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The Impact of Transportation Infrastructure on Women's Employment in India

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ABSTRACT

Indian women's labor force participation is extremely low, and women are much less likely than men to work in the nonfarm sector. Earlier research has explained women's labor supply by individual characteristics, social institutions, and cultural norms, but not enough attention has been paid to the labor market opportunity structure that constrains women's labor market activities. Using data from the India Human Development Survey (IHDS) in 2004–05 and 2011–12, this study examines how village transportation infrastructure affects women's and men's agricultural and nonagricultural employment. Results from fixed-effect analysis show that access by paved or unpaved roads and frequent bus services increase the odds of nonagricultural employment among men and women. The effect of road access on nonfarm employment (relative to not working) is stronger among women than among men. Improved transportation infrastructure has a stronger positive effect on women's nonfarm employment in communities with more egalitarian gender norms.

KEYWORDS

Labor supply and demand, transportation infrastructure, female labor force participation, gender norms, nonfarm employment, India

JEL Codes: J22, J23, J24

INTRODUCTION

India has one of the lowest levels of female labor force participation (FLFP) among developing countries. According to the sixty-eighth round of data from the National Sample Survey (NSS) collected in 2011–12, the FLFP rate was 35.8 percent in rural areas and 20.5 percent in urban areas, with the total FLFP being 31.2 percent (Andres et al. 2017). This is well below the global average of around 50 percent (Dasgupta and Verick 2016) and lower than some of the neighboring countries, such as Bhutan, Nepal, and Bangladesh (see Table 1). The FLFP in India has been stagnant since the late 1980s and has declined further over the past decade despite rising women's education levels and rapid economic growth (Klasen and Pieters

Table 1 Female labor force participation rate in South Asia

Country	*2010*	*2017*
India	28.6	27.2
Afghanistan	14.7	19.5
Bangladesh	30.0	33.0
Bhutan	64.6	58.0
Sri Lanka	34.8	35.0
Maldives	50.1	42.9
Nepal	79.6	82.7
Pakistan	21.7	24.9

Note: FLFP is defined as the percentage of female population age 15 and older that are in the labor force.
Source: International Labour Organization (ILO n.d.)

2015). Another important characteristic of Indian women's employment is the disproportional concentration in the agricultural sector. About 37 percent of male paid workers and only 20 percent of female paid workers in rural India were employed in the nonfarm sector according to the 2009–10 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 nonfarm activities, but this sectoral relocation was more prominent for male paid workers than for their female counterparts (Chowdhury 2011; Shaw 2013).

Agriculture increasingly forms a smaller share of India's gross domestic product (GDP), and with agricultural mechanization, opportunities in agriculture continue to decline (Papola 2012). Moreover, much of the agricultural employment for women tends to be on family farms (Desai et al. 2010), and does not result in independent income. As compared with work on family farms and in family businesses, women who work as wage laborers or in salaried jobs are more likely to receive direct payments, which are separate from their family income. Research shows that it is not women's employment per se but employment outside of family farms that contributes to women's control over resources and decision-making power (Anderson and Eswaran 2009). Another study found that off-farm wage employment improves poor women's happiness through increased income (Van den Broeck and Maertens 2017). Therefore, we focus on women's nonfarm employment in this paper.

Earlier research has 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; Jensen 2012; Das et al. 2015; 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; Andres et al. 2017). 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. Women are more likely than men to lack access to motorized transport options (Salon and Gulyani 2010) and to spend more time traveling to paid work (Anand and Tiwari 2006). The limited mobility tends to restrict women's economic activities and curtail their status in the society. Therefore, it is important to investigate whether improved road conditions and access to transport could help women to diversify their livelihood strategies out of agriculture into nonagricultural activities.

Although India has successfully maintained 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 2011). 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 1,000 or more, thereafter extending to villages with populations of 500–1,000. By 2017, over 136,000 roadworks with 523,907 kilometers of roads have been built under the PMGSY. In addition, the Indian Government has set a target of US$1 trillion for infrastructure spending during the period of 2012–17 to not only improve transportation networks but also provide electricity, water, and telecommunication services, among other things (Planning Commission Government of India 2013). 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 (Aggarwal 2015; Donaldson 2018), reduce poverty (Khandker, Bakht, and Koolwal 2009), boost local market development (Mu and van de Walle 2011), increase migration (Morten and Oliveira 2014), and relocate laborers from agriculture to the nonagricultural sector (Asher and Novosad 2016). However, most prior studies focus on highways and railroads that provide interregion connections. There is comparatively less research examining the economic effects of local transportation services and smaller-scale roads connecting villages. Though studies have documented the link between the lack of access to public transit and limited job opportunities for minority population in the US (Sanchez 1999; Holzer, Quigley, and Raphael 2003), the implications of bus services for labor market activities have not been investigated in developing countries.

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 (Aggarwal 2015; Asher and Novosad 2016). 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 the previous literature, this study provides 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) How does village transportation infrastructure influence women's participation in nonagricultural work in India? 2) How does improvement in rural transportation infrastructure affect the gender gap in nonagricultural work participation? 3) How does the effect of transportation infrastructure on women's employment vary by the gender context of the communities? 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 fixed-effect models to examine how the improvements in transportation infrastructure lead to changes in individuals' employment sector between 2005 and 2012.

THEORY AND LITERATURE

Women's labor force participation is determined by a confluence of social and economic forces at both the household and societal 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 paid work experiences improve their qualifications for jobs. However, whether these labor supply conditions can be translated into women's paid 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; Spierings 2014). In the Indian context, scholars have claimed that the recent decline in FLFP is due to a combination of supply-side and demand-side factors (Chatterjee, Murgai, and Rama 2015; Klasen and Pieters 2015; Lahoti and Swaminathan 2016). Rising household incomes 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 paid work.

In this study, we provide a theoretical framework explaining how village transportation infrastructure shapes women's nonfarm 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 tend to promote women's paid work participation and employment in the nonfarm sector by increasing access to both local and external job opportunities, reducing women's time spent in domestic work, and possibly by introducing more egalitarian gender attitudes.

There is a shortage of short-term and long-term employment opportunities for women in rural areas in India (World Bank 2010; Chowdhury 2011). The lack of nonfarm 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 time and money required to commute to nearby urban areas. When an urban wage minus commuting costs is higher than agricultural income, rural women would be attracted to external labor markets. Moreover, the presence of paved roads, frequent bus service, and access to train stations could reduce the time needed to travel to employment sites, making it feasible for women to engage in paid work in nearby towns while fulfilling family obligations.

