Council of Applied Economic Research (NCAER). This data suggests a much higher expansion of rural non-farm activity than that implied by the nationally representative employment survey data of NSS (Lanjouw and Murgai, 2009). To see if the non-farm sector gravitates towards agriculturally depressed areas in this data set, Lanjouw and Murgai(2009) estimate the impact of growth in agricultural yields on growth in non-farm sector employment. They take growth in agricultural yields as a proxy for agricultural productivity and do not find a negative relationship between manufacturing employment and yield growth. They find a positive association between the two in the specification with state fixed effects and no other district controls. However, the addition of region fixed effects makes the positive relation also disappear.

Therefore, if anything, the traded non-farm sector grew more in areas that were relatively agriculturally advanced. One explanation for this has been provided by Chakravarty and Lall (2005). They analyze the spatial location of industries in India in the late 1990s and find that private investment gravitates towards already industrialized and coastal districts with better infrastructure. No such pattern is seen for government investment. The significance of geographical clusters is that it makes initial conditions of agricultural productivity and infrastructure important in determining future investments. This implies that estimation of labor demandequation should include adequate controls for infrastructure to sustain the validity of the instrument.

Again, the adequacy of controls that ensures validity of the non-farm employment instrument may be hard to judge ex-ante. However, if non-farm employment instrument is correlated with omitted variables that affect overall agricultural labor demand, then the instrument ought to be significant in the first-stage regression for female employment. As we show later, this consistency check shows that non-farm employment in large manufacturing and mining units is not a significant explanatory variable for female employment in agriculture.

## 6. Data

The key data this paper uses is from the nationally representative Employment and Unemployment survey of 2004/05 conducted by NSS. The survey contains labor force participation and earnings details for a reference period of a week.Some of the other variables including the instruments are also constructed from this data set. The control variables are obtained from a variety of sources (see Appendix A.1).

The first set of control variables relate to agriculture: irrigation, inequality in land holdings, rainfall, agro-climatic endowments, and land allocation to various crops. The agro-climatic variables are derived from a classification of the country into 20 agro-ecological zones (AEZ) described in table 4. The independent variables are computed by taking the proportion of area of a district under a particular AEZ. A second set of control variables relate to infrastructure: roads, electrification and banking. A third set of variables relate to education and urbanization. Table 5 contains a description of all the variables, their definitions and descriptive statistics.

The district-level regressions are weighted by district population and the standard errors are robust and corrected for clustering at state-region level. In some districts, there are very few wage observations. To avoid the influence of outliers, the districts where the number of wage observations for either males or females was less than 5 were dropped from the analysis. Dropping districts where either male or female observations are few in number results in a data set with equal observations for males and females. However, this could lead to a biased sample as the districts where female participation in the casual labor market is the least are most likely to be excluded from the sample.To see whether such selection matters, we also estimate male labor demand function for districts in which number of male wage observations are at least five (ignoring the paucity, if any, in the number of female observations) and similarlyestimate female labor demand function for districts in which number of female wage observations are at least five (ignoring the paucity, if any, of male wage observations).

## 7. Main Findings

Table 6(a) shows the system two stage least squares(2SLS) estimates of inverse demand functions for total male and female labor in agriculture. The first specification considers only the agriculture controlsof irrigation, land inequality, rainfall, agro-ecological endowments and allocation of land to various crops. In the second specification, we add the infrastructure controls of roads, electrification and banking. The final specification includes the controls for education and urbanization. Table 6(b) shows the coefficients of the instruments in the first-stage reduced form regressions for each of these three specifications.Table 6(c) displays the coefficients of the labor supply variables from an ordinary least squares regression.

In Table 6(b), for all specifications, we find a significantly positive association between proportion of low caste households in a district and female employment in agriculture. Similarly, a greater presence of large scale non-farm enterprises in manufacturing and mining sectors decreases male employment in agriculture significantly in all the specifications. The F-statistic for the instruments is reported in the bottom of table 6(a) and it is significant at five percentlevel for female labor supply and at one percentlevel for male labor supply. The first-stage regressions thus confirm the causal story about these variables: that status norm govern female labor supply and that non-farm opportunities are primarily received by men.

Note also that the proportion of low caste households does not affect employment of male labor in agriculture and presence of large scale non-farm manufacturing and mining enterprises does not affect female labor employmentin agriculture significantly.The significance of this observation is that if, despite the controls, the instruments retained some residual correlation with demand for agricultural labor, then we would expect both instruments to be significant in both the first-stage reduced form regressions. The fact that this is not so supports the case that these are valid instruments for labor supply to agriculture.Returning to the labor demand equations, the system 2SLS estimates of the effect of female and male labor supply on own wage ratesin table 6(a) are larger in magnitude and statistically more significant than the OLS estimates in table 6(c), and have the expected negative signs for own effects.[10] The coefficients of the labor supply variables do not change much between the three specifications in table 6(a). The agriculture controls seem to be the most important in removing the correlation between agricultural labor demand and the instruments.

Thecross effects of labor supply on wage rates are negative in sign. This implies that males and females are substitutes in agriculture.However, male labor and female labor are not perfect substitutes. In the system 2SLS regressions with full set of controls (the third specification), female labor supply has a significant impact on female wage with an inverse demand elasticity of – 0.52. However, the impact of female labor supply on male wage is smaller (around -0.1) and is not significantly different from zero. Thus, an increase in female labor supply by 10% decreases female wage by 5.2%, male wage by 1.3% and decreases the female to male wage ratio by 4%.To test formally that the impact on female wage is greater (in absolute terms) than the impact on male wage, we carry out a chi-square-test. In all of the specifications, the chi-square-test rejects the null that the coefficients are equal against the alternative that the coefficient of female labor supply in the female wage regression is higher than the coefficient of female labor supply in the male wage regression.This is supportive of the Boserup hypothesis that the caste driven variation in female labor supply leads to variation in the gender wage gap in agriculture across regions of India. In particular, greater female work participation decreases female wage relative to male wage.[11]

In contrast, the effect of male labor supply variation is significant for both male and female wage rates. In the third specification with the full set of controls, the point estimate of the inverse demand elasticity is -0.37 for female and -0.28 for male wage with respect to male labor supply. Although large scale non-farm employment is dominated by men, non-farm labor demand has favorable effects on female and male wage rates. The point estimates would imply that a 10% decrease in male labor supply increases male wage by 2.8%, female wage by 3.7% and increases the female to male wage ratio by one percent. A chi-square test however, does not reject (in all the specifications) the null of equality of the two coefficients in the male and female inverse demand functions for male labor supply. Hence, a decrease in male labor supply to agriculture has no significant impact on gender wage gap in agriculture.

There is, thus, an asymmetry between the effects of gender specific variation in labor supply on the wage of the opposite gender. Male labor supply matters to female wage but the effect of female labor supply on male wage is small and insignificant.Why is this so?The theoretical model posited in section 3 predicts that the elasticity of female wage with respect to male labor supply relative to the similar cross elasticity of male wage is the product of two ratios: the ratio of male to female labor employment and the male to female wage ratio. The sample estimate of male and female labor employment is 5.17 and 2.57 days per week per hectare of land respectively while the sample estimate for male and female wage is Rs 47.3 and Rs 36.13 per day respectively. This gives an estimate of relative cross-wage elasticities to be 2.63. The results in table 6(a),for the specification with the full set of controls,yield an econometric estimate of the ratio of cross-wage elasticities as 2.84 which is close to the prediction from the theoretical model.

The control variables (i.e., other than the labor supply variables) could also have an effect on the gender wage gap. To ascertain this, a chi-square test was conducted to test for the equality of coefficients for each control variable across male and female demand equations. The null hypothesis of equality of coefficients is rejected at the five percent level of significance for rice cultivation, access to roads and landholding inequality. Rice growing areas have a higher demand for female labor which leads to a higher wage rate for women and translates into a lower gender wage gap.Many researchers have documented greater demand for female labor in rice cultivation due to greater demand for females in tasks like transplanting and weeding (Mbiti 2007) and this result validates their observations. On the other hand, access to roads seems to increase demand for only male labor resulting in a larger wage gap between females and males in districts with better access to roads. Landholding inequality measured by the Gini coefficient for a district affects demand for both males and females significantly negatively reflecting the well known feature that large farms use less labor per unit of land than small farms. However, women are moreadversely affected by men resulting in a larger gender wage gap in districts with higher land inequality. Theoretically, the effect of landholding inequality on gender wage differential is ambiguous (Rosenzweig 1978).

