Village Transportation Infrastructure and Women's Non-agricultural Employment in India: The Conditioning Role of Community Gender Context

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Abstract

Previous studies have examined how demographic characteristics, education, culture, and labor policy suppress Indian women's labor supply. However, not enough attention has been paid to the role of poor labor market opportunity structure in causing Indian women's exclusion from wage labor, particularly non-farm work. The recent government investments in transportation infrastructure has led to an expansion of employment opportunities for rural women, which allows us to examine the role of demand factors. Using data from the India Human Development Survey collected in 2005 and 2012, we study the impact of village transportation conditions on women's participation in non-agricultural work. Conditional logit models show that access by roads and frequent bus services positively influence men's and women's participation in non-agricultural work. Similar effects are found for women and men. The positive impact of transportation infrastructure on women's non-farm employment is stronger in communities with more egalitarian gender norms.

1. Introduction

India has one of the lowest levels of female labor force participation (FLFP) among developing countries, at around 33 percent in 2012 according to the Census (Das et al. 2015). This is well below the global average of around 50 percent and even below that of other Asian countries (Dasgupta and Verick 2017). The FLFP in India has been stagnant since the late 1980s and declined further during the past decade despite rising female education and rapid economic growth (Klasen and Pieters 2015). Another important characteristic of Indian women's employment is the disproportional concentration in the agricultural sector. About 37 percent of the male workers and only 20 percent of the female workers in rural India were usually employed in the non-farm sectors, according to the 2009-10 National Sample Survey (NSS) (Jatav and Sen 2013). The NSS also reported that from 2004-05 to 2011-12, a growing proportion of the workforce started moving to non-farm activities, but this sectoral relocation was more prominent for male workers than for their female counterparts (Shaw 2013; Chowdhury 2011). Agriculture increasingly forms a smaller share of India's GDP and with dwindling farm sizes, opportunities in agriculture continue to decline (Papola 2012). Moreover, much of the agricultural employment for women tends to be on the family farm (Desai et al. 2010), and does not result in independent income. Research shows that the earned income from non-farm work boosts women's control over resources, decision making power, and child welfare (Anderson and Eswaran 2009; Koolwal and Van de Walle 2013; Schultz 2001). Therefore, we focus on women's non-farm employment in this paper.

Earlier research used individual demographic characteristics, education, culture, labor policy, and labor market characteristics to explain the supply and demand of women's labor (Brinton,

Lee, and Parish 1995; Das et al. 2015; Jensen 2012; Klasen and Pieters 2015). Researchers attribute the low FLFP in India to increased rural income, reduced number of farming jobs, and the lack of jobs in the other sectors that are suitable for women (Chatterjee, Murgai, and Rama 2015). However, not enough attention has been paid to the role of economic development policies such as transportation infrastructure investment in shaping women's labor market activities.

Although India has successfully maintained a rapid economic growth in the past decade, its infrastructure is widely viewed as inadequate and inefficient. In 2000, about 40 percent of the 825,000 villages in India lacked access to all-weather roads (World Bank). The average travel speed of trucks and buses was only 30-40 kilometers per hour. Recognizing the poor rural transportation conditions, the Government of India launched the national rural road construction program—the Pradhan Mantri Gram Sadak Yojana (PMGSY)—in 2000. This rural road construction program prioritizes villages with a population of 1000 or more, thereafter extending to villages with a population of 500-1000. By 2016, over 125,000 roads in more than 118,000 habitations had been built under PMGSY. In addition, the Indian Government has set a target of $1 trillion for infrastructure spending during the period of 2012-2017 to not only improve transportation networks but also provide electricity, water, and telecommunication services, among other things (Planning Commission Government of India). With rising investments in infrastructure development in India, a better understanding of the consequences of infrastructure development, especially transportation, may yield substantial policy benefits.

Transportation infrastructure has been shown to increase agricultural trade and income (Donaldson 2010; Aggarwal 2015), boost local market development (Mu and van de Walle 2011), increase migration (Morten and Oliveira 2014), and relocate laborers from agriculture to

the non-agricultural sector (Asher and Novosad 2016). However, most prior studies focus on highways and railroads that provide inter-region connections. There is comparatively less research examining the economic effects of local transportation services and smaller-scale roads connecting villages. The implications of bus services for labor market activities have not been investigated before. Moreover, earlier studies investigating the impact of village transportation infrastructure on employment did not situate the analysis in India's social context marked by ingrained gender inequality (Asher and Novosad 2016; Aggarwal 2015). This study particularly takes into account the patriarchal values and gender relations in India and considers the restrictions imposed by community gender context on women's labor market activities.

Going beyond previous literature, this study provides causal estimates of the impact of access to rural roads and bus services on the economic activities of Indian women and men. Using two waves of data from the India Human Development Survey (IHDS), this study answers three research questions: 1) Does village transportation infrastructure influence women's participation in non-agricultural work in India? 2) Does improvement in rural transportation infrastructure reduce the gender gap in non-agricultural work participation? 3) Is the effect of transportation infrastructure on women's employment conditioned by gender context of the communities in which they live? India's diverse regional contexts provide a unique opportunity for us to compare areas that have experienced substantial improvement in infrastructure investment to those that have not in terms of the implications for women's labor market activities. We adopt a difference-in-difference approach to compare the changes in the non-farm employment status between individuals living in villages that acquired improvements in transportation infrastructure between 2005 and 2012, and those in villages experiencing no such improvements.

2. Theory and Literature

Women's labor force participation is determined by a confluence of social and economic forces at both the domestic and society levels. Previous literature has considered various factors that determine the supply and demand of women's labor. Several *labor supply conditions*, such as increased age at marriage, declining fertility, and reduced family obligations, are theorized to free women's time for labor market activities(Brinton, Lee, and Parish 1995). Meanwhile, increases in women's education and work experiences improve their qualifications for jobs. However, whether these labor supply conditions can be translated into women's work participation also depends on *labor demand condition*s, namely the characteristics of local labor markets, such as the availability of jobs, gender discrimination, and gender segregation in the labor markets (Brinton, Lee, and Parish 1995). In the Indian context, scholars claimed that the recent decline in FLFP is due to a combination of supply-side and demand-side factors (Klasen and Pieters 2015; Chatterjee, Murgai, and Rama 2015). Rising household income and husbands' education reduce women's labor supply. Further, the slow growth of sectors that draw women's labor also leads to limited demand for women's work.

In this study, we provide a theoretical framework explaining how village transportation infrastructure shapes women's non-farm employment in India by altering various aspects of the labor supply conditions and labor demand conditions. We suggest that improvements in the transportation infrastructure in rural India tends to promote women's work participation and employment in the non-farm sector by increasing access to both local and external job opportunities, reducing women's time spent in domestic drudgeries, and introducing more egalitarian gender attitudes.