On the other hand, transportation changes local 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 nonfarm sector within the village (Asher and Novosad 2016). One 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 nonfarm job opportunities. These changes within the village tend to attract women out of agricultural production and into paid work in the nonfarm sector.

A considerable proportion of women's time in less-developed regions is spent on domestic chores, food production, and other unpaid work. Women in poor families have to combine the inputs of time and market goods in order to maintain subsistence, which requires them to work for long hours in both paid and unpaid work without choice. Time-poverty literature finds that women are more likely than men to be time poor (Bardasi and Wodon 2010). 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 (Jain 1985; Agarwal 1986).

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 create opportunities for women to participate in labor activities on the farm and in the nonfarm sector. For example, an improvement in road conditions could lead to easier delivery of modern cooking fuels such as kerosene or liquefied petroleum gas (LPG), thereby reducing the time that women have to spend in collecting firewood.

Well-built transportation networks may 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 may weaken the traditional gender attitudes that confine 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 men in the queue (Reskin and Roos 1990). Changes in gender norms may alter the gender-biased preference of employers and reduce the prejudice against 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 nonfarm paid 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 the nonagricultural sector.*

Next, we examine whether an improvement in village transportation infrastructure could possibly reduce the gender gap in nonagricultural paid work participation. Due to the lack of agricultural jobs for women and the limited number of female-labeled nonfarm jobs within the village, such as those of teachers, nurses, and clerks, fewer women are employed in rural India than their male counterparts (Shaw 2013; Chatterjee, Murgai, and Rama 2015). Despite the social norms that confine women to the domestic space, there is a huge unmet need for jobs among rural women who have attained a certain level of education. In the IHDS-II survey conducted in 2012, 61 percent of the married women ages 15–49 who were not working for pay said that they would be willing to work for pay if they found a suitable job. This leaves more room for an increase in women's participation in the nonfarm sector as compared with men's nonfarm employment, as most men are already occupied by farming or nonfarm jobs. In addition, as discussed above, improvements in rural transportation infrastructure would free up women's time spent in household work 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 women's 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 nonfarm employment among women than that among men. We propose our *Hypothesis 2a: The gender gap in nonagricultural employment will be reduced with better transportation infrastructure in villages.* On the other hand, nearly all Indian men of employment age are already involved in the labor market, and their labor supply is not restricted by family responsibilities and unequal gender norms. Once provided transportation access, they could easily travel to nearby towns and cities to pursue nonfarm jobs, which provide higher wages than agricultural work. Asher and Novosad (2016) find that rural road construction only relocates male paid workers from agriculture to the nonfarm sector. Indian men are able to change their labor market behavior more easily than women, and they are more likely to respond to newly available nonfarm job opportunities. Thus, we propose a competing hypothesis, – *Hypothesis 2b: Better transportation infrastructure in villages will widen the gender gap in nonagricultural employment.*

However, it needs to be noted that village transportation may reduce the necessity of women's paid 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, Silberman, 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, Silberman, and Bourmpoula 2014). Transportation infrastructure has been seen to increase men's employment in the nonagricultural sector and household income (Asher and Novosad 2016; Donaldson 2018), which possibly reduces the need for women's earnings. This countervailing pathway may weaken the effect of transportation infrastructure on women's nonagricultural employment and broaden the gap between the nonfarm 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 the seclusion of women (Sharma 1990). The preferences for confining women to the domestic realm is perceived as the basis of the dichotomy between men and women or between the "public" and "private" realms of activities. Women are seen as intruders in the public world (Derné

1994). The ideology that women should be modest, obedient, docile, and attached to the home motivates husbands and families to restrict women's mobility (Derné 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: 290)

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 less autonomy or freedom of movement, and a married woman is often 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 (Asadullah and Wahhaj 2016). Women undertaking paid work 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 employment sites. In communities with more strict practices of *purdah/ghunghat*, employers may prefer hiring men due to the inconvenience that women encounter at places of employment. 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 *Hypothesis 3: Improvements in village transportation infrastructure have a stronger positive impact on women's employment in communities with a more egalitarian gender context.*

DATA AND METHODS

Data

This study uses data from two waves of the IHDS, which were conducted in 2004–05 and 2011–12, respectively, by the National Council of

Applied Economic Research (NCAER) in India and the University of Maryland (Desai and Vanneman 2018). The interviews for this survey were spread across thirty-four 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 recontact 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 roster, the survey also collected information on each household member's demographic characteristics, education, paid work status, income, and health. In each survey, women ages 15–49 years responded to additional questions about health, gender relations, fertility, and natal care in the eligible women questionnaire. At both waves, the 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 analysis, we restrict the sample to 20,640 rural women and 19,481 rural men ages 25–52 in 2005 (thus 32–59 years old in 2012) and were interviewed at both waves of the survey. 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. After deleting cases with missing values at either wave of the survey, the sample is reduced to 17,771 women and 16,827 men. In the conditional fixed-effect multinomial logistic models assessing the effect of road conditions, removing persons who did not change employment status between the two waves and cases with missing values results in an analytical sample of 7,251 women and 6,469 men, with two observations for each person. The sample contains 7,014 women and 6,281 men in the person fixed-effect models examining the effect of bus services. On average, individuals included in the sample were 36 years old at IHDS-I. Sixty percent of the women and 29 percent of the men received no education.

The *dependent variable* is a time-varying categorical variable reflecting the respondent's employment status and sector at each wave of the IHDS. The first category, "not working," contains respondents who did not work for pay or worked for pay for less than 240 hours in the past year. The second category, "agricultural employment," includes respondents who

participated in a combination of agricultural and nonagricultural paid work for more than 240 hours in the past year (including work on own farm, family business, agricultural labor, nonagricultural labor, and salary work). If the amount of nonagricultural paid work reaches 240 hours in the past year, the respondent is categorized into the third group, which is "nonagricultural employment." We use 240 hours as the cut-off because it distinguishes individuals who devote substantial time to a certain type of paid work and those who do not. This definition is also employed by the other major national-scale surveys in India, such as the National Statistical Survey (NSS). Using the same definition will allow for comparisons between our study and studies using NSS data.

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 service in the village is categorized into once a day, two to six times a day, and seven or more times a day, contrasting to no bus service.