A concern with the 2SLS results is that the first-stage F-statistic though significant is not very large. Weak-instruments could lead to biased estimates and to finite sample distributions that are poorly approximated by the theoretical asymptotic distribution. While such concerns are greater in an over-identified model, the weak-instrument critique suggests caution in interpreting the 2SLS results. As a check for just identified models with possibly weak-instruments,Angrist and Pischke(2008) and Chernozhukov and Hansen (2008) recommend looking at the reduced form estimates (of the dependent variable on all exogenous variables) since they have the advantage of being unbiased. Chernozhukov and Hansen (2008) formally show that the test for instrument irrelevance in this reduced form regression can be viewed as a weak-instrument-robust test of the hypothesis that the coefficient on the endogenous variable in the structural equation is zero. The sign and the strength of the coefficients in the reduced form regression can provide evidence of whether a causal relationship exists.

Table 6(d) shows the results for the coefficients of instruments from the reduced form regression of male and female wage on instruments and other covariates.The instruments are significant in this regression and so it can be concluded that the weak-instrument problem does not contaminate the inference from the structural regressions.It can be seen that an increase in proportion of low caste households reducesonly the female wage. This is entirely consistent with the 2SLS results where the instrument increases only female labor supply (the first-stage regression) which in turn has a significantly negative impact only on female wage. On the other hand, large scale industrial employment has a significantly positive impact on male and female wage rates. This is also in line with the 2SLS results where the presence of large enterprises in the non-farm sector decreases only male labor supply to agriculture which in turn impacts both male and female wage positively.

**8. Robustness checks**

The third specification in table 6(a) is our baseline and we consider the robustness of its estimates.Table 7(a) adds more agriculture controls: fertilizers per unit of cultivated land and implements(consisting of tractor and power operated tools) per unit of cultivated land.Including fertilizers (first two columns) does not change the impact of female labor supply on male and female wage and a 10% increase in female labor supply increases the gender wage gap by 3.6%. The chi-square test does not reject the equality of male labor supply coefficients across male and female labor demand equations but rejects the equality of female labor supply coefficients. The inclusion of fertilizers does, however, reduce the coefficient of irrigation in both equations to the point that it becomes insignificant in the female labor demand equation. This is possibly because of a high positive correlation(0.4) between irrigation and fertilizer use. Controlling for implements used per unit land cultivated (column 3 and 4) does not change any of the principal findings of the base specification. Again, the chi-square test does not reject the equality of male labor supply coefficients across male and female demand equations but rejects the equality of female labor supply coefficients.

In athird robustness check, we control for male and female health in rural areas. Nutrition status can affect productivity which in turn could impact rural wage. If nutrition status is correlated with our instrumental variable of low caste composition, then it could bias our results as well.Adult measures of health in India are not available at district level.Weight and height measurements are available at state level from the National Family and Health Survey of 2005-06. The measure of under-nutrition is percentage of rural adultswith a body mass index of less than 18.5. Table 7(b) shows the structural estimates for the total demand for labor with state level health controls.The results from the base specification continue to hold. While increase in female labor supply increases the gender wage gap significantly, male labor supply has no impact.

As a fourth check, we reconsider our sample selection rule. Recall, that we chose districts for which there were at least five observations for female as well as male wages. While this ensuresan equal sample size for males and females, it also entails a risk of dropping districts where female participation in wage work is the least. To check robustness, we consider the following alternative. For the male worker sample, we considered all districts where there are at least five observations for male wages. Similarly, for the female worker sample, we included all districts where there are at least five observations for female wages. This increases the number of districts from 279 in the matched sample to 359 for males and to 288 for females. Table 8 shows the estimates from the baseline specification on this enlarged sample. The estimates validate our central result that the gender wage gap is sensitive to female labor supply and not to male labor supply. In fact, the effect of female labor supply on gender wage gap in the enlarged sample is greater. A 10% increase in female labor supply results in a 4.8% decline in female to male wage ratio in the enlarged sample compared to 4% in the matched sample.

In a fifth robustness check, we control for differential participation in tasks by males and females across districts. As noted earlier, some agricultural tasks are traditionally deemed as male while others are dominated by women. In section 3, we showed that the gender wage gap in Indian agriculture is within tasks. A very small percentage of the wage gap can be attributed to differential participation of men and women across tasks. To address this issue formally, we regress individual wages on individual characteristics (age, age square, education dummies, and marital status dummies), district level female and male labor employment in agriculture (suitably instrumented), other district controls and dummy variables for agricultural tasks for which the wage is recorded. The agricultural tasks are ploughing, sowing, transplanting, weeding, harvesting and other agricultural activities.

The estimates are reported in table 9(a).They show that a 10% increase in female labor supply reduces female wage by 5.5% and has no significant effect on male wage. Male labor supply on the other hand has an identical negative effect on male and female wage.

Lastly, we consider the possibilitythat hired and family labor may not be equally efficient.Family labor may be more efficient because of better incentives.Ifthis is so, a simple aggregate of family and hired labor is not valid and could lead to inconsistent estimates. Suppose one unit of hired labor is equivalent to $\theta$ units of familylabor (with $\theta$ less than one). Then in terms of efficiency units of family labor, the total labor supply is $L_s^f + \theta L_s^o$ , where $L_s^f$

and $L_s^o$ are the aggregate labor supply tohome farm and to outside farms. In the regressions, we have measured labor supply asln$(L_s^f + L_s^o)$. Since,ln$(L_s^f + \theta L_s^o)$= ln$(L_s^f + L_s^o)$ + ln$[(L_s^f + \theta L_s^o)/(L_s^f + L_s^o)]$, the second term is absorbed in the error term of the regressions. This could lead to inconsistent estimates.The instruments will be correlated with ln$[\frac{L_{Fs}^f + \theta L_{Fs}^o}{L_{Fs}^f + L_{Fs}^o}]$ if they not only affect the total labor supply but also the allocation of labor between own farm and outside farm.It is possible that low caste women have a greater propensity to work outside their family farm due to less social restrictions. Similarly, the opportunity of employment in manufacturing and mining could lead landed households to divert their labor supply to industry and increase hiring of labor on their farms.

To meet these concerns, we estimate the baseline specification for values of $\theta$ ={0.5, 0.7,0.9}, for both male and female labor. The results are shown in table 10.The last column shows the results with $\theta$ =1 which corresponds to the results of the base specification in table 6(a). As the value of $\theta$ decreases, the impact of female labor supply on male wage does not change but the impact of female labor supply on female wage falls in magnitude. The chi-square test for the equality of the impact of female labor supply on female and male wage continues to be rejected for the selected values of $\theta$.A decrease in the value of $\theta$ increases the impact of male labor supply on both male and female wage.Once again, the chi-square test for the equality of the impact of male labor supply on male and female wage is not rejected for the selected values of $\theta$.

**9. Explaining the difference in wage gap between northern and southern states of India**

While our findings support the Boserup hypothesis, there are other factors as well that matter to the gender wage gap. So to what extent does the Boserup hypothesis, i.e., the difference in female work participation across northern and southern states in India explain the observed difference in the gender wage gap?