Access to job opportunities

In India, there is a shortage of short-term or long-term employment opportunities for women

in rural areas (World Bank 2010; Chowdhury 2011). The lack of non-farm jobs suitable for women in rural villages partially explains the recent decline in FLFP in India (Chatterjee, Murgai, and Rama 2015). Investment in transportation infrastructure can provide employment opportunities to rural women by connecting them to labor markets beyond the immediate community. Improved road conditions and bus services reduce the commuting costs to nearby urban areas. When the urban wages net of commuting costs are higher than agricultural income, rural women would be attracted to external labor markets. Moreover, presence of paved road, frequent bus services, and access to train stations could reduce the time needed to travel to the work sites, making it feasible for women to engage in paid work in nearby towns while fulfilling family obligations.

On the other hand, transportation changes labor market conditions within the village itself. Improvement in transportation infrastructure tends to increase agricultural productivity by introducing capital and technology (Aggarwal 2015), which reduces the demand for labor in the agricultural sector. Connections to outside markets could also boost the growth of the non-farm sector within the village (Asher and Novosad 2016). A prior study finds that better rural roads can enhance the development of local markets, services, and institutions (Mu and van de Walle 2011), which generates more non-farm job opportunities. These changes within the village tend to drive women out from agricultural production and into paid work the in the non-farm sector.

Time spent in domestic drudgeries

A considerable proportion of women's time in less developed regions is spent in domestic activities. In addition to household labor such as cooking and cleaning, poor women in India and other developing countries spend a significant amount of time fetching firewood and water, preparing cow dung cakes, and cleaning drains (Agarwal 1986; Jain 1985). Better transportation

infrastructure provides access to social services and markets, and brings in modern technologies and facilities such as tap water and modern fuel. These amenities would free up women's time spent in household drudgeries, and thus creates opportunities for women to participate in labor activities on the farm and in the non-farm sector. For example, an improvement in road conditions could lead to easier delivery of modern cooking fuels such as kerosene or LPG, thereby reducing the time that women have to spend in collecting firewood.

Changes in gender attitudes

Well-built transportation networks promote the exchange of information between villages and the larger society, leading to greater exposure to modern ideas and Western culture that communicate egalitarian gender ideologies. Diverse cultural exposure would weaken the traditional gender attitudes that prefer confining women to domestic activities. Family members then imbibe more positive attitudes toward women's participation in labor market activities outside of the household. In addition, as described by the labor queue theory, employers would only consider women for job openings when the labor demand exceeds the supply of males in the queue (Reskin and Roos 1990). Changes in gender norms may alter the gender-biased preference of employers and reduce the prejudice toward women in the local labor market. By reshaping attitudes toward women's employment, improvement in transportation connections may lead to greater increases in the participation of women in non-farm work as compared to that of men.

The arguments above together lead to our *Hypothesis 1: Improvements in village transportation infrastructure increase women's employment in non-agricultural sector.*

Next, we examine whether an improvement in village transportation infrastructure could possibly reduce the gender gap in non-agricultural work participation. Due to the lack of agricultural jobs for women and the limited number of female-labeled non-farm jobs within the

village, such as those of teachers, nurses, and clerks, fewer women are employed in rural India than their male counterparts (Chatterjee, Murgai, and Rama 2015; Shaw 2013). Despite the social norms that confine women to the domestic space, there is a huge unmet need for jobs among rural women who have achieved a certain level of education. This leaves a larger room for the increase in women's participation in the non-farm sectors, as compared with men's non-farm employment, as most men are already occupied by farming or non-farm jobs. In addition, as discussed above, improvements in rural transportation infrastructure would free up women's time spent in household drudgeries for labor market activities. Transportation connections to the world outside would also change gender attitudes toward women's employment. These mechanisms imply a positive impact of transportation infrastructure on females' labor supply but the same mechanisms do not work for men. Therefore, we expect that transportation networks connecting villages should have a more pronounced impact on the non-farm employment among women than that among men. We propose our *Hypothesis 2a: The gender gap in non-agricultural employment will be reduced with better transportation infrastructure in villages.* On the other hand, nearly all Indian men in the working-age are already involved in the labor market, and their labor supply are not suppressed by family responsibilities and traditional gender role expectations. Once provided transportation access, they could easily travel to nearby towns and cities to pursue for non-farm jobs which provide higher wages than agricultural work. Asher & Novosad (2016) find that rural road construction only relocates male workers from agriculture to the non-farm setors. Indian men are able to change their labor market behavior easier than women and they are more likely to respond to newly available non-farm job opportunities. Thus, we propose a competing hypothesis that *Hypothesis 2b: Better transportation infrastructure in villages will widen the gender gap in*

non-agricultural employment.

However, it needs to be noted that village transportation may reduce the necessity of women's work for the welfare of the family by increasing the income of other family members. Studies find that in India, women in the lower economic strata are far more likely to be employed than those in the higher strata (Kapsos, Silbermann, and Bourmpoula 2014) because their wages are necessary for the family to meet basic sustenance needs. Prior research has found that as family income increases, women move out from subsistence employment and become economically inactive (Kapsos, Silbermann, and Bourmpoula 2014). Transportation infrastructure has been seen to increase male employment in the non-agricultural sector and household income (Asher and Novosad 2016; Donaldson 2010), which possibly reduces the needs for women's earnings. This countervailing pathway may weaken the effect of transportation infrastructure on women's non-agricultural employment, and broaden the gap between the non-farm employment of men and women.

It is also important for studies on women's labor force participation to take into account patriarchal values and gender relationships (Brinton and Lee 2016) . The impact of rural transportation infrastructure on women's labor market activities is possibly conditioned by the gender context of local communities. In South Asian countries, there is a strong normative preference for female seclusion (Sharma 1990). The preferences for confining women to the domestic realm is perceived as the basis of the dichotomy between male and female or between the "public" and "private" realms of activities. Women are seen as intruders in the public world (Derne 1994). The ideology that women should be modest, obedient, docile, and attached to the home motivates husbands and families to restrict women's mobility (Derne 1994). The practice of *purdah/ghunghat* (or seclusion) is the most visible marker of gender. It is performed in a

variety of forms, including "wearing a full *burqa*, covering one's face with a shawl or *sari* when in the presence of men, lowering voices and eyes in the presence of men, remaining in separate rooms or behind a screen when unrelated men are present, or not going to public places unaccompanied" (Stroope 2015).

The practice of *purdah/ghunghat* varies widely across regions and communities in India due to the prevalence of different social systems, kinship structures, and gender norms (Desai and Andrist 2010). Women's seclusion is much more acute in north India than in south India. In north India, women have little autonomy or freedom of movement and a married woman is kept largely invisible to outsiders and under the authority of her husband's family, while women in south India are less secluded and have more freedom to venture outside the home (Jejeebhoy and Sathar 2001).

