

Mishra, Abhisek; Debata, Byomakesh

**Article**

## Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India

Cogent Economics & Finance

**Provided in Cooperation with:**

Taylor & Francis Group

*Suggested Citation:* Mishra, Abhisek; Debata, Byomakesh (2021) : Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 9, Iss. 1, pp. 1-14, <https://doi.org/10.1080/23322039.2021.1978705>

This Version is available at:

<https://hdl.handle.net/10419/270160>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*



<https://creativecommons.org/licenses/by/4.0/>

# Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India

Abhisek Mishra & Byomakesh Debata |

To cite this article: Abhisek Mishra & Byomakesh Debata | (2021) Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India, Cogent Economics & Finance, 9:1, 1978705, DOI: [10.1080/23322039.2021.1978705](https://doi.org/10.1080/23322039.2021.1978705)

To link to this article: <https://doi.org/10.1080/23322039.2021.1978705>



© 2021 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.



Published online: 29 Sep 2021.



Submit your article to this journal [↗](#)



Article views: 3686



View related articles [↗](#)



View Crossmark data [↗](#)



Received: 24 May 2019  
Accepted: 6 September 2021

\*Corresponding author: Byomakesh Debata, Assistant Professor, Department of Economics & Finance, Bits Pilani, Pilani, India  
E-mail: [byomakesh.debata@gmail.com](mailto:byomakesh.debata@gmail.com)

Reviewing editor:  
GOODNESS AYE, UNIVERSITY OF AGRICULTURE, MAKURDI BENUE STATE, NIGERIA

Additional information is available at the end of the article

## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India

Abhisek Mishra<sup>1</sup> and Byomakesh Debata<sup>2\*</sup>

**Abstract:** Livelihood insecurity remains a prime concern for low household income countries. To provide secured livelihood to rural poor, the government of India has introduced a self-employment type poverty alleviation programme namely National Rural Livelihood Mission (NRLM). This paper empirically examines the effect of participation in NRLM on the livelihood security of rural poor. Data were collected from 220 respondents (including both beneficiaries and non-beneficiaries) through a structured questionnaire from Sonepur district of Odisha (India). A livelihood security index (LSI) was constructed to capture the livelihood security of the respondents taking habitat security, health security, food security, and economic security into account. Further, the impact of the programme has been estimated using propensity score matching (PSM) method. The study finds a positive and significant effect of participation in the programme on livelihood security. Therefore, poor should be encouraged to participate in the programme to strengthen their livelihood security.

**Subjects:** Economics and Development; Economics; Development Economics

### ABOUT THE AUTHORS

Abhisek Mishra is a Lecturer in the School of Management, Gangadhar Meher University, Odisha, India. His primary area of research includes development economics, financial economics, public policy, nutrition, and public health. He has authored more than 5 research papers in the journal of international repute.

Byomakesh Debata is an Assistant Professor in the Department of Economics & Finance at BITS Pilani, India. He has research publications in the reputed journal like *Finance Research Letters*, *Journal of Financial Economic Policy*, *Journal of Applied Economic Research*, *IIMB Management Review*, and *International Review of Finance* to his credit and few papers are under review in reputed journals. In addition to his area of specialization in financial economics, he has scholarly interest in computational finance and behavioural finance.

### PUBLIC INTEREST STATEMENT

Poverty alleviation has been a prime concern for the Government of India (GoI) since independence. Therefore, various wage employment, self-employment, and food security type poverty alleviation programmes have been introduced by GoI across the time. In the year 2013, the GoI introduced a self-employment type poverty alleviation programme namely National Rural Livelihood Mission (NRLM) replacing previous *Swarnajayanti Gram Swarozgar Yojana* (SGSY) programme with the objective of providing secured and sustainable livelihood to the rural poor. To achieve the objective, various financial and livelihood services are provided to the beneficiaries under the programme. This study empirically examines the effectiveness of the programme in providing secured livelihood to the rural poor through a field survey conducted in one of the backward districts of Odisha, India. The outcome of the study revealed that participation in the programme helps the beneficiaries in achieving secured livelihood. The findings of the study have implications for the researchers and policy makers.

**Keywords: National Rural Livelihood Mission (NRLM); Impact Evaluation; Randomisation; Livelihood security; Propensity score matching (PSM)**

## 1. Introduction

Households' livelihood security remains a pertinent issue in the economic development of low household income communities (Bhandari & Grant, 2007). It has been defined as adequate and sustainable access to the income and resources required to meet basic needs.