The effect *moderator*, village gender context, is captured by the practice of *purdah*, which is measured by the percentage of sampled women ages 15–49 years in a village who said that they practice *purdah* at the baseline survey in 2005. In this analysis, we control for a myriad of individual, household, and village level characteristics that vary over time. At the individual level, the respondent's age, the number of children under age 6 in the household, and the number of married women in the household are simply continuous variables measured at both waves. Marital status is also a time-varying variable that compares the status of unmarried, widowed, separated or divorced, and married but spouse not present to married women. The other family member's income is calculated by using the sum of family income from each type of farm and nonfarm activity minus the respondent's contribution. The IHDS is the only data source in India that provides information on other family member's income, which is an important predictor of the labor market activity of women (Kapsos, Silberman, and Bourmpoula 2014; Klasen and Pieters 2015). The measure of household assets is originally a sum of thirty items indicating household possessions and housing quality. We construct a categorical variable reflecting the quintiles of household assets among all households in India.

To account for household work for women (such as fetching water and firewood), we measure the number of hours that electricity is available per day in the household, whether the household has piped (public supply) water, and whether the household uses modern fuel, such as LPG, kerosene, and coal, for cooking at both waves. Regarding village characteristics, we control for the village population at each wave of the survey because the national rural road construction program (PMGSY)

prioritizes villages with larger populations. The wage level in a village is calculated using the average hourly wage of all sampled adult men and adult women, respectively, in each village who undertake salary/wage jobs in the nonfarm sector at each wave of the survey.[1]

Methods of analysis

We first present the descriptive statistics, showing men's and women's nonagricultural employment sectors, occupational types, sociodemographic characteristics, and village characteristics in 2005 and 2012. Next, we estimate person fixed-effect multinomial logistic regression models predicting the employment sectors of women and men separately (see Equation 1). We first use not working for pay ($k = 1$) as the reference outcome category, contrasting agricultural employment ($k = 2$) and nonagricultural employment ($k = 3$) to not working for pay. Then, we set agricultural employment ($k = 2$) as the base category to examine the odds of nonagricultural employment ($k = 3$) relative to agricultural employment.

$$\log\left(\frac{p_{ijk}}{p_{ij1}}\right) = \mu_{kt} + \beta_{1k}x_{ijt} + \beta_{2k}v_{jt} + \gamma_k z_{ij} + \tau_k w_j + \alpha_{ijk} + \theta_{jk}, \quad k = 2, 3 \quad (1)$$

Equation 1 is essentially a set of binary logistic regression models that simultaneously compare each response category k to the first category. In this model, x_{it} represents the time-varying characteristics of individuals, and v_{jt} represents the time-varying characteristics of villages. The fixed effect α_{ijk} varies both over individuals and response categories, and the fixed effect θ_{jk} varies over villages and response categories. The time-invariant traits of individuals z_{ij} and villages w_j as well as the fixed effects α_{ijk} and θ_{jk} will be canceled out when estimating the model using conditional maximum likelihood. There are concerns of endogeneity of rural road construction and bus services because they are influenced by demand and the political bargaining power of local governments. We use person fixed-effect models to rule out all the observed and unobserved time-invariant individual and village characteristics that potentially confound the relationship between village transportation infrastructure and respondents' employment sectors. By using the person fixed-effect models, we take advantage of the longitudinal data and estimate how changes in rural transportation conditions are associated with changes in men's and women's participation in agricultural work and nonagricultural paid work over time. To test Hypothesis 2, we assess the gender difference 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 multinomial logit regression

models. Finally, to test Hypothesis 3, we examine the interactive effects between transportation conditions and the village-level practice of *purdah* in the fixed-effect multinomial logit models predicting women's and men's employment sectors.

RESULTS

Figure 1 describes the changes in women's and men's employment sectors between 2005 and 2012. The proportion of women who were not working for pay and those working in the agricultural sector both declined between 2005 and 2012. The nonagricultural employment rate increased for both men and women during this period, though the rate remained much lower for women. Only 10 percent of the women participated in nonagricultural paid work in 2005, while the number increased to 18 percent in 2012. The nonagricultural employment rate for men, on the other hand, increased from 47 percent in 2005 to 54 percent in 2012. The proportional change in men's nonagricultural employment over the interval was thus much smaller than the corresponding change for women (a 15 percent increase for men versus an 80 percent increase for women).

We further present the broad areas in which rural Indian women and men ages 25–59 were employed in 2005 and 2012 in Table 2 (statistics calculated using the IHDS data). As we mentioned earlier, women's employment was heavily concentrated in the agricultural sector (including forestry and fishery) as compared with that of men, and the relocation from the agricultural sector to the nonagricultural sector was more prominent

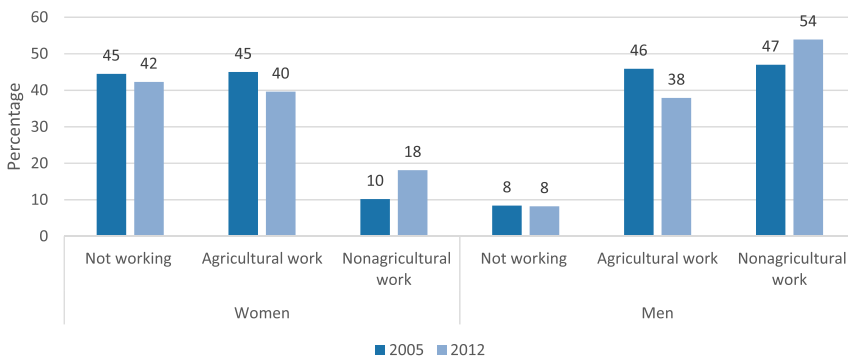

Figure 1 Trends for agricultural and nonagricultural employment among women and men ages 25–59 years between 2005 and 2012.
Notes: Respondents are defined as doing agricultural work if their total paid work hours were more than 240 in the past year and their paid work hours in the nonagricultural sector did not reach 240 hours. Respondents are considered participating in nonagricultural paid work if they worked for pay for more than 240 hours in the nonagricultural sector in the past year.

among men than among women. Table 2 shows that the percentage of women who were employed in the agricultural sector (including forestry and fishery) dropped from 61 percent in 2005 to 46 percent in 2012. Women tended to enter the industrial sector by taking jobs such as construction workers, drivers, and mobile operators, the percentage of which increased from 11 percent to 24 percent between the two waves of the survey. Meanwhile, a small but nontrivial proportion of women took professional and managerial jobs and clerical, sales, and service jobs, and these jobs accounted for a slightly higher proportion of all jobs over time.