As one dimension of the gendered structure in the community context, the practice of *purdah/ghunghat* places restrictions on women's movements and adversely affects women's ability to participate in economic activities outside the home. Working women have noted that due to women's lack of mobility, employers are reluctant to assign them on-site jobs or jobs that require them to travel at night (Liddle and Joshi 1986). Overprotective supervisors always send someone to accompany female employees when they are traveling to the work sites. In communities with more strict practices of *purdah/ghunghat*, employers may prefer hiring males due to the inconvenience that women encounter at work. Moreover, in places with more traditional gender norms, women themselves are less responsive to the availability of job opportunities due to resistance from the community and family members. Therefore, we propose that *Hypothesis 3: Improvements in village transportation infrastructure have a stronger positive impact on women's employment in communities with a more egalitarian gender context.*

3. Data and Methods

Data

This study uses data from two waves of IHDS, which were conducted in 2004-05 and 2011-12, respectively, by NCAER and the University of Maryland (Desai, Vanneman, and National Council of Applied Economic Research 2011-12). The interviews taken during this survey were spread across 34 states and Union Territories, and span 971 urban blocks and 1,503 villages in 388 districts in India. The 2004-05 sample consisted of 41,554 randomly selected households containing over 200,000 individuals; 83 percent of the same households (as well as any split households) were resurveyed in 2011-12. An additional sample of 2,148 households was added to refresh the urban sample where the re-contact rates were lower. This brings the 2011-12 sample to 42,152 households containing 215,748 individuals. The household questionnaire covered topics like household economic activities (including agricultural production, business operation, and consumption), social networks, and living standards. Through household roaster, the survey also collected information on each household member's demographic characteristics, education, work status, income, and health. In each survey, women aged 15 to 49 years responded to additional questions about health, gender relations, fertility, and natal care in the eligible women questionnaire. At both waves, IHDS conducted village level focus group discussions among village government officials, local businessmen, and other adults, to collect information about village structure, infrastructure, labor market characteristics, land use, and agricultural production, among other things. We combine data from all three sources: the household questionnaire, the eligible women questionnaire, and the village questionnaire.

In the cross-sectional analysis, we restrict the sample to 29,110 rural women and 27,595 rural men aged 25-59 years, who were interviewed in 2012. By the age of 25, most people have

completed their education, so the analysis does not need to consider the influence of increased educational opportunities for young women's labor market activities. The case-wise deletion of individuals with missing values results in an analytical sample of 27,382 women and 25,917 men. For the longitudinal analysis, we rely on respondents who have appeared in both waves of survey. After deleting cases with missing values and individuals who do not change on the response variable between the two waves, we include 3,373 women and 5,605 men in the fixed-effect logistic models, with two observations for each person.

The *dependent variable* for this analysis is a dichotomous variable reflecting participation in non-agricultural work at each wave of the IHDS. It is coded 1 if the respondent participates in any type of non-farm work for more than 240 hours per year. This includes manual labor at daily rates, salary work, and work in own business. The reference category (coded 0) is not participating any non-farm work, meaning that the respondent could be not working, working on own farms, or working as an agricultural laborer.

The two focal *independent variables* measure the village road condition and bus frequency, respectively, at both waves of the IHDS. The village road condition contains three categories, including no access by road, access by *katcha* (unpaved or dirt) road, and access by *pucca* (paved) road. The frequency of bus services in the village is categorized into once a day, 2-6 times a day, and 7 or more times a day, contrasting to no bus services.

The effect moderator, village gender context, is captured by the practice of *purdah*, which is measured by the percentage of sampled women aged 15 to 49 years in a village who said that they practice *purdah*, at the baseline survey in 2005. In this analysis, we control for myriad individual and village level characteristics. At the individual level, age, the number of children, and the number of women in the household are simply continuous variables measured at both

waves. Marital status is a time-varying variable that compares the status of unmarried, widowed, separated or divorced, and married but spouse not present to married. The level of education is treated as a time-invariant variable. It distinguishes no education, 1-4 years of education, primary school, 6-9 years of education, secondary school (11 years), higher secondary school (12, 13, or 14 years), and graduate school and above. Caste and social group is a time-invariance variable measuring whether a respondent belongs to a forward caste, Other Backward Class (OBC), the Dalit, Adivasi, Muslim or Christian category. The other family member's income is calculated using the sum of family income from each type of farm and non-farm activity minus the respondent's contribution. IHDS is the only data source in India that provides information on other family member's income, which tends to be an important predictor of the labor market activity of females.

Regarding village characteristics, we control for the village population, the percentage of households with electricity, the percentage of households with phones, whether the village uses modern fuel (such as LPG, biogas, electricity, and kerosene) (1= yes), and whether safe drinking water is available in the village (1=yes). The size of the village population is also controlled because the national rural road construction program (PMGSY) prioritizes villages with larger populations. The goal of PMGSY was to provide road connection to all habitations with a population greater than 1,000 by 2003 and to those with a population of 500 or more by 2007.

Methods of analysis

We first present descriptive statistics of respondents' non-agricultural employment status, demographic and social characteristics, and village characteristics in 2005 and 2012 for women and men, respectively. Then, we use cross-sectional data from the 2012 survey to estimate two-level logistic regression models predicting non-farm employment among rural women and

men using both individual and village characteristics. The second level (village) model consists of a population average intercept, the effects of village characteristics, and a random component showing the deviation of village-specific intercept from the population mean. Although most village road construction during 2005 and 2012 was implemented under the PMGSY, the process could be endogenous to the local political power and the level of economic development in villages. Therefore, we control for a rich array of individual and village characteristics when we assess the effects of village road access and bus frequency on non-farm employment. These cross-sectional models can show the associations between time-invariant personal characteristics and non-farm employment, which will not be estimated in the fixed-effect models later.

Next, we estimate person fixed-effect logit models (also known as conditional logit models) predicting changes in respondents' non-agricultural employment status between 2005 and 2012. Given the concerns of endogeneity of rural road construction and bus services, we use fixed-effect models to rule out all observed and unobserved time-invariant individual and village characteristics that potentially confound the relationship between village transportation infrastructure and non-agricultural employment. Time-varying village characteristics including village population and village facilities, such as water, fuel, and electricity, are also controlled because they are associated with the likelihood that a village gain improved transportation services. At the same time, improvement in village facilities could be a result of improved transportation networks, controlling for these village characteristics leads to a conservative estimation of the causal effect of village transportation conditions on non-farm employment.

To test our Hypothesis 2a and 2b, we assess the gender differences in the effects of village transportation variables by pooling men and women in the sample and including interaction terms between transportation conditions and gender in the fixed-effect models. Finally, to test

our Hypothesis 3, we examine the interactive effects between transportation conditions and the practice of *purdah/ghunghat* in the fixed-effect logit models predicting the odds of women's non-agricultural employment.

4. Results

[Figure 1 around here]

Figure 1 describes changes in women's and men's employment in the non-agricultural sector between 2005 and 2012. The non-agricultural employment rate has increased significantly for both men and women during this period, though the rate has remained much lower among women than among men. Only 10 percent of the women participated in non-agricultural work in 2005, while the number increased to 17 percent in 2012. The non-agricultural employment rate for men, on the other hand, increased from 47 per cent in 2005 to 55 per cent in 2012. The proportional change in men's non-agricultural employment over the interval between the two waves of IHDS is thus much smaller than the corresponding figure for women.

[Figure 2 around here]

The conditions of transportation infrastructure have also changed dramatically during the survey interval, particularly because of the strong push by the Indian Government through the PMGSY. Figure 2 shows that many more villages were accessible by *katcha* and *pucca* roads in 2012 than in 2005. The percentage of "no road access" dropped from 6 percent to 1 percent during the seven-year interval. Regarding the frequency of bus service, the percentage of villages with no bus services dropped from 47 percent in 2005 to 38 percent in 2012. More villages had bus services one to six times a day in 2012 than in 2005, but slightly fewer villages had bus services 7 times or more a day in 2012 compared to 2005.