From estimation equations (8a) and (8b), the gender wage gap in a southern state can be written as

$$(9)\bar{W}_{M,s} - \bar{W}_{F,s} = (\hat{\alpha}_0 - \hat{\alpha}_1)\bar{L}_{F,s} + (\hat{\beta}_0 - \hat{\beta}_1)\bar{L}_{M,s} + (\hat{\gamma}_0 - \hat{\gamma}_1)\bar{X}_s + (\bar{\varepsilon}_{M,s} - \bar{\varepsilon}_{F,s})$$

where, W is the log of wages, L is the log of labor supply and X are other district level covariates included in the empirical analysis. 'M' and 'F' index males and females respectively. Similarly, the gender wage gap in a northern state can be written as

$$(10)\bar{W}_{M,n} - \bar{W}_{F,n} = (\hat{\alpha}_0 - \hat{\alpha}_1)\bar{L}_{F,n} + (\hat{\beta}_0 - \hat{\beta}_1)\bar{L}_{M,n} + (\hat{\gamma}_0 - \hat{\gamma}_1)\bar{X}_n + (\bar{\varepsilon}_{M,n} - \bar{\varepsilon}_{F,n})$$

Subtracting 10 from 9, we obtain

$$(11)\quad \left(\bar{W}_{M,s} - \bar{W}_{F,s}\right) - \left(\bar{W}_{M,n} - \bar{W}_{F,n}\right) = (\hat{\alpha}_0 - \hat{\alpha}_1)(\bar{L}_{F,s} - \bar{L}_{F,n}) + (\hat{\beta}_0 - \hat{\beta}_1)(\bar{L}_{M,s} - \bar{L}_{M,n}) + (\hat{\gamma}_0 - \hat{\gamma}_1)(\bar{X}_s - \bar{X}_n) + (\bar{\varepsilon}_{M,s} - \bar{\varepsilon}_{F,s}) - (\bar{\varepsilon}_{M,n} - \bar{\varepsilon}_{F,n})$$

The ratio $[(\hat{\alpha}_0 - \hat{\alpha}_1)(\bar{L}_{F,s} - \bar{L}_{F,n})] / [\left(\bar{W}_{M,n} - \bar{W}_{F,s}\right) - \left(\bar{W}_{M,n} - \bar{W}_{F,n}\right)]$ is the proportion of the difference in wage gap across north and south that is explained by the difference in female labor supply.

To implement this, we let the variables take the average values of northern and southern states respectively.[12] The mean values are listed in table 11. The parameters are drawn from the coefficient estimates of the base specification estimated in column 3 of Table 6(a). Table 12 shows the proportion of the gender wage gap explained by each right hand side variable.The proportions for agro-ecological zones have not been shown for brevity.One can see that 55 percent of the regional difference in the gender wage gap is because of the larger female labor supply in the southern states. Greater land inequality and lowerarea under cultivation of rice in the southern states are other important and significant factors which lead to a greater gender wage gap in the south. On the other hand, greater electrification, lower male supply and the greater importance of coarse cereal crops (sorghum and millets) should lead to a lower wage gap in the south but these do not affect the gender wage gap significantly in the regressions.

## 10. Conclusion

The effect of variation in female work force participation on the gender wage gap in developed countries has been explored in recent papers. In a developing country context, such a connection was made by Boserup many decades ago. Based on data from 1950s, she posited that the gender wage gap was higher in the southern states of India relative to the northern states because of greater female labor supply in south India, which stemmed from differences in cultural restrictions on women's participation in economic activity. This paper confirms the hypothesis within a neo-classical framework of labor markets. Compared to the literature, this paper also pays attention to the variation in male labor supply and how that impacts the gender wage gap. The exogenous variation in labor supply was identified by spatial variation in caste composition and non-farm employment of men in large units.

We find that female labor supply has a sizeable effect on female wage but not so much on male wage. This result thus has important implications for the literature on gender wage differentials. It shows that the usual approach of attributing the gender wage gap to only individual characteristics or discrimination is incomplete. The overall labor market structure that determines labor supply and the substitutability between female and male labor may also have a significant impact on gender wage inequality.

The paper also found that male labor supply has sizeable effects on male as well as female wage. This finding is interesting on three counts. First, it provides a causal effect of withdrawal of males from agriculture due to non-farm employment opportunities on wages of men and women. The paper, therefore, sheds light on the economic processes that affect agricultural wage (Lanjouw and Murgai 2009; Eswaran et al. 2009; Foster and Rosenzweig 2003). Second, the strong effect of male labor supply on female wage is of independent interest since the sectoral mobility of women from the farm to the non-farm sector is much less marked compared to men (Eswaran et al. 2009). This could be because of lower education levels as well as societal constraints that limit female participation in most non-farm jobs. This raises a concern that rapid growth inthe non-farm sector does not entail much gain for women. Our finding, however, suggests that there is enough substitutability between men and women in the agricultural production process that a withdrawal of men from agriculture has positive effects on male and female wages.

Finally, the findings point to a marked asymmetry between the effects of female and male labor supply.Female labor supply does not impact male wage significantly but male labor supply does move female wage significantly. A standard neo-classical model predicts this asymmetry and its magnitude is determined by the gender gap in wage and the gender gap in labor supply. The findings match the prediction closely.

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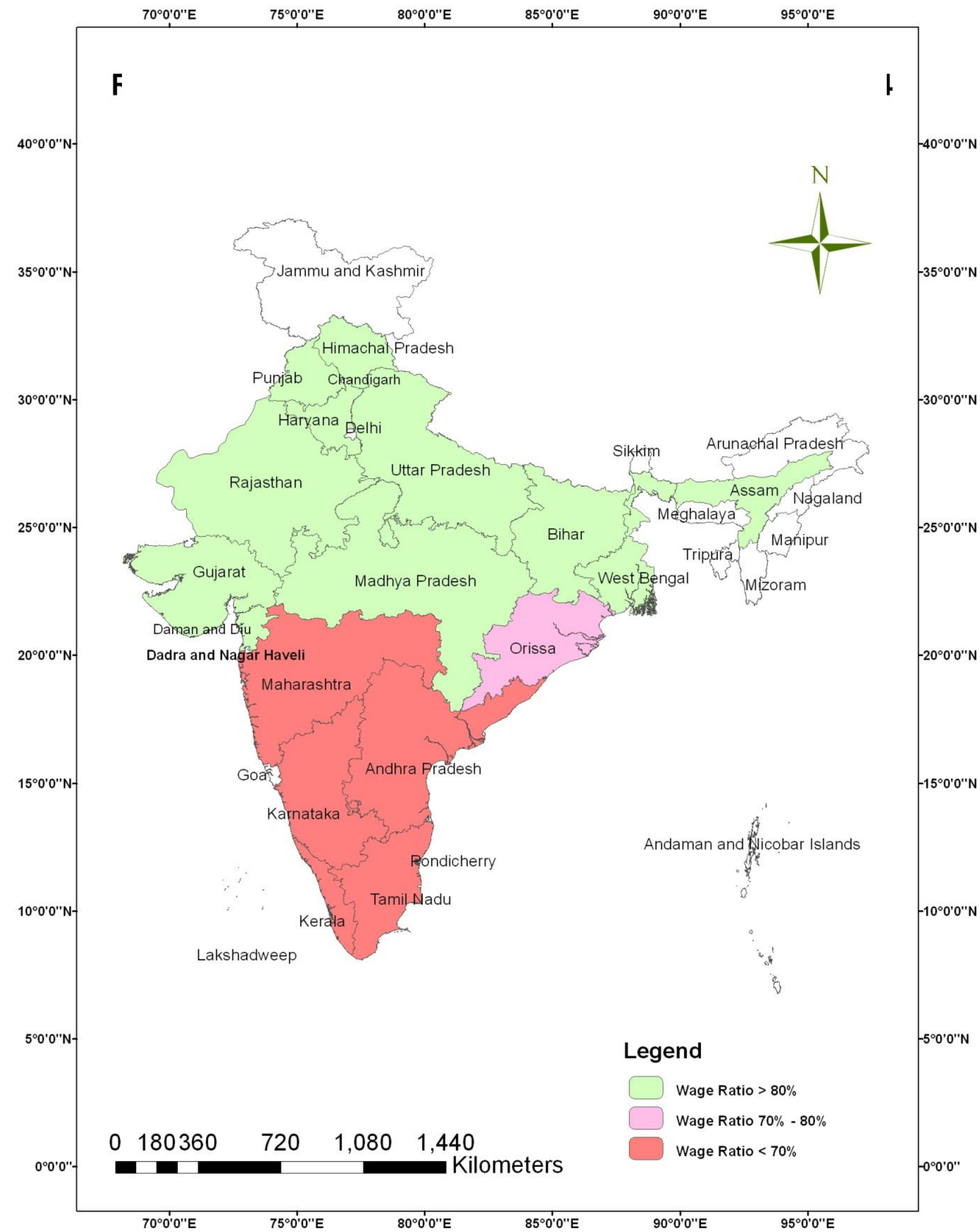
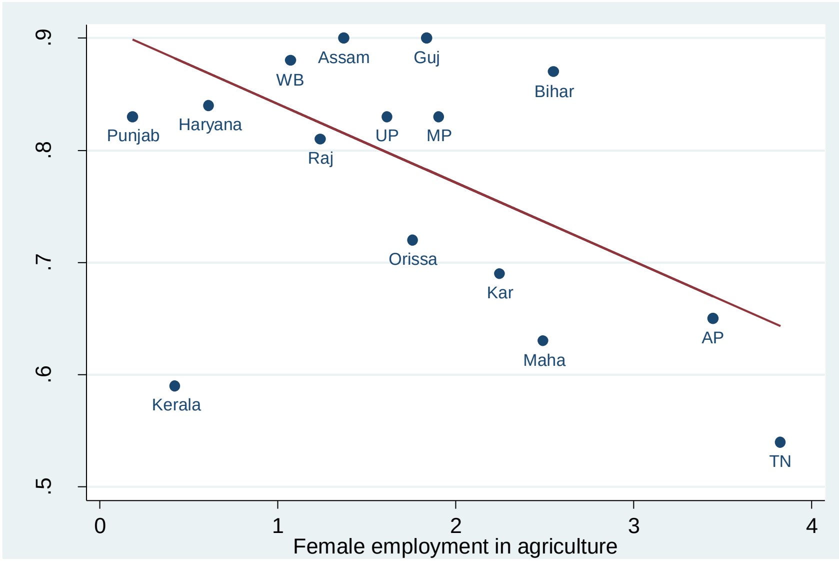
Figure 1. Regional variation in female to male wage ratio, 2004




