Nandwani, Bharti; Roychowdhury, Punarjit

Working Paper

Rural roads infrastructure and women empowerment in India

GLO Discussion Paper, No. 1320

Provided in Cooperation with:
Global Labor Organization (GLO)

Suggested Citation: Nandwani, Bharti; Roychowdhury, Punarjit (2023) : Rural roads infrastructure and women empowerment in India, GLO Discussion Paper, No. 1320, Global Labor Organization (GLO), Essen

This Version is available at:
https://hdl.handle.net/10419/274571

Rural roads infrastructure and women empowerment in India*

Bharti Nandwani†
Indira Gandhi Institute of Development Research, Mumbai, India

Punarjit Roychowdhury‡
Shiv Nadar University, Delhi NCR, India & GLO

July 14, 2023

Abstract

The paper examines the impact of a rural roads construction program in India on women's outcomes. While spatial integration can provide women with increased education and employment opportunities, the extent of benefits might be limited by underlying gender norms. We identify the impact of the policy by exploiting the program rule that assigned roads based on the village population. Using a two-way fixed effect methodology, we find that increase in rural roads construction lowers mobility restrictions faced by women and improves norms around domestic violence. However, the result are mixed with respect to participation in other decision making and financial autonomy. Additionally, while we find positive impact on education, there is no impact on employment outcomes for females. We argue that a possible reason for a partial improvement in women outcomes could be gendered impact of the policy - men benefit more in terms of employment than women.

JEL: J16, O12
Keywords: Gender Norms, India, Roads, Women Empowerment

*The authors are very grateful to Shilpa Aggarwal for sharing the PMGSY data files. All remaining errors are our own.

†Corresponding author. Economics Department, IGIDR, Film City Road, Goregaon East, Mumbai - 400065, email: bharti@igidr.ac.in

‡email: punarjitroychowdhury@gmail.com.

1 Introduction

For centuries, women have had limited decision making power and faced restrictions on their participation in economic activities outside the spheres of their homes. Examining policy interventions that can improve socio-economic status of women is therefore important from both academic and policy perspective. In that spirit, this paper studies the impact of a government of India policy that invested in rural roads infrastructure on various indicators of women autonomy and empowerment. The reason we focus on roads infrastructure is that mobility restriction has been recognised as a critical constraint limiting socio-economic participation of females (Field and Vyborny, 2022; Bankar et al., 2018; Goel, 2023). Societies where women find it difficult to freely travel from one place to the other have more stringent gender norms and lower female labour force participation rates[1]. The intervention that this paper focuses on eased constraints to mobility for women by connecting previously unconnected villages to the nearest market centre in India. The intervention roll-out provides us with an exogenous variation in the exposure of rural population to paved roads that helps us uncover the *causal* impact of easing restrictions to mobility on women outcomes.

The rural roads were constructed under Pradhan Mantri Gram Sadak Yojna (PMGSY) – a flagship rural roads construction program of the Government of India. PMGSY began in the year 2000 with the objective of connecting villages with a population of more than 500 to the nearest market centre by constructing all-weather roads. The rollout of the program was staggered with the larger villages (in terms of population) given the priority for placement of a paved road. In particular, villages with population above 1000 were to be connected first followed by villages with population size of 500. We use the variation created by the program rule in exposure to new rural roads to identify the impact of PMGSY on a range of indicators of women empowerment from 2000 to 2011.

Women in India have faced highly unequal gender norms and have limited agency both within and outside their house(Afridi et al., 2022; Nayak and Mahanta, 2012; Kishor and

[1] $https://iwwage.org/wp-content/uploads/2021/03/6_Mobility-and-Safety-of-Women.pdf$

Gupta, 2004). They also spend a disproportionately higher amount of time in domestic activities and unpaid health care for family members which leaves little time for participation in paid employment (Raney et al., 2011; Ratheesh and Anitha, 2022; Charmes, 2019). Women in rural areas are particularly at a disadvantage because of dilapidated transportation infrastructure, limited economic and education opportunities and deeply entrenched gender norms. Construction of rural paved roads is likely to improve some of those restrictions by various mechanisms. One, paved roads, facilitated by improved transportation facilities and reduction in transportation cost (Aggarwal, 2018), can make it easier for women to travel within and outside their village. Women in developing countries have to travel long distance to fetch water and firewood(Duchène, 2011). The time saved by making quicker trips can be used on other employment activity. Two, better connection with the market town can provide easy access to a multitude of education and employment opportunities outside agriculture. Three, increased interaction with people outside of their village and trips to market towns can lead to intercultural assimilation and change the perception about the appropriate role of women in society. While the mechanisms highlighted suggest a positive impact, it is possible that social norms governing female mobility are so deeply entrenched that investment in physical infrastructure that eases mobility for women might not be sufficient to bring about a change in their autonomy. Existing work shows that women are less likely than men to have access to motorized transport options (Salon and Gulyani, 2010) suggesting that even though construction of paved roads can reduce the travel time, the advantages are less likely to be enjoyed by women. Thus the impact of rural roads on women outcomes is a priori unclear.

We use two large datasets to examine the extent to which women benefit from rural roads construction - India Human Development Survey (IHDS) and National Sample Survey (NSS). IHDS is a nationally representative multi-topic panel household survey conducted by National Council of Applied Economics Research (NCAER). The first wave of IHDS was conducted in 2004-05 followed by the next wave in 2011-12 and each wave surveys close

to 40,000 households. The survey has a separate woman specific module, administered to one randomly chosen married female (above the age of 15) in the household, that contains questions on female mobility, perceptions about domestic violence, reproductive health and education. While we use IHDS to capture an array of indicators of female autonomy, we use NSS to get data on female education and employment. NSS is a large nationally representative household survey conducted by Ministry of Statistics and Program Implementation that captures detailed information on employment status of surveyed household members. We use the NSS rounds conducted in 2004-05 and 2011-12. Note that unlike IHDS, NSS is not a panel data and our NSS sample is a repeated cross section of surveyed individuals.

The data on village level exposure to new rural roads constructed under PMGSY has been made publicly available by the government and is available on the Online Management Monitoring System (OMMS). However, the IHDS and NSS do not have village level identifiers - the unit at which the PMGSY program was rolled out and the smallest geographic unit captured in these datasets is a district. We therefore aggregate the village level road construction information from 2000 to 2010 at the district level and construct the percentage of population in a district that is exposed to a paved road. We merge this district level road exposure information with the IHDS and NSS.

Given that our objective is to capture the impact on various measures of female empowerment, a plausible concern is that these measures might not change within a span of five to ten years. While we acknowledge that social norms governing female autonomy are sticky, we carefully choose indicators that are likely to quickly respond to increased spatial integration. The empirical methodology utilises the panel structure of the IHDS data and uses women fixed effects to capture the variation in the same female's exposure to a paved road over time. Our identifying assumption is that district level variation in exposure to roads over time is quasi-random. The assumption would be violated if the placement of roads is also correlated with provision of other public goods particularly those that benefit women. This is unlikely to be the case because (a) The program rule specifies that placement of rural

roads is only a function of the village population; Aggarwal (2018) shows that probability of receiving the program discontinuously jumps around the village population of 500 and 1000 and (b) Aggarwal (2018) also shows that placement of roads is uncorrelated with the initial provision of public services.