[Table 1 around here]

Table 1 presents the descriptive statistics of the socio-demographic characteristics of individuals and village characteristics based on cross-sectional samples in 2005 and 2012. In the analytical sample, the age of the respondents ranges from 25 to 59 years, with a mean of 39 years. In this age range, more than 80 percent of the men and women are married. A higher percentage of women than men had spouse migrated to other places in 2012 (6 percent) than in 2005 (3 percent). Half the women surveyed had received no education, as compared to only 5 percent of the men in this category. About 14 percent of the women and 30 percent of the men had acquired education up to the secondary school or higher levels. One-fifth of respondents belonged to the Forward Caste, 35 percent to the OBCs, while 22 percent to Dalits, 11 percent to Adivasis, 10 percent to Muslims, and 2 percent to Christians. The average number of children in a household grew from about 0.75 to 1.75 over the seven-year period. Each family gained one more child on average. As an indicator of household structure, the number of married women in each household had barely changed. A substantial proportion of Indian women were living with their parents-in-law.

The average village population grew from about 3,400 in 2005 to 4,600 in 2012. In a typical village, the average proportion of households with electricity increased from 68 percent in 2005 to 79 percent in 2012. The use of telephones too had become much more prevalent in the villages, with the average proportion of households with phones in a village rising from 13 percent in 2005 to 83 percent in 2012. In 2012, the proportion of villages using modern fuel as their primary source of fuel had more than doubled, going up to 18 percent from 8 percent in 2005. In 2005, 40 percent of the villages had access to safe drinking water, which increased to 46 percent in 2012. In terms of the community gender context, 60 percent of the women in a typical village were practicing *purdah* in 2005, but we notice a significant variation among villages across the

country (standard deviation = 0.4).

[Table 2 around here]

Table 2 presents the multilevel logistic regression models predicting non-agricultural employment among women and men separately using cross-sectional data in 2012. In Models 1 and 2, age has a curvilinear effect on non-agricultural work participation for both women and men. The likelihood of non-agricultural work peaks at around age 42 for women, and at age 23 for men. Older men are less likely to participate in non-farm work as compared to their younger counterparts, but women tend to seek non-farm work after the primary child-bearing age. Widowed and separated/divorced women are more likely to work in the non-farm sectors relative to married women. Married women with absent/migrant husbands are less likely to have non-farm employment than married women whose husbands are at home. Since women with migrant husbands are bound to take care of the affairs on the family farm or in family business, they get fewer opportunities to take up wage jobs; the inflow of remittance income may also reduce their desire to engage in wage work. In contrast, married men have a significantly higher likelihood of engaging in non-farm work than unmarried, widowed, and separated/divorced men. The level of education is positively associated with the probability of non-agricultural employment, and this relationship holds for both men and women. For both men and women, lower caste individuals, Dalits, Adivasis and Muslims are more likely to participate in non-farm work than the forward caste respondents. Christian men are the least likely to enter the non-farm sector as compared with men in all the other social and religious groups. However, the proportion of Christians in rural India is relatively small and tends to be geographically concentrated in states with lower non-farm opportunities (such as Kerala). Having more children and fewer married women in the household is linked to a higher probability of non-farm

employment among men and women. The positive effect of the number of children is contrary to our expectation that the responsibility of childcare would require women to stay at home, but it could indicate that women are more likely to return to the labor force after childbearing. Both women and men are less prone to participate in non-farm work when other members of their families earn higher incomes.

In terms of the village level factors, the village population is positively associated with men's non-farm employment, but is not related to women's employment. As indicators of economic development, village facilities (including electricity, safe water, modern fuel, and telephone) are expected have a positive impact on women's and men's employment in the non-farm sectors. But they do not show consistent effects on the labor market activities of the respondents.

The focal independent variable, village road access, does not show a significant impact on women's non-farm employment, but the presence of *pucca* (paved) roads increases men's involvement in non-farm work. An increase in frequency of bus services in the village boosts women's participation in non-farm work, but does not influence men's non-farm employment. These results from a cross-sectional analysis only partly support our Hypothesis 1 that improvements in village transportation infrastructure increase the non-farm employment of men and women. We suspect that transportation infrastructure has an indirect negative effect on women's non-farm work, by increasing the income of other family members. Controlling other family members' incomes is expected to augment the coefficients of road conditions and bus frequencies because by doing so, we exclude a negative mediating pathway. A sensitivity check shows that removing other family member's incomes from the model reduces the size of the coefficients for road access and bus frequencies by a small fraction, but does not change the level

of significance for those coefficients.

[Table 3 around here]

The fixed-effect logistic regression models predicting the non-farm employment of women and men are presented in Table 3. The coefficients of the survey Wave II indicate that non-farm work participation increased dramatically among women from wave 1 to wave 2 of IHDS, but did not change much among men. This is consistent with the age effects observed in the cross-sectional regression, with women entering non-farm work after completing their childbearing. Changes in marital status do not affect women's non-farm employment, but men become more likely to work in the non-farm sector after they get married. A greater number of children and fewer married women in the household are associated with a higher odds of non-farm employment for both men and women. Higher income of other family members tends to prevent men and women from participating in non-farm work.

The coefficients of village characteristics show that an increase in the village population barely affects the employment of women and men. The availability of telephones is positively linked to men's non-farm work but negatively influences women's non-farm employment. Access to modern fuel in a village tends to boost the employment among women and men in the non-farm sector. In terms of transportation conditions, building either *katcha* roads or *pucca* roads in a village increases the likelihood of women engaging in non-farm work. Only access to *pucca* roads has a positive impact on men's non-farm employment. Also, consistent with our expectations, an increase in bus frequency drives both women and men into non-farm labor activities. These findings from fixed-effect models fully support our Hypothesis 1 about the positive influence of village transportation on the participation of men and women in non-farm work. We expected the improvement in rural transportation conditions negatively influence

women's non-farm employment through increasing other family members' income. A sensitivity analysis shows that removing other family members' income from the models does not significantly change the effects of rural road access and bus frequency on women's non-farm work.

Indian men are much more likely than women to be employed in the non-farm sector. We also investigate whether improvements in transportation infrastructure could reduce the gender gap in non-agricultural employment in India. We compare the effects of road conditions and bus frequencies for women and for men, by pooling the sample of male and female respondents and including interaction terms between all the covariates and gender. The results suggest that increased access by roads and bus frequency do not affect women differently from the way in which they affect men. Therefore, investment in village transportation infrastructure is not likely to narrow the gender gap in non-farm work participation. Neither Hypothesis 2a nor Hypothesis 2b is supported by the results, possibly because of multiple countervailing processes are operating.

