The Gender Gap in Agricultural Wages in India:
Spatial Variation, Caste and Non-Farm Employment

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ABSTRACT

This paper looks at the regional variation in agricultural wages received by men and women in India and tries to explain a seemingly contradictory observation that the gender differential in wages is greatest in the Southern states of India, where women enjoy a better status in society as compared to the Northern states. To understand the factors which lead to a higher gender differential in wages we estimate district level aggregate demand equations for total male and female labor. In particular the paper asks whether variation in female and male labor supply has any role in the observed regional pattern of wage differentials. Suitable instruments for labor supply of men and women are used to identify the structural demand equations.

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1. Introduction

The gender gap in wages is a widely documented phenomenon. In developing countries, agriculture is typically the largest employer and most of the work force is rural. And in these countries, wage differences between males and females are commonly seen in agriculture and in the rural sector (World Bank, 2009; Food and Agriculture Organization, 2010 and 2011).

The gender wage gap also varies widely between countries. Female wages as a percentage of male wages is close to 100% in parts of Latin America and Kenya but can be just above 50% in Afghanistan and parts of South Asia. The standard wage discrimination analysis would suggest that this is due to cross-country variation in `explainable' differences in observed characteristics and endowments and the variation in `unexplained' differences commonly attributed to wage discrimination. However, 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 essentially unexplained.

This paper seeks to understand the regional variation in the gender gap in agricultural wages across India. The paper estimates district-level structural demand equations for female and male agricultural labor. It is thus able to shed light on the economic factors that play a role in explaining cross-sectional variation in the gender wage gap. In particular, the paper asks whether exogenous variation in female and male labor supply to agriculture play any part in causing the gender wage gap.

Within India, the ratio of female to male agricultural wages varies widely across regions ranging from 90% in Gujarat to 54% in Tamil Nadu in 2004/05. There is, however, a systematic regional pattern. Figure 1 shows that the gender differential in wages in the northern states is much lower than in the states of southern India. At a first glance this seems to be against the finding that women have greater autonomy in the southern states (Dyson and Moore, 1983). Basu (1992) and Jejeebhoy (2001) also find similar patterns in woman's agency across India's north and south.[1] The panels in Figure 2 cross-plots the female to male wage ratio against some commonly used indicators of the welfare of women – the sex ratio in the population, the percentage of women with a body mass index below the threshold of 18.5, the percentage of women who have experienced physical or sexual violence, the percentage of women who can make decisions regarding social visits, major household purchases and the percentage of women who can travel unaccompanied to the market, health facility and destinations outside the village. It can be seen that regions with greater gender wage gaps are, in fact, characterized by indicators that are favourable to women.

An explanation of this apparent paradox is provided by Boserup (1970). She posits that the variation in gender wage differential across states is because of variation in female labor supply. Female labor force participation is much higher in the southern states than in the north. This characteristic of the labor market has been well studied (e.g. Nayyar(1987), Chen(1995), Bennett(1992), Bardhan(1984) and Das(2006)). The variation in female labor force participation is in some studies is attributed to varying agro-ecological conditions in India. For instance, wet-rice farming, which traditionally employs female labor, is more prevalent in southern India than in the north (Agarwal, 1986 and Rosenzweig and Schultz, 1982).

Boserup's argument revolves around the cultural restrictions on woman's participation in work and the variation in this norm across India. Boserup points out 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.

[1] However, Rahman and Rao (2003) do not find such a distinct differentiation across all indicators of woman's agency.

She also points out that tribal and low caste populations are lower in north India relative to other parts of the country. The association of social group membership (caste and tribe) with female work participation has been confirmed in later work as well (e.g., Chen (1995), Das (2006), Eswaran, Ramaswami and Wadhwa (2010)). 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 labourer." (Boserup, p 61).

Boserup's hypothesis is based on raw correlations drawn from wage data across villages in different Indian states in the 1950s. However, the hypothesis is not immediately obvious because variations in female labor supply could affect male wages as well. Indeed, theoretically, the effects are ambiguous (Rosenzweig, 1978). Furthermore, there could be other factors that affect the gender wage gap as well. Firstly, the efficiency of male and female labor in agriculture could vary across regions because of differences in cropping patterns and agro-climatic conditions. Secondly, the analysis should account for gender segregation by task where `female' tasks are possibly paid less than supposedly `male' tasks. Thirdly, factors which affect supply of labor to agriculture like non-farm employment could also matter to the wage gap. 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). If the trends in any of these factors vary by state then this must also be reckoned as a possible explanation.

Indeed, the impact of non-farm employment on the gender wage gap is of independent interest as well. The non-farm sector is growing much faster than the farm sector as a result of which agriculture's share in GDP has dipped below 20%. The shift in the employment structure towards the non-farm sector is much slower; however the share of agriculture in the employment of men has fallen much faster than that of women (11% against 6% over the period 1983-2004).[2] If men have greater access to non-farm work opportunities, how does that affect the gender gap in agricultural wages? Again theoretically the effects are ambiguous because it all depends on the extent to which female and male labor are substitutes in agricultural production.

The goal of this paper is to empirically examine the effect of variations in female labor supply to agriculture (in part due to cultural restrictions) and variations in male labor supply to agriculture (because of non-farm employment opportunities) on female and male wages and the gap between them. This has been done before by Rosenzweig (1978) who estimated district level inverse demand (and supply) functions for hired labor of males, females and children for the year 1960-61. While this paper uses more recent data, it also departs from Rosenzweig in data sources, model specification and with respect to assumptions about the instruments that are used to identify the labor supply effects on wages. These differences are explained later in the paper. Rosenzweig's analysis does not find support for the Boserup hypothesis. A contrary result is reported by Singh (1996) who uses a pooled time series – cross section data for 1970 to 1989. The cross-sectional units are sixteen Indian states. Singh also estimates an inverse demand function; however ordinary least squares methods are used and the endogeneity of labor supply is not corrected.

In the next section we provide suggestive evidence in support of Boserup hypothesis and also examine other possible intuitive explanations for the observed geographic variation in gender differential of agricultural wages in India. Section 3 outlines the empirical strategy and section 4 describes the data and the basic findings of the estimation. In section 5 we provide a few robustness checks to see if the results hold under alternate specifications.

[2] Eswaran, Kotwal, Ramaswami and Wadhwa (2009)

2. **The Gender Gap in Wages and Female Labor Supply: Correlations**

Figure 3 cross-plots the state-level averages of female to male wage ratio against female labour time in agriculture (per unit of cultivable land). The figure is based on data from 2004/05 and is consistent with Boserup's hypothesis which was informed by data from the 1950s.

Table 1 displays the state average of agricultural wage ratio during the period 1983-2004/05 for the years in which such data was available from representative survey data. There is no clear discernible trend for any of the states except Rajasthan which shows a clear direction in favour of a decline in the gender gap. Most notably, the pattern pointed out by Boserup where the southern states have the lowest female to male wage ratios and the northern states have the highest ratios persists in each of the years for which the ratios are reported in Table 1. The inertia in the gender wage gap is suggestive of the influence of slow-changing factors such as cultural norms that matter to work participation.

If female and male labour are perfect substitutes in agricultural production, then a change in female labour 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 labour must not be perfect substitutes so that changes in female labour supply affect female wages more than male wages. The lack of perfect substitutability is implied by the sexual division of labour within agriculture that is often found in many countries (Burton and White, 1984). 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. In a study of peasant agriculture of the Peruvian Sierra, Jacoby (1991) showed how the sexual division of labour leads to limited substitutability between male and female labour.

The Boserup hypothesis is therefore founded on sexual division of labour. The limited substitutability between female and male labour ensures that the changes in female labour supply have a greater effect on female wages than on male wages. While this is the direct mechanism by which variation in female labour supply is transmitted to the gender wage ratio, an indirect mechanism might also be at work. This may happen if the sexual division of labour is itself endogenous to the gender wage ratio. The Indian data is suggestive of this possibility.

The Indian employment survey distinguishes between the following tasks in agriculture: ploughing, sowing, transplanting, weeding, harvesting and other agricultural activities. From the data we can compute the proportion of agricultural labor days of males and females spent in each task. We construct an index of gender segregation (in agricultural tasks) for each state by considering the Euclidean distance measure between female and male proportions (the sum of the square of the difference between female and male proportions in each activity). Figure 4 plots this index against the female to male wage ratio. It is clear that there is a broad association between the two variables: the sexual division of labour is more marked in the low wage ratio states than in the high wage ratio states. If the sexual division of labour is endogenously determined, a change in the female labour supply, say a decline, would lead more women to be allocated to the relatively higher paying agricultural tasks (traditionally reserved for men) and thus reducing the gender wage gap and reinforcing the direct labour supply effect conceived by the Boserup hypothesis.