The basic need includes adequate access to food, health facilities, educational opportunities, housing, community participation and social integration (Frankenberger & McCaston, 1998). India has emerged as one of the fast growing economies (Dreze & Sen, 2014). Despite this growth, insufficiencies in terms of income, education, health care are also visible (Kasthuri, 2018; Patidar, 2019). For instance, high level of malnutrition and hunger is prominent in the country; as around 60 million of undernourished from the total of 178 million (in world) reside in India (Yadav et al., 2016). Moreover, in terms of per capita income and poverty head count ratio India's performance is poorer than other countries. Therefore, to meet the above insufficiencies various wage employment and self-employment programmes like Integrated Rural Development Programme (IRDP), *Swarnajayanti Gram Swarozgar Yojana* (SGSY), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) have been introduced by the Government of India across time (Mishra, 2017a). The success rates of these programmes were low as a large group of vulnerable did not get benefits from the programmes (Breitkreuz et al., 2017; Mishra, 2017a). The effectiveness of poverty alleviation programmes will be high if the cause of poverty is rightly identified and the programmes are introduced in accordance with that (Bradshaw, 2007). Thus, it is imperative to identify the cause before the implementation of the programme.

In India, poverty is caused by interdependencies of multiple factors (Mishra, 2017b) and thus the poverty alleviation programmes should be implemented with the objective of providing secured and sustainable livelihood (Chamber, 1995; Krantz, 2001) through i) providing varieties of services, ii) collaborating with other organisations and iii) organising the communities adopting the cycle of poverty perspective (Bradshaw, 2007; Mishra, 2017b). Further, to enhance households' livelihood security, three approaches can be taken: a) livelihood promotion, b) livelihood protection, and c) livelihood provisioning (Das, 2016). These strategies, whether applied alone or in combination, help to enhance households' livelihood security (Frankenberger & McCaston, 1998).

Recently, with the objective of providing secured livelihood to rural poor, the government has introduced a self-employment type poverty alleviation programme (for the promotion of livelihood) namely National Rural Livelihood Mission (NRLM). The programme is introduced by restructuring the previous *Swarnajayanti Gram Swarozgar Yojana* (SGSY) programme. NRLM is a centrally sponsored scheme with a three tier structure-national, state, and district level. At the national level, Ministry of Rural Development takes the responsibility. In the state level, Ministry of *Panchayati raj* undertakes the responsibility and at district level, District Rural Development Agency handles the functionality of the programme. The financing of the programme is shared between the centre and state. The ratio of sharing between the centre and the state is 75:25 in all the Indian states except North Eastern states, where it is shared in the ratio of 90:10.

NRLM ensures that at least one member from the identified rural poor household is brought under the self-help group (SHG) network in a time bound manner. This clarifies that NRLM tries to address poverty through SHGs building strong institutions of poor. The programme further provides financial and livelihood services to the beneficiaries. The financial services are provided to the beneficiaries in the form of community investment fund, bank linkage and capital received under interest subvention. In the form of livelihood services, the programme imparts short duration learning (self-employment) programmes to the beneficiaries. Moreover, to make youths confident and self-employed, the programme collaborates (in partnership) with other organisation for trainings and post-training follow-up (Mishra, 2017b). The above description clearly depicts that NRLM

tries to alleviate poverty following cyclical perspective in terms of providing a variety of services, collaborating with other organisations and organising communities.

The extent of benefits derived from a programme can be known after impact evaluation as it addresses questions related to the causal effect of an intervention on an outcome (Mishra & Das, 2017). In the context of impact evaluation, Mohapatra and Sahoo (2016) report that the impact of a programme is better assessed if the study is conducted in a backward region<sup>[1]</sup>. On the contrary, a majority of the studies have been conducted in examining the impact of poverty alleviation programmes in developed states and the literature on backward region is scant. With this background, this study chooses Sonepur district of Odisha (India) as an ideal selection for the study (to bridge the gap) due to the following reasons. First, Sonepur is an indispensable core area of Kalahandi Balangir Koraput (KBK) region. The KBK region has been found to be the most underdeveloped and poverty-driven belt in India (Dash, 2007), which signifies the backwardness of this region. Second, the share of Gross District Domestic Product (GDDP) to Gross State Domestic Product (1.01% based on the Odisha Economic Survey of 2014–2015) of Sonepur is minimal in comparison to other districts of KBK region. The above scenario speaks about the backwardness of Sonepur that justifies the selection to be an ideal one.

The present study is carried out with the objective to examine the impact of NRLM on livelihood security of rural poor. The study constructs an index of livelihood security considering health security, habitat security, food security, and economic security. The study using propensity score matching method finds a positive impact of NRLM on livelihood security. This study empirically examining the impact of NRLM on livelihood security in a backward region overcomes the limitations of past literature (Kurian, 1987; Paul, 1998; Ray, 2008; Panda et al., 2012), which were limited to the impact assessments of self-employment programmes (in developed states) on poverty alleviation in terms of income generation and agricultural production which are few dimensions of livelihood security. Thus, it is believed to be an endeavour to enrich the existing literature as to our knowledge this study is the first ever empirical study on examining the impact of NRLM on livelihood security specifically in a backward state region. The remainder of the paper is as follows. Section 2 provides the theoretical framework and hypothesis formulation. Section 3 portrays the data sources and methodology used in the study. Section 4 explains about the impact of NRLM on livelihood security and section 5 concludes.