[Table 4 around here]

Finally, we investigate whether the influence of transportation on women's non-farm work participation is conditioned by the community gender context. Models 1 and 2 in Table 4 include interactions between road condition and the village level practice of *purdah*. The statistically significant negative coefficients of the interaction terms in Model 1 imply that the effects of road access on women's non-agricultural employment are weaker in the villages where *purdah* is widely practiced. In these communities, even when the women are provided easier access to non-farm jobs, they are unable to take advantage of the job opportunities due to restrictions on their physical mobility and norms preventing interactions with unrelated men.

[Figure 3 around here]

Figure 3 presents the predicted values of the odds ratios of women's and men's participation in non-farm work in villages with different road conditions under two extreme conditions—where no one practices *purdah* in a village and where everyone practices *purdah* in a village. In communities with egalitarian gender norms (that is, where no one practices *purdah*), the odds of women's non-farm work participation is more than doubled with connections by *katcha* or *pucca* roads, while men's non-farm work participation is not affected by road access. Thus, road access actually helps to reduce the gender gap in non-agricultural work in communities that embrace more egalitarian gender norms. In communities with universal practice of *purdah* (the panel on the right), the effect of roads is insignificant for both men and women.

In Model 2 in Table 4, the positive and non-significant coefficients of the interaction terms indicate that such mitigating effects do not exist for men. Since the coefficients for men in the pooled sample are significant in Table 3, it appears that standard errors have increased for men when the sample is divided by the community gender context. Models 3 and 4 in Table 4 examine the interactive effects between bus services and village-level *purdah* for women and men. Negative interaction effects are found for women, but an unequal gender context in the village makes the transportation effect on men's non-farm work even stronger. Taken together, these results support our Hypothesis 3 that improvements in village transportation infrastructure have a stronger positive impact on women's employment in communities with a more egalitarian gender context. Community gender context do not moderate the effects of transportation conditions on men's non-farm employment.

[Figure 4 around here]

Figure 4 shows the predicted odds ratios of women's and men's non-farm employment in villages with different bus frequencies under two extreme gender contexts, one wherein no one practices *purdah* and the other wherein all women in a village practice *purdah*. Similar to the result of road access, increased bus frequency significantly boosts the non-farm employment of women but not that of men in villages following an egalitarian gender norm, but bus services benefit men more than women in villages following traditional gender norms.

5. Discussion and Conclusion

In this paper, we address the role of village transportation in shaping women's employment in the non-agricultural sector. Relying on a framework of factors affecting the demand and supply of women's labor, we argue that transportation promotes women's non-agricultural work in several ways. The effect of transportation may operate through increasing women's access to non-farm job opportunities, freeing up women's time from family obligations, and changing gender attitudes among family members and local employers. We draw on longitudinal data and fixed-effect models to estimate the causal effect of transportation infrastructure on individual women's labor market behavior. Moreover, we examine whether an improvement in village transportation reduces the gender gap in non-farm employment, and whether the transportation effects on women's non-farm work participation are conditioned by the community gender context.

The results show that gaining access by *pucca* and *katcha* roads and an increase in bus frequency in a village improve women's participation in non-agricultural work, which has important implications for women's lives in rural India. Women who work on family farms or help with family businesses may not get paid, and may have only limited power in deciding the ways in which family income is spent. In contrast, employment in the non-farm sector helps

increase women's control over economic resources and consequently endows them with greater decision-making power. Prior research has shown that it is earned rather than unearned income that enhances women's relative bargaining power and autonomy (Anderson and Eswaran 2009). Non-farm work can also raise child welfare, given that the extra income accruing to women is likely to be invested in children (Schultz 2001; Koolwal and Van de Walle 2013). Therefore, as one of the paths of achieving economic growth, government investment in transportation has the potential to enhance women's autonomy by providing them access to non-farm jobs.

However, village transportation does not seem to shrink the overall gender gap in non-farm employment, as the effects of road access and bus frequency are not statistically different for women and men. Earlier research reported that the impact of rural roads construction on employment sector transition only exist among men, because men have lower costs and higher gains in relocating from the farm to the non-farm sector (Asher and Novosad 2016). Unlike this previous study, we show a more encouraging finding that improvements in rural transportation drive both men and women to the non-farm sector, rather than exclusively benefiting men. One possibility is that improved rural transportation connectivity not only encourage workers in agriculture to take on non-farm jobs, it also drives economically inactive women into the labor force, directly channeling them to the non-farm sector.

The large variation in gender practices across villages in India allows us to examine how the community gender context constrains the effect of transportation infrastructure on women's labor market activities. We find that improvements in transportation infrastructure have a weaker positive impact on women's non-agricultural employment in communities following more traditional gender practices. Given the strict practice of *purdah* that restricts their physical mobility, women are not able to take on non-farm jobs beyond the local village even if easy

transportation is provided. Hence, the barriers caused by traditional gender practices have to be removed for women to respond to the improved access to job opportunities. Where preference for women's seclusion is low, transportation improvements lead to greater impacts on women's non-farm work, resulting in a declining gender gap. With two waves of data collected seven years apart, we are unable to trace long-term changes in gender norms with improving village connectivity. However, it is possible that the gender norms themselves may change over time, increasing the impact of transportation networks on women, an area that deserves further investigation over a longer period.

Finally, our findings highlight the importance of access to work opportunities in enhancing women's labor market activities. There has been a heated scholarly discussion on why FLFP in India has been stagnant over the past several decades and has even declined recently. Traditionally, the time required by household drudgery and care-taking responsibilities draw women out from the labor market. Popular explanations for the recent decline in FLFP suggest that rising family income and expanded post-secondary education have suppressed women's labor supply (Kapsos, Silbermann, and Bourmpoula 2014; Klasen and Pieters 2015). On the demand side, scholars have recognized the limited number of agricultural job opportunities, given the decline in farm sizes, the rise in mechanization in farming, and the slow growth of white-collar jobs suitable for women (Klasen and Pieters 2015; Neff, Sen, and Kling 2012). We substantiate the demand-side explanation by showing that rural women in India would take up non-agricultural jobs in neighboring towns and villages if provided easier access by improved transportation infrastructure. In the Indian case, connecting women to a broader labor market outside of the local village might be a remedy for the low non-farm employment among women and the stagnant FLFP, especially since increased education levels among Indian women has

prepared a quality work force for non-agricultural sectors. In addition to generating industrial and service job positions suitable for women, we need to foster an institutional and social environment that allows more women, especially educated women, to take up non-farm jobs.

