Holding The Fort: Impact of circular male migration on female labor outcomes in rural India

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Abstract

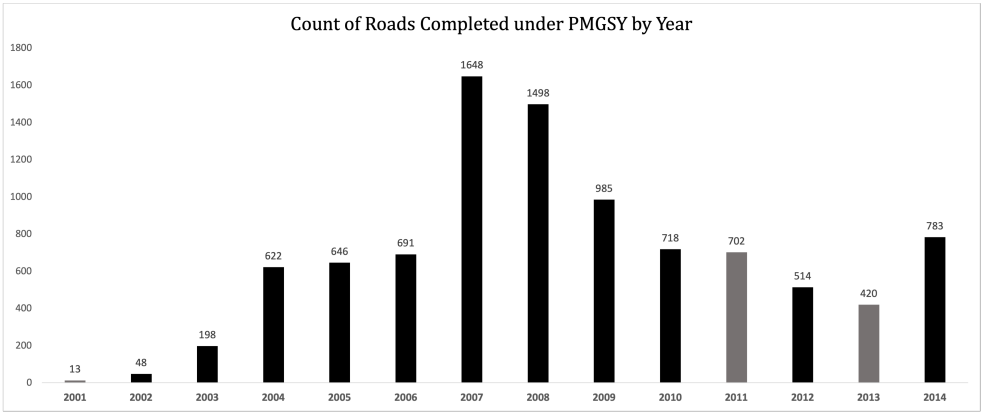
I estimate the impact of large-scale male migration on female labor force participation using the $40 billion National Rural Road Construction Program as a proxy for male out-migration, combined with comprehensive household and firm census data at the village level. In India, where traditional social norms have often constrained women's economic participation, male migration provides a unique lens to explore the evolving gender roles. Understanding how these dynamics influence labor decision making and household welfare is crucial for a comprehensive assessment of the impact of migration on rural communities. I employ a synthetic difference-in-differences estimation technique to analyze this relationship. My findings reveal that male migration positively influences female participation in the labor market, mainly as agricultural workers.

1 Introduction

Seasonal migration is a critical livelihood strategy for millions of people in developing countries, offering opportunities for higher incomes and improved household welfare. In India, this phenomenon is particularly significant, with data from the Indian census showing a 45% increase in internal migration, from 309 million in 2001 to approximately 450 million in 2011. Currently, internal migrants make up 37% of India's population, compared to 30% a decade earlier. The majority of migration is intra-district (62%), followed by inter-district movements within the same state (26%), and only 12% involves crossing state borders. These trends indicate a preference for migration within district and regional boundaries, which is highly sensitive to social networks, local economic development, and infrastructure.

Extensive research has highlighted the role of road infrastructure in facilitating migration flows in developing countries. Recognizing the critical role of connectivity, the Government of India launched the Pradhan Mantri Gram Sadak Yojana (PMGSY) in 2000. By 2015, the program had funded nearly 200,000 all-weather feeder roads with a budget of $40 billion. The figure below illustrates the progress of the program between the 2001 and 2011 population census years and the 2013 economic census round.

Figure 1: Pradhan Mantri Gram Sadak Yojana Progress



Although such infrastructural developments generally affect migration, they also have distinct implications for men and women, as migration in India is deeply gendered. Women account

for 77% of all internal migrants, but their movement is predominantly related to marriage. According to the 2011 census, marriage was the reason for more than 66% of total female migration, most of which involved rural to rural movement. In contrast, men mainly migrated to seek employment, and male migrants comprised 27% of the urban male population in 2011. Their migration was largely directed toward state capitals and rapidly growing Tier 1 and Tier 2 cities, fueled by industrialization and economic growth.

This pattern of temporary male migration, as documented in the 2011 census (Table 1; (Keshri and Bhagat, 2012)), has only increased further in the past decade. Prolonged male absence can have significant implications on households and local communities. This often reshapes the gender division of labor, increasing the workload of women, and making households increasingly dependent on them.

These shifts have profound and multifaceted consequences. On the one hand, remittances from a migrant spouse can significantly increase household income; for example, an agricultural worker earning 35 rupees per day in a semi-arid Indian village could earn 80 rupees per day through urban employment (1 USD = 50 rupees in 2006) (Deshingkar, 2005). This increased income may empower women with greater autonomy in household decision-making. However, it can also introduce new challenges and complexities. These include irregular remittances, increased childcare responsibilities, and social risks such as exposure to crime. In India, where women in economically disadvantaged households have traditionally been confined to domestic roles, this shift creates dynamics that I examine, particularly regarding how this impacts women's labor market outcomes.

Table 1.1: National Migration Rates (2011)