The conditions of transportation infrastructure also changed dramatically during the survey interval, particularly because of the strong push by the Indian Government through the PMGSY mentioned earlier. Figure 2 shows that many more villages were accessible by *katcha* and *pucca* roads in 2012 than in 2005. The percentage of people living in villages not accessible by roads dropped from 6 percent to 1 percent during the seven-year interval. As far as the frequency of bus service is concerned, the proportion 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 seven times or more a day in 2012 as compared to 2005.

Table 3 presents the descriptive statistics of the sociodemographic characteristics of individuals and village characteristics in 2005 and 2012. In the analytical sample, about 90 percent of both men and women were married in 2005. The percentage of unmarried individuals in 2005 was higher among men than among women, as women usually marry at an earlier age than men. Seven years later, the percentage of women who were married dropped to 83.6 percent, whereas the number increased to 93.5

Table 2 The type of employment among working women and men between ages 25 and 59 in India

	Women		*Men*	
Type of employment (%)	*IHDS-I (2004–05)*	*IHDS-II (2011–12)*	*IHDS-I (2004–05)*	*IHDS-II (2011–12)*
Professional and managerial jobs	7.62	9.68	9.74	8.50
Clerical, sales, and service	11.70	12.98	18.46	17.89
Agricultural, forestry, and fishery	60.68	45.82	30.17	22.21
Craft workers	9.92	7.76	14.34	14.42
Construction workers, drivers, and mobile operators	10.08	23.54	27.29	36.42
Other (student, retired, disabled, and unknown occupation)	0	0.22	0	0.56
N	9,864	12,665	26,771	27,563

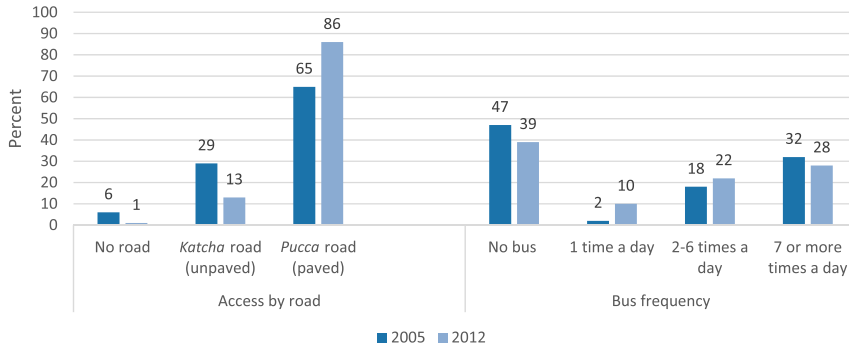

Figure 2 Changes in transportation infrastructure in Indian villages between 2005 and 2012

percent among men. Women were more likely than men to be widowed and to have their spouses absent from the household (mostly due to labor migration) at both waves. The average number of children under age 6 in each household decreased from about 1 to 0.6 between the two waves of the survey. As a proxy for household structure, the average number of married women in each household was 1.5 at both waves, indicating a substantial proportion of women who lived in extended families.

We consider the other family members' income because it reflects whether the women's paid work is needed for the family to maintain sustenance. Because in India men are more likely to be the major income earner in a household than women, the income of a man's family members was more likely than that of a woman to be ranked at a lower quintile. In this rural sample, there are more households located at the lower end rather than the higher end of the quintiles. With regard to the household facilities, in 2005, on average, each household had about 10 hours of electricity available per day, which increased to 11.5 hours in 2012. About 31 percent of the households had piped water publicly supplied in 2005 and it reached 38 percent in 2012. The percentage of the households that used modern fuel for cooking grew from about 33 percent to 36 percent over the two rounds of the survey.

At the village level, the average size of the population in a village grew from about three thousand in 2005 to 4.2 thousand in 2012. The average hourly wage for adult men employed in the nonfarm sector in each village increased by about 25 percent, from 19.7 Rupees in 2005 to 24.9 Rupees in 2012. The average hourly wage for women increased from 12.7 Rupees in 2005 to 16.5 Rupees in 2012. In terms of the community gender context, 60 percent of the women in a typical village practiced *purdah* at both waves, and there was a sizable variation among villages across the country (standard deviation = 0.4). In our sample, about 17 percent of the women

Table 3 Descriptive statistics of individual, household, and village characteristics of Indian women and men in 2005 and 2012

	IHDS-I (2004–05)		*IHDS-II (2011–12)*	
	Women	*Men*	*Women*	*Men*
	Percentage /mean (SD)	*Percentage /mean (SD)*	*Percentage /mean (SD)*	*Percentage /mean (SD)*
Marital status (%)				
Married	89.6	89.9	83.6	93.5
Unmarried	1.0	8.4	0.8	3.3
Widowed	4.9	1.2	9.5	2.1
Separated/divorced	0.8	0.5	0.9	0.5
Married, spouse not present	3.7	0.2	5.1	0.5
Number of children under age 6 in the household	1.0	1.1	0.6	0.7
	(1.2)	(1.2)	(0.9)	(1.0)
Number of married women in the household	1.5	1.5	1.4	1.4
	(.9)	(.9)	(.8)	(.8)
Other family members' income (%)				
Negative (ref.)	3.5	17.6	3.0	12.3
Quintile 1 (lowest)	23.8	35.8	20.7	36.8
Quintile 2	21.7	14.5	21.2	16.9
Quintile 3	18.3	11.5	20.1	12.6
Quintile 4	16.7	10.5	17.9	11.3
Quintile 5 (highest)	16.0	10.1	17.1	10.1
Household assets (%)				
Quintile 1 (poorest)	20.4	20.1	21.8	21.9
Quintile 2	23.4	23.0	21.4	21.5
Quintile 3	25.6	25.9	27.2	27.0
Quintile 4	19.4	19.8	17.2	17.1
Quintile 5 (richest)	11.2	11.2	12.4	12.4
Electricity (hours available)	9.8	9.9	11.5	11.5
	(8.5)	(8.5)	(8.0)	(7.9)
Piped water (%)	31.6	31.2	38.1	37.8
Modern fuel (%)	33.6	33.1	36.4	36.0
Village population (in thousand)	3.1	3.0	4.2	4.2
	(4.3)	(4.2)	(6.3)	(6.4)
Village wage level (per hour)	12.7	19.6	16.5	24.8
	(11.0)	(11.0)	(12.0)	(12.6)
Village-level practice of purdah (Average proportion)	0.6	0.6	0.6	0.6
	(0.4)	(0.4)	(0.4)	(0.4)
Number of individuals	17,771	16,827	17,771	16,827

Notes: Standard errors in parentheses.

lived in the villages where no one practiced *purdah*, and about 27 percent of the women lived in the villages where all practiced *purdah* in 2005 (numbers not shown in the tables).