Figure 1: Non-agricultural Employment for Women and Men Aged 25-59 in 2005 and 2012

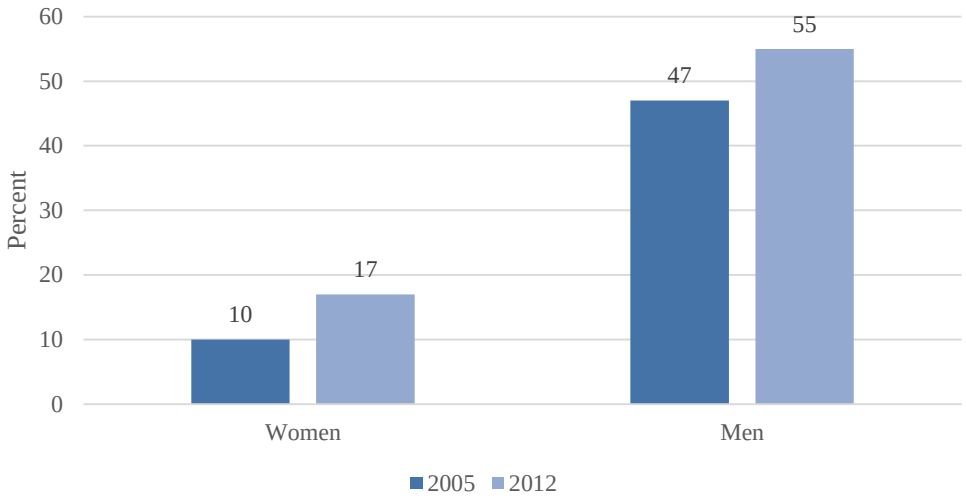


Figure 2: Changes in Transportation Infrastructure in Indian Villages between 2005 and 2012

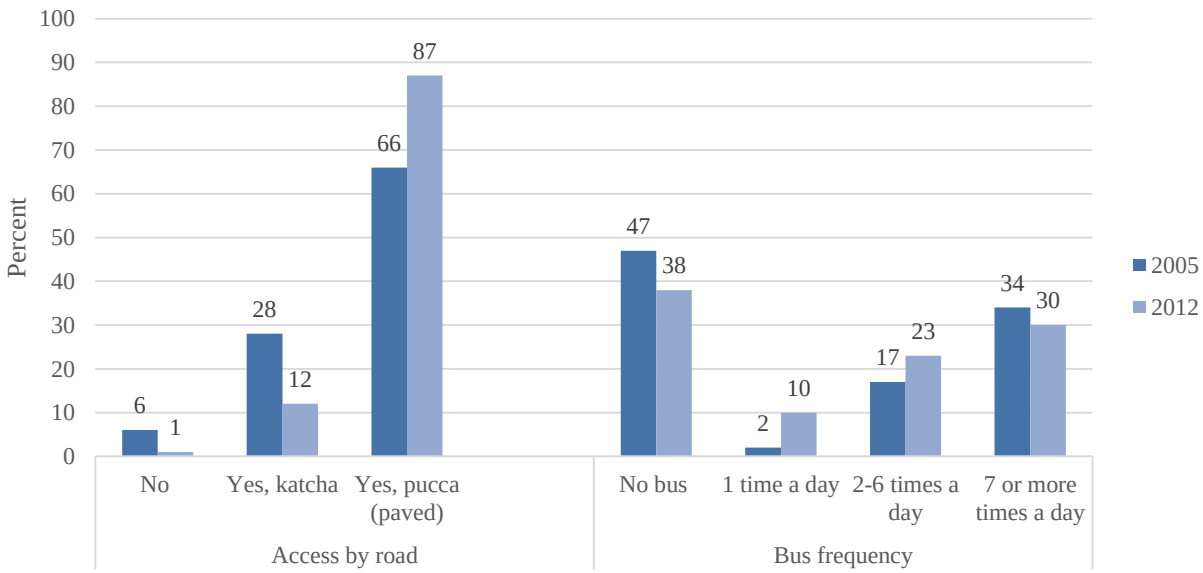
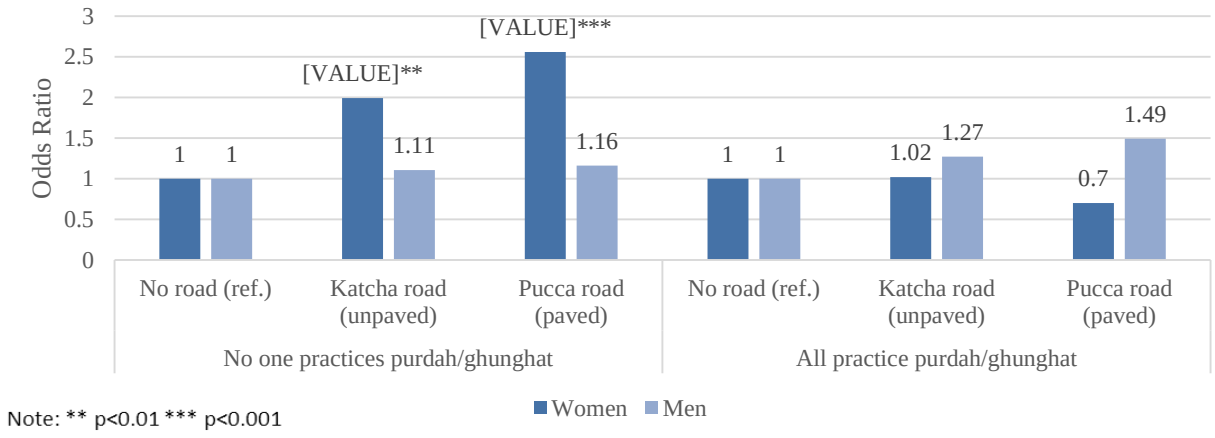
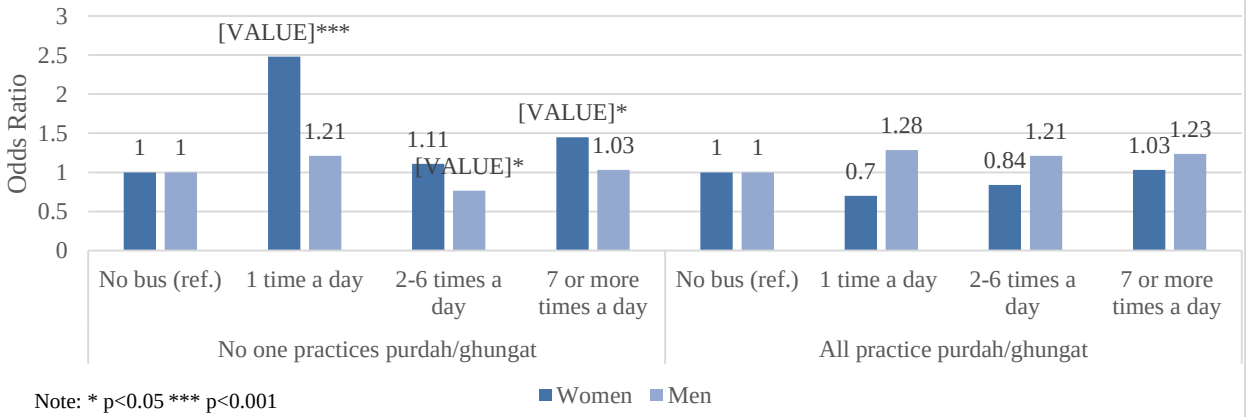


Figure 3: The Effect of Road Access on Rural Women's and Men's Non-agricultural Employment, by Community Gender Context



Note: ** p<0.01 *** p<0.001

Figure 4: The Effect of Bus Frequency on Rural Women's and Men's Non-agricultural Employment, by Community Gender Context



Note: * p<0.05 *** p<0.001

Table 1. Descriptive Statistics of Women and Men's Sociodemographic Characteristics and Village Characteristics in 2005 and 2012