2011	Work/employment	Business	Education	Marriage	Moved after birth	Moved with household	Others	Total	Work/employment	Business	Education	Marriage	Moved after birth	Moved with household	Others	Total
	Male								Female							
Total	**23.96**	**1.84**	**2.26**	**3.66**	**13.74**	**20.31**	**34.24**	**100**	**2.07**	**0.29**	**0.70**	**66.48**	**4.45**	**11.72**	**14.30**	**100**
Intra-district Migrants	13.67	1.24	2.00	4.22	16.34	17.95	44.57	100	1.41	0.23	0.64	68.71	4.74	8.18	16.08	100
Inter- district Migrants	32.50	2.41	2.99	3.73	13.48	23.51	21.37	100	2.79	0.37	0.80	66.74	4.22	14.20	10.87	100
Inter-state Migrants	47.17	3.00	2.12	1.83	6.18	21.86	17.84	100	4.26	0.50	0.78	54.15	3.40	25.77	11.14	100
International Migrants	18.69	2.02	1.29	1.42	3.67	36.28	36.62	100	2.78	0.43	0.55	40.90	2.12	30.40	22.81	100
Unclassifiable	20.72	2.05	2.45	1.24	7.90	27.55	38.08	100	3.61	0.76	1.08	38.50	4.43	27.46	24.17	100
Rural-Rural	17.24	1.11	2.50	9.39	23.19	21.79	24.79	100	1.23	0.17	0.40	83.83	3.04	4.62	6.71	100
Rural-Urban	45.39	3.01	3.18	2.15	7.34	23.81	15.12	100	4.28	0.45	1.49	52.10	4.09	28.04	9.54	100
Urban-Rural	12.74	1.02	2.01	2.73	37.48	17.28	26.74	100	1.99	0.31	0.77	53.42	17.23	12.14	14.14	100
Urban-Urban	28.25	2.75	2.44	1.69	11.98	26.08	26.82	100	3.85	0.68	1.33	41.24	7.25	27.18	18.47	100

Source: Migration Tables 2011, D5: Migrants by Place od Last Residence, Age, Sex, Reason for Migration – 2011, Soft Copy

1.1 A sketch of the literature

Townsend (1994) highlighted the significant volatility of income from year to year experienced by rural households in developing countries. In the absence of formal credit sources, households adopt various strategies to mitigate these shocks, with family migration emerging as a key mechanism for risk management. Migration enables households to access better opportunities in the labor market, offering a potential buffer against economic uncertainty. Previous studies, such as Spielvogel and Meghnagi (2018); Pardede et al. (2020), focused primarily on the macroeconomic impacts of migration, including changes in labor market composition and urbanization. However, in recent decades, research has increasingly examined the effects of migration on the well-being of migrants and their households, identifying benefits such as increased consumption (Taylor and Lopez-Feldman, 2010) and greater autonomy of household members over expenditures.

Before delving into the impacts of migration, it is essential to distinguish between different migration patterns, as these significantly influence the frequency and amount of remittances, as well as the productivity of other household members at home and in the labor market. Hugo and Böhning (2000) highlight that the type of migration plays a critical role in shaping the labor market behavior of all work-eligible family members. Permanent migration, characterized by long distance mobility, occurs steadily throughout the year, while temporary migration is usually seasonal (Smith, 1989). Zelinsky (1971) define temporary migration as a wide range of movements without a declared intention to permanently reside outside the place of origin, while Hugo and Böhning (2000) specify it as movements lasting at least six months but less than one year. A common pattern of temporary migration involves the primary earner traveling for work, with dependent family members remaining behind (Lahaie et al., 2009).

Female migration, particularly in sectors such as nursing or domestic work, has been increasing. However, social norms, safety, and domestic responsibilities guarantee that labor migration in developing countries will continue to be dominated by men in the coming decades (Desai and Banerji, 2008). This is in line with the numbers in Table 1.1 in the Introduction.

Recent literature suggests that the impact of temporary male migration on women's participation in the labor market depends on two main factors: woman's productivity at home and increased reservation wage due to the increase in income from the migrating family member. The labor supply theory posits that remittances increase household income, theoretically raising the reservation wage of women, thus reducing their participation in the labor force (Rosenzweig, 1980). In contrast, a decline in productive value at home or inconsistent remittances could drive increased participation in the labor force among women. This dynamic depends on whether spousal employment complements or substitutes for their labor.

An extensive study in Nepal by Lokshin and Glinskaya (2009) found that female labor force participation decreased with male migration, primarily due to increased household income. Cabegin (2006) and Yang (2008) similarly report a reduction in labor supply among spouses left behind due to overseas migration from the Philippines. Sadiqi and Ennaji (2004) observe a comparable trend in Morocco, where male migration to Europe led to reduced labor force participation among remaining household members.

On the other hand, a less explored but significant driver of increased female labor force participation is financial hardship arising from infrequent or insufficient remittances, compelling women to join the workforce to meet daily needs. This factor is particularly relevant in the context of temporary internal migration, where men often accept low-paying or informal jobs (Deshingkar, 2006). A qualitative study in India found that in villages in Uttar Pradesh, inadequate remittances drove several women to work as informal farm laborers (Paris et al., 2005). Similarly, studies in the Philippines (Rodriguez and Tiongson, 2001) and Botswana (Brown, 1983) also highlight the increased participation of women due to irregular remittances.

Beyond economic effects, Hugo and Böhning (2000) highlights significant social impacts, including greater autonomy for women in the absence of their husbands. Their study on the international migration of Indonesian men reveals that such migration not only expanded the responsibilities of wives but also promoted skill acquisition. Similarly, research by Parrado et al. (2005) and Rahman (2000) demonstrates that families adapt over time to the permanent absence of male members, with women increasingly assuming traditionally held roles by men,

leading to moderate changes in gender roles. However, relatively few studies have explored the effects of temporary internal migration, particularly in the Indian context. Given the short-term nature of these migration episodes, the impact on household dynamics may be markedly different.

Although Desai and Banerji (2008) examines the impact of husbands' migration on women's health outcomes and financial autonomy, there remains a significant gap in rigorous causal research on the effects of temporary internal migration on employment outcomes. This paper aims to address this gap by providing new insights into this unexplored area.