*Source:* NSS 2004, Schedule 10

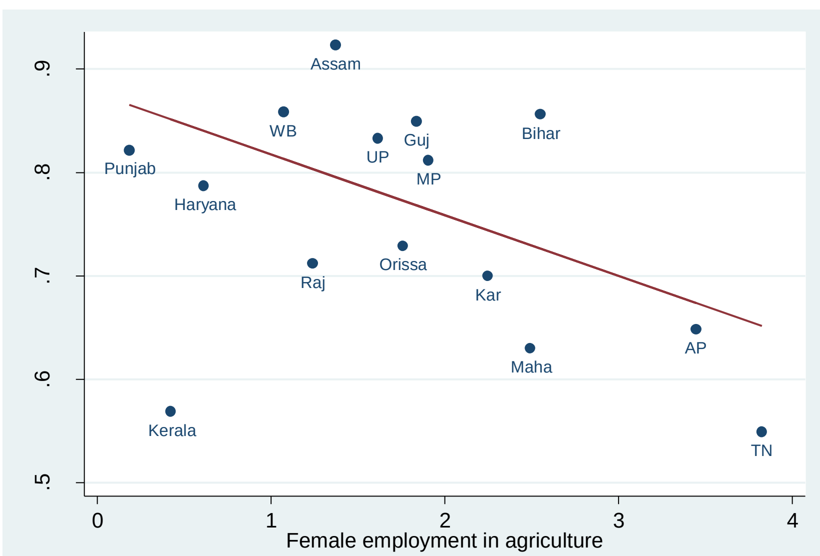
Figure 2.Female employment in agriculture and female to male wage ratio




*Source:* NSS 2004, Schedule 10

*Note:* Labor employment is measured as total days worked in a reference week per unit land under cultivation. Population weighted regression lines are fitted to the above plots

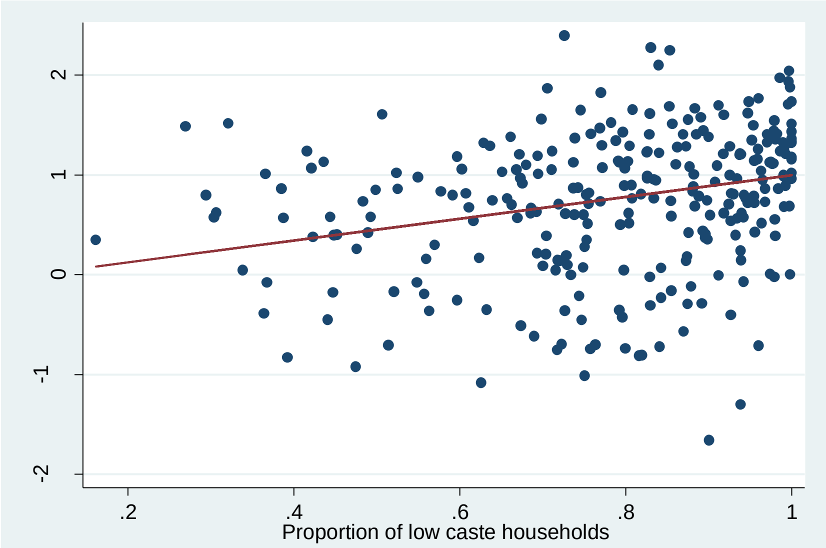
Figure 3. Female employment in agriculture and the re-weighted female to male wage ratio




*Source:* NSS 2004, Schedule 10

*Note:* Labor employment is measured as total days worked in a reference week per unit land under cultivation. Population weighted regression lines are fitted to the above plots

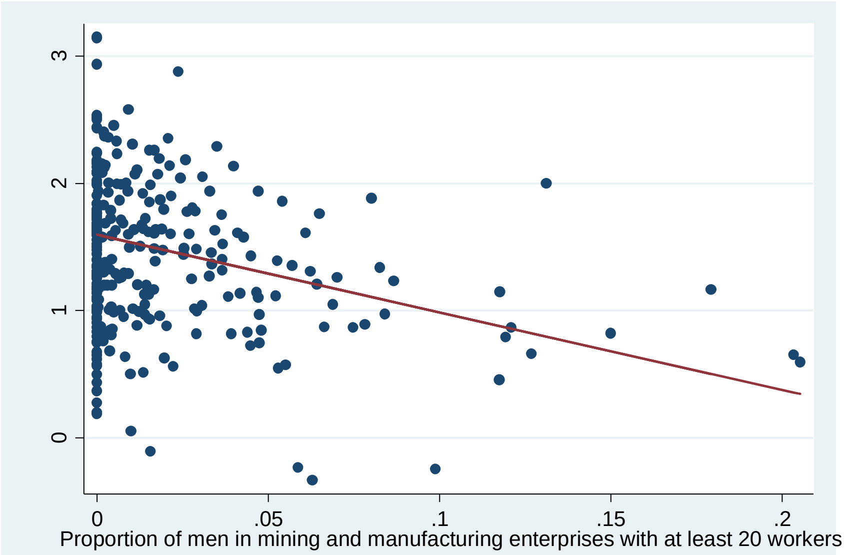
Figure 4. Low caste households and female employment in agriculture




*Source:* NSS 2004, Schedule 10

*Note:* Labor employment is measured as total days worked in a reference week per unit land under cultivation. Population weighted regression lines are fitted to the above plots

Figure 5. Large scale industrial employment and male employment in agriculture




*Source:* NSS 2004, Schedule 10

*Note:* Labor employment is measured as total days worked in a reference week per unit land under cultivation. Population weighted regression lines are fitted to the above plots