States with low female labor time in agriculture might also be states with low male labor time in agriculture. If this is so, could the relative absence of gender-wage gap in these states be because of general labor scarcity (combined with a low sexual division of labor noted earlier). To control for these possibilities, figure 5 plots the female to male wage ratio against the female to male labor supply ratio. From the figure, it is evident that the Boserup hypothesis survives the inclusion of factors that lower aggregate demand for labor in agriculture.[3]

3. Empirical strategy

The empirical analysis estimates separate inverse demand functions for female and male agricultural labour. For observed levels of female and male employment in agriculture, the inverse demand functions can be written as

$$W_{Fi} = \alpha_1 L_{F,i} + \beta_1 L_{M,i} + \alpha_3 X_i + \varepsilon_{F,i} \qquad (1)$$

$$W_{Mi} = \alpha_0 L_{F,i} + \beta_0 L_{M,i} + \alpha_2 X_i + \varepsilon_{M,i} \qquad (2)$$

where $k = F, M$ indexes female and males respectively, i indexes district, W is log of real wage, L is log of labour employed in agriculture, X are other control variables. The inverse demand functions are estimated at the level of a district. It is well known that migration across districts is low in India. Census data show that intra-state flows dominate this low rate and more than half of intra-state migration is accounted by intra-district flows from rural to rural areas (Mitra and Murayama, 2008). Females dominate migration streams due to marriage and account for more than 70% of intra-district migration. Munshi and Rosenzweig (2009) argue that caste and kinship based networks, that are indispensable for consumption insurance, have restricted mobility. As they point out, the assumption that the rural population is essentially immobile has been made in many studies of rural India. This is also true of Rosenzweig's (1978) early study of rural labour markets which models them at the district level.

The key data used in this paper is from the Employment and Unemployment survey of 2004/05 conducted by National Sample Survey (NSS)[4]. The survey contains labour force

[3] Olivetti and Petrongolo (2008) observe a negative correlation between the gender gaps in wages and employment among the OECD countries. They attribute this to the selection of females into labor force in the low female employment countries.

participation and earnings details for the reference period of a week and follows a two stage sampling design. In the rural areas, the first stratum is a district. Villages are primary sampling units (PSU) and are picked randomly in the district and the second stage households are randomly chosen in the selected PSU's. However, households are divided into three strata before sampling: relatively affluent households, from the remaining households having principal earning from non-agricultural activity and other households. The sampling design is such that the proportion of these households in the sample is 1:2:2. A total of 79, 306 households are surveyed in the rural areas. The analyses includes 15 major states in the sample: Punjab, Haryana, Uttar Pradesh(includes Uttarakhand), Madhya Pradesh (includes Chattisgarh), Bihar (includes Jharkhand), Gujarat, Rajasthan, Assam, West Bengal, Maharashtra, Andhra Pradesh, Karnataka, Orissa, Tamil Nadu and Kerala.

From (1) and (2), it can be seen that the effect of female labour supply on the gender gap in agricultural wages is given by $(\alpha_1 - \alpha_0)$. As the alpha coefficients are expected to be negative, an increase in female labour 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 labour supply on the gender gap in agricultural wages is $(\beta_1 - \beta_0)$. A decline in male labour supply to agriculture due to greater non-farm employment opportunities would increase the gender gap in agricultural wages if $(\beta_1 - \beta_0) < 0$.

The female and male labour employment in agriculture is endogenous to wages as long as labour supply to agriculture is not totally inelastic. Hence identification requires that

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[4] There are primarily two sources for district level agricultural wages- Agricultural wages in India (AWI) and Employment and Unemployment schedule of the National Sample Survey in India. The problem with AWI is that no standard procedure is followed by states as the definition of "wage" is ambiguous. Also, just one village is required to be selected in a district for the purpose of reporting of wage data. See Rao (1972) and Himanshu (2005) for discussion about the merits of different sources of data. The consensus is that although the AWI data may work well for long-term trend analyses it is not suitable for a cross sectional analyses if the data biases differ across states.

we relate wages to exogenous variation in female and male labour supply to agriculture. What instrument variables could identify such exogenous variation?

For female labour supply, this paper uses the proportion of district population that is tribal and low caste as an instrument. Earlier work has established the effect of caste and tribal status on female labour supply. As remarked earlier, sociologists have observed that high caste women refrain from work participation because of `status' considerations (Aggarwal, 1994; Beteille, 1969; Boserup, 1970; Chen, 1995). These observations from village level and local studies have been confirmed by statistical analysis of large data sets. Using nationally representative employment data, Das (2006) showed that castes ranked 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 only to the income effect (although the greater education levels among higher castes should work in the opposite direction)? In an empirical model of household labour supply, Eswaran, Wadhwa and Ramaswami (2011) showed that `higher' caste households have lower female labour supply even when there are controls for male labour supply, female and male education, family wealth, family composition, and village level fixed effects that control for local labour market conditions (male and female wages) as well as local infrastructure.

Could the caste composition of a district directly affect the demand for agricultural labour? Rajaraman (1986) and Das and Dutta (2007) find no evidence of discrimination against lower castes in the casual labor market in India. If, however, the caste composition is correlated with developmental indicators that affect agricultural technology then it could have an indirect impact on demand for labour. Such a correlation could arise from public and private investments. For instance, Banerjee and Somanathan (2007) find that districts with greater tribal population have less access to public goods due to their limited political clout.

This would mean that the proportion of district proportion that is tribal and low caste would be a suitable instrument if it is conditioned on development indicators such as irrigation, education, access to roads, commercial banks and electricity. Binswanger et al (1993) find that infrastructure investments affect agricultural productivity and agro-climatic conditions play a very important role in determining the public and private infrastructure investment decisions. Controlling for agro-ecological conditions is thus critical as they affect agriculture production technology directly and indirectly by affecting the placement of public goods.

Another possibility is that the caste and tribal 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 call for adequate controls for agro-ecological conditions and infrastructure. Finally, could caste and tribal composition itself be influenced by wages? Anderson (2011) argues that village level caste composition has remained unchanged for centuries and the location of castes is exogenous to economic outcomes. This is, of course, entirely consistent with the low levels of mobility noted earlier.

Turning to male labour supply to agriculture, the paper uses a measure of the presence of the non-farm economy as an instrument. The competition from non-farm jobs reduces the labour supply to agriculture and increases wages. Evidence on this relation has been presented by Lanjouw and Murgai (2009). Rosenzweig's (1978) study of agricultural labour markets also uses indicators of non-farm economy as an instrument for labour supply to agriculture.[5] However, non-farm activity is in general endogenous to the agricultural labour market as agricultural productivity drives agricultural wages and also matters to the demand for non-farm goods and services (Johnston and Mellor(1961)).

The rural non-farm sector is known to be heterogenous. Some non-farm activity is of very low productivity and "functions as a safety net – acting to absorb labor in those regions

[5] The relevant variables are the number of factories and workshops per household, percentage of factories and workshops employing 5 or more people and the percentage of factories and workshops using power.

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. In the usual case of a dynamic non-farm sector, a distinction can be made between non-traded goods and services (which directly respond to local demand) and traded goods and services (which respond to external demand). The employment in the non-traded sector would be positively correlated with agricultural productivity. On the other hand, the traded sector would not depend on local demand and would not be correlated with agricultural productivity via this route. Using a panel data set for a set of villages across India, Foster and Rosenzweig (2003, unpublished) 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 average non-traded service enterprises consists of 2-3 workers.

From this evidence, it is clear that if there is any component of rural non-farm activity that might be exogenous to agricultural labour demand, it has to be the traded sector that is not dependent on local demand. For this reason, the instrument for male labour supply that is used in the paper is the district wide percentage of men (in the age group 15-59) employed in non-farm units with a workforce of at least 20. The variable is a measure of non-farm employment in large work units and possibly therefore reflects demand from external sources rather than from within the rural areas of district. This variable would also exclude the rural non-farm employment that is of residual nature as mentioned by Lanjouw and Murgai. 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 9 or less in column 2 of Table 3. It can be seen that, manufacturing and public administration have a higher proportion in large work units while non-tradeables such as trade and hotels, transport and construction are less important. Nonetheless, the effects of local agricultural productivity cannot be conclusively ruled out and therefore the validity of this instrument has to be conditioned on the controls for agricultural productivity that are included in the labour demand equation (agro-ecological endowments, crop composition, irrigation, infrastructure).

Even though the tradable non-farm goods and services do not depend on local demand, the variable could still be endogenous if the non-farm enterprises locate themselves in areas of low agricultural wages. This possibility was suggested by the work of Foster and Rosenzweig (2003). Their findings stem from a panel data set over the period 1971-99 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 employment survey data of NSS (Lanjouw and Murgai, 2009). The findings of Foster and Rosenzweig have been interpreted by them as well as others that non-farm enterprises move to areas of low wages. However, this is at odds with their results. In their panel regressions, they find that after controlling for unobserved village effects and observed village variables like electrification, proximity to markets, population, number of schools and wealth, the growth in village factories (the tradable sector) is negatively correlated with the growth in agricultural yields. In other words, increases in agricultural yields reduces the size of the traded non-farm sector[6]. However, as the authors recognize, yields increased fastest in the areas with the lowest yield levels. This is also supported by analyses in Bhalla and Singh(2001) who find that post-1970 agricultural yield growth was more in Central and Eastern India – the areas with traditionally low yields.