Our empirical results suggest that the impact of construction of rural roads on indicators of women empowerment is mixed at best. Increase in percentage of population exposed to paved roads lowers mobility restrictions faced by women–they are less likely to report needing permission to move outside their homes. Further, exposure to paved roads also improves norms around domestic violence reducing the likelihood of women reporting that domestic violence is common in their community. Also, increase in exposure to rural roads increases the participation of women in discussion on expenditure decisions with husbands. Additionally, increase in exposure to rural roads negatively impacts the prevalance of patriarchal norms like men should take their meal before women in a household.

However, we do not find positive impact for a number of indicators of female empowerment. While exposure to roads reduces the number of children considered ideal by women, it does not have any impact on son preference expressed by women. Additionally, while women in districts exposed to more rural roads have more cash in hand, there is no impact on their bank account ownership or house ownership/rental. The exposed women also have lower likelihood of participation in household decision making particularly with regard to number of children or household expenditure. Turning to the impact on education, in line with the findings of (Adukia, Asher and Novosad, 2020; Shimamura, Shimizutani, Yamada and Yamada, 2023), we find that road exposure increases the likelihood of females being currently enrolled in education institutes. However, we show that the improvement in education is not accompanied with increase in female employment. The exposure to paved roads does not increase participation of women in labour force or wage employment.

In addition we document that road exposure differentially benefits females *relative* to men increasing the likelihood of men being employed as compared to females after the road

construction. Given that the gain to men is more than females, the socio-economic gap between males and females is unlikely to have reduced post rural roads construction. This finding helps explain the lack of strong positive effects on female financial autonomy and employment. A recent literature has documented negative effects of increase in income of males on female employment due to positive income effect(Mehrotra and Parida, 2017; Mehrotra and Sinha, 2017). The improvement in female mobility might simply reflect that since husbands go out to work and are not at home, females do not have to rely on their permission to travel outside their homes.

There is a large body of work assessing the impact of transport infrastructure on economic development (Ghani, Goswami and Kerr, 2016; Asturias, García-Santana and Ramos, 2019; Alder, 2016), poverty reduction (Lokshin and Yemtsov, 2005; Khandker, Bakht and Koolwal, 2009), education (Chaudhary and Fenske, 2023) and employment generation (Roberts, Bougna, Melecky and Xu, 2018). There is a particularly growing interest in the evaluation of the PMGSY intervention both due to the quasi random nature of its roll-out and its introduction in a very large developing country. The literature has broadly found that paved roads improve employment opportunities for males outside agriculture (Asher and Novosad, 2020), adoption of agricultural technology (Shamdasani, 2021), crop and diet diversity, reduce price disparity (Aggarwal, 2018), improve education opportunities for the younger cohort (Adukia, Asher and Novosad, 2020), increase health care utilisation and health outcomes for women (Aggarwal, 2021) and children (Dasgupta, Karandikar and Raghav, 2022). We contribute to this literature by studying the impact on women empowerment outcomes. The paper that comes close to our research question is Lei, Desai and Vanneman (2019) that evaluates the impact of rural roads construction of female employment in non-agriculture. Though the paper focuses on rural roads network it does not particularly look at PMGSY roads. In contrast to our findings, the paper finds that female non-agricultural employment increased after the construction of rural roads and the gap in female and male employment declines. In addition, the paper does not focus on other measures of women empowerment.

Our results are, however, in line with the existing work that evaluates the impact of rural roads construction programs in Morocco (Shimamura, Shimizutani, Yamada and Yamada, 2023), India (Dasgupta, Karandikar and Raghav, 2022) and Bangladesh (Khandker, Bakht and Koolwal, 2009), respectively, and find that the gain to male employment from road construction is much higher as compared to female employment.

The rest of the paper is structured as follows: section 2 provides a background to the PMGSY program, section 3 discusses the data sources, section 4 presents the empirical framework, section 5 presents the results and section 6 concludes.

2 Background

There are around 6,00,000 villages in India and as of 2000 around 50% of them were unconnected by a paved road. The geographical isolation has been considered as an impediment to provision of public services and engagement in economic activities outside agriculture. Given this backdrop, the government of India in the year 2000 launched PMGSY - a flagship rural roads construction program with the objective of connecting previously unconnected habitations with a population of more than 500 to the nearest market center by constructing all-weather roads[2]. A habitation is considered connected if it is located at a distance of less than 500 meters from an all-weather road or a connected habitation. The population census of 2001 was used to determine habitation population. Note that a habitation is a neighbourhood within a village (the location of which does not change over time) and a typical village contains between 1 to 3 habitations. For the purpose of this paper we use habitation and village interchangeably[3].

The rollout of the program was staggered with the larger villages (in terms of population) being given the priority for placement of a paved road. In particular, villages with population above 1000 were to be connected first followed by villages with population size of 500 and

[2]The population cut-off was 250 for hilly and tribal areas.

[3]Also, most Indian datasets are available at the village level (instead of the habitation)

then 250 (if eligible). According to estimates provided by the Government of India, by the end of the 2010-11, approximately 290,000 km of paved roads have been constructed connecting nearly 85000 villages to their nearest market centers. The program is centrally funded but implemented by states and therefore some of the states have not strictly adhered to the 1000 and 500 priority guideline with smaller villages getting a road sooner than larger villages. Note that upgradation of existing roads was also permitted under PMGSY however we only consider newly constructed roads to measure exposure to PMGSY roads.

3 Data

3.1 Data Sources

The data for the analysis comes from several sources including administrative sources, India Human Development Survey (IHDS), National Sample Survey (NSS) and Indian Census 2001.

3.1.1 Administrative Data on Road Construction

Information on rural roads constructed under PMGSY is available online through Online Management and Monitoring System (OMMS). The data has habitation level information on baseline level of road-connectivity, population (in order to determine eligibility), whether it got a road under the program, and if so, the year in which the road was approved and built. Following Aggarwal (2018), in all of our analysis, we use the approval date as the date on which the road was built, and use the words "approved" and "built" interchangeably[4].

[4]Understandably, there could be delays in roads construction and therefore our results in those cases would be under-estimate of the true impact.

3.1.2 India Human Development Survey

IHDS is a nationally representative multi-topic panel household survey conducted by NCAER in New Delhi and University of Maryland (Desai et al. 2010; Desai et al. 2015). It was designed to complement existing Indian household surveys by bringing together a wide range of socio-economic topics in a single survey. The sample was drawn using stratified random sampling with survey weights provided. The first wave was conducted in 2004-05 and covered 41,554 households in 1,503 villages and 971 urban neighborhoods across India. The second wave was conducted in 2011-12 and covered 42,152 households. Not all households in the first wave could be surveyed in the second wave; in fact, 6,911 households interviewed in the first wave are not available in the second wave. The data is publicly available from the Data Sharing for Demographic Research program of the Inter-university Consortium for Political and Social Research (ICPSR).[5]

In both waves, the IHDS randomly chose one ever-married woman above the ages of 15 from each surveyed household. These women were then administered a separate health and education questionnaire which included questions on marriage and reproductive history, as well as questions on gender norms and health investments. We use information provided by these women to construct our main outcome variables which can be broadly grouped into seven categories: (i) restrictions on female mobility, (ii) norms regarding domestic violence, (iii) participation in discussion within households, (iv) fertility preferences, (v) financial autonomy, (vi) decision making within households, and (vii) other miscellaneous gender norms/outcomes (e.g., practice of purdah, etc.). Table 1 presents the details of the variables (including questions based on which they are generated) that are used to measure the prevalance of each of these norms. Additionally, individual/household demographic characteristics of women are also drawn from the IHDS.