Table 1. Gender wage gap in Indian agriculture

| | Wage<br>(1) | | Wage<br>(2) | |
|---|---|---|---|---|
| Female | -0.35*** | (0.03) | -0.33*** | (0.03) |
| Age | 0.02*** | (0.00) | 0.02*** | (0.00) |
| Age square | -0.00*** | (0.00) | -0.00*** | (0.00) |
| Below primary | 0.06*** | (0.02) | 0.06** | (0.02) |
| Primary | 0.05* | (0.02) | 0.05* | (0.02) |
| Middle | 0.03 | (0.03) | 0.02 | (0.03) |
| Secondary | 0.04 | (0.03) | 0.04 | (0.03) |
| Senior secondary and above | -0.03 | (0.03) | -0.03 | (0.03) |
| Married | -0.02 | (0.02) | -0.01 | (0.02) |
| Widowed | -0.06** | (0.03) | -0.05 | (0.03) |
| Divorced | -0.13*** | (0.04) | -0.11** | (0.05) |
| Sowing | | | -0.17** | (0.06) |
| Transplanting | | | -0.04 | (0.05) |
| Weeding | | | -0.20*** | (0.04) |
| Harvesting | | | -0.12*** | (0.04) |
| Other cultivation | | | -0.11*** | (0.03) |
| Constant | 3.37*** | (0.05) | 3.50*** | (0.06) |
| Observations | 14,190 | | 14,190 | |
| R-square | 0.21 | | 0.22 | |

*Note:*The above table reports the results from an OLS regression of individual wage on individual characteristics. Log of wage is the dependant variable. Robust standard errors clustered at state-region level are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. Districts having at least 5 wage observations for males and females are included

Table 2.Effect of low caste on individual female wage

| | Female wage | |
|---|---|---|
| | Coefficient | Standard Error |
| Low caste | -0.00 | (0.01) |
| Age | 0.01** | (0.00) |
| Age square | -0.00** | (0.00) |
| Below primary | 0.01 | (0.02) |
| Primary | 0.02 | (0.02) |
| Middle | 0.02 | (0.02) |
| Secondary | 0.01 | (0.04) |
| Senior secondary and above | 0.13*** | (0.04) |
| Married | 0.00 | (0.02) |
| Widowed | -0.01 | (0.02) |
| Divorced | -0.05 | (0.04) |
| Sowing | -0.01 | (0.08) |
| Transplanting | 0.08 | (0.07) |
| Weeding | -0.03 | (0.07) |
| Harvesting | 0.04 | (0.07) |
| Other cultivation | 0.02 | (0.06) |
| Constant | 3.23*** | (0.08) |
| District fixed effect | Yes | |
| Observations | 6,377 | |
| R-squared | 0.49 | |

*Note:*The above table reports the results from an OLS regression of individual female wage on individual characteristics. Log of wage is the dependant variable. Robust standard errors clustered at state-region level are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. Districts having at least 5 wage observations for females are included

Table 3.Sectoral distribution of non-farm employment

| Industry | Percentage in units with 20 or more workers (1) | Percentage in units with 9 or less workers (2) |
|---|---|---|
| Allied activities in agriculture | 1% | 7% |
| Fishing | 0% | 1% |
| Mining | 7% | 1% |
| Manufacturing | 44% | 20% |
| Construction | 11% | 17% |
| Trade and hotels | 3% | 28% |
| Transport | 9% | 12% |
| Finance and real estate | 3% | 2% |
| Public administration | 22% | 11% |
| Domestic services | 0% | 1% |

*Note:* The above figures are calculated from the usual status activity status of respondents in NSS 2004, Schedule 10.The sample includes men aged 15-59.

## Table 4. Agro-Ecological Zones (AEZ)

| AEZ | Description |
|---|---|
| 2 | Western Plain, Kachch and part of Kathiarwar, peninsular, hot arid ecoregion, with desert and saline soils and LGP (Length of Growing Period) <90 d |
| 3 | Deccan Plateau, hot arid ecoregion, with red and black soils and LGP < 90 d |
| 4 | Northern Plain and Central Highlands including Aravelli hills, hot semi-arid ecoregion with alluvium derived soils and LGP 90-150 d |
| 5 | Central Highlands, Gujarat Plains, Kathiarwar peninsular, hot arid ecoregion, with medium and deep black soils and LGP 90-150 d |
| 6 | Deccan Plateau, hot semi aridecoregion, with mainly shallow and medium but some deep black soils and LGP 90-150 d |
| 7 | Deccan Plateau of Telengana and Eastern ghats, hot semi-arid ecoregion with red and black soils and LGP 90-150 d |
| 8 | Eastern Ghats, Tamil Nadu uplands and Deccan (Karnataka) Plateau, hot semi aridecoregion with red loamy soils and LGP 90-150 d |
| 9 | Northern Plain, hot subhumid (dry) ecoregion with alluvium derived soils and LGP 150-180 d |
| 10 | Central Highlands (Malwa, Bundelkhand, an Eastern Satpura), hot subhumidecoregion, with black and red soils and LGP 150-180 d up to 210 d in some places |
| 11 | Eastern Plateau (Chattisgarh), hot subhumidecoregion, with red and yellow soils and LGP 150-180 d |
| 12 | Eastern (Chotanagpur) plateau and Eastern Ghats, hot subhumidecoregion with red and lateritic soils and LGP 150-180 to 210 d |
| 13 | Eastern Gangetic Plain, hot subhumid (moist) ecoregion, with alluvium derived soils and LGP 180-210 d |
| 14 | Western Himalayas, warm subhumid(to humid and perhumidecoregion) with brown forest &podzolic soils, LGP 180-210+d |
| 15 | Bengal and Assam Gangetic and Brahmaputra plains , hot subhumid (moist) to humid (and perhumid) ecoregion, with alluvium derived soils and LGP 210+ d |
| 16 | Eastern Himalayas, warm perhumidecoregion with brown and red hill soils and LGP 210+ d |
| 17 | Northeastern Hills (Purvachal), warm perhumidecoregion with red and lateritic soils and LGP 210+ d |
| 18 | Eastern coastal plain, hot subhumid to semi-arid ecoregion, with coastal alluvium derived soils and LGP 210+ d |
| 19 | Western ghats and coastal plain, hot humid region, with red, lateritic and alluvium derived soils and LGP 210+d |

*Source:*Gajbhiye and Mandal(2006).

## Table 5. Variable description and summary statistics

| | Variable | Definition | Mean | Standard deviation |
|---|---|---|---|---|
| Wage | Male wage | ln(Real average male casual manual worker wage in cultivation, aged 15-59 years) | 3.82 | 0.28 |
| | Female wage | ln(Real average female casual manual worker wage in cultivation, aged 15-59 years) | 3.54 | 0.31 |
| Labor supply | Male LS | $\ln\left(\frac{\textbf{Total days worked in a reference week in cultivation by males aged 15-59}}{\textbf{Area under cultivation}}\right)$ | 1.46 | 0.61 |
| | Female LS | $\ln\left(\frac{\textbf{Total days worked in a reference week in cultivation by females aged 15-59}}{\textbf{Area under cultivation}}\right)$ | 0.73 | 0.71 |
| Instruments | Low caste | Percentage SC/ST/OBC households | 0.75 | 0.19 |
| | Industry | Percentage men aged 15-59 engaged in a manufacturing or mining unit employing more than 20 workers | 0.02 | 0.03 |
| Agriculture | Irrigation | Percentage cultivated area irrigated | 0.43 | 0.26 |
| | Gini | Gini coefficient for land holding inequality | 0.69 | 0.10 |
| | Rainfall | Rainfall received during June to September 2004 in cms | 8.30 | 5.41 |
| | Coarse cereals | Percentage area under production of coarse cereals | 0.16 | 0.19 |
| | Cotton | Percentage area under production of cotton, jute, mesta, tobacco and sugarcane | 0.08 | 0.11 |
| | Oilseeds and Pulses | Percentage area under production of oilseeds and pulses | 0.25 | 0.20 |
| | Rice | Percentage area under production of rice | 0.35 | 0.29 |
| | Horticulture | Percentage area under production of horticulture crops | 0.06 | 0.12 |
| | Wheat | Percentage area under production of wheat | 0.10 | 0.15 |
| Infrastructure | Paved roads | Percent villages accessible by a paved road | 0.66 | 0.24 |
| | Electrified | Percent villages electrified | 0.86 | 0.23 |
| | Commercial bank | Percent villages having a commercial bank | 0.09 | 0.13 |
| Education and Urbanization | Primary-Middle male | Percentage Primary-Middle educated male aged 15-59 | 0.36 | 0.09 |
| | Secondary male | Percentage Secondary or more educated male aged 15-59 | 0.23 | 0.09 |
| | Primary-Middle fem | Percentage Primary-Middle educated female aged 15-59 | 0.25 | 0.10 |
| | Secondary fem | Percentage Secondary or more educated female aged 15-59 | 0.11 | 0.07 |
| | Urban | Percentage population in a district living in urban areas | 0.27 | 0.18 |

*Note:* Weighted mean with weights equal to district population, Agro-Ecological Regions are described in Table 2.