Therefore, even the traded non-farm sector grew more in the areas that were relatively agriculturally advanced by the early 1970s. One explanation for this has been provided by

[6] Lanjouw and Murgai (2009) also attempt to estimate this relationship with the NSS data. Their findings are mixed. One set of regressions support the Foster and Rosenzweig finding while another set with more control variables does not.

Lall and Chakravarty (2005). They analyse the spatial location of industries in India in the late 1990s and find that private investment is biased towards already industrialized and coastal districts. 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. Once again the validity of the proposed measure of non-farm employment in large units as an instrument depends on the inclusion of adequate controls of infrastructure.

Relation to Literature

As mentioned earlier, Rosenzweig (1978) was the first paper to estimate labour demand functions for agricultural labour in India. This exercise is embedded within a general equilibrium market clearing model of wage determination. In the model, “male” and “female” labour are imperfect substitutes. There are three types of agricultural households – landless, small landholding and large landholding. Both the landless and small-farm are labour supplying households while the large-farm household hires in labour. Competitive markets are assumed with wage rates for hired labour determined endogenously by market labour supply and labour demand. Comparative statics show that an increase in female work participation decreases female and male wages but the impact on the wage gap is ambiguous.[7]

In the empirical exercise, Rosenzweig estimates inverse demand and supply equations for hired labour of males, females and children in agriculture at the district level using wage data on 159 districts in India for the year 1960-61.[8] To identify the inverse demand equation he uses following exclusion restrictions: demand for hired male, female and labour is not affected by proportion of population living in urban areas in the district, indicators of non-farm economy and the percentage of Muslims in the district. These variables affect only the

[7] The principal goal of the paper is to analyse the effect of land reforms on male and female wage rates.
[8] The data source is Agricultural Wages in India.

off-farm supply of labour. His results show that variations in female labour supply have a negative effect on both male and female wages. 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 points of departure for this paper. First, while the identification strategy for male labour supply is similar (relying on measures of the district non-farm sector), the identification for female labour supply is different. This paper relies on the caste-specific norms of female labour supply.

Second, this paper estimates the demand for total labour and not just hired agricultural labour. Suppose L_s^h and L_s^o are the aggregate labour supply to the home farm and to outside farms respectively. Similarly, let L_d^f and L_d^h be the aggregate demand for family and hired labour respectively. Then equilibrium in the labour market can either be written as $L_s^h + L_s^o = L_d^f + L_d^h$ or as $L_s^o = L_d^h$. However, for econometric estimation, it is preferable to estimate the inverse demand for all agricultural labour than for hired labour alone. This is because the instruments that affect off-farm labour supply could also potentially affect the demand for hired labour. For instance, higher caste women may refrain from work outside the home and also limit their work on own farms. Similarly, the availability of non-farm work opportunities may affect the family labour supply of landed households to own farms and increase the demand for hired labour. Also, while measuring hired labor, Rosenzweig's paper does not normalize it for total availability of cultivable land in a district.

Third, there are differences in specification. For instance, this paper employs controls for agricultural technology, soil and climate, and district infrastructure (of roads, banks and electricity) which are absent in Rosenzweig.

Other studies that estimate structural demand and supply equations for hired agricultural labour in India are Bardhan (1984) and Kanwar (2004). Bardhan (1984) estimates simultaneous demand and supply equations for hired male labourers 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 labour demand and supply equations for hired agricultural labour simultaneously accounting for non-clearing of the labour market using ICRISAT data. Neither of these studies analyse males and females labourers separately and they cover only a few villages in a state.

4. Data and Findings

As mentioned before, the key endogenous variables of wages and labour use in agriculture are sourced from the employment survey of the NSS. Some of the other variables including the instruments are also constructed from this data set. However, other correlates such as crop composition, soil and climate endowments and district infrastructure are collected from other sources. Table 5 contains a description of the variables, their definitions and descriptive statistics. Appendix A lists the sources for each variable used.

Aside from the endogenous variables, the control variables are land distribution, irrigation, rainfall, crop composition, infrastructure (roads, electrification and banking), urbanization, education and agro-climatic variables.[9] The last set of variables comes from the classification of the country into 20 agro-ecological regions by the National Bureau of Soil Survey based on soil, physiography of the area, bioclimatic conditions and length of growing period which depends on moisture availability in soil. The nature of crops grown in an area depends on climatic and soil suitability. Table 4 gives a brief description of the AER's to

9 Education and urbanization affect the supply of labour to agriculture. However, this paper does not use them as instruments because by changing the skill composition of the labour force and also affecting the access to non-labour inputs, these variables can also affect the demand for agricultural labour.

which the districts in the sample belong. There was no district under AER 1 and 20 in the sample. The independent variables are created by taking the proportion of area of the district under the particular AER.[10] In general AER's having features which are more suitable to agriculture should positively affect the demand for labour.

Our 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 for which number of wage observations for either males or females was less than 5 were dropped from the analyses. The rule of dropping districts where either male or female observations are few 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. We later see if the results are sensitive to this type of district selection by estimating male labour 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 female labour demand function for districts in which number of female wage observations are at least five (ignoring the paucity, if any, of male wage observations).

Panel A of Table 6 shows the two stage least squares estimates of inverse demand functions for total male and female labour in agriculture. Panel B shows the first stage results for the corresponding specifications in Panel A. The first stage estimates show that greater the proportion of low caste and tribal households in a district, greater is female labour employment in agriculture and that this relation is significant. Similarly, a greater presence of large scale non-farm enterprise decreases male labour in agriculture significantly. The caste variable is not important for male labour supply to agriculture and similarly large scale

[10] The coding for this variable was obtained from Richard Palmer-Jones.

non-farm enterprise is not significant for female labour supply. The F-statistic for the instruments is reported in the bottom half of Panel A. The first stage regressions confirm the causal story about these variables: that status norms govern female labour supply and that non-farm opportunities are primarily received by men.

Table 6 considers two specifications. The first specification includes the controls of land distribution, rainfall, infrastructure, education and agro-ecological regions. The second specification augments the first regression by adding control variables for crop composition. The 2SLS estimates of female and male labour supply are larger in magnitude than the OLS estimates in Panel C of Table 6, and have the expected negative signs. The Hausman test (reported in the bottom half of Panel A) rejects the null that the labour supply variables are exogenous in the second specification for both male and female demand equation. The coefficients of the labour supply variables do not change much between the two specifications.

In the 2SLS regressions, the variations in female labour supply have a significant impact on female wages with the inverse demand elasticity being – 0.5 or greater (in absolute value). However, the impact of female labour supply on male wages is smaller (around -0.1) and is not significantly different from zero. An increase in female labour supply by 1 percent decreases the female to male wage ratio by 0.44% and 0.39% in the two specifications respectively. To test formally that the impact on female wages is greater (in absolute terms) than the impact on male wages, we estimate the covariance between the two coefficients and carry out a chi-square-test.[11] The chi-square-test rejects the null that the coefficients are equal against the alternative that the coefficient of female labour supply in the female wage regression is higher than the coefficient of female labour supply in the male wage regression. This is supportive of the Boserup hypothesis that the caste driven variation in female labour

[11] This done by a system IV regresion that stacks the data of the two regressions (Wooldridge. ??)

supply leads to variation in the gender wage gap. In particular, greater female work participation decreases female wages relative to male wages.

In contrast, the effect of male labour supply variation is significant for both male and female wages. In the first specification, the point estimate of the inverse demand elasticity is -0.37 for females and -0.23 for males and both are significant. The estimates for the second specification are similar. Although non-farm employment is dominated by men, non-farm labour demand has favourable effects on female and male wages. The point estimates would imply that a 1% decrease in male labour supply increases the female to male wage ratio by .10 %. Formal tests do not reject the equality of the coefficients of male labour supply in the male and female inverse demand functions.

The absence of a significant effect of female labour supply on male wages suggests that male labour productivity is not affected by female labour supply. However, the significant impact of male labour supply on female wages suggests that female labour productivity is affected by variation in male labour supply.

As expected irrigation increases the demand for labour while greater land inequality reduces it. The latter reflects the well-known feature that larger farms use less labour (per unit of land) than smaller farms. Some of the infrastructure variables like paved roads and electrification are significant for male demand. The surprise is the negative impact of electrification. Presumably, it leads to greater use of labour displacing machinery. The gendered response of wages is also seen in the coefficients of the Gini variable and paved roads.