Another key contribution of this study is the introduction of feeder road infrastructure as a proxy to examine this phenomenon. Feeder roads are smaller secondary roads that connect villages to larger main roads, facilitating movement and access to markets. The welfare effects of road networks have been previously explored in various contexts. For instance, Zhang et al. (2021) studied their influence in China, while Morten and Oliveira (2024) illustrated how highway construction in the 1960s in Brazil was associated with local GDP growth and increased temporary migration. Similarly, Thiede and Gray (2016) highlights how improved road conditions in Indonesia significantly reduced travel costs, promoting inter-provincial migration.

In establishing this proxy, my paper derives insights from Asher and Novosad (2020a), who analyzed the economic effects of the Pradhan Mantri Gram Sadak Yojana (PMGSY) program in India. Using a regression-discontinuity design, they demonstrated how new feeder roads reduced transportation costs, enabling workers to access non-agricultural employment outside their villages. However, their findings also revealed that these roads alone did not significantly promote firm-level growth within villages or fundamentally transform local economic conditions. This underscores the potential of the placement of feeder roads as a proxy to capture outmigration at the village level, allowing this study to investigate the nuanced effects of temporary internal migration on women.

2 Data Framework

To evaluate my research question, I rely on multiple data sources, including aggregate district-level data from the 2001 and 2011 Indian Census, administrative records from the Pradhan Mantri Gram Sadak Yojana (PMGSY) program, and the Socioeconomic High Resolution Rural-Urban Geographic Data Set on India (SHRUG)[1]. The SHRUG dataset provides detailed socioeconomic information on approximately 600,000 cities, towns, and villages in India, spanning 1990 to 2013. It combines firm-level data from Economic Censuses, population demographics from the 1991, 2001, and 2011 population censuses, and proxies for economic well-being, such as nighttime luminosity data.

Due to the lack of publicly available household-level census data, I use village-level outcome variables to construct the analysis framework. A key strength of SHRUG is its ability to link village-level census data with road construction records, leveraging high geographic resolution and consistent village identifiers for longitudinal analysis across three decades.

Despite these strengths, both the SHRUG and publicly available village-level census data have notable limitations. They capture only a subset of variables from the underlying datasets, omitting critical information such as village-level male outmigration rates and detailed working-age population demographics. Additionally, while I incorporate the 2012 Socio-Economic Caste Census (SECC), its utility is constrained. The SECC provides only village-level aggregates, which are not aligned with the 2011 Census, and its data are limited to a single time period, further restricting its applicability within my empirical strategy.

Sample selection is guided by the administrative priorities of the PMGSY program. The program aimed to maximize road connectivity by linking the largest number of locations with the external road network and followed prioritization guidelines applied at the state level, targeting villages with populations greater than 1,000 in 2003, then those with more than 500 and finally villages with 250 residents. For my analysis, I focus on six states—Chhattisgarh, Gujarat, Madhya Pradesh, Maharashtra, Orissa and Rajasthan—that adhered to these criteria, as identified by Asher and Novosad (2020a).

[1] https://www.devdatalab.org/shrug

3 Empirical Strategy

Following the discussion on literature and available data, I formulate a testable hypothesis that village-level female labor force participation is causally influenced by the rate of male outmigration from the village. A naive approach to examining this effect would be to estimate the following regression equation:

$$FLFPRate_v = \beta_0 + \beta_1 OutmigrationRate_v + \beta_2 Z'_v + \epsilon_v \tag{1}$$

where $FLFPRate_v$ is the rate of female labor force participation in the village v. $OutmigrationRate_v$ represents the rate of male outmigration due to employment opportunities. Z'_v is a vector of village-level covariates such as access to transportation (e.g., bus stops), public health centers, maternity centers, average female educational attainment, the ratio of agricultural households, and the percentage of households with electricity.

However, given the lack of data on village-level male out-migration rates, the construction of a feeder road is used as a proxy. As highlighted in the review of the literature, previous research has established this relationship. Furthermore, Asher and Novosad (2020a) indicate that rural roads, in the absence of complementary policies, did not stimulate local economic development, but instead led to increased outmigration of workers in India. Since work-related migration among women accounts for less than 2% of total female migration, while male outmigration is predominantly employment-related (34%), road access appears to be an appropriate proxy for male outmigration. Thus, $RoadRecieved_v$ is defined as a binary instrument that indicates whether village v received a feeder road under the PMGSY program between 2003 and 2011. The corresponding regression model is:

$$FLFPRate_v = \beta_0 + \beta_1 RoadRecieved_v + \beta_2 Z'_v + \epsilon_v \tag{2}$$

Although this specification addresses the absence of direct male outmigration data, it can produce biased estimates due to the potential endogeneity of road placement. Villages that received a road may have been more economically prosperous or developed, which could independently increase employment opportunities for women. Table 3.1 compares these baseline characteristics for 111,351 villages in 6 states in 2001 in my sample.