Note, the sample size of the panel of women is smaller than the sample size of panel of households in the IHDS as some women who were surveyed in the first round were not

[5]http://www.icpsr.umich.edu/icpsrweb/DSDR/studies/36151

available to be surveyed in the second. The total number of women who could be surveyed in both the rounds is 25,479, of which 17,614 were living in rural areas. This means, the maximum sample-size of the IHDS panel which we can work with is 35,228 (=17,614 $\times$ 2).

3.1.3 National Sample Surveys

We use National Sample Survey (NSS) data to get information on education and employment status of women (see Table 1 for the details of these variables). In particular, we use two rounds of NSS conducted in 2004-05 (61st round) and 2011-12 (68th round). NSS is a large nationally representative survey of households that contains detailed information on household consumption expenditure as well as employment and education information on household members and other demographic and socio-economic household characteristic. NSS is conducted after every five years and we use the latest two rounds that focus on employment information on household members. Note that NSS is not a panel data and the individuals observed in one round are not necessarily surveyed in the other.

NSS conducted in 2004-05 provides information on 3,29,665 women and of these, 2,24,233 reside in rural areas. NSS conducted in 2011-12 surveyed 2,39,384 women and out of these 1,50,646 reside in rural areas. Thus, the total number of rural women who were surveyed in these two rounds of NSS is 3,74,879.[6]

3.1.4 Population Census 2001

Finally, we use the 2001 population census to obtain data on several district-level socio-economic indicators and availability of public goods. These include literacy rate, female literacy rate, work participation rate, female work participation rate, number of primary schools, number of middle schools, number of secondary schools, number of senior secondary

[6]Even though IHDS collects information on women's employment and labor force participation, we use the NSS data for this information. The reason is that the accuracy of the IHDS labor market outcomes (and the methodology used to measure these outcomes) is often questioned. The issue can be illustrated by simply noting that while estimates based on almost all Indian household-level surveys (including those specifically designed to measure labor market outcomes) suggest that women's labor force participation rate in 2011-2012 was around 30%, estimates based on the the IHDS suggest that the figure was more than 40%.

schools, number of hospitals (allopathic), number of maternity and child welfare centres, number of primary health centres, availability of drinking water facility, and number of commercial banks.

3.2 Analytic Samples

We create two analytic samples. The first is created by merging the (women module of) IHDS panel data with administrative data on roads construction. The second sample is created by merging the NSS repeated cross-sections with administrative data on roads construction. As mentioned in the introduction the women module in the IHDS only includes women who are currently married or were married in past. The IHDS-based analytic sample that we construct only includes rural women who are above the age of 18. In the NSS-based analytic sample we include rural women (married and unmarried) between the age of 18 and 65.[7] These restrictions imply that both the analytic samples are necessarily smaller in size as compared to their parent sample (IHDS panel or NSS repeated cross-sections).

Tables 2 provides the summary statistics of all the outcome variables used in our analysis. Table 3 provides the summary statistics of the independent variable of interest, individual/household-level controls and district-level controls. For a given variable, 'Obs' denotes the total number of cases (individuals or districts) in our analytic sample for which this variable takes a valid value. This, as evident, is not constant across the outcomes or controls since there are missing as well as invalid responses for some of the questions. Note, as discussed in the next section, our analysis based on the IHDS based analytical sample precludes us from using time invariant individual/household level controls like caste and religion; hence, we do not report the summary statistics of these variables in Table 3. The spatial distribution of percentage of district's population exposed to PMGSY roads upto 2004 and 2010 is reported in Figures 1 and 2, respectively.

[7] We use an upper bound of 65 years for the NSS-based analytic sample because the it is used to examine employment related outcomes.

4 Empirical Model

Ideally, we would like to exploit the program rule that uses village population threshold to determine eligibility in a Regression Discontinuity Design (RDD) Framework for identification. However, the IHDS, which is the main source of our outcome variables, unfortunately, does not have village-level identifiers; the smallest geographical identifier that is available is the district. Therefore, we aggregate the roads data to the district level and instead employ a two-way fixed effects estimation strategy exploiting the panel structure of IHDS data to identify the effect of road construction on women outcomes. Specifically, for any female outcome of interest y, we estimate the following regression model:

$$y_{idt} = \alpha_i + \gamma_t + \beta PopExposed_{dt} + \delta X_{idt} + \varepsilon_{idt},\ t = 2005,\ 2011 \tag{1}$$

where subscript i denotes individual; d denotes districts; t denotes survey year; $PopExposed_{dt}$ measures that percentage of district d's 2001 population that resides in a village that received a PMGSY road between the years 2001 and t (i.e., percentage of district d's 2001 population that resides in a village that received a PMGSY road from the start of the program upto $t-1$); X_{idt} is the vector of time varying individual/household level demographics including age of respondent, household size, annual household consumption expenditure, and asset score; α_i is the individual or household fixed effect; γ_t is the survey year fixed effect; and ε_{idt} is the random error term. We cluster the standard error at the district level. Inclusion of α_i enables us to control for time-invariant unobservables which vary across households (e.g., customs, culture, etc.); they also account for time-invariant unobservables at the village, district and state level (e.g., social norms) because all women are located in the same village across the two survey rounds in the IHDS panel sample. γ_t allows us to control for survey year specific shocks.

Our coefficient of interest, β, shows how individuals' outcomes vary in response to variations in the percentage of population that received a road in their district of residence. It is

worth keeping in mind here that the due to the PMGSY program rule, the variation in the percentage of population receiving roads in each district is primarily a function of variation in the distribution of sizes of unconnected villages in each district. While in theory only population was the determining factor for rural roads construction, we acknowledge that in practice, factors other than population could be playing a role in selection into the treatment and some of those could have implications for women outcomes. For example, there could be village-level initial public goods or existing policy interventions that influence provision of a paved road in a village. While we cannot completely rule out these concerns, a couple of things are worth noting in this context. First, we include individual/household level time varying observables; this should account for village level time varying unobservables to the extent they are correlated with individual/household level time varying observables. Second, as discussed earlier Aggarwal (2018) shows that there is a discontinuous jump in the probability of road construction by 2010 around the village population of 500 and 1000 (recall, these are the population cutoffs which determine provision of roads under PMGSY); and the initial provision of public goods (i.e., public goods in 2001) at the village level is not correlated with likelihood of road construction by 2011. These observations increase our confidence that program rule was followed in rural roads construction. Nevertheless, in section 5.2, in addition to the baseline controls, we include controls for a host of district level provision of public services and village level presence of redistributive policies and public goods and re-estimate our main regression model to allay concerns regarding systematic selection into treatment.

As mentioned earlier, in addition to the IHDS, we use the 61st and 68th rounds of NSS to examine the impact of rural roads construction on education and employment outcomes for women. Towards that end, we re-estimate (1) using this dataset for females. However, unlike the IHDS, NSS does not survey the same individuals/households in the two periods; hence we cannot use individual fixed to control for time-invariant individual heterogeneity. Instead, we include district fixed effects θ_d and for any outcome of interest y, we estimate

the following regression model:

$$y_{idt} = \alpha + \beta PopExposed_{dt} + \delta X_{idt} + \theta_d + \gamma_t + \varepsilon_{idt},\ t = 2005,\ 2011. \quad (2)$$

All notations of Equation (2) are identical to Equation (1). However X_{idt} is now a vector of time varying as well as time-invariant individual/household level controls (such as caste and religion of household head).[8]

5 Results

5.1 Main Results

The main results are presented in Tables 4 to 7. We start by examining the effect of road construction on three indicators of restrictions on female mobility (Table 4, Columns 1-3). We find that the estimated coefficient of *PopExposed* is negative and highly statistically significant in all the three regressions (at 5% or lower level of significance) suggesting that higher exposure to roads reduces the likelihood that women need permission to go to the health center, friend's home and Kirana shop. The estimated effects are also large: specifically, a 10% increase in population's exposure to roads in a district decreases women's likelihood to need permission to visit the health center, friends' home and Kirana shop by 5, 8, and 8 percentage points (p.p.) respectively. These represent a 6, 10 and 14% increase as compared to baseline (2005) average.