In Table 7 we control for other covariates which could affect demand for labour like fertiliser usage and tractors and power operated implements per unit land cultivated in a district. These were not included in the base specification since these variables can be potentially endogenous, as a profit maximising farmer will also make simultaneous decisions regarding fertiliser and capital usage. Including fertilisers does not change the impact of female labour supply on male and female wages and the elasticity of wage ratio with respect to female labour supply is -.40 percent. The effect of male labour supply however changes drastically as the coefficients for both equations increase and the elasticity of wage ratio with respect to male labour supply increases to -.24 which is a big change from base specification (the chi-square test does not reject the equality of male labor supply coefficients across male and female demand equations). However, a note of caution is the high correlation between irrigation and fertiliser usage which makes the coefficient of irrigation smaller and for female demand equation it becomes insignificant altogether. Fertiliser itself affects the demand for both male and female labour significantly positively. The other variable which shows a drastic change is urban percentage which increases in absolute. Adding implements used per unit land cultivated does not change any of the coefficients of the base specification by a large magnitude. The elasticity of the wage ratio with respect to female and male labour supply remains at -.42 and -.10 respectively.

As a second robustness check we do not restrict ourselves to districts for which both male and female wage are at least five, which makes the districts included in analyses same for male and female demand equation. Now we estimate male demand equation for districts for which we have at least five wage observations for males and same for female demand equation. This increases the districts from 279 to 388 for males and 288 for females. Table 8 shows the results from the estimation of specification 1 and 2 on this new set of districts. In the specification with full set of controls, the elasticity of the wage ratio with respect to female and male labour supply is -.52 and -.05 respectively. Thus, female labour supply affects the wage ratio more adversely now while the effect of male labour supply falls. The other significant variables for which the magnitude of coefficient changes are irrigation and landholding inequality. For both these variables the coefficients fall in absolute magnitude. However, the conclusions of the base specification do not change.

As a third robustness check, we exclude ploughing activity while estimating the wages. This reduces the districts in the analyses to 273. Table 9 shows the results. We discuss the results of the specification with full set of controls. The elasticity of wage ratio with respect to female and male labour supply is -.41 and -.08 respectively. For the other significant variables, the effect of irrigation increases in magnitude for both males and females, while the effect of land inequality decreases for males. Again, the conclusions from the base specification do not changes.

6. Possible sources of bias in estimates

As discussed previously there is a concern of possible correlation of the instrument of industry with the error term. The structural equations are given by:

$$W_F = \alpha_1 L_F + \beta_1 L_M + \alpha_3 X + \varepsilon_F \qquad (1)$$

$$W_M = \alpha_0 L_F + \beta_0 L_M + \alpha_2 X + \varepsilon_M \qquad (2)$$

Let Z_1 and Z_2 be low-caste and off-farm employment respectively. Let $\widetilde{Z_1}$ and $\widetilde{Z_2}$ be the part of Z_1 and Z_2 which is uncorrelated with the X's. Then the first stage equation can be written as:

$$L_F^S = \pi_1 \widetilde{Z_1} + \pi_2 \widetilde{Z_2} + \varphi_F X + u_F \qquad (3)$$

$$L_M^S = \delta_1 \widetilde{Z_1} + \delta_2 \widetilde{Z_2} + \varphi_M X + u_M \qquad (4)$$

Substituting from (3) and (4) into (1), we get:

$$W_F = \alpha_1 (\pi_1 \widetilde{Z_1} + \pi_2 \widetilde{Z_2}) + \beta_1 (\delta_1 \widetilde{Z_1} + \delta_2 \widetilde{Z_2}) + \omega_F X + v_F \qquad (5)$$

Similarly, substituting from (3) and (4) into (2), we get

$$W_M = \alpha_0 (\pi_1 \widetilde{Z_1} + \pi_2 \widetilde{Z_2}) + \beta_0 (\delta_1 \widetilde{Z_1} + \delta_2 \widetilde{Z_2}) + \omega_M X + v_M \qquad (6)$$

With the following assumptions:

1) $\pi_2 = 0$

2) $\delta_1 = 0$

3) $Cov(\tilde{Z}_1, \tilde{Z}_2) = 0$

We can write (5) and (6) as:

$$W_F = \alpha_1 (\pi_1 \widetilde{Z_1}) + \beta_1 (\delta_2 \widetilde{Z_2}) + \omega_F X + v_F$$

$$W_M = \alpha_0 (\pi_1 \widetilde{Z_1}) + \beta_0 (\delta_2 \widetilde{Z_2}) + \omega_M X + v_M$$

The bias in the two stage least squares estimate then is given by

$$\hat{\alpha}_1 = \alpha_1 + \frac{cov(\hat{\pi}_1 \widetilde{Z_1}, \varepsilon_F)}{Var(\hat{\pi}_1 \widetilde{Z_1})}$$

$$\hat{\alpha}_0 = \alpha_0 + \frac{cov(\hat{\pi}_1 \widetilde{Z_1}, \varepsilon_M)}{Var(\hat{\pi}_1 \widetilde{Z_1})}$$

$$\hat{\beta}_1 = \beta_1 + \frac{cov(\hat{\delta}_2 \widetilde{Z_2}, \varepsilon_F)}{Var(\hat{\delta}_2 \widetilde{Z_2})}$$

$$\hat{\beta}_0 = \beta_0 + \frac{cov(\hat{\delta}_2 \widetilde{Z_2}, \varepsilon_M)}{Var(\hat{\delta}_2 \widetilde{Z_2})}$$

The parameter of our interest will be given by:

$$\hat{\alpha}_1 - \hat{\alpha}_0 = \alpha_1 - \alpha_0 + \frac{cov(\hat{\pi}_1 \widetilde{Z_1}, \varepsilon_F)}{Var(\hat{\pi}_1 \widetilde{Z_1})} - \frac{cov(\hat{\pi}_1 \widetilde{Z_1}, \varepsilon_M)}{Var(\hat{\pi}_1 \widetilde{Z_1})} = \alpha_1 - \alpha_0$$

$$\hat{\beta}_1 - \hat{\beta}_0 = \beta_1 - \beta_0 + \frac{cov(\hat{\delta}_2 \widetilde{Z_2}, \varepsilon_F)}{Var(\hat{\delta}_2 \widetilde{Z_2})} - \frac{cov(\hat{\delta}_2 \widetilde{Z_2}, \varepsilon_M)}{Var(\hat{\delta}_2 \widetilde{Z_2})}$$

Given that low-caste and the error terms are uncorrelated we get an unbiased estimate of $\alpha_1 - \alpha_0$. But $\widetilde{Z_2}$ and the error term could be correlated if we have any omitted variable which is correlated with both industry placement and demand for labour in agriculture. Under the condition that $\frac{cov(\widehat{\delta}_2\,\widetilde{Z}_2,\varepsilon_F)}{Var(\widehat{\delta}_2\,\widetilde{Z}_2)} = \frac{cov(\widehat{\delta}_2\,\widetilde{Z}_2,\varepsilon_M)}{Var(\widehat{\delta}_2\,\widetilde{Z}_2)}$, the bias in individual estimates will cancel out to give an unbiased estimate of $\beta_1 - \beta_0$. This will be case if, $\theta_F = \theta_M$,where θ_F and θ_M are given by:

$$\varepsilon_F = \theta_F\left(\hat{\delta}_2\,\widetilde{Z_2}\right) + \vartheta_F$$

$$\varepsilon_M = \theta_M\left(\hat{\delta}_2\,\widetilde{Z_2}\right) + \vartheta_M$$

This may not necessarily be the case. But since the variables which enter into the error terms are likely to be the same and to the extent their effect on both male and female labour demand is in the same direction, the bias in $\hat{\beta}_1 - \hat{\beta}_0$ will be less than the bias in individual estimates with the bias eliminated if the variables have the same affect on male and female labour demand.