	IHDS-I (2004-05)		IHDS-II (2011-12)	
	Women	Men	Women	Men
	Proportion /Mean (SD)	Proportion /Mean (SD)	Proportion /Mean (SD)	Proportion /Mean (SD)
Individual characteristics				
Age	--	--	39.24 (9.69)	39.42 (9.70)
Marital status				
Married	.86	.89	.83	.88
Unmarried	.02	.09	.02	.09
Widowed	.07	.02	.08	.02
Separated/Divorced	.01	.01	.01	.01
Married (spouse not present)	.03	.00	.06	.01
Education				
None	--	--	.51	.05
1-4 years	--	--	.08	.09
Primary	--	--	.09	.09
6-9 years	--	--	.18	.28
Secondary (&11)	--	--	.07	.14
Higher secondary (&13,14)	--	--	.04	.09
Graduate+	--	--	.03	.07
Caste and social groups				
Forward caste	--	--	.20	.20
OBC	--	--	.36	.35
Dalit	--	--	.22	.22
Adivasi	--	--	.11	.11
Muslim	--	--	.10	.09
Christian, Sikh, Jain	--	--	.02	.02
Number of children in the household	.75 (.97)	.73 (.97)	1.76 (1.64)	1.74 (1.60)
Number of married women in the household	1.49 (.90)	1.53 (.89)	1.45 (.85)	1.48 (.85)
Village characteristics				
Village population	3,454 (4,909)	3,421 (4,894)	4,635 (7,069)	4,539 (6,862)
% of households with electricity	68.33 (33.46)	68.30 (33.54)	79.45 (26.48)	79.76 (26.36)
% of households with phone	12.99 (18.90)	12.69 (18.69)	83.38 (19.23)	83.33 (19.13)
Modern fuel				
No	.92	.93	.82	.82
Yes	.08	.07	.18	.18
Safe drinking water				
No	.60	.60	.54	.54
Yes	.40	.40	.46	.46
Village-level *purdah* (Proportion of	.59	.60	.61	.61

married women who practice *purdah*)	(.40)	(.40)	(.40)	(.40)
N	25,498	25,861	27,386	25,917

Table 2. Multilevel Logistic Regression Models Predicting Participation in Non-agricultural Work, IHDS 2012

	Women	Men	Women	Men
	(1)	(2)	(3)	(4)
Age	0.283***	0.035*	0.282***	0.035*
	(0.019)	(0.015)	(0.019)	(0.015)
Age squared	-0.003***	-0.001***	-0.003***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Marital status				
Married (ref.)				
Unmarried	-0.017	-0.636***	-0.021	-0.639***
	(0.123)	(0.059)	(0.123)	(0.059)
Widowed	0.239***	-0.412***	0.237***	-0.408***
	(0.071)	(0.113)	(0.071)	(0.113)
Separated/Divorced	0.465**	-0.528**	0.464**	-0.528**
	(0.154)	(0.183)	(0.154)	(0.183)
Married, spouse not present	-0.314***	-0.296	-0.310***	-0.296
	(0.085)	(0.181)	(0.085)	(0.181)
Education				
None (ref.)				
1-4 years	0.238***	0.197***	0.232***	0.197***
	(0.070)	(0.057)	(0.070)	(0.057)
Primary	0.149*	0.294***	0.146*	0.292***
	(0.068)	(0.058)	(0.068)	(0.058)
6-9 years	0.183**	0.283***	0.177**	0.283***
	(0.058)	(0.044)	(0.058)	(0.044)
Secondary (&11)	0.429***	0.346***	0.423***	0.348***
	(0.083)	(0.054)	(0.083)	(0.054)
Higher secondary (&13,14)	1.048***	0.427***	1.044***	0.427***
	(0.101)	(0.063)	(0.101)	(0.063)
Graduate +	1.803***	0.846***	1.795***	0.847***
	(0.112)	(0.069)	(0.112)	(0.069)
Caste and social groups				
Forward caste (ref.)				
OBC	0.403***	0.302***	0.400***	0.300***
	(0.065)	(0.049)	(0.065)	(0.049)
Dalit	0.812***	0.735***	0.808***	0.732***
	(0.067)	(0.053)	(0.067)	(0.053)
Adivasi	0.688***	0.369***	0.689***	0.363***
	(0.089)	(0.074)	(0.089)	(0.074)
Muslim	0.414***	0.714***	0.416***	0.697***
	(0.102)	(0.080)	(0.102)	(0.080)
Christian, Sikh, Jain	-0.228	-0.549***	-0.237	-0.561***
	(0.175)	(0.129)	(0.175)	(0.130)
Number of children in the household	0.058***	0.045***	0.059***	0.045***
	(0.015)	(0.012)	(0.015)	(0.012)
Number of married women in the household	-0.348***	-0.200***	-0.347***	-0.199***
	(0.033)	(0.024)	(0.033)	(0.024)
Other family members' income				
Negative (ref.)				
Quintile 1	-0.170	-0.374***	-0.170	-0.373***

	(0.108)	(0.052)	(0.108)	(0.052)
Quintile 2	-0.190+	-0.574***	-0.190+	-0.572***
	(0.108)	(0.059)	(0.108)	(0.059)
Quintile 3	-0.388***	-0.732***	-0.388***	-0.731***
	(0.109)	(0.062)	(0.109)	(0.062)
Quintile 4	-0.480***	-0.824***	-0.481***	-0.821***
	(0.112)	(0.065)	(0.112)	(0.065)
Quintile 5	-0.878***	-0.944***	-0.877***	-0.942***
	(0.117)	(0.071)	(0.117)	(0.071)
Village population (in thousands)	-0.003	0.014**	-0.006	0.014**
	(0.005)	(0.005)	(0.005)	(0.005)
% households with electricity	0.006***	0.000	0.005***	0.000
	(0.001)	(0.001)	(0.001)	(0.001)
% households with phone	-0.007***	0.005**	-0.007***	0.006***
	(0.002)	(0.002)	(0.002)	(0.002)
Modern fuel	0.148	0.279**	0.126	0.275**
	(0.096)	(0.091)	(0.096)	(0.091)
Safe drinking water	0.084	-0.183*	0.070	-0.158*
	(0.077)	(0.072)	(0.077)	(0.073)
Access by road				
No (ref.)				
Yes, *katcha* (unpaved or dirt)	0.252	0.201		
	(0.329)	(0.308)		
Yes, *pucca* (paved)	0.335	0.491+		
	(0.316)	(0.295)		
Bus frequency				
No bus (ref.)				
1 time a day			0.280*	-0.006
			(0.123)	(0.117)
2-6 times a day			0.037	-0.264**
			(0.097)	(0.090)
7 or more times a day			0.262**	0.090
			(0.090)	(0.085)
Constant	-7.668***	-0.606	-7.394***	-0.202
	(0.537)	(0.450)	(0.442)	(0.347)
Number of persons	27,386	25,917	27,386	25,917
Number of villages	1,382	1,382	1,382	1,382
Log-likelihood	-10947	-15520	-10942	-15517
Chi square	1054	1464	1062	1468
Degree of freedom	31	31	32	32