Table 3.1: Summary Statistics and Balance

	No Treatment		Treatment		
	mean	sd	mean	sd	Difference
Number Of Households	128	49.97	132	48.89	-3.542***
Total Population- Persons	666	241.90	733	247.80	25.041***
Males(share)	0.51	0.03	0.51	0.02	-0.002**
Scheduled Caste(share)	0.13	0.16	0.13	0.16	0.016***
Literate(share)	0.49	0.16	0.45	0.15	-0.003
Working(share)	0.49	0.11	0.49	0.11	-0.007**
Children per Female	0.35	0.09	0.39	0.09	0.012***
Number Of Primary School	1.07	0.41	1.08	0.38	0.009
Number Of Training Schools	0.00	0.04	0.00	0.07	0.005**
Number Of Primary Health Centre	0.01	0.10	0.01	0.08	-0.003
Land irrigated(Share)	19.01	25.06	18.59	22.52	-0.156
Agricultural HHs(Share)	0.53	0.38	0.63	0.43	0.050***
Power Supply	0.94	0.24	0.88	0.32	-0.048***
Approach - Paved Road	0.55	0.50	0.24	0.43	-0.241***
Bus Services	1.00	0.01	1.00	0.00	0.000
Number Of Middle School	0.21	0.42	0.17	0.38	-0.036***
Number Of Secondary School	0.05	0.21	0.02	0.16	0.001
Number Of Senior Secondary School	0.01	0.10	0.00	0.07	-0.000
Number Of Family Welfare Centre	0.01	0.10	0.00	0.04	-0.008***
Distance From The Nearest Town	26.75	24.06	28.70	23.12	0.780

Note: The table presents mean values for village characteristics measured in the baseline period from the 2001 Population Census. 'No treatment' villages did not receive a road till 2011, whereas 'Treatment' villages received one. Columns 1 & 3 show the unconditional means for villages receiving a road, and villages not receiving a road, respectively. Column 4 displays the difference in means between Columns 1 and 3. The p-value is calculated using heteroskedasticity-robust standard errors.

It is evident that villages that received a road are not balanced on baseline characteristics compared to those that did not. To address these differences, the model is further refined using a difference-in-differences (DiD) or two-way fixed effects approach. The specification is as follows:

$$\begin{aligned} FLFPRate_{vt} =& \beta_0 + \beta_1 RoadRecieved_v * Period_t + \\ &+ \beta_2 RoadRecieved_v + \beta_3 Period_t + \beta_4 Z'_{vt} + \epsilon_{vt} \end{aligned} \tag{3}$$

In equation (3), $Period_t$takes a value of 1 for the year 2011 and 0 for 2001, while $RoadRecieved_v$ is equal to 1 if the village received a road before 2011 and 0 otherwise. This (DiD) approach isolates the impact of road construction on female labor force participation by controlling for time-invariant unobserved village characteristics and general time trends that may affect outcomes independently of road access.

Recognizing that road placement is still endogenous to the economic conditions of villages, which may grow at different rates over time, I further refine my sample by restricting it to villages with populations within a range of 116 persons above or below the government threshold for road eligibility. This threshold, set arbitrarily under program guidelines, provides quasi-exogenous variation in road assignment. I determined this optimal bandwidth following the methodology outlined in Calonico et al. (2020), resulting in a final sample of 49,976 villages. This sample also is sufficiently narrow to also enable valid comparison with results in Asher and Novosad (2020b). To test the robustness of my results, this bandwidth shall be varied, examining the sensitivity of the findings to alternative sample definitions.

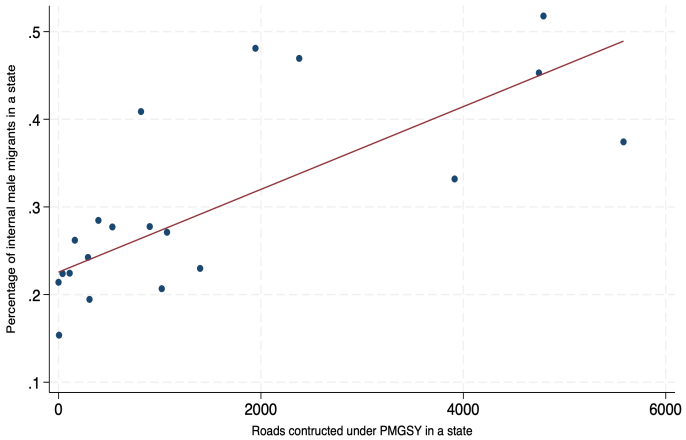
4 Results

4.1 First Stage

To use feeder road construction as a proxy, it is essential first to establish a relationship between out-migration and road connectivity. Although several studies have demonstrated this relationship in various global contexts, this section aims to further investigate it within rural India. Since village-level data is not available, I begin by plotting a scatter plot of state-level male migration in 2011 against the total number of roads constructed before 2011 in each state. This data is drawn from the Indian Census at the state level.

The internal migration variable captures both inter- and intra-state migration of rural males who reported employment as the primary reason for migration, reflecting short-term migration with a duration of residence of less than one year. This scatter plot includes all 35 states. In Figure 2, the y-axis shows the percentage of rural male migrants (both rural-to-rural and rural-to-urban) relative to the total male population in each state. Despite the limited number of observations due 10 states did not implement the program, there is still a positive correlation between migration rate and road construction.