The person fixed-effect multinomial logistic regression models assessing the impact of road conditions on the employment sectors of the women and the men are presented in Table 4. The coefficients of the second survey wave across the columns indicate that employment in the nonfarm sector increased statistically significantly among women over the seven-year interval, while the employment in the farm sector (relative to not working for pay) decreased. Similarly, among men, the odds of working in the agricultural sector (relative to not working for pay) declined over time and the odds of nonagricultural employment (relative to agricultural employment) increased over the period. These trends may reflect the fact that women enter the labor force after completing childbearing and both men and women tend to relocate from the agricultural sector to the nonagricultural sector. For women, marital status does not affect their sector of employment. Married men are more likely than never-married men and widowed men to be employed, and they are more likely to enter the nonagricultural sector. The number of children under age 6 in the household is negatively associated with the likelihood of women's employment in both the agricultural and nonagricultural sectors because it imposes a greater childcare burden on women. As expected, the presence of young children has no significant impact on the employment of men. The number of married women, a proxy for an extended household structure, is associated with a lower odds of farm employment (versus not working for pay) among women and a lower odds of nonfarm employment (versus not working for pay and farm employment) among both women and men. A higher level of other family members' income makes women less likely to participate in farmwork and nonfarm paid work (relative to not working for pay) but does not affect their transition from the farm sector to the nonfarm sector. This implies that women's transition into the nonfarm sector is not driven by household economic needs. When family members' income increased, the male respondents also become less likely to be employed in both the farm sector and the nonfarm sector (relative to not working for pay) or to relocate from the farm sector to the nonfarm sector. Men and women from wealthy families (household assets in the higher quintiles) are more likely than those from poor families to participate in nonfarm labor activities.

We expect that improvement in household amenities and facilities can free up women's time and allow them to participate in labor market activities, especially those off the family farm. Table 4 shows that the hours of electricity supply is associated with a higher odds of women's agricultural employment but a lower odds of transition from farmwork to nonfarm paid work. The availability of piped water through public supply tends to

Table 4 Person fixed-effect multinomial logistic regression models assessing the impact of road conditions on women's and men's employment sectors

	Women			*Men*		
	Farm vs. not working for pay	*Nonfarm vs. not working for pay*	*Nonfarm vs. Farm*	*Farm vs. not working for pay*	*Nonfarm vs. not working for pay*	*Nonfarm vs. Farm*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Survey 2012	− 0.108**	0.767***	0.876***	− 0.354***	− 0.003	0.351***
	(0.038)	(0.052)	(0.052)	(0.065)	(0.063)	(0.041)
Marital status						
Married (ref.)						
Unmarried	0.659	0.111	− 0.548	− 0.749***	− 1.482***	− 0.734***
	(0.740)	(0.716)	(0.885)	(0.202)	(0.191)	(0.159)
Widowed	− 0.199	− 0.152	0.048	− 0.776*	− 0.827*	− 0.051
	(0.151)	(0.192)	(0.191)	(0.375)	(0.353)	(0.237)
Separated/divorced	− 0.147	− 0.502	− 0.355	− 0.747	− 0.751	− 0.003
	(0.438)	(0.469)	(0.424)	(0.545)	(0.548)	(0.430)
Married, spouse not present	− 0.113	− 0.237	− 0.124	− 0.073	− 0.281	− 0.208
	(0.139)	(0.204)	(0.213)	(0.535)	(0.562)	(0.415)
Number of children under age 6 in the household	− 0.115***	− 0.134***	− 0.019	0.069	0.067	− 0.002
	(0.023)	(0.035)	(0.035)	(0.039)	(0.039)	(0.023)
Number of married women in the household	− 0.101*	− 0.316***	− 0.215***	− 0.025	− 0.286***	− 0.261***
	(0.040)	(0.064)	(0.063)	(0.066)	(0.065)	(0.042)
Other family members' income						
Negative (ref.)						

(*Continued*)

Table 4 Continued.

	Women			*Men*		
	Farm vs. not working for pay	*Nonfarm vs. not working for pay*	*Nonfarm vs. Farm*	*Farm vs. not working for pay*	*Nonfarm vs. not working for pay*	*Nonfarm vs. Farm*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Quintile 1	− 0.128	− 0.269	− 0.141	− 0.110	− 0.316*	− 0.206**
	(0.134)	(0.183)	(0.169)	(0.139)	(0.137)	(0.070)
Quintile 2	− 0.346*	− 0.416*	− 0.071	− 0.485**	− 0.813***	− 0.328***
	(0.135)	(0.186)	(0.173)	(0.151)	(0.148)	(0.082)
Quintile 3	− 0.635***	− 0.711***	− 0.076	− 0.861***	− 1.326***	− 0.466***
	(0.136)	(0.189)	(0.177)	(0.157)	(0.153)	(0.091)
Quintile 4	− 0.713***	− 0.731***	− 0.018	− 1.214***	− 1.532***	− 0.318**
	(0.139)	(0.195)	(0.185)	(0.162)	(0.157)	(0.102)
Quintile 5	− 0.653***	− 0.795***	− 0.141	− 1.407***	− 1.774***	− 0.367**
	(0.147)	(0.218)	(0.211)	(0.177)	(0.171)	(0.119)
Household assets						
Quintile 1 (ref.)						
Quintile 2	− 0.075	0.028	0.103	0.097	0.041	− 0.055
	(0.072)	(0.101)	(0.095)	(0.139)	(0.138)	(0.070)
Quintile 3	− 0.166	− 0.001	0.165	0.267	0.286	0.020
	(0.090)	(0.126)	(0.119)	(0.157)	(0.157)	(0.086)
Quintile 4	− 0.311**	0.156	0.467**	0.154	0.466*	0.312**
	(0.112)	(0.159)	(0.154)	(0.192)	(0.192)	(0.111)
Quintile 5	− 0.389**	0.279	0.668**	0.209	0.713**	0.504**
	(0.144)	(0.222)	(0.226)	(0.234)	(0.233)	(0.158)