## 2. Theoretical framework and hypothesis formulation

Poverty alleviation programmes with SHG—linkage model is gaining popularity as participation in SHG empowers the beneficiaries (Desai & Joshi, 2012; Deininger & Liu, 2013; Mohapatra & Sahoo, 2016; Kumar et al., 2019; Nayak & Panigrahi, 2020). Further, the long-term exposure of the beneficiaries to the programme through SHG positively impacts their consumption, nutritional intake, and asset accumulation (or wealth accumulation) (Deininger & Liu, 2009), which ensures their economic and food security. Moreover, involvement in SHG networks increases the social capital (a resource derived from people's social participation) of members, which enhances the awareness regarding basic necessities including education (a component of educational security), sanitation, and drinking water (which are subcomponents of health security). Thus, it is clear that participation in SHGs can ensure educational security and health security to the rural poor through the creation of social capital. Therefore, broadly, five dimensions of livelihood security, i.e., empowerment, health security, economic security, educational security, and food security can be achieved through the participation in SHG. Earlier it was mentioned that NRLM tries to alleviate poverty by bringing beneficiaries into SHG network. Thus, it is articulated from the above literature that through the participation in SHG, NRLM can meet the five dimensions of livelihood security.

Availability of capital in the right quantity at an affordable cost has the potential to reduce the high incidence of poverty and contribute to household well-being (Mohapatra & Sahoo, 2016). NRLM provides financial assistance to the beneficiaries in the form of capital and bank linkages. Along with the financial assistance, the programme also provides self-employment trainings to the beneficiaries. The duo effect of training and capital can help the beneficiaries in either starting their own

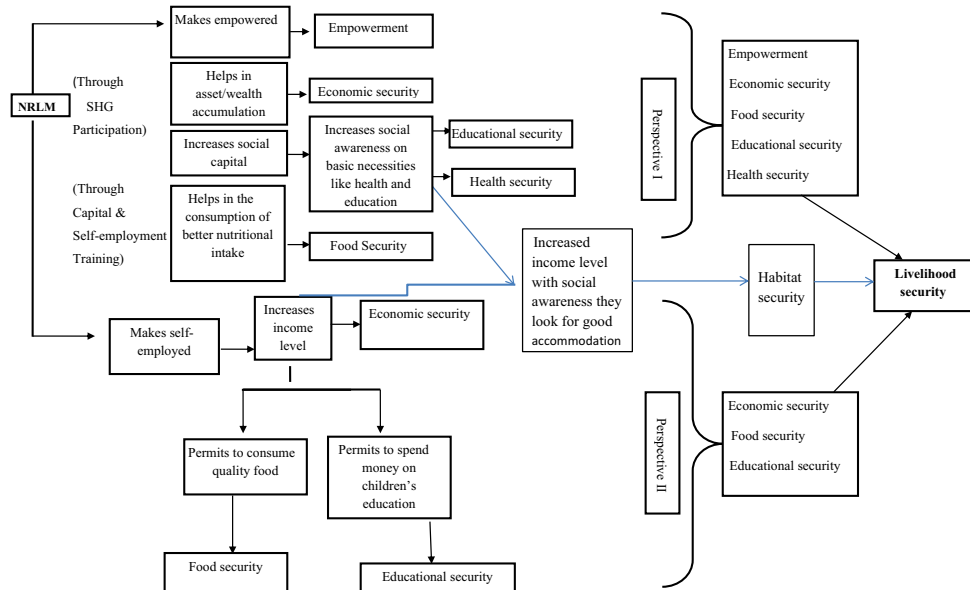
business or making investment in agriculture, which may increase their income level and can provide economic security. The increased level of income will permit families to consume quality food leading to a state of food security. Economic security coupled with social capital will enhance their social awareness and due to which they will look for better accommodation (house), which will ensure their habitat security. In rural India, the educational attainment of children is significantly affected by their parents' financial constraints. The increased level of income after participation in the programme can help parents educating their children and thus can ensure educational security. Taking a cue from the above literature, we hypothesise that livelihood security (considering the dimensions of educational security, economic security, health security, empowerment, educational security & food security) of people can be enhanced through the participation in NRLM. This theoretical framework is depicted in Figure 1.