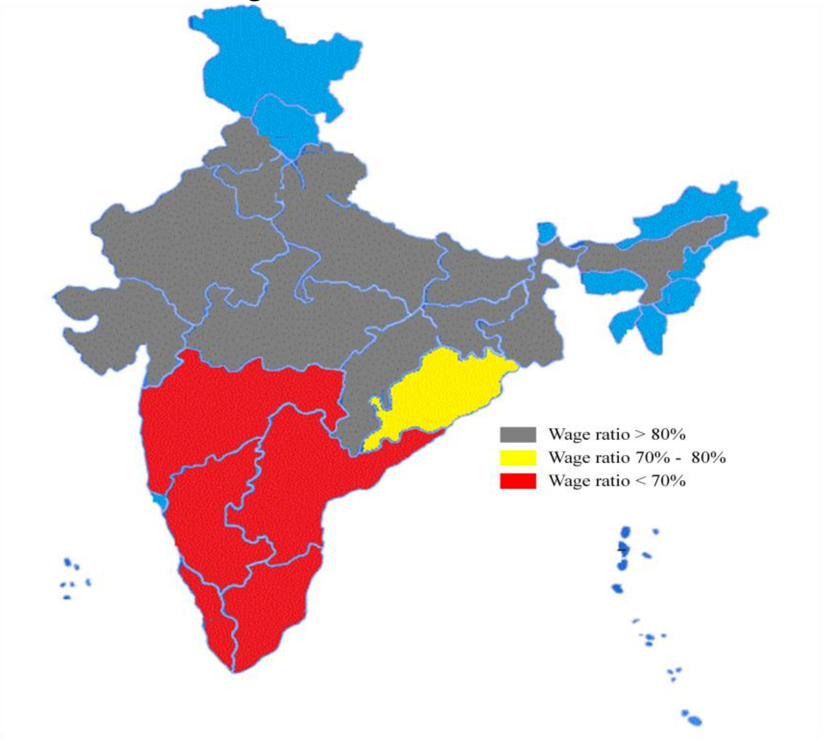
If the conclusion reached by Foster and Rosenzweig (2003) is correct then estimates of β_1 and β_0 will be biased towards zero and the net effect on $\beta_1 - \beta_0$ cannot be determined. On the other hand if the error term and the industry are positively correlated then β_1 and β_0 will be upward biased and the net effect on $\beta_1 - \beta_0$ cannot be determined again. But as argued earlier the bias in $\beta_1 - \beta_0$ is likely to be smaller than the bias in individual estimates.

7. Conclusion

In this paper we try to explain the larger gender wage differentials in the Southern states of India in agriculture. Using the neo-classical framework we formally test the hypothesis previously put forth by Emily Boserup that this geographical pattern of wage differentials in India could be a result of greater female labour supply in these states as cultural restrictions on participation in work force on women is much less in these states. Our findings provide evidence that greater female labour supply to agriculture reduces female wages more than male wages in agriculture and hence affects the female to male wage ratio negatively. Greater male supply on the other hand affects both male and female wages equally negatively. The asymmetry in affect of male and female labor supply on wages needs further investigation.

While female participation in labour force is associated with greater autonomy and should be encouraged, the policy implication of our results is that women should be provided with alternative employment opportunities especially in Southern India where they are more willing to work. This could be one of the ways to increase their wages relative to males in agriculture. Agriculture sector employs majority of women workforce in India. Against the background of greater participation of females in agriculture in the past decade which could be due to males moving to a more lucrative off-farm sector, this result has a profound implication.

Figure 1: Regional variation in wage ratios, 2004



Source: National sample survey (NSS) 2004, Schedule 10

Table1. Female to male wage ratio

State	1983	1993	1999	2004
Assam	86%	81%	78%	90%
Gujarat	88%	98%	89%	90%
West Bengal	93%	88%	89%	88%
Bihar	84%	87%	88%	87%
Haryana	97%	85%	90%	84%
Madhya Pradesh	85%	83%	85%	83%
Punjab	81%	108%	94%	83%
Uttar Pradesh	79%	75%	78%	83%
Rajasthan	65%	75%	80%	81%
Orissa	75%	73%	79%	72%
Karnataka	71%	73%	68%	69%
Andhra Pradesh	66%	72%	67%	65%
Maharashtra	59%	63%	65%	63%
Kerala	65%	70%	63%	59%
Tamil Nadu	55%	57%	58%	54%
All India	69%	72%	72%	70%

Source: NSS Schedule 10, 1983, 1993, 1999, 2004

Figure 2

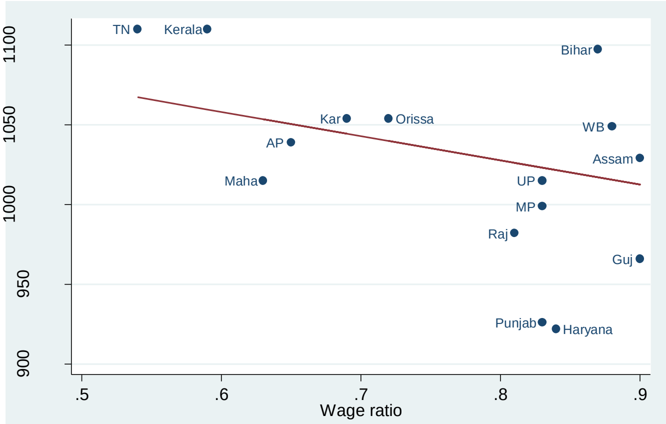


Figure 2(a)

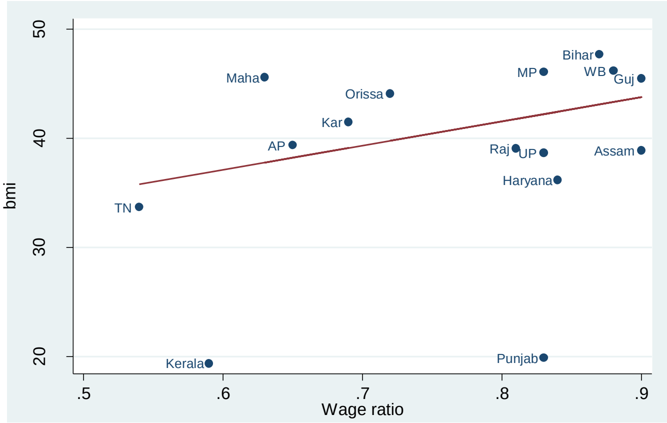


Figure 2(b)

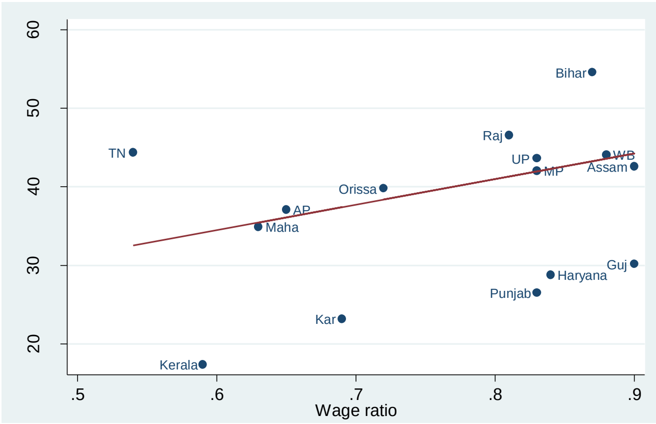


Figure 2(c)

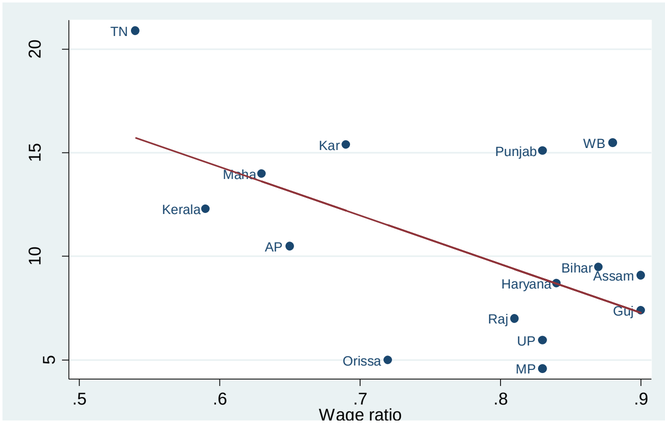


Figure 2(d)

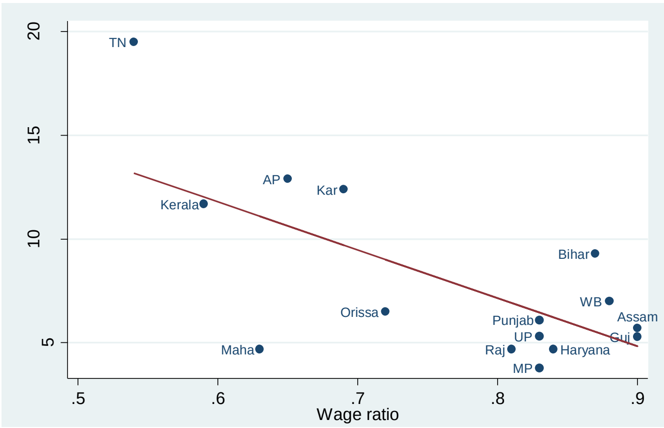


Figure 2(e)