Electricity (hours available)	0.019***	− 0.000	− 0.019***	0.011	0.013*	0.002
	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)	(0.003)
Piped water	0.024	0.199*	0.175	0.219*	0.330**	0.111
	(0.066)	(0.093)	(0.093)	(0.111)	(0.110)	(0.068)
Modern fuel	− 0.103	0.009	0.112	− 0.023	− 0.020	0.003
	(0.054)	(0.075)	(0.074)	(0.091)	(0.089)	(0.055)
Village population (in thousand)	0.008	− 0.005	− 0.013	0.020**	0.007	− 0.013*
	(0.007)	(0.008)	(0.009)	(0.007)	(0.007)	(0.006)
Village wage level	− 0.000	0.001	0.001	− 0.007	0.003	0.010**
	(0.003)	(0.003)	(0.004)	(0.005)	(0.005)	(0.003)
Access by road						
No (ref.)						
Yes, *katcha* (unpaved or dirt)	0.115	0.451*	0.337*	− 0.355	− 0.177	0.178
	(0.127)	(0.183)	(0.164)	(0.209)	(0.212)	(0.115)
Yes, *pucca* (paved)	0.092	0.360	0.267	− 0.581**	− 0.279	0.302*
	(0.129)	(0.185)	(0.166)	(0.207)	(0.212)	(0.119)
Number of person-years	14,990	14,990	14,990	13,162	13,162	13,162
Log-likelihood	− 4754	− 4754	− 4754	− 4155	− 4155	− 4155
Chi-square	882.0	882.0	882.0	812.9	812.9	812.9
Degree of freedom	46	46	46	46	46	46

Notes: Standard errors in parentheses. ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

increase women's employment in the nonagricultural sector (relative to not working for pay) as we expected, but similar effects are found among men as well. We suspect that the public water supply is related to the level of economic development in the villages, which in turn determines the availability of nonfarm employment opportunities. Therefore, the association is similar for women and men. The adoption of modern fuel by the household does not have significant relationships with women's and men's employment status. Regarding village-level characteristics, the population size of the village does not matter for women's employment sectors, but it is positively associated with men's agricultural work (versus not working for pay) and is negatively associated with their transition from farm to nonfarm paid work. An increase in the local wage level leads to a higher odds of relocation to the nonfarm sector from the farm sector among men but does not influence the employment sectors of women.

In terms of transportation conditions, gaining *katcha* roads increases the likelihood that women join the nonfarm sector (relative to not working for pay) by about 57 percent ($\exp[0.451] = 1.57$) and improves their odds of transition from farm to nonfarm paid work by 40 percent ($\exp[0.337] = 1.40$). Access by *pucca* roads decreases the odds of men's employment in the farm sector (relative to not working for pay) by 44 percent ($\exp[-0.581] = 0.56$) and boosts men's odds of nonfarm employment (relative to farm employment) by 35 percent ($\exp[0.302] = 1.35$). As we expected, access by roads can create more nonagricultural job opportunities within the village and provide connections to the external job markets, which in turn enhances nonfarm employment among rural men and women. The negative impact of road access on men's agricultural employment may be attributable to the decreased demand for labor after the introduction of technology and capital in agricultural production or the influx of laborers from outside of the village. We suspect that as men move to the nonfarm sector, women may fill up the slack in the agricultural sector, but the results do not seem to support our conjecture.

Table 5 presents person fixed-effect multinomial logistic regressions showing the impact of bus services on women's and men's employment sectors, with the same set of control variables included as in Table 4. Slightly different from the impact of road access, the transition from no bus to two to six times a day improves the odds of women participating in farm labor activities (relative to not working for pay) by 15 percent ($\exp[0.143] = 1.15$). Bus services of seven times per day or more are associated with a 23 percent ($\exp[0.207] = 1.23$) increase in women's nonfarm employment (relative to not working for pay) and a 20 percent ($\exp[0.179] = 1.20$) higher odds of men's nonfarm employment (relative to farm employment). These findings from the fixed-effect regression models in Tables 4 and 5 provide support for Hypothesis 1 about

Table 5 Person fixed-effect multinomial logistic regression models assessing the impact of bus service on women's and men's employment sectors

	Women			*Men*		
	Farm vs. not working for pay	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*	*Farm vs. not working for pay*	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Bus frequency						
No bus (ref.)						
1 time a day	0.025	0.259	0.234	0.132	0.326	0.195
	(0.103)	(0.148)	(0.146)	(0.177)	(0.174)	(0.104)
2–6 times a day	0.143*	− 0.011	− 0.154	− 0.103	− 0.085	0.018
	(0.072)	(0.101)	(0.097)	(0.120)	(0.117)	(0.072)
7 or more times a day	0.072	0.207*	0.135	− 0.156	0.023	0.179*
	(0.071)	(0.100)	(0.098)	(0.120)	(0.117)	(0.074)
Number of person-years	14,990	14,990	14,990	13,162	13,162	13,162
Log-likelihood	− 4737	− 4737	− 4737	− 4154	− 4154	− 4154
Chi-square	916.6	916.6	916.6	815.4	815.4	815.4
Degree of freedom	48	48	48	48	48	48

Notes: The models in this table include all the control variables. Standard errors in parentheses. ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

the positive influence of village transportation infrastructure on the participation of men and women in nonfarm paid work.

As a supplementary analysis, we also consider how the location of the village, in addition to the transportation conditions, matters for rural people's nonfarm employment because earlier research shows that rural nonfarm wage employment in India is concentrated in small- and medium-size service firms located in the "corridors" of interurban transport and in broad swathes around cities (Bhalla 1997). We test the interactive effects between road conditions and the distance to the nearest town in regression models (results not shown in tables). Results show that distance to towns neither has a significant impact on women's employment sectors nor alters the effects of road access on women's employment sectors. However, a greater distance to towns predicts lower odds of nonfarm employment among men and strengthens the effect of road access on men's nonfarm employment (relative to farm employment). The distance only matters for men possibly because men are more able than women to travel outside of the village to search for jobs, whereas women are more constrained to the farm and nonfarm job opportunities within the villages. For villages that are close enough to the urban centers, men may have already been able to get access to jobs even without a *pucca* or *katcha* road. Thus, gaining access by roads makes a bigger difference for men in villages that are more remote.