Columns 4-8 in Table 4 present the estimated effect of road construction on norms regarding domestic violence. We find that coefficient of road construction is negative and statistically effect (at 1% level of significance) in four of the five cases. This suggests that road construction reduces the likelihood of women saying the domestic violence is usual in the community under most of the situations considered. In terms of the magnitudes of the

[8]NSS does not report household asset score; hence we use land owned by the household as an indicator of asset.

estimated coefficients, an increase in population's exposure to roads within a district by 10% decreases women's likelihood to say that domestic violence is usual if the wives leave home without taking permission from husbands by 8 p.p, if they bring no dowry during marriage by 8 p.p, if they neglect households by 10 p.p, and if they cook badly by 8 p.p. Compared to the baseline average, these represent a 18% 28%, 28%, and 26% decrease respectively.

The impact of rural roads construction on women's participation in household decision making captured by three indicators are reported in Columns 1-3 of Table 5. The coefficient of *PopExposed* is positive and statistically significant (at 10% level of significance) for only the second indicator suggesting an increase in population's exposure to roads within a district by 10% increases women's likelihood to participate in discussion regarding household expenditure by 7 p.p. (which, compared to the baseline average, represents a 15% increase). We do not find any statistically significant effect of road construction on women's likelihood to participate in discussion regarding work related issues as well as political issues.

The effect of rural roads on women's fertility preferences are reported in Columns 4 and 5 of Table 5. The estimated coefficients indicate that a rise in population's exposure to roads within a district by 10% reduces the desired number of children by 0.07 which means the desired number of children, on average, falls from 2.49 to 2.42 (thus representing a reduction by 2.8% in the desired number of children as compared to the average). However, we do not find any effect on son preference.

We next turn to results pertaining to the financial autonomy of women (Table 5, Columns 6-8). We find that the coefficient of *PopExposed* is statistically significant in the regression reported in column (6). The estimated coefficient suggests that an increase in population's exposure to roads within a district by 10% increases women's likelihood to have cash in hand to spend on household expenditures by 4 p.p. (compared to the baseline average, this represents a 5% increase). However, we do not find any effect of increase in exposure to paved roads on the likelihood of women having a bank accounts and on the likelihood of women's name being there on home ownership or rental papers.

Table 6 presents the estimated effects of road construction on women's role in household decision making. The results obtained are mixed. While road construction increases women's decision making power with respect to animal care (column (6)), it does not alter women's decision making power with respect to cooking decisions, decisions during child sickness and decisions about children's wedding (columns (1), (4), (5)), and it infact reduces women's decision making power with respect to household purchases and number of children (columns (2) and (3)). Specifically, the estimated coefficients indicate that a rise in population's exposure to roads within a district by 10% increases women's likelihood to make decisions regarding animal care by 6 p.p., and decreases women's likelihood to make decisions regarding household purchases and number of children by 1 p.p. and 3 p.p. respectively.

The effect of road construction on several miscellaneous gender norms, and women's ability to converse in English language are considered in Table 7. We find that coefficient of *PopExposed* is negative and statistically significant (at 1% level of significance) when the outcome variable indicates whether men in the family take meal first. In terms of the magnitudes of the estimated coefficient, this suggests that a rise in population's exposure to roads within a district by 10% decreases the likelihood of men taking the meal first by 5p.p. As compared to the baseline average, this represents a 14% decrease. Rural roads construction seems to have no effect on norms regarding practice of veil, norms regarding women visit to their natal family, and women's ability to speak in English.

Table 8 reports the results of the regression that examines the link between road construction and women's education. The estimated coefficient in the first column suggests that an increase in population's exposure to roads within a district by 10% increases women's likelihood of attending an educational institution by 2 p.p. Compared to the average, this represents a 6% rise in women's likelihood of attending an educational institution. The coefficient in the second column, however, suggests there is no impact of an increase in population's exposure to roads within a district on women's likelihood of attending technical education institutes.

Table 9 reports the impact of road construction on different indicators of women's employment. The coefficient of *PopExposed* is statistically and economically significant for the regression reported in column (6) only. The estimated coefficient suggest that a 10% increase in population's exposure to roads within a district increases women's likelihood of working in a job that provides social security benefits by 4 p.p. (as compared to the average, this represent a 16% increase). An increase in population's exposure to roads within a district does not seem to have any effect on any other labor market outcome of women.

5.2 Robustness checks

A potential endogeneity concern is that construction of rural roads under PMGSY was influenced by underlying village/district characteristics which can differentially affect women outcomes. While existing work has shown that policy roll-out was only a function of the population of villages within a district, we conduct robustness tests to ensure that the reported outcomes for women are driven by the PMGSY roll out and not other confounding factors. We do so by re-estimating equation 1 after adding the interaction between survey year and a series of district characteristics (mainly public goods) as per 2001 census. These interactions allow us to partial out the impact that initial public goods can have on women outcomes over time. The public goods included are the number of primary schools, number of middle schools, number of secondary schools, number of senior secondary schools, number of hospitals (allopathic), number of maternity and child welfare centres, number of primary health centres, availability of drinking water facility, and number of commercial banks. In addition, we also control for district characteristics like literacy rate, female literacy rate, work participation rate and female work participation rate.

Appendix tables A.1 to A.4 report the results for IHDS outcomes after controlling for census 2001 district level characteristics interacted with year trend. Our findings confirm that even after controlling for public goods provision, our coefficients mostly remain the same in comparison with Tables 4 to 7 (if anything, the coefficients are larger). Panel A of

Tables A.5 and A.6 that report the results for education and employment outcomes after controlling for district level public goods also suggest that our results are robust to inclusion of district level public goods controls.

While the district level controls allay endogeneity concerns to an extent, the PMGSY was rolled out at the village level and therefore we would like to ensure that village level factors like public services, policies active in the village are not confounding the effect of PMGSY. Even though our empirical specification allows us to control for village specific time invariant factors (equation 1), time varying factors that are potentially correlated with PMGSY exposure could be a concern. As mentioned earlier, IHDS has a separate village level model that has information on amenities that the village has. We use this information and control for village level availability of public goods like schools, health centers, whether the village has an active widow pension scheme, food security program (annapurna program), program to promote education and skill development in the youth, maternity benefit scheme, housing, safe drinking water, sanitation and street and lighting programs. The results reported in Panel B of Tables A.1 to A.4 however show that our coefficients only marginally change after inclusion of village level time-varying controls.

5.3 Discussion

Our results clearly suggest increase in exposure to paved rural roads lowers mobility restrictions faced by women and improves norms around domestic violence. However, the result are largely mixed with respect to participation of women in discussion with husbands, fertility preference and financial autonomy. In line with the findings of (Adukia, Asher and Novosad, 2020) and (Shimamura, Shimizutani, Yamada and Yamada, 2023), we find that road exposure increases the likelihood of females being currently enrolled in education institutes. However, the improvement in education is not accompanied with increase in female employment. Specifically, the increase in exposure to paved roads does not increase participation of women in labour force or wage employment. This is consistent with the findings

of Shimamura, Shimizutani, Yamada and Yamada (2023) who find no effect of rural roads construction on female self employment or wage employment. Overall, our findings suggest that the impact of construction of rural roads on gender norms and female empowerment is mixed.

