

Impact of Pradhan Mantri Gram Sadak Yojana on Rural Employment: Evidence from a Large-Scale Household Survey in India

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Abstract

Rural road infrastructure plays a vital role in improving economic opportunities by enhancing connectivity, reducing transportation costs, and facilitating labor mobility. The Pradhan Mantri Gram Sadak Yojana (PMGSY) is one of the largest rural road development programs in India, aimed at providing all-weather road access to unconnected rural habitations. This study examines the impact of PMGSY on employment outcomes using a large-scale primary household survey covering 22,730 rural respondents across multiple Indian states. To capture variation in program intensity, a composite PMGSY Exposure Index is constructed based on household awareness of the scheme, perceived road quality, and ease of road usage. Employing a fixed-effects empirical framework with state-level controls, the results reveal a positive and statistically significant association between PMGSY exposure and employment improvement. Heterogeneity analysis indicates that while both farming and non-farming households benefit from improved rural connectivity, the employment gains are moderately stronger for farming households. The findings provide policy-relevant evidence on the role of rural road infrastructure in supporting employment generation and inclusive rural development in India.

Keywords: PMGSY, Rural Roads, Employment, Infrastructure, India, Impact Assessment

1. Introduction

Infrastructure development is widely regarded as a cornerstone of economic growth and structural transformation, particularly in developing economies where spatial frictions constrain market access and labor mobility. Among various forms of infrastructure, rural road connectivity plays a critical role in integrating remote areas with markets, public services, and employment centers. By reducing transportation costs and travel time, rural roads can enhance agricultural commercialization, stimulate non-farm economic activities, and improve access to employment opportunities. In India, inadequate rural connectivity has historically been a major impediment to inclusive development. A large share of rural habitations remained unconnected by all-weather roads for decades, limiting economic participation and reinforcing regional disparities. Recognizing this challenge, the Government of India launched the Pradhan Mantri Gram Sadak Yojana (PMGSY) in 2000 with the objective of providing reliable road connectivity to unconnected rural habitations. Over the past two decades, PMGSY has emerged as one of the most extensive rural infrastructure initiatives globally, substantially expanding the rural road network.

While the scale of PMGSY is well documented, understanding its socio-economic impacts remains an important empirical question. Existing research provides evidence that rural roads can influence agricultural productivity, market integration, and poverty reduction. However, empirical evidence on

employment outcomes is comparatively limited, particularly at the household level and across diverse regional contexts. Moreover, many studies rely on binary measures of road access, which may not fully capture differences in road quality, usability, and effective exposure to infrastructure. This study seeks to address these gaps by examining the employment impacts of PMGSY using a large-scale primary household survey. Rather than treating road connectivity as a binary intervention, the analysis constructs a composite PMGSY Exposure Index that captures multiple dimensions of road access and quality as perceived by households. This approach allows for a more nuanced assessment of how varying degrees of exposure to rural road infrastructure relate to employment outcomes.

The empirical strategy employs a fixed-effects framework to control for unobserved statelevel heterogeneity, such as differences in economic structure, governance quality, and labor market conditions. In addition, the study explores heterogeneity in employment effects across household occupations, with a particular focus on differences between farming and non-farming households. This dimension is especially relevant in the Indian context, where agriculture continues to employ a large share of the rural workforce. The contribution of this paper is threefold. First, it provides new household-level evidence on the employment impacts of PMGSY using a large and diverse primary dataset. Second, it introduces a composite exposure-based measure of rural road connectivity that moves beyond simple access indicators. Third, it offers insights into the distributional effects of rural road infrastructure by examining heterogeneity across household occupations. Together, these contributions enhance understanding of how large-scale rural infrastructure programs can support employment generation and inclusive rural development.