Table 6(a). Aggregate demand for total labor in agriculture

| | District Controls: Agriculture | | | | District Controls: Agriculture<br>District Controls: Infrastructure | | | | District Controls: Agriculture<br>District Controls: Infrastructure<br>District Controls: Education & Urbanization | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male wage | | Female wage | | Male wage | | Female wage | | Male wage | | Female wage | |
| | (1) | | | | (2) | | | | (3) | | | |
| Female LS | -0.08 | (0.17) | -0.49* | (0.27) | -0.11 | (0.17) | -0.54* | (0.31) | -0.13 | (0.15) | -0.52** | (0.25) |
| Male LS | -0.29*** | (0.09) | -0.35*** | (0.12) | -0.23*** | (0.09) | -0.36*** | (0.14) | -0.28*** | (0.09) | -0.37** | (0.15) |
| Irrigation | 0.21* | (0.12) | 0.30* | (0.17) | 0.28** | (0.12) | 0.41** | (0.19) | 0.31** | (0.12) | 0.41** | (0.20) |
| Gini | -0.52 | (0.37) | -1.28** | (0.54) | -0.64* | (0.34) | -1.33** | (0.56) | -0.65* | (0.33) | -1.30** | (0.51) |
| Rainfall | -0.00 | (0.01) | 0.01 | (0.01) | 0.00 | (0.00) | 0.01 | (0.01) | 0.00 | (0.01) | 0.01 | (0.01) |
| Paved roads | | | | | 0.43*** | (0.10) | 0.05 | (0.25) | 0.47*** | (0.11) | 0.08 | (0.23) |
| Electrified | | | | | -0.55*** | (0.17) | -0.41* | (0.25) | -0.61*** | (0.18) | -0.44* | (0.24) |
| Commercial bank | | | | | 0.04 | (0.20) | -0.01 | (0.21) | 0.04 | (0.17) | -0.00 | (0.21) |
| Primary-Middle female | | | | | | | | | -0.01 | (0.27) | -0.15 | (0.54) |
| Secondary female | | | | | | | | | 0.39 | (0.35) | 0.39 | (0.66) |
| Primary-Middle male | | | | | | | | | -0.28 | (0.26) | -0.20 | (0.40) |
| Secondary male | | | | | | | | | -0.16 | (0.24) | 0.04 | (0.45) |
| Urban percent | | | | | | | | | -0.15** | (0.08) | -0.08 | (0.16) |
| Constant | 4.50*** | (0.37) | 4.64*** | (0.49) | 4.85*** | (0.41) | 5.08*** | (0.69) | 5.10*** | (0.49) | 5.16*** | (0.76) |
| AEZ | Yes | | | | Yes | | | | Yes | | | |
| Land Allocation to crops | Yes | | | | Yes | | | | Yes | | | |
| Observations | 279 | | 279 | | 279 | | 279 | | 279 | | 279 | |
| Under-id (p-val) | 0.00 | | 0.00 | | 0.01 | | 0.01 | | 0.01 | | 0.01 | |
| F(excluded instruments) $L^S_F$ | 3.93 | | 3.93 | | 3.53 | | 3.53 | | 4.81 | | 4.81 | |
| F(excluded instruments) $L^S_M$ | 26.79 | | 26.79 | | 23.90 | | 23.90 | | 17.52 | | 17.52 | |
| Null Female labor supply has equal effect on male and female wage (at 5% level) | Reject | | | | Reject | | | | Reject | | | |
| Null Male labor supply has equal effect on male and female wage (at 5% level) | Accept | | | | Accept | | | | Accept | | | |

## Table 6(b). First-stage for Labor supply by males and females to agriculture

| | Male LS | | Female LS | | Male LS | | Female LS | | Male LS | | Female LS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | | | | (2) | | | | (3) | | | |
| Low caste | -0.11 | (0.19) | 0.70** | (0.27) | -0.15 | (0.20) | 0.66** | (0.26) | -0.22 | (0.19) | 0.79*** | (0.27) |
| Industry | -3.86*** | (0.53) | -0.58 | (0.77) | -3.68*** | (0.55) | -0.29 | (0.89) | -3.33*** | (0.59) | -0.26 | (0.97) |
| R-Square | 0.69 | | 0.53 | | 0.70 | | 0.54 | | 0.71 | | 0.54 | |
| Observations | 279 | | 279 | | 279 | | 279 | | 279 | | 279 | |

## Table 6(c). Ordinary least squares estimates

| | Male wage | | Female wage | | Male wage | | Female wage | | Male wage | | Female wage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | | | | (2) | | | | (3) | | | |
| Female LS | -0.07** | (0.03) | -0.15*** | (0.04) | -0.06** | (0.03) | -0.15*** | (0.04) | -0.06** | (0.03) | -0.15*** | (0.04) |
| Male LS | -0.01 | (0.05) | 0.04 | (0.05) | -0.01 | (0.04) | 0.05 | (0.05) | -0.01 | (0.04) | 0.06 | (0.05) |
| R-Square | 0.62 | | 0.62 | | 0.68 | | 0.63 | | 0.69 | | 0.64 | |
| Observations | 279 | | 279 | | 279 | | 279 | | 279 | | 279 | |

Table 6(d). Reduced form estimates

| | Male wage | | Female wage | | Male wage | | Female wage | | Male wage | | Female wage | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | | | | (2) | | | | (3) | | | |
| Low caste | -0.02 | (0.11) | -0.31** | (0.13) | -0.04 | (0.10) | -0.30** | (0.13) | -0.04 | (0.10) | -0.34** | (0.13) |
| Industry | 1.15*** | (0.35) | 1.63*** | (0.42) | 0.89*** | (0.33) | 1.47*** | (0.44) | 0.98*** | (0.34) | 1.37*** | (0.48) |
| R-Square | 0.62 | | 0.61 | | 0.68 | | 0.62 | | 0.68 | | 0.63 | |
| Observations | 279 | | 279 | | 279 | | 279 | | 279 | | 279 | |

*Note:*Table 6(a) reports two stage least squares estimates, instrumenting for labor supply of males and females using low caste and large enterprise industry employment as defined in table 5. Log of wages and labor supply are used in the above regressions. Table 6(b) reports the corresponding first-stage. Table 6(c) reports the results from OLS regression of the dependant variable against total labor employed in agriculture with other controls the same as in table 6(a). Table 6(d) reports the results from reduced form regression of the log wageon instruments with other controls the same as in table 6(a). Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analysis is a district and districts having at least 5 wage observations for male and female each are included here.