Indian men are much more likely than women to be employed in the nonfarm sector. Our next goal is to examine whether improvement in transportation infrastructure can reduce the gender gap in nonagricultural employment in India. We compare the coefficients of road conditions for women and men in Table 4 by pooling the sample of male and female respondents and estimating fixed-effect multinomial logistic regression models including interaction terms between all the covariates and gender. According to these models, the positive effects of road access on women's nonfarm employment (relative to not working for pay) in column 2 are significantly larger than those for men in column 5. This means that gaining *katcha* or *pucca* roads is more likely to drive women than men from not working for pay to nonfarm employment. The influence of road conditions on the odds of relocation from the farm to the nonfarm sector does not vary by gender. The comparison of the coefficients of bus frequency in the models for women and those in the models for men in Table 5 shows that the effects of bus frequencies on employment sectors are not statistically different across the gender groups. Therefore, Hypothesis 2 is only partially supported by the empirical results, as road access improves women's transition from not working for pay to nonfarm employment more than that of men.

Finally, we investigate whether the influence of transportation on women's employment sectors is conditioned by the community gender context. Models in Table 6 include interactions between road conditions

Table 6 Person fixed-effect multinomial logistic regression models assessing the impact of road conditions on women's and men's employment sectors, examining the conditioning role of community gender context

	Women			*Men*		
	Farm vs. not working for pay	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*	*Farm vs. not working for pay*	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Access by road						
No (ref.)						
Yes, *katcha* (unpaved or dirt)	0.284	0.857**	0.574*	− 1.169**	− 0.975*	0.194
	(0.237)	(0.315)	(0.254)	(0.426)	(0.429)	(0.181)
Yes, *pucca* (paved)	0.339	1.081***	0.742**	− 0.989*	− 0.833*	0.155
	(0.237)	(0.313)	(0.252)	(0.408)	(0.413)	(0.183)
Yes, *katcha* × purdah	− 0.227	− 0.873	− 0.646	1.257*	1.262*	0.005
	(0.317)	(0.460)	(0.409)	(0.555)	(0.570)	(0.267)
Yes, *pucca* × purdah	− 0.334	− 1.418**	− 1.084**	0.590	0.854	0.264
	(0.312)	(0.453)	(0.400)	(0.533)	(0.551)	(0.266)
Number of person-years	14,990	14,990	14,990	13,162	13,162	13,162
Log-likelihood	− 4734	− 4734	− 4734	− 4148	− 4148	− 4148
Chi-square	921.5	921.5	921.5	827.4	827.4	827.4
Degree of freedom	50	50	50	50	50	50

Notes: The models in this table include all the control variables. Standard errors in parentheses. ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

and the village level practice of *purdah* measured at IHDS-1.[2] The negative and significant coefficients of the interaction terms in columns 2 and 3 imply that the effects of road access on women's nonagricultural employment are weaker in the villages where *purdah* was more widely practiced. In these communities, even when the women are provided easier access to nonfarm jobs, they are unable to take advantage of the job opportunities due to restrictions on their physical mobility and norms that do not allow interaction between women and unrelated men. In columns 4 and 5, the positive coefficients of the interaction terms indicate that in more traditional gender contexts, getting access by roads has a larger positive impact on men's participation in farm and nonfarm paid work (relative to not working for pay).

Figure 3 presents the predicted values of the odds ratios of the participation of women and men in nonfarm paid work (relative to farmwork) 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.[3] In communities with egalitarian gender norms (that is, where no one practices *purdah*), the odds of women's nonfarm employment (versus farmwork) increases by 78 percent when villages get connections by *katcha* roads, and it is more than doubled with connections by *pucca* roads, while in this context men's nonfarm paid work participation is not significantly influenced by road access. Thus, improvements in road conditions are more likely to reduce the gender gap in nonagricultural employment in communities following more egalitarian

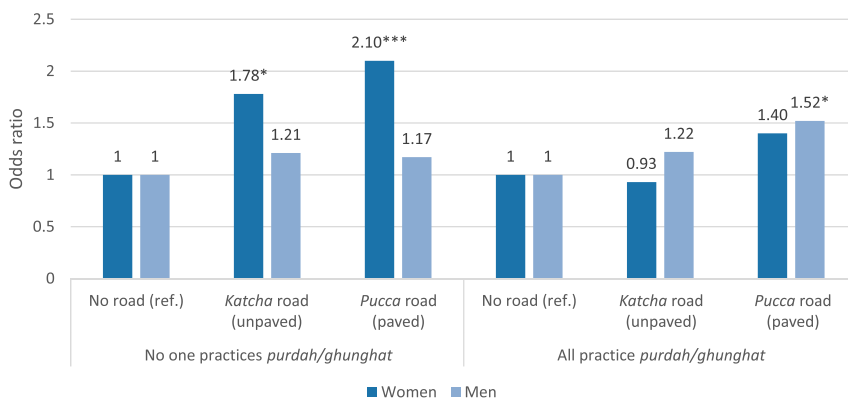

Figure 3 The effect of road access on the odds of rural women's and men's nonagricultural employment (relative to agricultural employment), by community gender context
Notes: ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

Table 7 Person fixed-effect multinomial logistic regression models assessing the impact of bus service on women's and men's employment sectors, examining the conditioning role of community gender context

	Women			*Men*		
	Farm vs. not working for pay	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*	*Farm vs. not working for pay*	*Nonfarm vs. not working for pay*	*Nonfarm vs. farm*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Bus frequency						
No bus (ref.)						
1 time a day	0.478*	1.034***	0.556*	0.859*	0.758*	− 0.101
	(0.207)	(0.246)	(0.238)	(0.346)	(0.336)	(0.199)
2–6 times a day	0.268	0.197	− 0.071	− 0.071	− 0.369	− 0.299*
	(0.152)	(0.181)	(0.159)	(0.223)	(0.223)	(0.137)
7 or more times a day	0.130	0.406*	0.277	0.060	0.046	− 0.014
	(0.151)	(0.186)	(0.172)	(0.234)	(0.229)	(0.147)
1 time a day × purdah	− 0.695**	− 1.449***	− 0.753*	− 1.123*	− 0.689	0.434
	(0.268)	(0.357)	(0.349)	(0.459)	(0.451)	(0.268)
2–6 times a day × purdah	− 0.159	− 0.341	− 0.181	− 0.007	0.487	0.494**
	(0.195)	(0.253)	(0.233)	(0.309)	(0.307)	(0.185)
7 or more times a day × purdah	− 0.049	− 0.307	− 0.258	− 0.307	− 0.034	0.273
	(0.194)	(0.254)	(0.242)	(0.316)	(0.310)	(0.193)
Number of person-years	14,990	14,990	14,990	13,162	13,162	13,162
Log-likelihood	− 4727	− 4727	− 4727	− 4146	− 4146	− 4146
Chi-square	935.6	935.6	935.6	830.2	830.2	830.2
Degree of freedom	54	54	54	54	54	54

Notes: The models in this table include all the control variables. Standard errors in parentheses. ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

gender norms. In communities with unequal gender norms, the effects of roads are statistically significant for men rather than for women.