2. Background of the Pradhan Mantri Gram Sadak Yojana

The Pradhan Mantri Gram Sadak Yojana (PMGSY) is one of the largest rural infrastructure programs implemented in India, launched in December 2000 with the primary objective of providing all-weather road connectivity to unconnected rural habitations. The scheme targets habitations with a population of 500 or more in plain areas and 250 or more in hilly, tribal, and backward regions. By improving last-mile connectivity, PMGSY aims to integrate rural areas with markets, health services, educational institutions, and employment centers. PMGSY is centrally sponsored and implemented through state-level agencies, with funding support shared between the central and state governments. The program emphasizes quality standards, durability of rural roads, and post-construction maintenance. Over time, the scope of PMGSY has expanded beyond basic connectivity to include upgradation of existing rural roads and consolidation of the rural road network. From an economic perspective, rural roads constitute a critical enabling infrastructure. Improved connectivity reduces transportation costs, shortens travel time, and lowers uncertainty in accessing markets and services. These mechanisms are expected to influence rural employment outcomes through multiple channels, including increased agricultural commercialization, expansion of non-farm activities, improved labor mobility, and better access to input and output markets.

Despite its scale and importance, the impacts of PMGSY are likely to vary across regions and household types, depending on the extent of exposure to the scheme, road quality, and local economic conditions. This study focuses on capturing such differential exposure to PMGSY and assessing its association with employment outcomes at the household level.

3. Review of Literature

A substantial body of economic literature has examined the role of infrastructure development in shaping growth, employment, and welfare outcomes, particularly in rural and developing-country contexts. Transport infrastructure, and rural roads in particular, is widely recognized as a critical enabling factor that reduces spatial frictions, facilitates market integration, and improves access to economic opportunities.

Early theoretical and empirical contributions emphasize that public infrastructure investment enhances productivity by lowering transaction and transportation costs and improving factor mobility. Aschauer (1989) highlights the macroeconomic importance of infrastructure in supporting long-term economic growth, laying the foundation for subsequent empirical work on transport infrastructure and development.

At the micro level, several studies document the importance of road access for agricultural households. Jacoby (2000) shows that poor road connectivity significantly raises transportation costs for rural producers, limiting their participation in markets and reducing welfare. Improved road access, therefore, plays a key role in integrating rural households into broader economic networks.

A growing empirical literature focuses specifically on the employment and income effects of rural road investments. Khandker, Bakht, and Koolwal (2009), using evidence from Bangladesh, find that rural road development increases agricultural productivity, non-farm employment, and household consumption. Their findings suggest that improved connectivity facilitates labor reallocation and diversification of income sources. Similarly, Mu and van de Walle (2011) demonstrate that rural road rehabilitation in Vietnam leads to improved market development and employment outcomes, particularly in remote areas.

In the Indian context, several studies evaluate the impacts of the Pradhan Mantri Gram Sadak Yojana (PMGSY). Asher and Novosad (2020) exploit quasi-experimental variation in PMGSY implementation and show that rural road construction increases employment and supports structural transformation by enabling movement away from subsistence agriculture toward non-farm activities. These findings underscore the role of improved connectivity in expanding labor market access.

Aggarwal (2018) examines the effects of PMGSY on agricultural outcomes and finds that improved road access enhances input use, crop yields, and market participation. The study highlights the importance of rural roads in reducing isolation and promoting agricultural commercialization. Complementing this evidence, Shamdasani (2021) shows that rural road investments in India improve labor mobility and employment access, with particularly strong effects for disadvantaged populations. Beyond employment and income, the literature also documents broader socio-economic impacts of rural road development. Fan and Chan-Kang (2005) find that investments in rural roads contribute significantly to poverty reduction by improving access to markets and public services. Gibson and Rozelle (2003) demonstrate that improved road connectivity reduces spatial price dispersion and enhances household welfare in rural economies.

Despite the extensive literature on rural roads and development, several gaps remain. First, many studies rely on binary indicators of road access, which may not adequately capture heterogeneity in exposure, quality, and usability of infrastructure. Second, relatively few studies use large-scale primary household survey data that incorporate perceptions of infrastructure quality alongside employment outcomes. Third, evidence on differential employment impacts across household types, particularly between farming and non-farming households, remains limited.