These results are puzzling and we examine what could be the reason for these mixed results? A possibility is that like many other government policies, PMGSY has gendered effect benefiting men more than women. If that is the case the gap between socio-economic status of men and women might not necessarily reduce and thus while rural roads construction might be changing norms regarding gender roles, the extent of change might be only partial. In other words, rural roads construction might not be leading to a complete overhaul of the existing gender norms. That might potentially be why we observe women being empowered along some dimensions but not others.

To check whether that is the case, we examine the male-female differential in education and labor market indicators pooling data on both males and females from the NSS: We estimate the following regression equation

$$y_{idt} = \alpha + \beta PopExposed_{dt} + \tau(PopExposed_{dt} \times Fem_{idt}) + \delta X_{idt} + \theta_d + \gamma_t + \varepsilon_{idt},\ t = 2005,\ 2011. \tag{3}$$

where Fem_{idt} is a dummy variable taking value 1 if the individual is a female and 0 otherwise. In this equation the effect of road construction on outcomes for females is given by $\beta + \tau$, and that for males is given by β. Thus, the coefficient of the interaction term, τ, measures the difference in these two effects: if $\tau > 0$, the effect of road construction is stronger for females than males; if $\tau < 0$, the effect is stronger for males than females.[9]

Table 10 reports the results for educational outcomes. For both the outcome variables, the magnitude of the coefficient of the interaction term is zero. This suggests that the effect

[9]We do not estimate Equation (3) using the IHDS because the outcomes that come from the survey are not relevant for men, and hence they are available only for women.

of roads construction on the educational status of young children does not differ by gender. Importantly, it is not the case the roads construction benefits boys more than girls.

On the other hand, Table 11 which reports the results for the labour market indicators, shows that the coefficient of the interaction term is either negative or zero. This is a striking result suggesting that increase in access to paved roads does not benefit women more than men in terms of labour market outcomes. In fact, men seem to benefiting significantly more than women in terms of most of the outcomes considered. Specifically, women are 5 p.p. less likely to be employed and 6 p.p. less likely to participating in the labor force as compared to men. Further, compared to men, women are 3 p.p. less likely to be engaged in casual employment and subsidiary employment, 2 p.p. less likely to be engaged in self-employment and 3 p.p less likely to engaged in subsidiary employment. These results suggest that the effect of access to paved roads construction is gendered: men unequivocally benefit more from access to paved roads than women at least in terms of labour market outcomes. This finding helps explain the lack of strong impact on outcomes for women post rural roads construction. The improvement in indicators of mobility for women could be on account of men moving out for work and women not having to seek men's permission to move outside their homes. However, data limitations preclude the possibility of a conclusive evidence on this.

6 Conclusion

Mobility restrictions caused by infrastructure inadequacies have been shown to be particularly harmful for conduct of economic activities. Females, who have historically faced constraints to their participation in employment activities and decision making, are particularly at a disadvantage due to spatial isolation. The paper examines the impact of a flagship government of India policy that connected villages to the nearest market centers through an all-weather road on women socio-economic outcomes. Our findings indicate that while

women experience lower mobility restrictions and improved norms related to IPV, there is absence of any impact on financial autonomy and infact there is negative impact on decision making within household. We also find mixed results when we look at the impact of rural roads on education and employment. While access to rural roads improves education outcomes, there is no impact on employment outcomes for women. Our findings suggest that a part of this reason could be that men gain more, in terms of employment, than women from the exposure to connected rural roads. These results indicate that even the gender-neutral policies like road construction programs can have gendered impact where the benefit is likely to accrue more to men than women. A policy implication that follows is that policy makers must pay special attention to ensuring that women are not left behind and become equal beneficiaries of government policies.

References

Adukia, Anjali, Sam Asher, and Paul Novosad, "Educational investment responses to economic opportunity: evidence from Indian road construction," *American Economic Journal: Applied Economics*, 2020, *12* (1), 348–76.

Afridi, Farzana, Monisankar Bishnu, and Kanika Mahajan, "What determines women's labor supply? The role of home productivity and social norms," *Journal of Demographic Economics*, 2022, pp. 1–33.

Aggarwal, Shilpa, "Do rural roads create pathways out of poverty? Evidence from India," *Journal of Development Economics*, 2018, *133*, 375–395.

_ , "The long road to health: Healthcare utilization impacts of a road pavement policy in rural India," *Journal of Development Economics*, 2021, *151*, 102667.

Alder, Simon, "Chinese roads in India: The effect of transport infrastructure on economic development," *Available at SSRN 2856050*, 2016.

Asher, Sam and Paul Novosad, "Rural roads and local economic development," *American economic review*, 2020, *110* (3), 797–823.

Asturias, Jose, Manuel García-Santana, and Roberto Ramos, "Competition and the welfare gains from transportation infrastructure: Evidence from the Golden Quadrilateral of India," *Journal of the European Economic Association*, 2019, *17* (6), 1881–1940.

Bankar, Shweta, Martine Collumbien, Madhumita Das, Ravi K Verma, Beniamino Cislaghi, and Lori Heise, "Contesting restrictive mobility norms among female mentors implementing a sport based programme for young girls in a Mumbai slum," *BMC public health*, 2018, *18*, 1–11.

Charmes, Jacques, "The Unpaid Care Work and the Labour Market. An analysis of time use data based on the latest World Compilation of Time-use Surveys," *International Labour Office–Geneva: ILO*, 2019.

Chaudhary, Latika and James Fenske, "Railways, development, and literacy in India," *Journal of Economic History*, 2023.

Dasgupta, Aparajita, Anahita Karandikar, and Devvrat Raghav, "Road Access, Fertility and Child Health in Rural India," *Fertility and Child Health in Rural India (October 14, 2022)*, 2022.

Duchène, Chantal, "Gender and transport," 2011.

Field, Erica and Kate Vyborny, "Women's Mobility and Labor Supply: Experimental Evidence from Pakistan," *Asian Development Bank Economics Working Paper Series*, 2022, (655).

Ghani, Ejaz, Arti Grover Goswami, and William R Kerr, "Highway to success: The impact of the Golden Quadrilateral project for the location and performance of Indian manufacturing," *The Economic Journal*, 2016, *126* (591), 317–357.

Goel, Rahul, "Gender gap in mobility outside home in urban India," *Travel Behaviour and Society*, 2023, *32*, 100559.

Khandker, Shahidur R, Zaid Bakht, and Gayatri B Koolwal, "The poverty impact of rural roads: Evidence from Bangladesh," *Economic development and cultural change*, 2009, *57* (4), 685–722.

Kishor, Sunita and Kamla Gupta, "Women's empowerment in India and its states: evidence from the NFHS," *Economic and Political weekly*, 2004, pp. 694–712.

Lei, Lei, Sonalde Desai, and Reeve Vanneman, "The impact of transportation infrastructure on women's employment in India," *Feminist economics*, 2019, *25* (4), 94–125.

Lokshin, Michael and Ruslan Yemtsov, "Has rural infrastructure rehabilitation in Georgia helped the poor?," *The World Bank Economic Review*, 2005, *19* (2), 311–333.

Mehrotra, Santosh and Jajati K Parida, "Why is the labour force participation of women declining in India?," *World Development*, 2017, *98*, 360–380.