In Table 7, we examine the interactive effects between bus service and village-level *purdah* in models for women and men. Negative and significant interaction effects are found for women. The transition from no bus service to having bus service once a day leads to higher odds of nonfarm employment (versus not working for pay and farmwork) among women, but this positive effect becomes weaker in villages with a more unequal gender context. In contrast, columns 5 and 6 show that gaining bus service of two to six times a day has a stronger positive impact on men's nonfarm employment (relative to not working for pay and farmwork) in villages with more unequal gender norms than in villages with egalitarian gender norms. Taken together, these results support Hypothesis 3 that improvements in village transportation infrastructure have a stronger positive impact on women's nonfarm employment in communities with more egalitarian gender contexts. Such interactions do not exist or are in the opposite directions for men.

Figure 4 shows the predicted odds ratios of nonfarm employment (relative to farm employment) by the frequency of bus service among women and men in villages 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 results for road access, increased bus frequency significantly boosts the nonfarm employment of women but not that of men in villages following an egalitarian gender norm, but

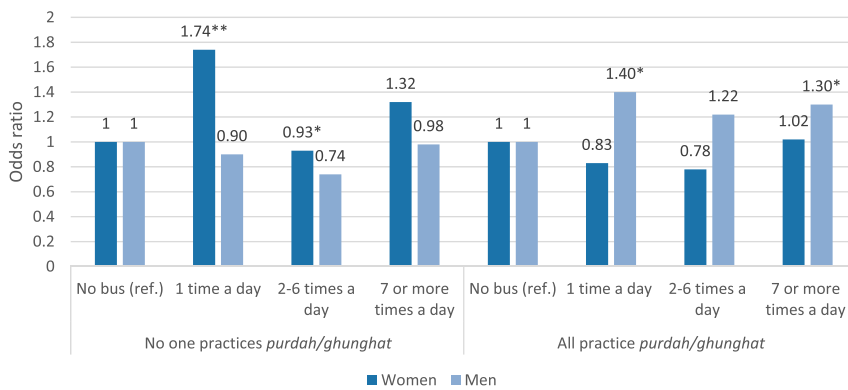

Figure 4 The effect of bus frequency on the odds of rural women's and men's nonagricultural employment (relative to agricultural employment), by community gender context

Notes: ***, **, * denote statistical significance at the 1, 5, and 10 percent levels, respectively.

bus service benefits men more than women in villages following unequal gender norms.

DISCUSSION AND CONCLUSION

In this paper, we address the role of village transportation in shaping women's employment in the nonagricultural sector. Relying on a framework of factors pertaining to the demand side and the supply side of women's labor, we argue that transportation promotes women's nonagricultural employment in several ways. The effect of transportation may operate through increasing women's access to nonfarm 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 effect of transportation infrastructure on women's employment sectors. Moreover, we examine whether an improvement in village transportation reduces the gender gap in nonfarm employment and whether the transportation effects on women's nonfarm employment 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 nonagricultural employment, which has important implications for women's lives in rural India. Women's agricultural work often takes place on the family farm, which does not generate independent income or increase women's power in deciding how to spend family income. In contrast, employment in the nonfarm sector is more likely than work on family farms to generate independent income for the woman. This helps increase women's control over economic resources and consequently endows them with greater decision-making power. Prior research has shown that earned income, especially from working for pay off the family farm, enhances women's relative bargaining power and autonomy (Anderson and Eswaran 2009). The direct payment from nonfarm employment 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 to economic growth, government investment in transportation has the potential to contribute to women's autonomy and empowerment by providing them access to nonfarm jobs.

In addition, we find that improvement in road conditions tends to shrink the gender gap in nonagricultural employment by boosting the nonfarm employment of women more than that of men. Earlier research reported that the impact of construction of rural roads on nonagricultural employment is pronounced for men but insignificant for women because men have lower costs and higher gains in relocating from the farm to the

nonfarm sector (Asher and Novosad 2016). Unlike this previous study, we show a more encouraging finding that investment in rural transportation propels both women and men into the nonfarm sector (the impact of road construction is even stronger among women than among men), rather than exclusively benefiting men.

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 nonagricultural employment in communities following more unequal gender practices. Given the strict practice of *purdah* that restricts their physical mobility, women are not able to take on nonfarm jobs outside the household or beyond the local village even if easy transportation is provided. Hence, the barriers caused by unequal 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 a greater impact on women's nonfarm employment than on men's, resulting in a smaller gender gap. With two waves of data collected seven years apart, we are unable to trace long-term changes in gender norms. Although the gender norms did not change dramatically over the two waves of the IHDS, they may change toward a gender egalitarian direction over the long term, which will increase the impact of transportation networks on women. This is an area that deserves further investigation over a longer period.

Finally, our findings highlight the importance of access to employment 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 work and caretaking responsibilities draw women out from the labor market. Popular explanations for the recent decline in FLFP aver that rising family incomes and expanded postsecondary education have suppressed women's labor supply (Kapsos, Silberman, and Bourmpoula 2014; Klasen and Pieters 2015). On the demand side, scholars have recognized the availability of limited agricultural job opportunities, given the decline in farm sizes and the rise in mechanization in farming, and the slow growth of white-collar jobs suitable for women (Neff, Sen, and Kling 2012; Klasen and Pieters 2015). We substantiate the demand-side explanation by showing that rural women in India would seize the growing nonfarm job opportunities within the villages and take up nonagricultural jobs in neighboring towns when easier transportation is provided. In the Indian case, connecting women to a broader labor market outside of the local village might be a remedy for the incidence of low nonfarm employment among women and the stagnant FLFP, especially since increased education levels among Indian

women have prepared a qualified workforce for the nonagricultural sectors. In addition to generating industrial and service job positions suitable for women, it is also desirable to foster an institutional and social environment that allows more women, especially educated women, to take up nonfarm jobs.

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NOTES

[1] The average village wage level is not available for 2,005 women out of 17,771 women in our analytical sample because there are not any women taking salary/wage jobs in their villages. Thus, their village wage level is mean imputed.

[2] The level of *purdah* practice in Indian villages increased slightly between 2005 and 2012. We have tried to treat gender context as a time-varying variable, and the results remain largely unchanged.

[3] Calculations are based on columns 3 and 6 in Table 6.

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