Table 7(a). Aggregate demand for total labor in agriculture with additional controls

| | Male wage | | Female wage | | Male wage | | Female wage | |
|---|---|---|---|---|---|---|---|---|
| Female LS | -0.10 | (0.14) | -0.46** | (0.23) | -0.12 | (0.15) | -0.52** | (0.26) |
| Male LS | -0.31*** | (0.10) | -0.44*** | (0.15) | -0.29*** | (0.09) | -0.37** | (0.15) |
| Irrigation | 0.25** | (0.11) | 0.27 | (0.17) | 0.31** | (0.13) | 0.40** | (0.20) |
| Gini | -0.66** | (0.33) | -1.31*** | (0.48) | -0.64* | (0.34) | -1.28** | (0.51) |
| Rainfall | 0.00 | (0.00) | 0.01 | (0.01) | 0.00 | (0.01) | 0.01 | (0.01) |
| Paved roads | 0.52*** | (0.11) | 0.18 | (0.20) | 0.49*** | (0.12) | 0.09 | (0.23) |
| Electrified | -0.60*** | (0.18) | -0.43* | (0.24) | -0.62*** | (0.19) | -0.45* | (0.24) |
| Commercial bank | -0.02 | (0.19) | -0.15 | (0.19) | 0.04 | (0.18) | 0.00 | (0.21) |
| Primary-Middle female | -0.04 | (0.26) | -0.23 | (0.52) | -0.02 | (0.27) | -0.16 | (0.54) |
| Secondary female | 0.07 | (0.40) | -0.35 | (0.65) | 0.36 | (0.33) | 0.37 | (0.65) |
| Primary-Middle male | -0.24 | (0.25) | -0.13 | (0.37) | -0.28 | (0.26) | -0.20 | (0.40) |
| Secondary male | -0.05 | (0.25) | 0.30 | (0.47) | -0.14 | (0.24) | 0.06 | (0.45) |
| Urban percent | -0.23*** | (0.09) | -0.27 | (0.17) | -0.15** | (0.07) | -0.08 | (0.15) |
| Fertilizer | 0.04** | (0.02) | 0.10*** | (0.03) | | | | |
| Implements | | | | | 0.08 | (0.10) | 0.06 | (0.12) |
| Constant | 5.13*** | (0.50) | 5.23*** | (0.75) | 5.06*** | (0.50) | 5.13*** | (0.76) |
| AEZ | | Yes | | | | Yes | | |
| Land allocation to crops | | Yes | | | | Yes | | |
| Observations | 279 | | 279 | | 279 | | 279 | |
| Under-id (p-val) | 0.01 | | 0.01 | | 0.01 | | 0.01 | |
| F(excluded instruments) $L^S_F$ | 4.86 | | 4.86 | | 4.60 | | 4.60 | |
| F(excluded instruments) $L^S_M$ | 15.81 | | 15.81 | | 17.06 | | 17.06 | |

*Note:* Two stage least squares estimates, instrumenting for labor supply of males and females using low caste and large enterprise industry employment as defined in table 5. Log of wages and labor supply are used in the above regressions. Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analysis is a district and districts having at least 5 wage observations for male and female each are included here.

Table 7(b). Aggregate demand for total labor in agriculture with health controls

| | Male wage | | Female wage | |
|---|---|---|---|---|
| Female LS | -0.16 | (0.16) | -0.53* | (0.28) |
| Male LS | -0.28*** | (0.10) | -0.37** | (0.16) |
| Irrigation | 0.33*** | (0.12) | 0.39** | (0.19) |
| Gini | -0.75*** | (0.29) | -1.20** | (0.47) |
| Rainfall | 0.00 | (0.01) | 0.01 | (0.01) |
| Paved roads | 0.35*** | (0.13) | 0.13 | (0.26) |
| Electrified | -0.59*** | (0.21) | -0.50* | (0.30) |
| Commercial bank | -0.04 | (0.16) | -0.01 | (0.23) |
| Primary-Middle female | 0.04 | (0.27) | -0.15 | (0.55) |
| Secondary female | 0.38 | (0.35) | 0.34 | (0.66) |
| Primary-Middle male | -0.29 | (0.27) | -0.21 | (0.42) |
| Secondary male | -0.16 | (0.25) | 0.11 | (0.48) |
| Urban percent | -0.11 | (0.08) | -0.09 | (0.17) |
| BMI (Female) | -0.00 | (0.01) | -0.01 | (0.02) |
| BMI (Male) | -0.01 | (0.01) | 0.01 | (0.02) |
| Constant | 5.73*** | (0.60) | 4.91*** | (0.87) |
| AEZ | | Yes | | |
| Land allocation to crops | | Yes | | |
| Observations | 279 | | 279 | |
| Under-id (p-val) | 0.01 | | 0.01 | |
| F(excluded instruments) $L^S_F$ | 3.957 | | 3.957 | |
| F(excluded instruments) $L^S_M$ | 17.25 | | 17.25 | |

*Note:* Two stage least squares estimates, instrumenting for labor supply of males and females using low caste and large enterprise industry employment as defined in table 5. Log of wages and labor supply are used in the above regressions. Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analysis is a district and districts having at least 5 wage observations for male and female each are included here.

Table 8. Aggregate demand for total labor in agriculture with all observations

| | Male wage | | Female wage | |
|---|---|---|---|---|
| Female LS | -0.05 | (0.06) | -0.53** | (0.24) |
| Male LS | -0.36*** | (0.13) | -0.34** | (0.16) |
| Irrigation | 0.22** | (0.10) | 0.42** | (0.19) |
| Gini | -0.46** | (0.20) | -1.32** | (0.53) |
| Rainfall | -0.01 | (0.01) | 0.01 | (0.01) |
| Paved roads | 0.40*** | (0.12) | 0.09 | (0.22) |
| Electrified | -0.60*** | (0.20) | -0.47* | (0.24) |
| Commercial bank | 0.06 | (0.22) | -0.03 | (0.22) |
| Primary-Middle female | 0.08 | (0.22) | -0.24 | (0.51) |
| Secondary female | 0.20 | (0.30) | 0.29 | (0.64) |
| Primary-Middle male | -0.21 | (0.20) | -0.16 | (0.37) |
| Secondary male | 0.11 | (0.26) | 0.14 | (0.42) |
| Urban percent | -0.16* | (0.09) | -0.01 | (0.15) |
| Constant | 5.09*** | (0.50) | 5.22*** | (0.77) |
| AEZ | Yes | | | |
| Land allocation to crops | Yes | | | |
| Observations | 359 | | 288 | |
| Under-id (p-val) | 0.02 | | 0.02 | |
| F (excluded instruments) $L^S_F$ | 8.76 | | 5.54 | |
| F (excluded instruments) $L^S_M$ | 6.69 | | 17.03 | |

*Note:* Two stage least squares estimates, instrumenting for labor supply of males and females using low caste and large enterprise industry employment as defined in table 5. Log of wages and labor supply are used in the above regressions. Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analysis is a district and districts having at least 5 wage observations for male and female separately are included here for estimating male and female demand equations respectively.

Table 9(a). Impact of female and male labor supply on female and male wages

| | Male wage | | Female wage | |
|---|---|---|---|---|
| Female LS | -0.06 | (0.23) | -0.55** | (0.28) |
| Male LS | -0.39*** | (0.13) | -0.40* | (0.20) |
| Observations | 7,812 | | 6,378 | |
| Under-id (p-val) | 0.00 | | 0.00 | |
| F(excluded instruments) $L^S_F$ | 3.71 | | 5.34 | |
| F(excluded instruments) $L^S_M$ | 12.96 | | 13.14 | |

Table 9(b). First-stage coefficients

| | Male LS | | Male LS | |
|---|---|---|---|---|
| Low caste | -0.24 | (0.15) | -0.18 | (0.16) |
| Industry | -2.84*** | (0.56) | -2.61*** | (0.55) |
| R-square | 0.71 | | 0.64 | |
| | Female LS | | Female LS | |
| Low caste | 0.61*** | (0.23) | 0.60*** | (0.18) |
| Industry | 0.53 | (1.18) | -0.54 | (0.85) |
| R-square | 0.57 | | 0.52 | |

*Note:*Table 10(a) reports two stage least squares estimates, instrumenting for labor supply of males and females using low caste and large enterprise industry employment as defined in table 5 and controlling for individual characteristics like age, age square, education dummies, marital status and agricultural task along with all district controls in the base specification in table 6(a). Log of wages and labor supply are used in the above regressions. Table 10(b) reports the corresponding first-stage. Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The districts are restricted to the ones included in analysis in table 6(a).