_ **and Sharmistha Sinha**, "Explaining falling female employment during a high growth period," *Economic and Political Weekly*, 2017, pp. 54–62.

Nayak, Purusottam and Bidisha Mahanta, "Women empowerment in India," *Bulletin of Political Economy*, 2012, *5* (2), 155–183.

Raney, Terri, Gustavo Anríquez, André Croppenstedt, Stefano Gerosa, Sarah K Lowder, Ira Matuschke, and Jakob Skoet, "The role of women in agriculture," 2011.

Ratheesh, C and V Anitha, "Gender Disparity in Invisible Economy: Lessons from Indian Time Use Survey," *The Indian Journal of Labour Economics*, 2022, *65* (2), 463–481.

Roberts, Mark, Theophile Bougna, Martin Melecky, and Yan Xu, "Transport corridors and their wider economic benefits: A critical review of the literature," *World Bank Policy Research Working Paper*, 2018, (8302).

Salon, Deborah and Sumila Gulyani, "Mobility, poverty, and gender: travel 'choices' of slum residents in Nairobi, Kenya," *Transport Reviews*, 2010, *30* (5), 641–657.

Shamdasani, Yogita, "Rural road infrastructure & agricultural production: Evidence from India," *Journal of Development Economics*, 2021, *152*, 102686.

Shimamura, Yasuharu, Satoshi Shimizutani, Eiji Yamada, and Hiroyuki Yamada, "The gendered impact of rural road improvement on schooling decisions and youth employment in Morocco," *The Journal of Development Studies*, 2023, *59* (3), 413–429.

7 Tables and figures

Table 1: Description of Outcome Variables

Category	Survey Question	Outcome Variable
I. Female mobility	Do you have to ask permission of your husband or a senior family member to go to the local health center? (Yes/No)	HealthCentreVis (=1 if yes)
	Do you have to ask permission of your husband or a senior family member to go to the home of relatives and friends (in the village/neighborhood)? (Yes/No)	FriendHomeVis (=1 if yes)
	Do you have to ask permission of your husband or a senior family member to go to the Kirana Shop? (Yes/No)	KiranaShopVis (=1 if yes)
II. Norms regarding domestic violence	In your community is it usual for husbands to beat their wives if she goes out without telling him? (Yes/No)	LeaveWoPerm (=1 if yes)
	In your community is it usual for husbands to beat their wives if he suspects her of having relations with other men? (Yes/No)	ExtraMarrAff (=1 if yes)
	In your community is it usual for husbands to beat their wives if her natal family does not give expected money, jewelry or other items (dowry)? (Yes/No)	NoDowry (=1 if yes)
	In your community is it usual for husbands to beat their wives if she neglects the house or the children? (Yes/No)	HouseNglct (=1 if yes)
	In your community is it usual for husbands to beat their wives f she doesn't cook food properly? (Yes/No)	BadCooking (=1 if yes)
III. Participation in household discussion	Do you and your husband talk about things that happen at work/on the farm? (Yes/No)	WorkDiscuss (=1 if yes)
	Do you and your husband talk about about what to spend money on? (Yes/No)	ExpDiscuss (=1 if yes)
	Do you and your husband talk about things that happen in the community such as elections or politics? (Yes/No)	PolitDiscuss (=1 if yes)
IV. Fertility preferences	Desired number of children	DesirChild
	Number of sons desired by a woman is more than the number of daughters? (Yes/No)	SonPref (=1 if yes)
V. Financial autonomy	Do you yourself have any cash in hand to spend on household expenditures? (Yes/No)	CashInHand (=1 if yes)
	Is your name there on any bank account? (Yes/No)	BankAccount (=1 if yes)
	Is your name on the ownership or rental papers for your home? (Yes/No)	HousePaper (=1 if yes)
VI. Decision making with households	Who in your family decides what to cook on a daily basis?	Cooking (=1 if respondent)
	Who in your family decides whether to buy an expensive item such as a TV or fridge?	HHPurchase (=1 if respondent)
	Who in your family decides how many children you have?	NumChildren (=1 if respondent)
	Who in your family decides what to do if your child falls sick?	ChildIllness (=1 if respondent)
	Who in your family decides how much money to spend on a social function such as marriage?	ChildWedding (=1 if respondent)
	Who in the household help take care of the animals in the last 12 months?	Animal Care (=1 if respondent)
VI. Miscelleneous norms	Do you practice ghungat / burkha/ purdah/ pallu? (Yes/No)	Purdah (=1 if yes)
	When your family takes the main meal, do men eat first by themselves? (Yes/No)	MenMealFirst (=1 if yes)
	Do you visit members from natal family once a year/less than once a year? (Yes/No)	NatalVisit (=1 if yes)
	Can you converse in English at least a little? (Yes/No)	English (=1 if yes)
VII. Education	Are you currently attending any education institution (Yes/No)	Attending edu inst (=1 if yes)
	Are you currently attening any technical education institution (Yes/No)	Attending tech inst (=1 if yes)
VIII. Employment	Are you currently employed (Yes/No)	Employed (=1 if yes)
	Are you currently in labour force (Yes/No)	Inlabforce (=1 if yes)
	Are you currently working as a wage employee (Yes/No)	Wageemployee (=1 if yes)
	Are you currently working as a casuallabor (Yes/No)	Casuallabor (=1 if yes)
	Are you currently selfemployed (Yes/No)	Selfemployed (=1 if yes)
	Does your job provide you with social security benefits (Yes/No)	Socialsecurity (=1 if yes)
	Are you currently employed in a subsidiary employment (Yes/No)	Subsidiary (=1 if yes)

Table 2: Summary statistics

Variable	Obs	Mean	Std. Dev.	Mean (2005)	Mean (2011)
Outcome Variables (IHDS)					
HealthCentreVis	31,674	0.78	0.41	0.79	0.78
FriendHomeVis	31,485	0.74	0.44	0.78	0.69
KiranaShopVis	26,162	0.58	0.49	0.58	0.57
LeaveWoPerm	31,748	0.49	0.50	0.43	0.56
ExtrMarAff	31,720	0.88	0.33	0.89	0.86
NoDowry	31,745	0.32	0.46	0.29	0.34
HouseNglct	31,755	0.40	0.49	0.36	0.45
BadCooking	31,743	0.33	0.47	0.31	0.34
WorkDiscuss	30,912	0.42	0.49	0.39	0.45
ExpDiscuss	30,926	0.51	0.50	0.48	0.53
PolitDiscuss	30,911	0.20	0.40	0.19	0.21
DesirChild	30,023	2.55	0.99	2.49	2.60
SonPref	27,760	0.29	0.45	0.30	0.28
CashInHand	31,776	0.87	0.34	0.80	0.93
BankAccount	15,638	0.53	0.50	0.42	0.58
HousePaper	30,630	0.16	0.37	0.15	0.18
Cooking	31,686	0.73	0.44	0.73	0.74
HHPurchase	31,589	0.11	0.31	0.09	0.12
NumChildren	30,671	0.21	0.40	0.16	0.25
ChildIllness	31,001	0.29	0.45	0.28	0.30
ChildWedding	30,813	0.11	0.32	0.08	0.14
AnimalCare	19,765	0.45	0.50	0.41	0.48
Purdah	31,779	0.60	0.49	0.59	0.61
Menmealfirst	31,733	0.33	0.47	0.37	0.28
English	31,546	0.09	0.29	0.07	0.11
Outcome Variables (NSS)					
Attending edu inst	1,57,340	0.40	0.49	0.36	0.46
Attending tech inst	2,89,349	0.01	0.08	0.01	0.01
Employed	1,77,951	0.38	0.49	0.42	0.32
Inlabforce	1,77,951	0.40	0.49	0.44	0.33
Wageemployee	1,77,951	0.02	0.16	0.02	0.03
Casuallabor	1,77,951	0.12	0.33	0.14	0.10
Selfemployed	1,77,951	0.24	0.42	0.27	0.19
Socialsecurity	8,416	0.26	0.44	0.25	0.26
Subsidiary	1,82,923	0.28	0.45	0.31	0.23

Notes: Source: Author's own calculations. The IHDS sample consists of women above the age of 18 living in rural areas. The NSS sample consists of rural women between the age of 18 and 65 for employment related questions.