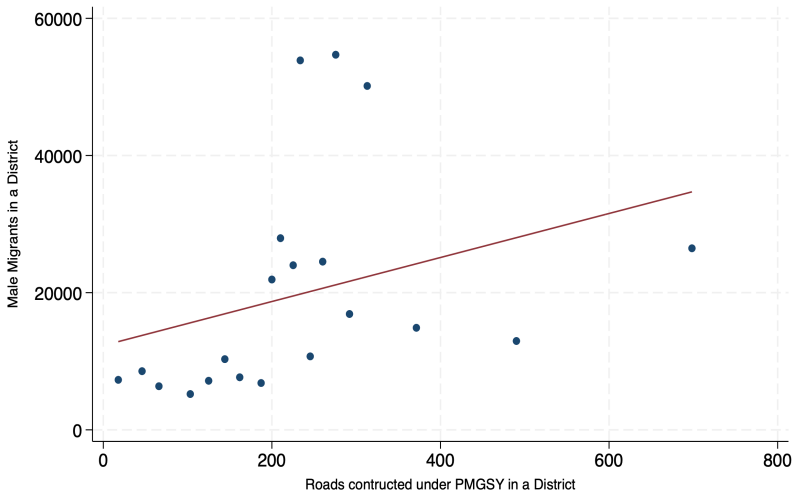
Figure 2: Scatter Plot of Migrants at State level and Roads Constructed



Note: This is a binned scatter-plot to adjust for bunching at 0, since 10 states did not implement the program.Total observations are 35. The states with more roads also implemented the program well.

Next, I use district-level migration data from the Indian Census district tables. I begin by aggregating the number of roads constructed under the PMGSY between 2001 and 2011 to the district level. I then select all districts within six states for analysis. Figure 3 reveals that as the number of roads in a district increases, so does the number of male migrants from rural areas seeking employment in other rural and urban centers within the district. To further examine this relationship, I run a regression with state fixed effects and find that the addition of one road is associated with an increase of 79 internal migrants in a district, significant at the 5 percent level. While I am unable to establish this relationship at the village level due to the data constraints, these results indicate a positive relationship between road construction and migration, consistent with findings by Aggarwal (2018).

Figure 3: Scatter Plot of Migrants at District and Roads Constructed

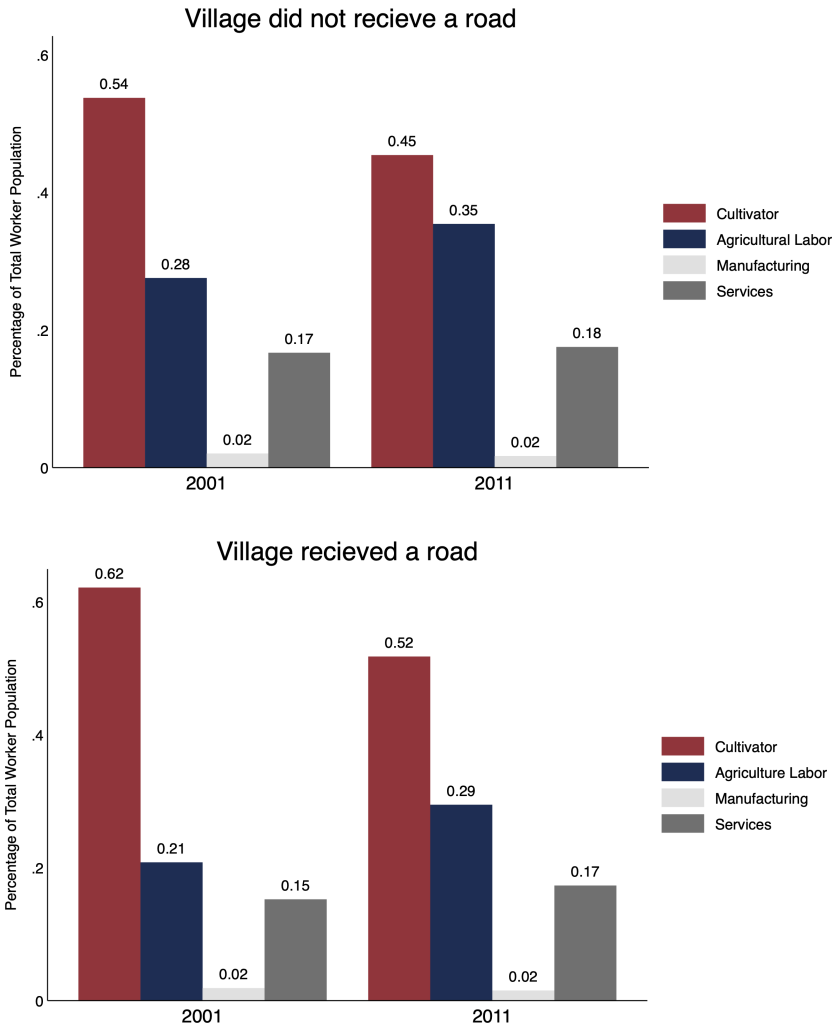


Note: This is a binned scatter-plot to adjust for bunching near 10. This is restricted to the six states and the total number of districts are 184. The number of roads constructed was aggregated to the district level. The migrant data is from census 2011 district level tables. This captures male migrants who traveled for employment for under 1 year within the district.

Next, I examine the distribution of sectoral choices for males from 2001 to 2011, comparing villages that received a road with those that did not. As shown in the figure below, in both types of villages, workers shifted out of cultivation, moving either into agricultural labor or the services sector. Studies indicate that the rural services sector in India is predominantly composed of construction jobs, which are generally informal. The shift to services is slightly

more pronounced in villages with road access. While this does not constitute robust evidence of a causal relationship, it provides suggestive evidence that males are transitioning from cultivation to seasonal jobs, with internal migration rates likely facilitated by feeder roads and reduced transportation costs.

Figure 4: Male Worker Composition



Note: This is a binned scatter-plot to adjust for bunching at 0, since 10 states did not implement the program.Total observations are 35. The states with more roads also implemented the program well.