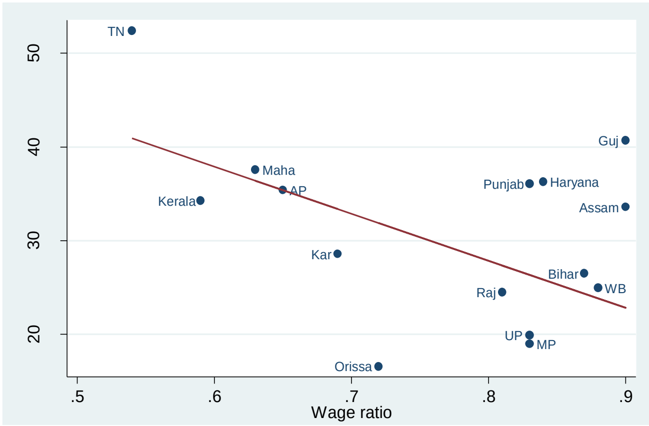
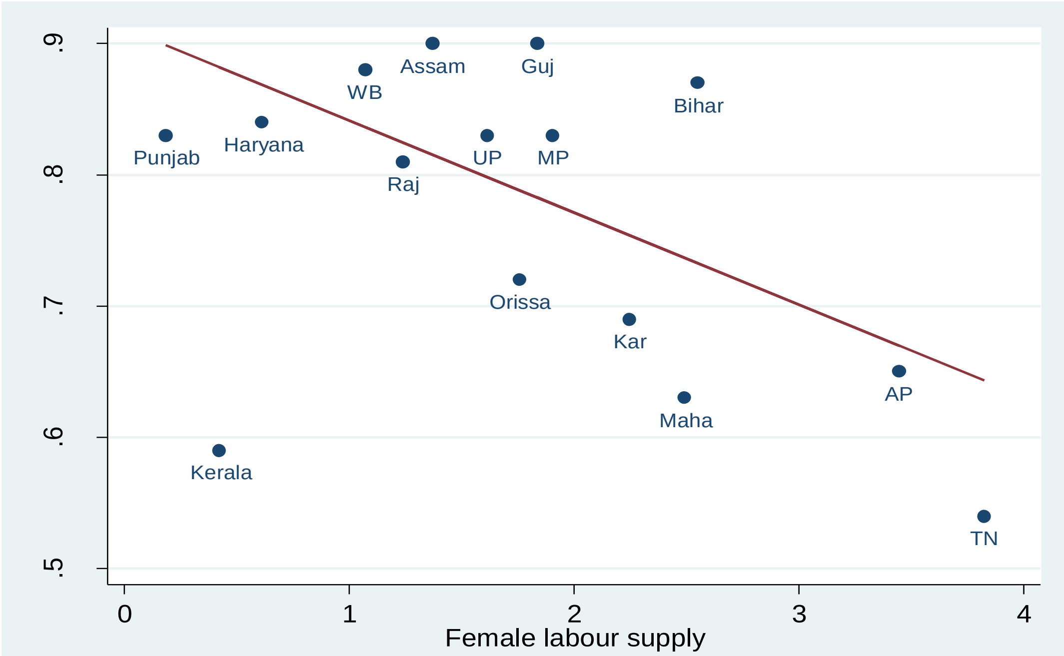


Figure 2(f)

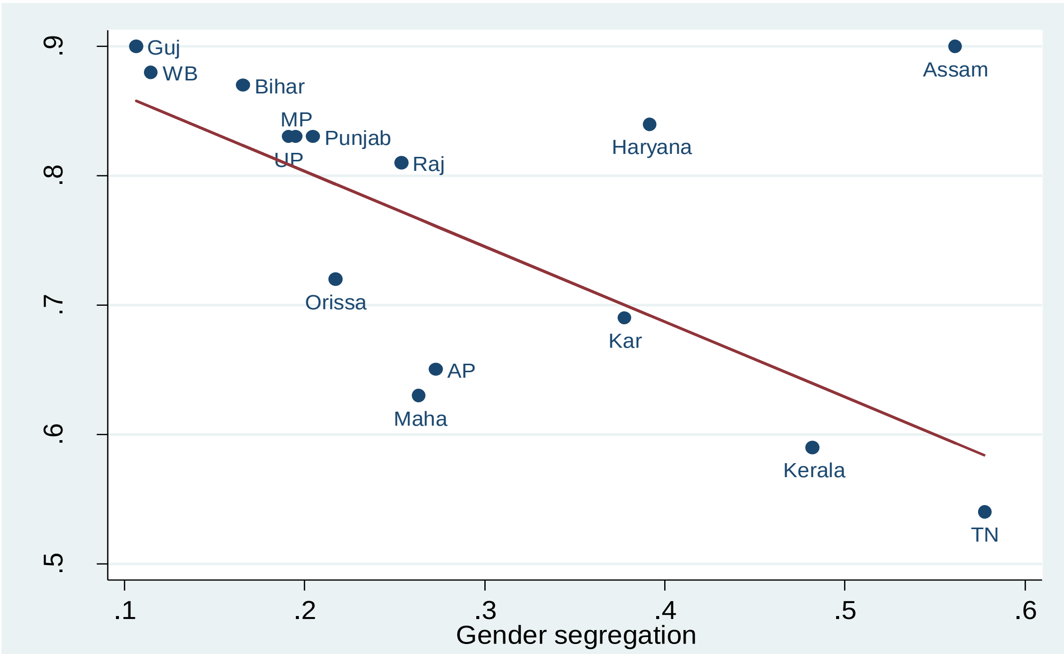
2(a) Sex ratio
2(b) Percent women having body mass index below 18.5
2(c) Percent women who have experienced physical/sexual violence
2(d) Percent women who make the decision to visit family/relatives
2(e) Percent women who make the decision regarding major household purchases
2(f) Percent women allowed to the market, to the health facility, and to places outside the village alone
Population weighted regression lines are fitted to the above plots
Source: NSS 2004 Schedule 10, National Family and Health Survey (NFHS) 2005-06

Figure 3: Female labour supply and the gender wage ratio



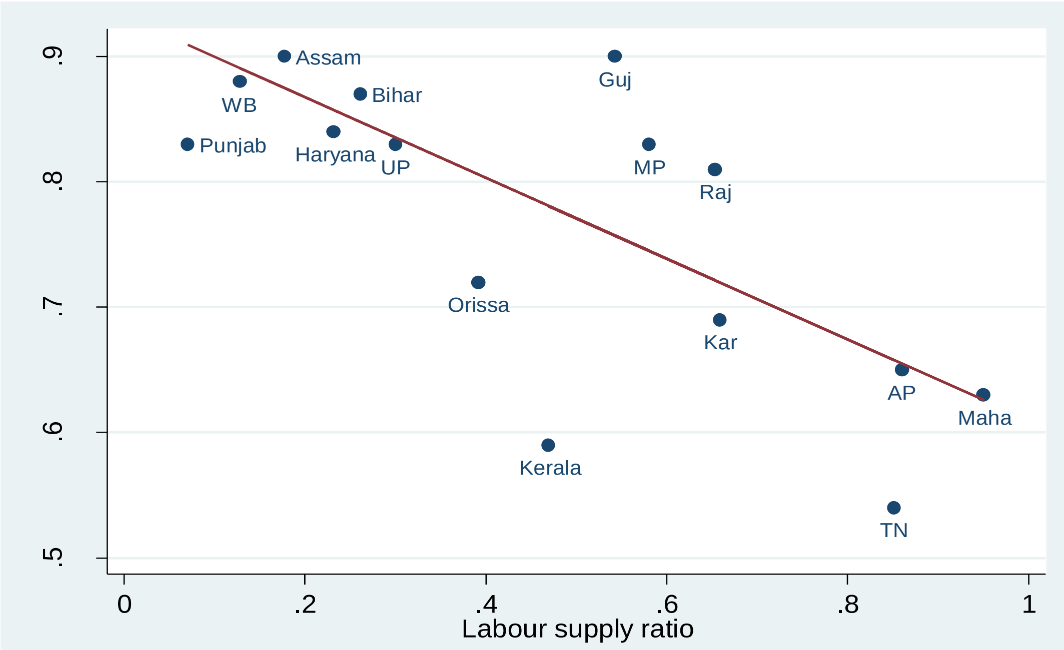
Notes- Labour supply is measured as total days worked in a reference week per unit land under cultivation,
- Population weighted regression lines are fitted to the above plots; Source: NSS 2004 Schedule 10

Figure 4: Gender-segregation and the gender wage ratio



Notes- Labour supply 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; Source: NSS 2004 Schedule 10

Figure 5: Labour supply ratio and the gender wage ratio



Notes- Labour supply is measured as total days worked in a reference week per unit land under cultivation,
- Gap in labour supply is (Male labour supply-Female labour supply)
- Population weighted regression lines are fitted to the above plots; Source: NSS 2004 Schedule 10

Table 2: Task wise allocation of workers in agriculture

Task	Male	Female
Ploughing	95%	5%
Sowing	67%	33%
Transplanting	55%	45%
Weeding	48%	52%
Harvesting	63%	37%
Other cultivation activities	73%	27%
All activities	67%	33%

Source: NSS 2004 Schedule 10

Table 3: Sectoral distribution of off-farm employment

	Percentage in units with 20 or more workers	Percentage in units with 9 or less workers
Industry	(1)	(2)
Agriculture and allied activities	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%

Notes: The above figures are calculated from the usual status activity status of respondents in NSS 2004 Schedule 10 for men aged 15-59