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 3. Fixed-effect Logistic Regression Models Predicting Participation in Non-agricultural Work for Women and Men Aged 25-59, Using IHDS 2005 and 2012

	Women	Men	Women	Men
	(1)	(2)	(3)	(4)
Survey 2012	0.973***	0.138	0.960***	0.150
	(0.115)	(0.091)	(0.116)	(0.092)
Marital status				
Married (ref.)				
Unmarried	-0.061	-0.944***	-0.085	-0.943***
	(0.672)	(0.136)	(0.672)	(0.136)
Widowed	-0.120	-0.198	-0.099	-0.178
	(0.170)	(0.207)	(0.170)	(0.207)
Separated/Divorced	-0.612	-0.449	-0.625	-0.453
	(0.387)	(0.387)	(0.388)	(0.389)
Married, spouse not present	-0.219	-0.205	-0.209	-0.184
	(0.194)	(0.381)	(0.194)	(0.380)
Number of children in the household	0.080***	0.031*	0.079***	0.032*
	(0.021)	(0.015)	(0.021)	(0.015)
Number of married women in the household	-0.285***	-0.231***	-0.277***	-0.230***
	(0.054)	(0.034)	(0.053)	(0.034)
Other family members' income				
Negative (ref.)				
Quintile 1	-0.172	-0.255***	-0.180	-0.256***
	(0.158)	(0.066)	(0.158)	(0.066)
Quintile 2	-0.169	-0.414***	-0.180	-0.420***
	(0.161)	(0.077)	(0.161)	(0.077)
Quintile 3	-0.277+	-0.628***	-0.285+	-0.635***
	(0.165)	(0.083)	(0.165)	(0.083)
Quintile 4	-0.281+	-0.593***	-0.294+	-0.597***
	(0.171)	(0.091)	(0.171)	(0.091)
Quintile 5	-0.396*	-0.679***	-0.405*	-0.690***
	(0.194)	(0.104)	(0.195)	(0.104)
Village population (in thousand)	-0.011	-0.008+	-0.011	-0.009+
	(0.007)	(0.005)	(0.008)	(0.005)
% households with electricity	-0.001	-0.001	-0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
% households with phone	-0.003+	0.002+	-0.003+	0.002*
	(0.002)	(0.001)	(0.002)	(0.001)
Modern fuel	0.250*	0.191**	0.233*	0.184*
	(0.100)	(0.073)	(0.100)	(0.073)
Safe water	0.125	0.014	0.103	0.008
	(0.077)	(0.060)	(0.077)	(0.060)
Access by road				
No (ref.)				
Yes, *katcha* (unpaved or dirt)	0.448**	0.165		
	(0.159)	(0.110)		
Yes, *pucca* (paved)	0.351*	0.281*		
	(0.161)	(0.114)		
Bus frequency				
No bus (ref.)				

1 time a day			0.297*	0.246*
			(0.137)	(0.097)
2-6 times a day			-0.050	0.008
			(0.090)	(0.067)
7 or more times a day			0.175+	0.153*
			(0.092)	(0.068)
Number of person-years	6,784	11,300	6,784	11,300
Number of persons	3,392	5,650	3,392	5,650
Log-likelihood	-2024	-3659	-2023	-3657
Chi square	654.0	514.4	656.8	518.4
Degree of freedom	19	19	20	20

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

Table 4. Fixed-effect Logistic Regression Models Predicting Participation in Non-agricultural Work for Women and Men Aged 25-59, Examining Interactions with Community Gender Context, Using IHDS 2005 and 2012

	Women	Men	Women	Men
	(1)	(2)	(3)	(4)
Survey 2012	0.953***	0.141	0.935***	0.167+
	(0.116)	(0.092)	(0.116)	(0.092)
Marital status				
Married (ref.)				
Unmarried	0.003	-0.944***	-0.039	-0.956***
	(0.680)	(0.136)	(0.676)	(0.136)
Widowed	-0.120	-0.196	-0.093	-0.184
	(0.170)	(0.207)	(0.171)	(0.207)
Separated/Divorced	-0.612	-0.450	-0.617	-0.459
	(0.388)	(0.387)	(0.390)	(0.390)
Married, spouse not present	-0.225	-0.206	-0.221	-0.168
	(0.195)	(0.380)	(0.193)	(0.380)
Number of children in the household	0.089***	0.030*	0.080***	0.032*
	(0.021)	(0.015)	(0.021)	(0.015)
Number of married women in the household	-0.280***	-0.231***	-0.277***	-0.230***
	(0.054)	(0.034)	(0.054)	(0.034)
Other family members' income				
Negative (ref.)				
Quintile 1	-0.171	-0.257***	-0.177	-0.253***
	(0.159)	(0.066)	(0.159)	(0.066)
Quintile 2	-0.175	-0.416***	-0.185	-0.417***
	(0.162)	(0.077)	(0.162)	(0.077)
Quintile 3	-0.290+	-0.631***	-0.295+	-0.629***
	(0.166)	(0.083)	(0.166)	(0.083)
Quintile 4	-0.298+	-0.594***	-0.306+	-0.595***
	(0.172)	(0.091)	(0.172)	(0.091)
Quintile 5	-0.416*	-0.678***	-0.420*	-0.686***
	(0.195)	(0.104)	(0.196)	(0.105)
Village population	-0.012	-0.008+	-0.012	-0.009+
	(0.007)	(0.005)	(0.008)	(0.005)
% households with electricity	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
% households with phone	-0.002	0.002+	-0.002	0.002+
	(0.002)	(0.001)	(0.002)	(0.001)
Modern fuel	0.221*	0.197**	0.201*	0.185*
	(0.101)	(0.073)	(0.101)	(0.073)
Safe water	0.122	0.015	0.114	0.003
	(0.077)	(0.060)	(0.077)	(0.060)
Access by road				
No (ref.)				
Yes, *katcha* (unpaved or dirt)	0.687**	0.098		
	(0.248)	(0.174)		
Yes, *pucca* (paved)	0.940***	0.150		
	(0.246)	(0.175)		
Yes, *katcha* × *purdah*	-0.665+	0.142		
	(0.393)	(0.259)		

Yes, *pucca* × *purdah*	-1.287***	0.247		
	(0.385)	(0.257)		
Bus frequency				
No bus (ref.)				
1 time a day			0.910***	0.189
			(0.217)	(0.184)
2-6 times a day			0.099	-0.273*
			(0.145)	(0.126)
7 or more times a day			0.375*	0.034
			(0.159)	(0.134)
1 time a day × *purdah*			-1.257***	0.064
			(0.327)	(0.250)
2-6 times a day × *purdah*			-0.285	0.461**
			(0.216)	(0.171)
7 or more times a day × *purdah*			-0.341	0.180
			(0.225)	(0.178)
Number of person-years	6,784	11,300	6,784	11,300
Number of persons	3,392	5,650	3,392	5,650
Log-likelihood	-2014	-3658	-2015	-3653
Chi square	674.3	515.6	671.7	526.6
Degree of freedom	21	21	23	23

*** p<0.001, ** p<0.01, * p<0.05, + p<0.1

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