4.2 Difference-in-Difference

Next, I discuss the difference-in-differences (DiD) model using the proxy variable. I test the hypothesis across nine outcomes related to female labor force participation. First, I examine total labor force participation, followed by specific effects for main and marginal workers. Main workers are employed throughout the year, while marginal workers are hired seasonally for 3-6 months, typically as agricultural labor on farms. I then analyze sectoral effects, focusing on four sectors: cultivators, agricultural labor, services, and manufacturing, paralleling the categories for male employment. Additionally, I assess impacts on the literacy rate and the average number of children borne per woman. All variables are expressed as ratios over the total female population in each village.

The variable Road*2011 represents the interaction between the road binary indicator and the post-treatment period. The chosen set of controls includes amenities that support short-distance travel and account for potential dependencies, such as the presence of children or elderly dependents.

Table 4.1 indicates that villages with road access experienced a 3.5% increase in total female labor force participation, significant at the 1% level, as shown in column 1. This increase is primarily driven by a rise in main workers, also statistically significant at the 1% level. Despite the growth in female labor force participation, there is a 2% decrease in literacy rates and an increase in childbearing.

Table 4.2 explores occupational choices. Notably, women did not offset the decline in male cultivators, as indicated by the negative coefficient for cultivation in column 2. In villages with road access, 4% of females shifted into agricultural labor, while 1% moved into the services sector.

Table 4.1: Impact on Workforce Participation, Literacy and Children Borne

	(1) (Total Workers)	(2) (Main Workers)	(3) (Marginal Workers)	(4) (Literate Women)	(5) (Children per woman)
Road*2011	0.0315***	0.0358***	-0.00414	-0.0261***	0.0182***
	(0.006)	(0.006)	(0.006)	(0.003)	(0.005)
2011	-0.0126***	0.0240***	-0.0368***	-0.0617***	0.121***
	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)
Received a Road	-0.00545	-0.0294***	0.0240***	0.0470***	-0.0637***
	(0.005)	(0.006)	(0.006)	(0.003)	(0.005)
Bus Availability	0.0215***	0.0884***	-0.0668***	-0.0251***	0.0710***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Middle School	-0.00402**	0.00637***	-0.0103***	-0.0120***	0.0249***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Secondary School	-0.0579***	-0.0524***	-0.00534*	-0.0245***	0.0498***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.003)
Serion Secondary School	0.00555	0.00430	0.00107	0.00223	0.0140*
	(0.008)	(0.007)	(0.006)	(0.004)	(0.008)
Maternal and Child Center	-0.00343	-0.0142**	0.0108	-0.00396	0.00483
	(0.008)	(0.007)	(0.008)	(0.003)	(0.006)
PHC	-0.0240***	-0.0106	-0.0134	-0.00413	-0.00483
	(0.009)	(0.009)	(0.009)	(0.004)	(0.007)
Closest town(Kms)	0.000924***	0.000216***	0.000706***	0.000511***	-0.00127***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Ratio of SC population	-0.127***	-0.0725***	-0.0541***	-0.0145***	0.0792***
	(0.005)	(0.005)	(0.005)	(0.002)	(0.004)
Constant	0.422***	0.174***	0.248***	0.360***	0.348***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.002)
Observations	53882	53882	53882	53882	53882
Mean	0.429	0.230	0.198	0.310	0.456

Notes: This population only includes female working population. It does not differentiate between married and unmarried women.
Main workers work the entire year. Marginal workers work for 3-6 months. Total workers = Main workers + Marginal workers
Literacy rate = literate women/Total women in the village.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.2: Impact on Occupational Choice

	(1) (Agricultural Labours)	(2) (Cultivators)	(3) (Manufacturing)	(4) (Services)
Road*2011	0.0422***	-0.0166***	-0.00207*	0.00832***
	(0.005)	(0.006)	(0.001)	(0.002)
2011	0.0399***	-0.0548***	-0.00218***	0.00423***
	(0.002)	(0.002)	(0.000)	(0.001)
Received a Road	-0.0653***	0.0662***	0.0000861	-0.00612***
	(0.004)	(0.006)	(0.001)	(0.002)
Bus Availability	0.00781***	0.0138***	-0.00303***	0.00340***
	(0.002)	(0.002)	(0.000)	(0.001)
Middle School	0.00106	0.00386**	0.000683**	-0.00902***
	(0.002)	(0.002)	(0.000)	(0.001)
Secondary School	-0.0319***	-0.0407***	0.00225***	0.0122***
	(0.003)	(0.003)	(0.001)	(0.001)
Sr. Secondary School	0.00756	-0.00295	-0.00106	0.00141
	(0.006)	(0.008)	(0.001)	(0.003)
Maternity and Child Center	0.0104	-0.0105*	-0.00131	-0.00175
	(0.006)	(0.006)	(0.001)	(0.003)
PHC	0.00275	-0.0317***	-0.00222**	0.00757**
	(0.008)	(0.007)	(0.001)	(0.004)
Closest Town(Kms)	0.000246***	0.000747***	0.0000263***	-0.000104***
	(0.000)	(0.000)	(0.000)	(0.000)
Ratio of SC population	-0.0282***	-0.104***	0.00482***	0.00119
	(0.005)	(0.004)	(0.001)	(0.002)
Constant	0.173***	0.193***	0.0112***	0.0432***
	(0.003)	(0.003)	(0.001)	(0.001)
Observations	53882	53882	53882	53882
Mean	0.204	0.171	0.00957	0.0431