Figure 4: Agro Ecological regions in India

Source: NBSS and Land Use Planning, Nagpur

Table 4: Agro-Ecological Regions

AER	Description
2	Western Plain, Kachch and part of Kathiarwar, peninsular, hot arid ecoregion, with desert and saline soils and LGP<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 LG 150 d
5	Central Highlands, Gujarat Plains, Kathiarwar peninsular, hot arid ecoregion, with medium and deep black soils and LGP d
6	Deccan Plateau, hot semi arid ecoregion, 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 arid ecoregion with red loamy soils and LG 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 subhumid ecoregion, with black and red soils and LGP 180 d up to 210 d in some places
11	Eastern Plateau (Chattisgarh), hot subhumid ecoregion, with red and yellow soils and LGP 150-180 d
12	Eastern (Chotanagpur) plateau and Eastern Ghats, hot subhumid ecoregion with red and lateritic soils and LGP 150-180 to
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 perhumid ecoregion) with brown forest & podzolic soils, LGP 180-210
15	Bengal and Assam Gangetic and Brahmaputra plains , hot subhumid (moist) to humid (and perhumid) ecoregion, with allu derived soils and LGP 210+ d
16	Eastern Himalayas, warm perhumid ecoregion with brown and red hill soils and LGP 210+ d
17	Northeastern Hills (Purvachal), warm perhumid ecoregion 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

Table 5. Variable Description and Summary Statistics

	Variable	Definition	Mean	Standard deviation
Wage	$\ln(W_{M,i})$	ln(Real average male casual manual worker wage in cultivation, aged 15-59 years)	3.82	0.28
	$\ln(W_{F,i})$	ln(Real average female casual manual worker wage in cultivation, aged 15-59 years)	3.54	0.31
Labour supply	$\ln(L^{S}_{M,i})$	$\ln\left[\frac{\text{Total days worked in a reference week in cultivation by all males aged15-59 in district i)}}{\text{Area under cultivation in district i}}\right]$	1.46	0.61
	$\ln(L^{S}_{F,i})$	$\ln\left[\frac{\text{Total days worked in a reference week in cultivation by all females aged15-59 in district i}}{\text{Area under cultivation in district i}}\right]$	0.73	0.71
Land	Gini	Gini coefficient for land holding inequality	0.69	0.10
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	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
Others	Irrigation	Percentage cultivated area irrigated	0.43	0.26
	Rainfall	Rainfall received during June to September 2004 in cms	8.30	5.41
	Urban	Percentage population in a district living in urban areas	0.27	0.18
Instruments	Low caste	Percentage SC/ST/OBC households	0.75	0.19
	Industry	Percentage men aged 15-59 engaged in a unit employing more than 20 persons as their usual status activity	0.04	0.05
Crop Composition	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

Notes: Weighted mean with weights equal to district population, Agro-Ecological Regions described in Table 4

Table 6. Aggregate demand for total labor in agriculture

	Panel A: Two stage least squares							
	male wage		female wage		male wage		female wage	
	(1)				(2)			
log female LS	-0.11	(0.15)	-0.55*	(0.29)	-0.12	(0.14)	-0.51**	(0.23)
log male LS	-0.23***	(0.09)	-0.37*	(0.19)	-0.22***	(0.09)	-0.32*	(0.17)
Irrigation	0.27***	(0.11)	0.45**	(0.22)	0.28***	(0.11)	0.38**	(0.19)
Gini	-0.58*	(0.32)	-1.26**	(0.52)	-0.61**	(0.30)	-1.26***	(0.47)
Rainfall	-0.00	(0.01)	0.02*	(0.01)	0.00	(0.00)	0.01	(0.01)
Coarse Cereals					0.09	(0.21)	0.54*	(0.31)
Cotton					0.10	(0.26)	0.47	(0.44)
Oilseeds and Pulses					0.03	(0.18)	0.13	(0.28)
Rice					0.05	(0.22)	0.68**	(0.34)
Horticulture					0.27	(0.32)	-0.20	(0.44)
Paved roads	0.49***	(0.09)	0.27	(0.24)	0.48***	(0.10)	0.09	(0.22)
Electrified	-0.58***	(0.18)	-0.58**	(0.30)	-0.58***	(0.17)	-0.41*	(0.23)
Commercial bank	0.13	(0.21)	-0.44	(0.55)	0.04	(0.17)	0.00	(0.20)
Urban percent	-0.15**	(0.08)	-0.03	(0.17)	-0.13*	(0.07)	-0.06	(0.15)
Primary-Middle female	0.01	(0.24)	-0.28	(0.55)	-0.01	(0.25)	-0.15	(0.51)
Secondary female	0.46	(0.31)	0.30	(0.78)	0.36	(0.33)	0.37	(0.63)
Primary-Middle male	-0.27	(0.23)	-0.10	(0.43)	-0.24	(0.25)	-0.17	(0.38)
Secondary male	-0.20	(0.22)	0.14	(0.47)	-0.13	(0.23)	0.07	(0.43)
AEZ 2	-0.33**	(0.16)	-0.31	(0.43)	-0.24	(0.22)	-0.29	(0.39)
AEZ 3	-0.88***	(0.20)	-0.62**	(0.31)	-0.79***	(0.19)	-0.68**	(0.27)
AEZ 4	-0.40***	(0.13)	0.00	(0.27)	-0.32**	(0.16)	-0.04	(0.27)
AEZ 5	-0.42***	(0.14)	0.09	(0.22)	-0.36***	(0.14)	0.02	(0.21)
AEZ 6	-0.40***	(0.14)	-0.14	(0.27)	-0.34**	(0.14)	-0.30	(0.24)
AEZ 7	-0.44*	(0.23)	0.31	(0.40)	-0.35**	(0.18)	0.04	(0.27)
AEZ 8	0.01	(0.25)	0.64*	(0.38)	0.06	(0.18)	0.43	(0.29)
AEZ 9	-0.47***	(0.17)	0.04	(0.30)	-0.40**	(0.18)	-0.07	(0.27)
AEZ 10	-0.45***	(0.12)	-0.24	(0.25)	-0.37***	(0.13)	-0.31	(0.22)
AEZ 11	-0.48***	(0.14)	-0.10	(0.25)	-0.41***	(0.13)	-0.43*	(0.24)
AEZ 12	-0.46***	(0.16)	-0.25	(0.31)	-0.40*	(0.21)	-0.58*	(0.34)
AEZ 13	-0.22	(0.16)	0.45*	(0.26)	-0.16	(0.17)	0.29	(0.26)
AEZ 14	0.31*	(0.18)	1.07***	(0.28)	0.36**	(0.16)	1.03***	(0.21)
AEZ 15	-0.19	(0.19)	-0.07	(0.42)	-0.16	(0.23)	-0.32	(0.41)
AEZ 16	-0.14	(0.29)	-0.33	(0.60)	-0.14	(0.30)	-0.30	(0.45)
AEZ 17	0.39	(0.39)	1.11**	(0.50)	0.49*	(0.29)	0.43	(0.40)
AEZ 18	-0.01	(0.21)	0.46	(0.31)	0.06	(0.13)	0.11	(0.24)
Constant	5.11***	(0.38)	5.28***	(0.81)	4.97***	(0.45)	5.06***	(0.70)
Observations	279		279		279		279	
Hausman test (endogeneity)	0.12		0.02		0.09		0.02	
Under-id (p-val)	0.02		0.02		0.01		0.01	
F(excluded instruments) L^S_F	3.80		3.80		5.19		5.19	
F(excluded instruments) L^S_M	9.72		9.72		11.82		11.82	

Panel B: First Stage for Total Labour supply by males and females to agriculture								
	male labor supply		female labor supply		male labor supply		female labor supply	
	(1)				(2)			
Low caste	-0.21	(0.21)	0.77***	(0.29)	-0.2	(0.19)	0.79	(0.27)
Off-farm employment	-2.87***	(0.67)	-0.21	(0.95)	-2.96	(0.62)	-0.39	(0.97)
R-Square	0.67		0.49		0.71		0.54	

Panel C: Ordinary Least Squares								
log female LS	-0.08***	(0.03)	-0.15***	(0.04)	-0.06**	(0.03)	-0.15***	(0.04)
log male LS	-0.05	(0.05)	0.04	(0.05)	-0.01	(0.04)	0.06	(0.05)
R-square	0.66		0.63		0.69		0.64	
Number of observations	279		279		279		279	

Notes: Panel A reports two stage least squares estimates, instrumenting for labor supply of males and females using caste and off-farm employment. Log of wages and labor supply are used in the above regressions. Panel B reports the corresponding first stage. Panel C reports the results from OLS regression of the dependant variable against total labor employed in agriculture with other controls the same as in Panel A. Robust standard errors are in parenthesis; ***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analyses is a district and districts having more than 5 wage observations for male and female each are included here.