The present study contributes to this literature by addressing these gaps. By constructing a composite PMGSY Exposure Index based on multiple dimensions of road access and quality and employing a fixed-effects framework using large-scale primary survey data, this study provides new evidence on the employment impacts of rural road infrastructure in India. Furthermore, the heterogeneity analysis offers insights into how these impacts differ across household occupations, thereby contributing to a more nuanced understanding of the distributional effects of rural connectivity investments.

4. Research Problem and Objectives

4.1. Research Problem

Rural road infrastructure has long been recognized as a critical component of rural development policy in India. The Pradhan Mantri Gram Sadak Yojana (PMGSY), one of the largest rural

connectivity programs in the world, was designed to provide all-weather road access to unconnected rural habitations with the aim of improving economic opportunities and social inclusion. While a growing body of literature documents the impacts of PMGSY on market access, agricultural productivity, and poverty reduction, empirical evidence on its employment effects remains relatively limited and fragmented.

Existing studies often rely on binary indicators of road access or administrative measures of connectivity, which may not fully capture variation in the quality, usability, and effective exposure to rural road infrastructure. Moreover, many analyses are based on secondary data or focus on specific regions, limiting their ability to reflect household-level employment dynamics across diverse geographic and socio-economic contexts. As a result, there is insufficient evidence on how differences in the intensity of PMGSY exposure translate into employment outcomes for rural households.

Another important gap in the literature concerns distributional effects. Rural households are heterogeneous in their economic activities, and the employment impacts of improved connectivity may differ between farming and non-farming households. Understanding whether PMGSY generates broad-based employment gains or disproportionately benefits specific household groups is essential for designing complementary policies and improving the effectiveness of rural infrastructure investments.

Against this backdrop, the central research problem addressed in this study is to assess how differential exposure to PMGSY road infrastructure influences employment outcomes at the household level and whether these effects vary across household occupations.

4.2. Research Objectives

The primary objective of this study is to assess the impact of exposure to Pradhan Mantri Gram Sadak Yojana (PMGSY) road infrastructure on employment outcomes among rural households in India. Specifically, the study aims to construct a composite measure of PMGSY exposure capturing road awareness, quality, and usability; to estimate the association between PMGSY exposure and employment improvement using a fixed-effects empirical framework that controls for state-level heterogeneity; and to examine whether the employment effects of rural road connectivity differ between farming and non-farming households. By addressing these objectives, the study seeks to provide policy-relevant evidence on the role of rural road infrastructure in promoting employment and inclusive rural development.

5. Data and Survey Design

The analysis is based on a large-scale primary household survey conducted across multiple states in India to assess the socio-economic impacts of PMGSY. The survey covers 22,730 respondents residing in rural habitations with varying levels of exposure to PMGSY road infrastructure. Data collection was carried out using a structured questionnaire administered in both English and Hindi to ensure inclusiveness and reduce response bias.

The survey collected detailed information on demographic characteristics, occupation, awareness of PMGSY, perceived quality and usability of rural roads, changes in travel patterns, access to markets and services, and employment outcomes. Employment improvement is measured as an ordinal variable capturing self-reported changes in work or income opportunities following improvements in road connectivity.

A key strength of the dataset is its breadth and granularity. The large sample size allows for meaningful sub-group analysis and improves statistical precision. Additionally, the survey captures multiple dimensions of PMGSY exposure, enabling the construction of a composite exposure index rather than relying on a single binary treatment indicator.

To facilitate empirical analysis, responses from Hindi and English versions of the questionnaire were harmonized, and all variables were systematically cleaned and standardized. Observations with missing values in key outcome or exposure variables were excluded from the regression analysis. The final estimation sample consists of 18,877 observations.