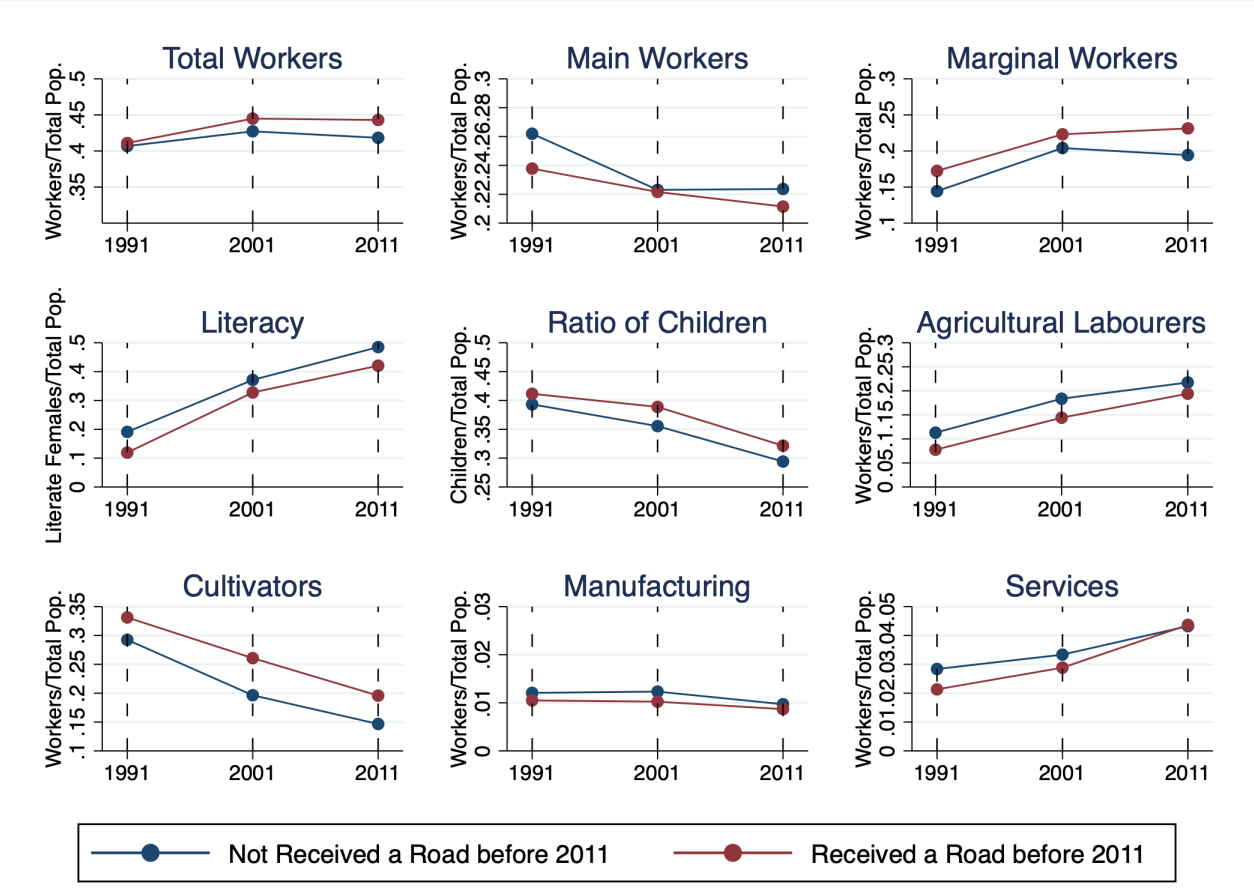
Note: Agricultural labours are landless labours who are usually hired for the season.

This population only includes female working population. It does not differentiate between married and unmarried women. The pre-period is 2001 and post period is 2011 SEs are robust.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

To test the robustness of these results, I perform a parallel trends check, with Figure 5 providing a visual representation of trends prior to the start of the PMGSY scheme in 2001. Since census data is only available from 1991, there is only one pretreatment period available. As shown in Figure 1, with the exception of agricultural labor and marginal workers, most outcomes do not strictly follow the parallel trends assumption. My results also fail the pretrend analysis test. However, it should be noted that if parallel trends were strictly met, the difference in total labor force participation would likely be higher than observed, suggesting a possible underestimation of the effect.

Figure 5: Figure: Parallel Trends Check



Note: Total population refers to the total female population enumerated in the village on the day of the survey.

4.3 Synthetic Difference-in-Difference

As shown above, most outcomes do not exhibit pre-period parallel trends. Upon conducting a pre-trend test, I find that the outcomes fail to meet the parallel trend assumption. To address this, I employ the Synthetic Difference-in-Differences (SDID) estimator by Arkhangelsky et al. (2021), which combines the strengths of the synthetic control and difference-in-differences (DID) methods. Like DID, SDID accommodates treated and control villages trending at different levels before the road construction program. Additionally, it optimally re-weights the control sample to create a matched control unit that satisfies parallel trend assumptions. Unlike synthetic control, SDID does not require the treated unit to be within the "convex hull" of control units, making it a more robust approach.

Table 6.1 presents the coefficients of the interaction term for various outcome variables, focusing exclusively on the female population in the village. The female labor force participation rate ("Total" in the table) is 1.92% higher in villages that received a road compared to those that did not. Although this is lower than the 3% increase reported in Table 5.1, the direction and magnitude are consistent between the two models. Table 5.1 further shows that this increase is driven by a rise in marginal workers, primarily as agricultural laborers. Coefficients for service and manufacturing sectors are not included, as female employment in these sectors is minimal.