Table 3: Summary statistics

Variable	Obs	Mean	Std. Dev.
Independent variable			
Exposed pop (till 2004)	464	5.9	5
Exposed pop (till 2010)	465	14.3	13
Exposed pop (average)	929	10.1	10.7
Controls (IHDS)			
HH size	31,839	5.58	2.46
Age	31,839	36.58	8.96
HH cons exp	31,825	98764.04	95022.22
Initial wealth	31,835	11.70	5.69
Controls (NSS)			
HH size	1,82,923	5.81	3.05
ST	1,82,923	0.09	0.29
SC	1,82,923	0.19	0.39
OBC	1,82,923	0.44	0.50
Hindu	1,82,923	0.84	0.37
Muslim	1,82,923	0.09	0.28
Age	1,82,923	36.77	12.92
Land Owned	1,76,831	1233.86	2533.20
Monthly cons exp	1,82,923	219.38	190.44
Married	1,82,911	0.92	0.27
Controls (census)			
Literacy rate	473	59.3	12.7
Female literacy rate	473	46	15
Work participation rate	473	43.3	7.7
Female work participation rate	473	33.3	12.8
Primary schools	477	1.01	0.64
Middle schools	477	0.29	0.22
Secondary schools	477	0.11	0.09
Senior secondary schools	477	0.03	0.04
Hospitals	477	0.01	0.02
Maternity and child welfare centers	477	0.05	0.06
Primary health centers	477	0.03	0.02
Drinking water facility	477	0.99	0.01
Commercial Banks	477	0.05	0.06

Notes: Source: Author's own calculations.

Table 4: Mobility restrictions and Domestic violence

	Mobility			**Domestic violence**				
	(1) HealthCentreVis	(2) FriendHomeVis	(3) KiranaShopVis	(4) LeaveWoPerm	(5) ExtrMarAff	(6) NoDowry	(7) HouseNglct	(8) BadCooking
Exposed pop	-0.005***	-0.008***	-0.008***	-0.008***	0.001	-0.008***	-0.010***	-0.008***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.54)	(0.00)	(0.00)	(0.00)
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	31657	31469	26150	31731	31703	31728	31738	31726

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Participation in discussion, fertility and financial autonomy

	Participation in discussion			**Fertility**		**Financial autonomy**		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	WorkDiscuss	ExpDiscuss	PolitDiscuss	DesirChild	SonPref	CashInHand	BankAccount	HousePaper
Exposed Pop	0.001	0.007*	0.002	-0.007**	-0.000	0.004*	-0.001	0.000
	(0.71)	(0.08)	(0.32)	(0.04)	(0.92)	(0.05)	(0.71)	(0.98)
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	30895	30909	30894	30009	27749	31759	15614	30613

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Household decision making

	(1) Cooking	(2) HHPurchase	(3) NumChildren	(4) ChildIllness	(5) ChildWedding	(6) AnimalCare
Exposed pop	-0.002	-0.001^{+}	-0.003**	0.003	0.000	0.006***
	(0.27)	(0.11)	(0.01)	(0.20)	(0.67)	(0.00)
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
N	31670	31572	30654	30984	30796	19762

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Miscellaneous gender outcomes

	(1) Purdah	(2) menmealfirst	(3) natalvisit	(4) English
Exposed pop	-0.001	-0.005***	-0.001	0.001
	(0.24)	(0.00)	(0.32)	(0.24)
Individual FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	31762	31716	30707	31531

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Rural roads and education outcomes for females

	(1) Attending edu inst	(2) Attending tech inst
Exposed pop	0.002***	0.000**
	(0.00)	(0.01)
District FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
Observations	151433	279572

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Rural roads and female employment

	(1) Employed	(2) inlabforce	(3) wageemployee	(4) casuallabor	(5) selfemployed	(6) socialsecurity	(7) subsidiary
Exposed pop	0.000	0.000	0.000*	-0.000	0.000	0.004***	0.001
	(0.61)	(0.71)	(0.10)	(0.61)	(0.50)	(0.00)	(0.18)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	171998	171998	171998	171998	171998	7705	176821

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Differential impact: Rural roads and education outcomes

	(1) Attending edu inst	(2) Attending tech inst
Exposed pop	0.002***	0.000
	(0.00)	(0.77)
Female	0.014***	-0.012***
	(0.00)	(0.00)
Fem × Exposed pop	-0.000*	0.000***
	(0.07)	(0.00)
District FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
Observations	314913	572052

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Differential impact: Rural roads and employment

	(1) Employed	(2) inlabforce	(3) wageemployee	(4) casuallabor	(5) selfemployed	(6) socialsecurity	(7) subsidiary
Exposed pop	0.003***	0.003***	0.000	0.002***	0.001	0.000	0.002***
	(0.00)	(0.00)	(0.52)	(0.00)	(0.31)	(0.62)	(0.01)
Female	-0.538***	-0.534***	-0.084***	-0.131***	-0.323***	-0.005	-0.017
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.70)	(0.17)
Fem × Exposed pop	-0.005***	-0.006***	0.000	-0.003***	-0.002**	0.000	-0.003***
	(0.00)	(0.00)	(0.87)	(0.00)	(0.01)	(0.71)	(0.00)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	341248	341248	341248	341248	341248	47939	355141

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Rural population exposed to PMGSY as of 2004