Given the nationwide coverage of PMGSY and the decentralized nature of implementation, substantial variation exists across states in terms of baseline economic conditions, governance capacity, and labor market structure. This variation motivates the use of state fixed effects in the empirical strategy to control for unobserved state-level heterogeneity.

6. Empirical Strategy

The empirical strategy is designed to assess the association between exposure to PMGSY road infrastructure and employment outcomes while accounting for observed and unobserved heterogeneity. Rather than relying on a binary treatment indicator, the analysis exploits variation in the degree of exposure to PMGSY across households.

6.1. PMGSY Exposure Index

A composite PMGSY Exposure Index is constructed using Principal Component Analysis (PCA). The index is based on three key dimensions captured in the survey: (i) household awareness of PMGSY, (ii) perceived ease of using roads constructed under PMGSY, and (iii) perceived improvement in road quality. These variables are standardized and combined using the first principal component, which captures the largest share of common variation among the indicators. The resulting index provides a continuous measure of relative exposure to PMGSY infrastructure.

6.2. Baseline Model

The baseline specification estimates the following fixed-effects regression model:

$$Employment_{is} = \beta_1 PMGSY Exposure_{is} + \alpha_s + \varepsilon_{is} \quad (1)$$

where $Employment_{is}$ denotes the employment improvement outcome for household i in state s , $PMGSY Exposure_{is}$ is the exposure index, α_s represents state fixed effects, and ε_{is} is the error term. Standard errors are clustered at the state level to account for within-state correlation.

The inclusion of state fixed effects controls for time-invariant unobserved factors such as institutional quality, labor market conditions, and policy environments that may influence employment outcomes.

6.3. Heterogeneity Analysis

To examine whether the employment impacts of PMGSY differ across household types, the analysis extends the baseline model by interacting the exposure index with a farmer household indicator. The heterogeneity specification is given by:

$$Employment_{is} = \beta_1 PMGSY Exposure_{is} + \beta_2 Farmer_{is} \quad (2)$$

$$+ \beta_3 (PMGSY Exposure_{is} \times Farmer_{is}) + \alpha_s + \varepsilon_{is}$$

This specification allows the marginal effect of PMGSY exposure on employment to differ between farming and non-farming households. The interaction term captures whether improved rural connectivity yields differential employment benefits for households primarily engaged in agriculture. The empirical strategy does not claim strict causal identification but provides quasicausal evidence based on differential exposure, controlling for state-level heterogeneity. The results are interpreted as impact assessment estimates rather than definitive causal effects.

7. Results

This section presents the empirical findings on the relationship between PMGSY exposure and employment outcomes. The analysis proceeds in three stages. First, baseline fixed-effects regression results are discussed. Second, graphical evidence illustrating the exposure-employment relationship is presented. Third, heterogeneity in employment effects across household occupation is examined.

7.1. Baseline Fixed-Effects Estimates

Table 1 reports the baseline fixed-effects regression results corresponding to Equation (3). The coefficient on the PMGSY Exposure Index is positive and statistically significant at the 1% level, indicating a robust association between improved rural road connectivity and employment outcomes. Specifically, a one-unit increase in the PMGSY Exposure Index is associated with an average increase of 0.177 units in the employment improvement indicator, measured on a 0–2 ordinal scale. This result suggests that households residing in areas with higher effective exposure to PMGSY roads are more likely to experience improvements in employment or income opportunities. The inclusion of state fixed effects controls for unobserved heterogeneity across states, such as differences in institutional quality, labor market conditions, and economic structure. Standard errors are clustered at the state level to account for within-state correlation.

$$Employment_{is} = \beta_1 PMGSY\ Exposure_{is} + \alpha_s + \varepsilon_{is} \quad (3)$$

Table 1: Baseline Fixed-Effects Estimates of PMGSY Exposure on Employment Improvement

Variable	Coefficient	Std. Error	Significance
PMGSY Exposure Index	0.177	0.022	***
State Fixed Effects	Yes		
Observations	18,877		
Adjusted R^2	0.179		
Within R^2	0.085		

Notes: The dependent variable is employment improvement measured on a 0–2 ordinal scale. All specifications include state fixed effects. Standard errors are clustered at the state level. *** denotes statistical significance at the 1% level.