Table 10. Aggregate demand for total labor in agriculture when total labor is measured in efficiency units

| θ= | 0.5 | | 0.7 | | 0.9 | | 1 | |
|---|---|---|---|---|---|---|---|---|
| Male Wage | | | | | | | | |
| Female LS | -0.12 | (0.15) | -0.13 | (0.15) | -0.13 | (0.15) | -0.13 | (0.15) |
| Male LS | -0.37*** | (0.13) | -0.32*** | (0.11) | -0.29*** | (0.10) | -0.28*** | (0.09) |
| | | | | | | | | |
| Female Wage | | | | | | | | |
| Female LS | -0.47* | (0.26) | -0.50** | (0.25) | -0.52** | (0.25) | -0.52** | (0.25) |
| Male LS | -0.58*** | (0.22) | -0.47*** | (0.18) | -0.40** | (0.16) | -0.37** | (0.15) |

*Note:*Two stage least squares estimates, instrumenting for labor supply of males and females using caste and large enterprise industry employment as defined in table 5. Log of wages and labor supply are used in the above regressions. Robust clustered standard errors are in parenthesis;***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analysis is a district and districts having at least 5 wage observations for male and female each are included here.

Table 11. Summary statistics of variables across northern and southern states

| Variable | Northern states: Mean | Northern states: Standard deviation | Southern states: Mean | Southern states: Standard deviation |
|---|---|---|---|---|
| Female LS | 0.54 | 0.73 | 0.98 | 0.60 |
| Male LS | 1.70 | 0.61 | 1.19 | 0.53 |
| Irrigation | 0.52 | 0.27 | 0.34 | 0.22 |
| Gini | 0.66 | 0.10 | 0.71 | 0.09 |
| Rainfall | 9.21 | 4.73 | 7.12 | 6.11 |
| Paved roads | 0.53 | 0.23 | 0.83 | 0.13 |
| Electrified | 0.75 | 0.27 | 0.99 | 0.02 |
| Commercial bank | 0.06 | 0.03 | 0.14 | 0.17 |
| Primary-Middle female | 0.23 | 0.10 | 0.27 | 0.11 |
| Secondary female | 0.09 | 0.05 | 0.15 | 0.07 |
| Primary-Middle male | 0.36 | 0.09 | 0.36 | 0.10 |
| Secondary male | 0.21 | 0.09 | 0.25 | 0.08 |
| Urban percent | 0.23 | 0.18 | 0.32 | 0.18 |
| Coarse Cereals | 0.09 | 0.13 | 0.24 | 0.22 |
| Cotton | 0.08 | 0.12 | 0.09 | 0.11 |
| Oilseeds and Pulses | 0.22 | 0.20 | 0.30 | 0.19 |
| Rice | 0.39 | 0.28 | 0.25 | 0.25 |
| Horticulture | 0.03 | 0.03 | 0.10 | 0.17 |
| Male wage | 3.77 | 0.25 | 3.88 | 0.30 |
| Female wage | 3.63 | 0.29 | 3.43 | 0.29 |

*Note:*Weighted mean with weights equal to district population. Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu are classified as Southern states while Assam, Bihar, Gujarat, Haryana, Rajasthan, Madhya Pradesh and West Bengal are classified as Northern states.

Table 12. Explained difference in wage gap between northern and southern states

| Variable | Proportion wage gap explained |
|---|---|
| Female LS | 55% |
| Paved roads | 36% |
| Rice | 29% |
| Horticulture | 10% |
| Gini | 10% |
| Rainfall | 7% |
| Irrigation | 5% |
| Primary-Middle female | 2% |
| Commercial bank | 1% |
| Secondary female | 0% |
| Primary-Middle male | 0% |
| Cotton | -2% |
| Urban percent | -2% |
| Oilseeds and Pulses | -2% |
| Secondary male | -2% |
| Electrified | -13% |
| Male LS | -14% |
| Coarse Cereals | -22% |

**Appendix A.1: Data sources**

Wages, Labor supply, Gini,Education, Low caste, Large scale non-farm employment in manufacturing and mining units- National Sample survey 2004-05

Irrigation, Land under cultivation- Land Use Statistics 2004-05

Fertilizer- Fertilizer Association of India 2004-05

Crop composition- Area, Production and Yield statistics 2004-05

Rainfall- India Water Portal 2004-05(data originally collected by Indian Meteorological Department)

Agro Ecological Zones- Compiled by Richard Palmer-Jones and KunalSen

Urban, Paved roads, Electrified and Commercial banks- Census of India 2001, Village directory

Implements- Livestock Census 2003

**Endnotes**

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[1]However, Rahman and Rao (2004) do not find such a distinct differentiation across all indicators of woman's status.

[2]Cross-country variation in women's participation can also be related to cross-country variation in social norms (Cameron, Dowling and Worswick 2001)

[3]Rosenzweig (1978) uses the wage data reported in Agricultural Wages in India (AWI). The problem with AWI is that no standard procedure is followed by states as the definition of 'wage' is ambiguous. Only one village is required to be selected in a district for the purpose of reporting wage data and the prevailing wage is reported by a village official on the basis of knowledge gathered.

[4] See Rao (1972) and Himanshu (2005) for a discussion about the merits of different sources of data. The consensus is that although the AWI data may work well for long-term trend analysis but it is not suitable for a cross sectional analysis if the data biases differ across states.

[5]Kerala, the state with the best human development indicators, is an outlier to the Boserup relation. Like other southern states, its female to male wage ratio is low. Unlike other southern states, however, the agricultural female employment (per unit of land) is also low. This is partly because Kerala uses less labor (female or male) per unit of land than other southern states. So if the female labor supply was measured as a proportion of male labor supply, Kerala is substantially closer to the Boserup line although it remains an outlier.

[6]This was found by computing, for each state, the proportion of agricultural labor days of males and females spent in each task. An index of gender division of labor (in agricultural tasks) for each state was constructed by considering the Euclidean distance measure between female and male labor proportions.

[7]The definition of `low caste' is the following. In the employment survey (which is our data source), households are coded as 'scheduled tribes', 'scheduled castes', 'other backward classes' and 'others'. Scheduled tribes (ST) and scheduled castes (SC) are those social groups, in India, that have been so historically disadvantaged that they are constitutionally guaranteed affirmative action policies especially in terms of representation in Parliament, public sector jobs, and education. Other backward class (OBC) is also a constitutionally recognized category of castes and communities that are deemed to be in need of affirmative action (but not at the cost of the representation of ST and SC groups). 'Others' are social groups that are not targets of affirmative action. We define a household to be low caste if it is ST, SC or OBC.

[8]In another set of regressions, we control for the interaction of caste with the education and the age of an individual. The earnings for low caste women are lower than that of others for educations levels of graduate and higher.

[9] The variables used by Rosenzweig are the number of factories and workshops per household, percentage of factories and workshops employing five or more people and the percentage of factories and workshops using power.

[10]By the Durbin-Wu-Hausman test, the null hypothesis that the employment variables can be treated as exogenous is rejected for all specifications (at 10 % significance level).

[11]Following a reviewer suggestion, we also estimated the Rosenzweig specification for our data set with instruments that are as close as possible to those employed by him. In these results, the female labor supply has a significant negative impact on both female and male wages but not on the gender wage gap. This matches the finding of Rosenzweig for the 1961 data. We also find that male labor supply does not have a significant impact on the gender wage gap even though

the impact on male wages is significant and negative and insignificant for female wages. In Rosenzweig's earlier analysis, male labor supply had an insignificant impact on male and female wages and therefore did not matter to the gender wage gap.

[12]We classify Andhra Pradesh, Karnataka, Kerala, Maharashtra and Tamil Nadu as southern states while Assam, Bihar, Gujarat, Haryana, Punjab, Rajasthan, Uttar Pradesh, Madhya Pradesh and West Bengal are classified as northern states. Orissa is omitted from the north-south analysis since it does not fall clearly into any of the categories and also is geographically sandwiched between the north and the south.