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

	male wage		female wage		male wage		female wage	
	(3)				(4)			
log female LS	-0.10	(0.13)	-0.46**	(0.23)	-0.11	(0.14)	-0.51**	(0.24)
log male LS	-0.28***	(0.10)	-0.47**	(0.19)	-0.23***	(0.09)	-0.32*	(0.17)
Irrigation	0.24**	(0.10)	0.28*	(0.17)	0.28**	(0.11)	0.38**	(0.19)
Gini	-0.63**	(0.31)	-1.33***	(0.47)	-0.59*	(0.31)	-1.25***	(0.47)
Rainfall	0.00	(0.00)	0.01	(0.01)	0.00	(0.00)	0.01	(0.01)
Coarse Cereals	0.05	(0.22)	0.44	(0.29)	0.12	(0.21)	0.56*	(0.30)
Cotton	0.10	(0.26)	0.46	(0.44)	0.15	(0.26)	0.51	(0.43)
Oilseeds and Pulses	0.06	(0.19)	0.19	(0.27)	0.08	(0.18)	0.15	(0.28)
Rice	0.06	(0.23)	0.70**	(0.33)	0.09	(0.22)	0.71**	(0.33)
Horticulture	0.31	(0.34)	-0.08	(0.50)	0.32	(0.33)	-0.17	(0.45)
Paved roads	0.52***	(0.11)	0.18	(0.20)	0.49***	(0.11)	0.10	(0.22)
Electrified	-0.59***	(0.18)	-0.44*	(0.24)	-0.59***	(0.17)	-0.43*	(0.23)
Commercial bank	-0.02	(0.19)	-0.15	(0.19)	0.05	(0.17)	0.01	(0.20)
Urban percent	-0.22***	(0.08)	-0.28	(0.18)	-0.13*	(0.07)	-0.06	(0.15)
Primary-Middle female	-0.04	(0.25)	-0.23	(0.53)	-0.02	(0.25)	-0.16	(0.51)
Secondary female	0.08	(0.38)	-0.35	(0.66)	0.34	(0.31)	0.35	(0.63)
Primary-Middle male	-0.23	(0.24)	-0.14	(0.37)	-0.24	(0.25)	-0.17	(0.38)
Secondary male	-0.04	(0.25)	0.29	(0.48)	-0.11	(0.22)	0.08	(0.43)
Fertiliser	0.00**	(0.00)	0.00***	(0.00)				
Implements					0.07	(0.09)	0.05	(0.11)
Constant	5.06***	(0.49)	5.29***	(0.78)	4.94***	(0.45)	5.03***	(0.71)
AEZ	Yes		Yes		Yes		Yes	
Observations	279		279		279		279	
Hausman test (p-val)	0.06		0.01		0.09		0.02	
Under-id (p-val)	0.01		0.01		0.01		0.01	
F(excluded instruments) L^S_F	5.23		5.23		5.03		5.03	
F(excluded instruments) L^S_M	10.14		10.14		11.57		11.57	

Notes: Two stage least squares estimates, instrumenting for labor supply of males and females using caste and off-farm employment. Log of wages and labor supply are used in the above regressions. Robust standard errors are in parenthesis; ***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analyses is a district and districts having more than 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		male wage		female wage	
	(1)				(2)			
log female LS	-0.04	(0.06)	-0.55**	(0.27)	-0.04	(0.05)	-0.52**	(0.22)
log male LS	-0.27**	(0.12)	-0.34*	(0.19)	-0.26**	(0.11)	-0.29*	(0.17)
Irrigation	0.18**	(0.08)	0.46**	(0.22)	0.19**	(0.09)	0.39**	(0.18)
Gini	-0.44**	(0.17)	-1.28**	(0.52)	-0.44**	(0.18)	-1.27***	(0.48)
Rainfall	-0.01	(0.01)	0.02*	(0.01)	-0.01	(0.00)	0.01	(0.01)
Coarse Cereals					0.16	(0.21)	0.44	(0.33)
Cotton					0.11	(0.24)	0.44	(0.45)
Oilseeds and Pulses					0.04	(0.19)	0.05	(0.32)
Rice					0.11	(0.22)	0.60	(0.38)
Horticulture					0.22	(0.33)	-0.16	(0.41)
Paved roads	0.45***	(0.09)	0.26	(0.24)	0.43***	(0.10)	0.09	(0.21)
Electrified	-0.56***	(0.19)	-0.59**	(0.30)	-0.54***	(0.19)	-0.43*	(0.23)
Commercial bank	0.13	(0.20)	-0.40	(0.49)	0.07	(0.21)	-0.02	(0.21)
Urban percent	-0.14*	(0.08)	0.04	(0.17)	-0.12	(0.08)	0.01	(0.15)
Primary-Middle female	0.04	(0.20)	-0.35	(0.52)	0.05	(0.20)	-0.24	(0.48)
Secondary female	0.27	(0.27)	0.21	(0.74)	0.20	(0.25)	0.26	(0.62)
Primary-Middle male	-0.17	(0.19)	-0.05	(0.38)	-0.17	(0.19)	-0.12	(0.35)
Secondary male	0.07	(0.26)	0.24	(0.46)	0.11	(0.24)	0.18	(0.40)
Constant	5.04***	(0.36)	5.25***	(0.80)	4.88***	(0.44)	5.08***	(0.72)
Observations	359		288		359		288	
Hausman test (p-val)	0.23		0.02		0.18		0.02	
Under-id (p-val)	0.01		0.01		0.00		0.01	
F(excluded instruments) L^S_F	0.00		0.02		0.00		0.00	
F(excluded instruments) L^S_M	0.01		0.00		0.00		0.00	

Notes: Two stage least squares estimates, instrumenting for labor supply of males and females using caste and off-farm employment. Log of wages and labor supply are used in the above regressions. Robust standard errors are in parenthesis; ***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analyses is a district and districts having more than 5 wage observations for male and female separately are included here for estimating male and female demand equations respectively.

Table 9. Aggregate demand for total labor in agriculture without ploughing activity

	male wage		female wage		male wage		female wage	
	(1)				(2)			
log female LS	-0.07	(0.14)	-0.53*	(0.27)	-0.09	(0.13)	-0.50**	(0.22)
log male LS	-0.23**	(0.09)	-0.42**	(0.19)	-0.23***	(0.09)	-0.34**	(0.17)
Irrigation	0.27**	(0.12)	0.56**	(0.24)	0.30**	(0.12)	0.48**	(0.20)
Gini	-0.49	(0.30)	-1.25***	(0.46)	-0.52*	(0.28)	-1.23***	(0.40)
Rainfall	-0.00	(0.01)	0.02*	(0.01)	0.00	(0.00)	0.01	(0.01)
Coarse Cereals					0.07	(0.22)	0.57*	(0.31)
Cotton					0.09	(0.27)	0.54	(0.43)
Oilseeds and Pulses					0.04	(0.19)	0.18	(0.27)
Rice					0.01	(0.22)	0.69**	(0.32)
Horticulture					0.32	(0.30)	-0.01	(0.41)
Paved roads	0.50***	(0.09)	0.27	(0.24)	0.50***	(0.10)	0.09	(0.22)
Electrified	-0.59***	(0.21)	-0.67**	(0.33)	-0.61***	(0.19)	-0.48*	(0.26)
Commercial bank	0.19	(0.22)	-0.43	(0.54)	0.04	(0.18)	-0.05	(0.23)
Urban percent	-0.15*	(0.08)	-0.05	(0.17)	-0.12*	(0.07)	-0.05	(0.15)
Primary-Middle female	0.01	(0.23)	-0.27	(0.57)	-0.02	(0.25)	-0.18	(0.52)
Secondary female	0.49	(0.31)	0.55	(0.74)	0.39	(0.33)	0.48	(0.63)
Primary-Middle male	-0.26	(0.23)	-0.17	(0.44)	-0.24	(0.25)	-0.19	(0.38)
Secondary male	-0.19	(0.21)	0.11	(0.47)	-0.11	(0.22)	0.10	(0.43)
Fertiliser								
Implements								
Constant	5.03***	(0.41)	5.43***	(0.79)	4.91***	(0.43)	5.02***	(0.67)
Observations	273		273		273		273	
Hausman test (p-val)	0.13		0.02		0.09		0.02	
Under-id (p-val)	0.01		0.01		0.00		0.00	
F(excluded instruments) L^S_F	0.02		0.02		0.00		0.00	
F(excluded instruments) L^S_M	0.00		0.00		0.00		0.00	

Notes: Two stage least squares estimates, instrumenting for labor supply of males and females using caste and off-farm employment. Log of wages and labor supply are used in the above regressions. Robust standard errors are in parenthesis; ***, ** and * indicate significance at the 1, 5 and 10% levels respectively. The unit of analyses is a district and districts having more than 5 wage observations, excluding ploughing, for male and female each are included here.

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