Source: Authors calculations based on primary PMGSY household survey data.

7.2. Graphical Evidence

Figure 1 illustrates the relationship between PMGSY exposure and employment improvement. The figure plots household-level observations along with a fitted linear trend. A clear positive association is observed, supporting the regression-based evidence that higher exposure to PMGSY infrastructure is associated with improved employment outcomes.

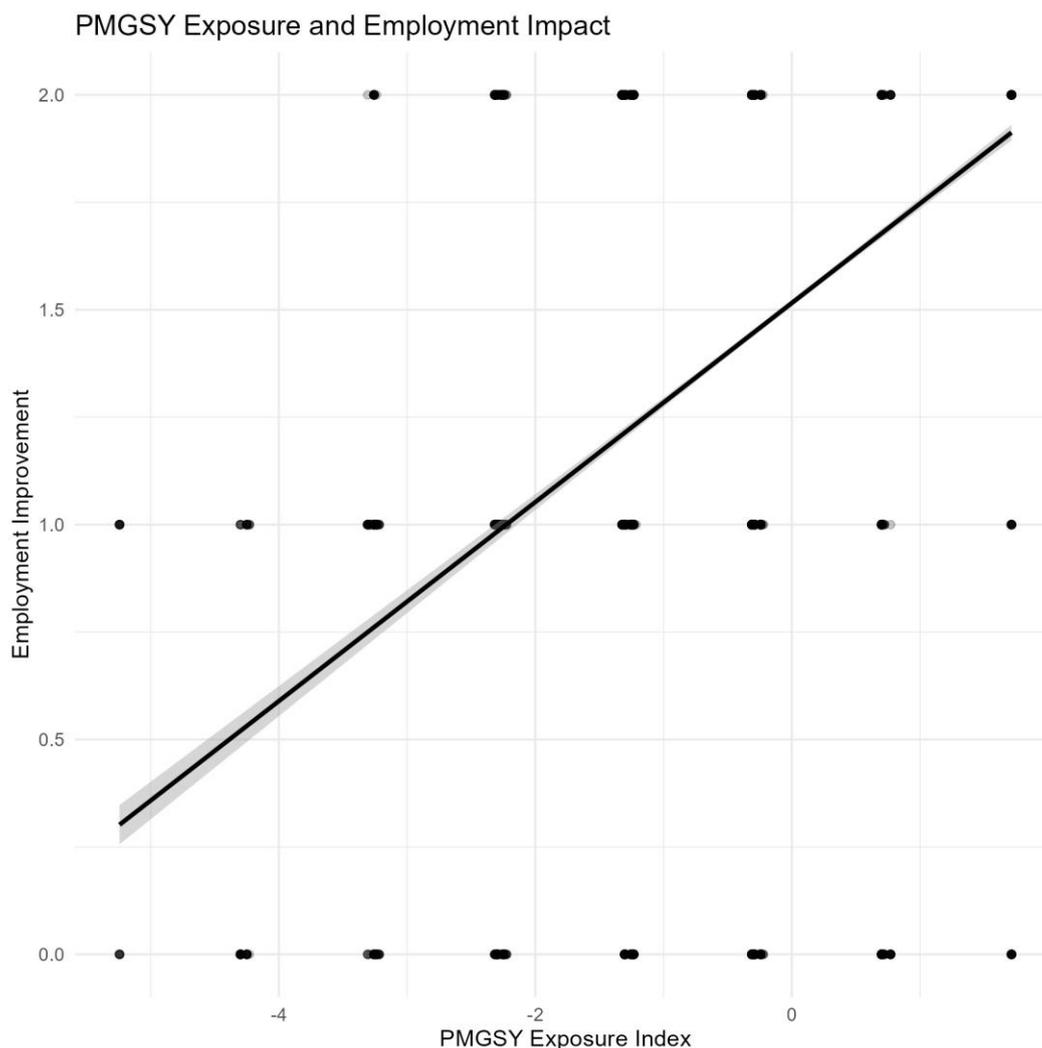


Figure 1: PMGSY Exposure and Employment Improvement

Notes: The figure plots household-level employment improvement against the PMGSY Exposure Index.