Table 4.3: Model without covariates

	(Total)	(Main)	(Marginal)	(Agriculture)	(Cultivators)	(# Children)
Road*2011	0.0192***	0.000387	0.0211**	0.0238**	0.00388	0.0001
	(0.006)	(0.009)	(0.009)	(0.007)	(0.008)	(0.003)

the variable is the ratio of the outcome over the total female population in the village.
The pre-period is 2001 and post period is 2011 SEs are robust.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Next, I incorporate the baseline covariates used in the difference-in-difference model. As expected, the magnitude and significance of the coefficients remain unchanged, further validating the estimates. It is important to note that, due to computing power limitations, the above estimates are based on a randomly selected 10% sample of the total dataset and rely on only 50 bootstrap repetitions to calculate the standard errors. To assess the stability of the

model, I first vary the sample size while maintaining 50 bootstrap repetitions. In Table 6.3, I increase the number of repetitions for the same randomly chosen 10% sample. The variable of interest here is the female labor force participation rate. While there is some deviation from the original estimate for 10% of the sample, I observe a 1.6% increase in female labor force participation in treated villages when expanding the sample to 25%.

Table 4.4: Model with covariates

	(Total)	(Main)	(Marginal)	(Agriculture)	(Cultivators)	(# Children)
Road*2011	0.0182***	-0.00148	0.0222**	0.0238***	0.000439	-0.00980
	(0.006)	(0.009)	(0.011)	(0.007)	(0.002)	(0.006)

Measure is the ratio of the outcome over the total female population in the village.
The pre-periods are 1991 and 2001 and post period is 2011. SEs are robust.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4.5: Validity check: varying sample size

	(10%)	(15 %)	(20%)	(25%)
Road*2011	0.0192***	0.0147**	0.0143**	0.0164***
	(0.006)	(0.006)	(0.006)	(0.005)
Observations	11136	16704	22269	27837

The pre-periods are 1991 and 2001 and post period is 2011. SEs are robust.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Next, I increase the number of repetitions for my 10% sample. Table 6.4 shows that the magnitude and significance of the coefficient is stable in all repetitions. Although there are limitations to the model, it allows me to interpret that male outmigration has led to a positive and significant increase in female labor force participation in rural India. In the next section, I enumerate challenges and next steps to further investigate this phenomenon.

Table 4.6: Validity check: varying bootstrap repetitions

	(50)	(100)	(200)	(400)	(1000)
Road*2011	0.0192***	0.0192***	0.0192***	0.0192***	0.0192***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)
Observations	11136	11136	11136	11136	11136

The pre-periods are 1991 and 2001 and post period is 2011. SEs are robust.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5 Discussion

In summary, this paper examines how male migration affects the participation of women in the labor force of migrant-sending households in rural India, using nationally representative census data and the socioeconomic high resolution rural-urban geographic dataset (SHRUG). Male migration is hypothesized to have varied effects on women's labor market participation. On the one hand, increasing the income of the household from remittances may reduce the participation of women in the labor force. However, changes in household composition due to male migration could alter women's home productivity. Additional factors, such as seasonal agricultural work, irregular remittances, increased caregiving responsibilities for children or the elderly, and greater autonomy, contribute to an overall ambiguous effect on the participation of women in the labor market.

Due to the lack of data on male migration at the village level, this analysis uses feeder roads constructed from 2003 to 2011 as a proxy. The empirical results indicate that the construction of an additional feeder road in a village, through its effect on male out-migration, increases women's labor market participation by 3.1 percentage points. To address endogeneity in road placement, the analysis adopts two key strategies. First, it restricts the sample to villages closer to the eligibility threshold for receiving a road. Second, upon observing non-parallel pre-treatment trends, a synthetic control is constructed to enhance causal inference. Although the estimated impact of feeder roads on women's participation in the labor market is reduced to 1.92 percentage points, the effect remains positive and statistically significant. Furthermore, the increase is primarily driven by agricultural workers, suggesting that women might be taking on agricultural labor to compensate for the absence of male household members.

These estimates, however, come with certain limitations. First, data on the working-age population and migration patterns at the village level is unavailable in either the publicly available Census tables or the SHRUG dataset. As next steps, I first want to validate the relationship between feeder roads and district-level migration found in the Census data. I plan to use the National Sample Survey(NSS) to calculate the proportion of outmigration

for each district in the sample, then apply a shift-share methodology to validate my results.

Second, with improved computing power, I intend to apply the synthetic difference-in-difference model to the entire dataset with at least 1,000 bootstraps, rather than relying on a randomly selected 10% sample. Third, since road treatment was implemented over a span of seven years, future analysis will incorporate heterogeneous treatment exposure. Finally, I will conduct a comprehensive review of the control variables and test multiple sets of controls to ensure the robustness of the results.

As discussed above, the observed increase in women's labor force participation may be linked to seasonal dynamics, such as men migrating during non-peak agricultural periods, while labor demand for women and wages remain inflexible. To better understand this, disaggregated village-level data on time use, wages, and seasonal migration should be collected and made publicly available. Such data would be crucial for assessing how to improve the wage labor market in rural areas for women.

As a policy imperative, governments must address the often-overlooked gender dynamics of predominantly male-led migration. Women's time allocation choices carry profound implications for their economic and social standing. By understanding the nature and scope of women's work, policymakers can not only enhance their contributions to the economy but also design targeted social security measures that empower and them effectively.

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