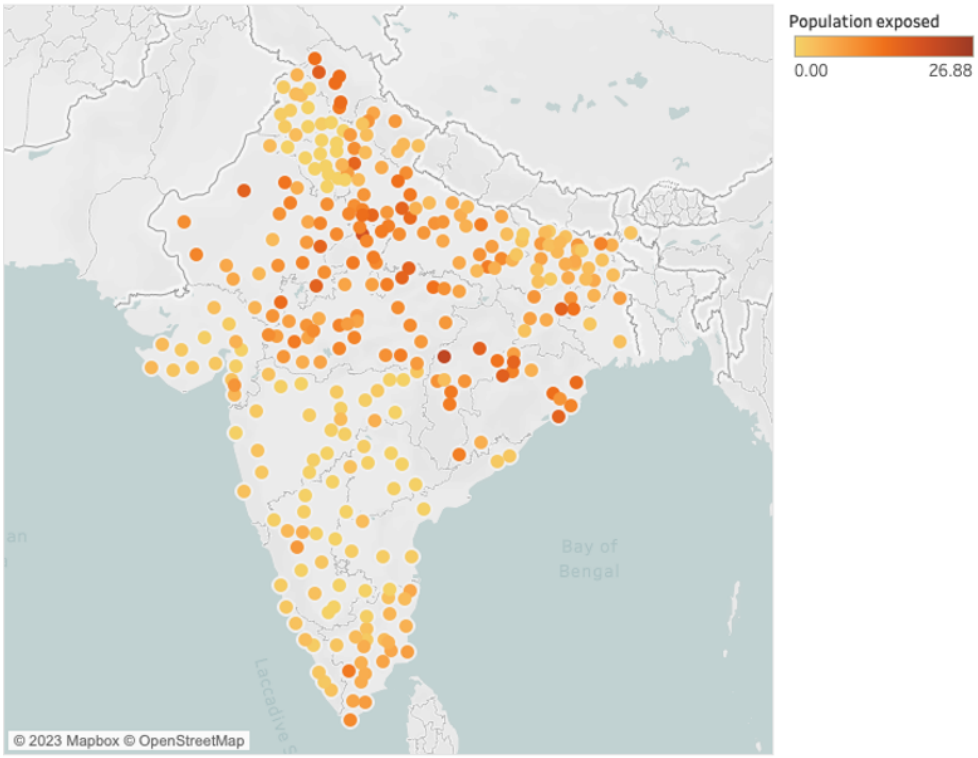
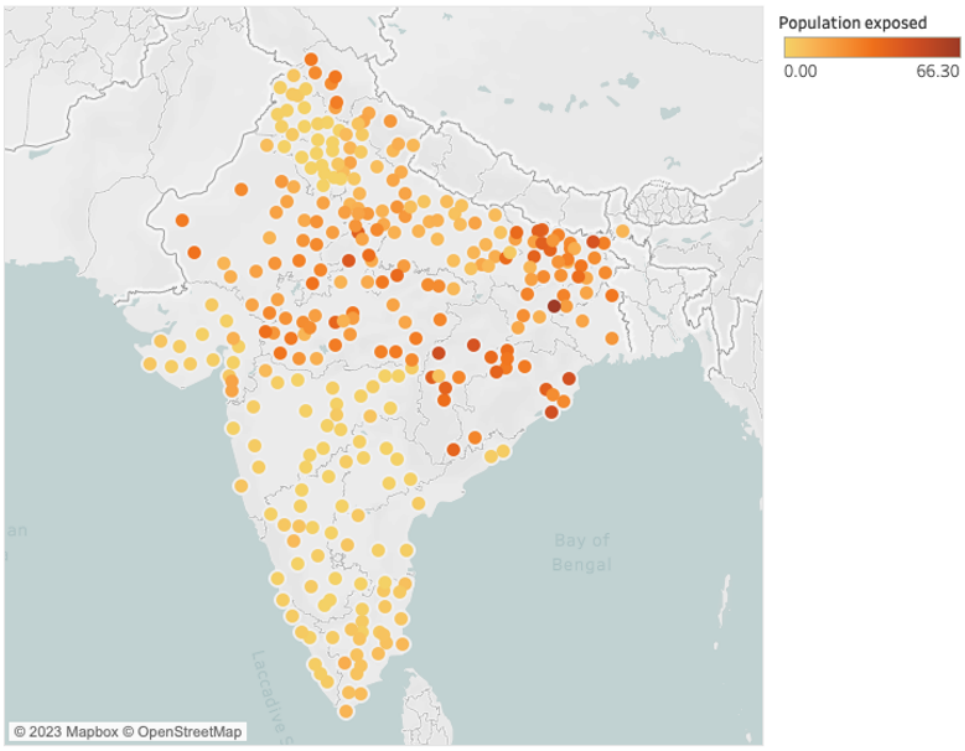


Figure 2: Rural population exposed to PMGSY as of 2010



8 Appendix

Table A1: Mobility restrictions and domestic violence

	(1) HealthCentreVis	(2) FriendHomeVis	(3) KiranaShopVis	(4) LeaveWoPerm	(5) ExtrMarAff	(6) NoDowry	(7) HouseNglct	(8) BadCooking
				Panel A - District Controls				
Exposed Pop	-0.005***	-0.009***	-0.008**	-0.011***	0.001	-0.009***	-0.012***	-0.010***
	(0.01)	(0.00)	(0.01)	(0.00)	(0.75)	(0.00)	(0.00)	(0.00)
N	31657	31469	26150	31731	31703	31728	31738	31726
				Panel B - Village Controls				
Exposed pop	-0.005***	-0.009***	-0.008***	-0.010***	0.001	-0.007***	-0.010***	-0.009***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.69)	(0.01)	(0.00)	(0.00)
N	30515	30328	25137	30586	30560	30586	30594	30583
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Participation in discussion and Fertility and Financial Autonomy

	(1) WorkDiscuss	(2) ExpDiscuss	(3) PolitDiscuss	(4) DesirChild	(5) SonPref	(6) CashInHand	(7) BankAccount	(8) HousePaper
				Panel A - District controls				
Exposed pop	0.001	0.007*	0.002	-0.007**	-0.000	0.004*	-0.001	0.000
	(0.71)	(0.08)	(0.32)	(0.04)	(0.92)	(0.05)	(0.71)	(0.98)
N	30895	30909	30894	30009	27749	31759	15614	30613
				Panel B - Village controls				
Exposed pop	0.001	0.006+	0.002	-0.007**	0.000	0.003*	-0.001	0.001
	(0.79)	(0.11)	(0.35)	(0.03)	(0.69)	(0.06)	(0.75)	(0.69)
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	29778	29792	29779	28927	26829	30615	14938	29489

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Household decision making

	(1) Cooking	(2) HHPurchase	(3) NumChildren	(4) ChildIllness	(5) ChildWedding	(6) AnimalCare
			Panel A - District Controls			
Exposed pop	-0.002	-0.001**	-0.004**	0.001	-0.000	0.006***
	(0.40)	(0.05)	(0.01)	(0.67)	(0.99)	(0.00)
N	31686	31589	30671	31001	30813	19765
			Panel B - Village Controls			
Exposed pop	-0.002	-0.002**	-0.005***	0.001	-0.000	0.006***
	(0.34)	(0.03)	(0.00)	(0.79)	(0.99)	(0.00)
N	30535	30435	29543	29888	29720	19321
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.
$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Miscellaneous gender outcomes

	(1) Purdah	(2) menmealfirst	(3) natalvisit	(4) English
		Panel A - District Controls		
Exposed pop	-0.000	-0.006***	-0.002	0.002***
	(0.85)	(0.00)	(0.21)	(0.01)
N	31779	31733	30724	31546
		Panel B - Village controls		
Exposed pop	0.000	-0.006***	-0.002	0.002***
	(0.78)	(0.01)	(0.18)	(0.01)
Individual FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
N	30617	30573	29621	30387

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Rural roads and education outcomes for females

	(1) Attending edu inst	(2) Attending tech inst
Exposed pop	0.002***	0.000^{+}
	(0.00)	(0.14)
District FE	Yes	Yes
Year FE	Yes	Yes
Controls	Yes	Yes
District Char X t	Yes	Yes
Observations	150918	278482

p-values in parentheses

Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.

$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Rural roads and female employment

	(1) Employed	(2) inlabforce	(3) wageemployee	(4) casuallabor	(5) selfemployed	(6) socialsecurity	(7) subsidiary
Exposed pop	0.000	-0.000	0.000***	-0.001*	0.000	0.003*	0.002*
	(0.98)	(0.85)	(0.00)	(0.08)	(0.65)	(0.06)	(0.08)
District FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District Char X t	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	171257	171257	171257	171257	171257	7659	176066

p-values in parentheses
Notes: Refer to Table 1 for definition of outcome variables. *Exposedpop* is the percentage of district 2001 population exposed to PMGSY roads. Standard errors are clustered at the district level in all specifications.
$^{+}$ $p < 0.15$, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$