The solid line represents the fitted linear relationship.

Source: Authors calculations based on primary PMGSY household survey data.

7.3. Heterogeneity by Household Occupation

To assess whether the employment effects of PMGSY exposure differ across household types, the analysis extends the baseline model by interacting PMGSY exposure with a farmer household indicator. The estimated specification is given by Equation (4).

$$Employment_{is} = \beta_1 PMGSY Exposure_{is} + \beta_2 Farmer_{is}$$

(4)

$$+ \beta_3 (PMGSY Exposure_{is} \times Farmer_{is}) + \alpha_s + \varepsilon_{is}$$

Table 2 presents the heterogeneity results. The baseline PMGSY exposure effect remains positive and statistically significant, reflecting employment gains for non-farming households. The interaction term between PMGSY exposure and the farmer indicator is positive and statistically significant at the 10% level, indicating that farming households experience moderately stronger employment gains from improved rural connectivity.

Table 2: Heterogeneous Employment Effects of PMGSY Exposure by Household Occupation

Variable	Coefficient	Std. Error	Significance
PMGSY Exposure Index	0.177	0.022	***
Farmer (Dummy)	-0.013	0.015	
PMGSY Exposure × Farmer	0.039	0.022	*
State Fixed Effects	Yes		
Observations	18,877		
Adjusted R^2	0.179		
Within R^2	0.085		

Notes: The dependent variable is employment improvement measured on a 0–2 ordinal scale. The farmer variable equals one for households primarily engaged in agriculture. Standard errors are clustered at the state level. *** and * denote significance at the 1% and 10% levels, respectively. *Source:* Authors calculations based on primary PMGSY household survey data.

8. Discussion

The empirical results provide consistent evidence that improved rural road connectivity under the Pradhan Mantri Gram Sadak Yojana is associated with better employment outcomes. The positive and statistically significant relationship between PMGSY exposure and employment improvement suggests that rural infrastructure plays an important enabling role in enhancing economic opportunities. These findings are in line with the broader literature emphasizing the role of transport infrastructure in reducing spatial frictions and facilitating labor mobility in rural areas. The heterogeneity analysis further indicates that while employment gains are observed across both farming and non-farming households, the effects

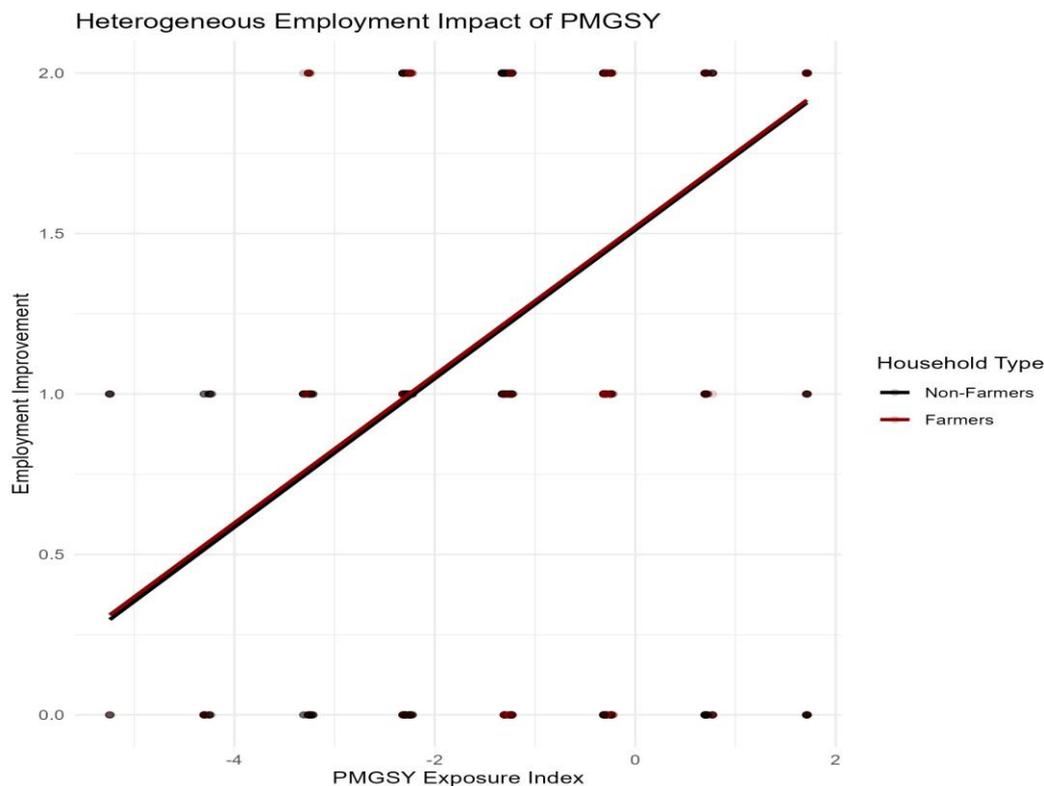


Figure 2: Heterogeneous Employment Impact of PMGSY by Household Type

Notes: The figure shows fitted relationships between PMGSY exposure and employment improvement for farming and non-farming households.

Source: Authors calculations based on primary PMGSY household survey data.

are modestly stronger for farming households. This pattern is economically intuitive. Improved road access lowers transportation costs for agricultural inputs and outputs, reduces post-harvest losses, and improves access to local and regional markets. These channels can translate into increased labor demand in agriculture and related activities. At the same time, the presence of positive effects for non-farming households highlights the broader role of rural roads in supporting diversification into non-farm employment, including trade, services, and small-scale enterprises.

It is important to note that the estimated effects should be interpreted as impact assessment estimates rather than strictly causal effects. While the empirical strategy controls for state-level unobserved heterogeneity through fixed effects and exploits variation in exposure intensity, unobserved household-level factors may still influence both PMGSY exposure and employment outcomes. Nevertheless, the consistency of results across regression estimates and graphical analysis strengthens confidence in the findings.

Overall, the results suggest that the benefits of PMGSY are broad-based rather than narrowly concentrated. Improved rural connectivity appears to support employment outcomes through multiple channels, reinforcing the importance of complementary investments in markets, skills, and services to fully realize the economic potential of rural road infrastructure.

9. Policy Implications

The findings of this study carry several policy-relevant implications for rural infrastructure planning and implementation in India. First, the positive association between PMGSY exposure and employment improvement underscores the importance of sustained public investment in rural road infrastructure. Ensuring reliable all-weather connectivity remains a critical prerequisite for enhancing rural livelihoods and reducing spatial inequalities.

Second, the modestly stronger employment gains observed among farming households suggest that rural roads can play a pivotal role in supporting agricultural commercialization. Policymakers may enhance these benefits by integrating PMGSY investments with complementary interventions, such as improved access to agricultural markets, storage facilities, and extension services. Such coordination can amplify the employment and income effects of rural connectivity.

Third, the presence of employment gains among non-farming households highlights the role of rural roads in facilitating economic diversification. Improved connectivity can lower entry barriers for non-farm enterprises and service activities. Policies that promote skill development, rural entrepreneurship, and access to credit can help leverage PMGSY infrastructure to generate more inclusive employment opportunities.

Finally, the variation in exposure and outcomes across regions emphasizes the importance of maintenance and quality assurance. Ensuring timely maintenance of rural roads is essential for sustaining the long-term benefits of PMGSY. Targeting lagging regions and habitations with lower effective exposure may further enhance the equity and effectiveness of the program.

10. Conclusion

This study examines the employment impacts of the Pradhan Mantri Gram Sadak Yojana using a large-scale household survey and a composite measure of program exposure. By exploiting variation in exposure intensity and controlling for state-level heterogeneity, the analysis provides evidence that improved rural road connectivity is associated with meaningful improvements in employment outcomes. The results indicate that higher exposure to PMGSY is linked to increased employment opportunities for rural households, with gains observed across both farming and non-farming

households. Heterogeneity analysis suggests that farming households experience moderately stronger benefits, consistent with improved access to agricultural markets and labor mobility. At the same time, the presence of positive effects for non-farming households highlights the broader role of rural roads in supporting economic diversification. While the analysis does not claim strict causal identification, the consistency of findings across regression estimates and graphical evidence strengthens the case for PMGSY as an important enabling intervention in rural development. Future research could build on this work by incorporating longitudinal data or exploiting policy discontinuities to further strengthen causal inference. Overall, the study underscores the continued relevance of rural road infrastructure as a cornerstone of inclusive growth and employment generation in rural India.

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Appendix

Appendix A. Construction of the PMGSY Exposure Index

This appendix describes the construction of the composite PMGSY Exposure Index used in the empirical analysis. The index is designed to capture household-level effective exposure to rural road

infrastructure under the Pradhan Mantri Gram Sadak Yojana (PMGSY), rather than mere physical proximity to roads.

The index combines multiple survey-based indicators reflecting different dimensions of road access and usability, including: (i) awareness of the PMGSY scheme, (ii) perceived improvement in road quality, and (iii) ease of road usage for daily activities. Prior to index construction, all component variables were recoded such that higher values represent greater exposure or better road conditions. Principal Component Analysis (PCA) was employed to aggregate these indicators into a single continuous index. The first principal component, which explained the largest proportion of total variance, was retained as the PMGSY Exposure Index. The resulting index was standardized to have a mean of zero and a standard deviation of one to facilitate interpretation and comparability across specifications.

Appendix B. Variable Definitions

Table A1 provides definitions and measurement details for the key variables used in the analysis.

Table A1: Definition of Key Variables

Variable	Definition
Employment Improvement	Ordinal indicator taking values 0 (no improvement), 1 (moderate improvement), and 2 (significant improvement in employment or income).
PMGSY Exposure Index	Standardized composite index constructed using PCA from road awareness, quality, and usability indicators.
Farmer	Dummy variable equal to 1 if the households primary occupation is agriculture; 0 otherwise.
State Fixed Effects	Indicator variables capturing unobserved statelevel heterogeneity.

Source: Authors compilation based on primary PMGSY household survey data.

Appendix C. Robustness and Additional Checks

Several robustness checks were conducted to assess the stability of the main results. First, alternative specifications excluding potentially collinear exposure components were estimated, yielding qualitatively similar coefficients on the PMGSY Exposure Index. Second, models were re-estimated using alternative clustering levels, and inference remained unchanged.

In addition, propensity score matching was implemented as a complementary approach to reduce observable selection bias between high-exposure and low-exposure households. The estimated average treatment effects from the matched sample were consistent in sign and magnitude with the baseline fixed-effects results, reinforcing confidence in the empirical findings.

Appendix D. Limitations

While the study provides robust evidence on the employment impacts of PMGSY exposure, certain limitations should be acknowledged. The analysis relies on cross-sectional primary survey data, which constrains the ability to make strong causal claims. Although state fixed effects and robustness checks mitigate concerns related to unobserved heterogeneity, future research using panel data or quasi-experimental designs could further strengthen causal inference.

Despite these limitations, the findings offer valuable insights into the employment implications of large-scale rural road infrastructure programs in developing economies.