### 3. Data and methodology

This study is based on both primary and secondary data. Due to dearth of secondary data on the functioning of NRLM to assess the impact, the study relies on primary data. To collect the primary data, a field survey was conducted at the household level using a structured questionnaire. A three-stage probability (and non-probability) sampling was followed to collect data, with blocks as the primary units, *Gram-panchayats* and villages as the secondary units, and beneficiaries and non-beneficiaries [2] as the ultimate sampling units.

Under the NRLM, two types of blocks were found in Sonapur district, intensive and non-intensive [4]. In the case of intensive blocks, all components of the programme work intensively, whereas in the non-intensive blocks all components do not operate to that extent. To obtain an unbiased outcome, data were collected from two blocks, one intensive and one non-intensive. In the year 2015 (when the study was undertaken), Tarbha was identified as the only intensive block in Sonapur district. Therefore, based on the judgemental sampling this intensive block (Tarbha) was chosen. Sonapur block (a non-intensive block for NRLM) was chosen from the rest five blocks at random. In six different *Gram Panchayats* of Tarbha block, intensive works were underway. Out of those, five *panchayats* were chosen purposively for this study. Further, one village from each intensive *panchayat* was chosen at random. In parallel, five villages from five different *panchayats* of Sonapur block (non-intensive) were also chosen at random. Lastly, a total of 220 respondents (120 beneficiaries and 100 non-beneficiaries) were interviewed.

**Figure 1. Conceptual framework on achieving livelihood security through NRLM.**



Based on Soper's (2020) sample size calculator for multiple regressions with anticipated effect size of 0.15, desired probability level of 0.005 and desired statistical power of 0.8 for seven (in eq<sup>n</sup>12) and two (in eq<sup>n</sup>11) independent variables were found to be 103 and 67, respectively. Hence, sample size of 120 beneficiaries is adequate to achieve the satisfactory effect size. In the present study, it was imperative to include non-beneficiaries as they act as a counterfactual [3]. Moreover, in the use of propensity score matching method, it is evident from the past literature that the percentage of non-beneficiaries in the total sample size in comparison to the beneficiaries varies from 30% to 90% (Gebrehiwot & Van der veen, 2015; Mohapatra & Sahoo, 2016; Satapathy et al., 2020). This justifies the inclusion of 100 non-beneficiaries (which constitutes 83% of beneficiaries) in the study. Non-beneficiaries were selected from the same village or nearby villages at random from the below-poverty-line (BPL) lists that were collected from the *panchayat* office.

#### 4. Socio-economic profile of sample households

In the context of social stratification, caste has a significant importance (Mohapatra & Sahoo, 2016); it has been found to be one of the key markers of socio-economic status in rural India (Rao & Ban, 2007). Scheduled Castes (SCs) and Scheduled Tribes (STs) have largely remained outside the mainstream of modern Indian society. In the present study, most beneficiaries belonged to the SC category (85%), followed by Other Backward Classes (OBC, 12%), and general (3%). Approximately the same distribution pattern is found among non-participants.

In addition to caste, occupation, household income, and land holdings are important indicators of economic status. Occupation denotes the economic condition of a household, which in turn describes their social status. Casual laborer was the primary occupation for a majority of respondents (72%), followed by agricultural laborer (20%), and self-employed (8%). The average annual income of beneficiaries was Rs.38,300 (\$538.02), while the average annual income of non-beneficiaries was Rs. 35,200 (\$494.48). Land is a primary asset in rural areas, as it is used not only for agricultural production but also as a security against shocks by selling those assets in the market (Mohapatra & Sahoo, 2016). The study revealed that 45% of beneficiaries and 69% of non-beneficiaries do not have cultivated land. The above discussion is summarised in Table 1.

##### 4.1. Measure

A livelihood security index (LSI) was constructed to capture the livelihood security (understood as outcomes of the NRLM) of the respondents, as LSI helps in providing a clearer profile of livelihood security at the community level (Lindenberg, 2002). Furthermore, it provides information regarding all the dimensions in a single number (Sarma, 2008).

**Table 1. Socio-economic profile of the respondents**

Household characteristics	Treatment group	Control group
Percentage of SCs	85%	86%
Percentage of OBCs	12%	12%
Percentage of General	3%	2%
Average annual income	38,300 (\$538.02)	35,200 (\$494.48)
Average age	36.62	35.4
Average education	4	3
Percentage of respondents holding Land	55%	31%

(Source: Field Survey)

Note: values in the parenthesis represent the dollar equivalent of average annual income.

#### 4.2. Determining variables and indicators

The measurement of livelihood security requires considering the best variables (or indicators) to capture it. CARE, the internationally recognised non-governmental organisation, groups the sub-components of livelihood security into economic security, food security, health security, educational security, and empowerment. Due to variations in people’s bio-physical and socio-economic conditions, the indicators for studying livelihood security should be location specific and be constructed based on the socio-economic particulars of the location under examination (Bhandari & Grant, 2007).

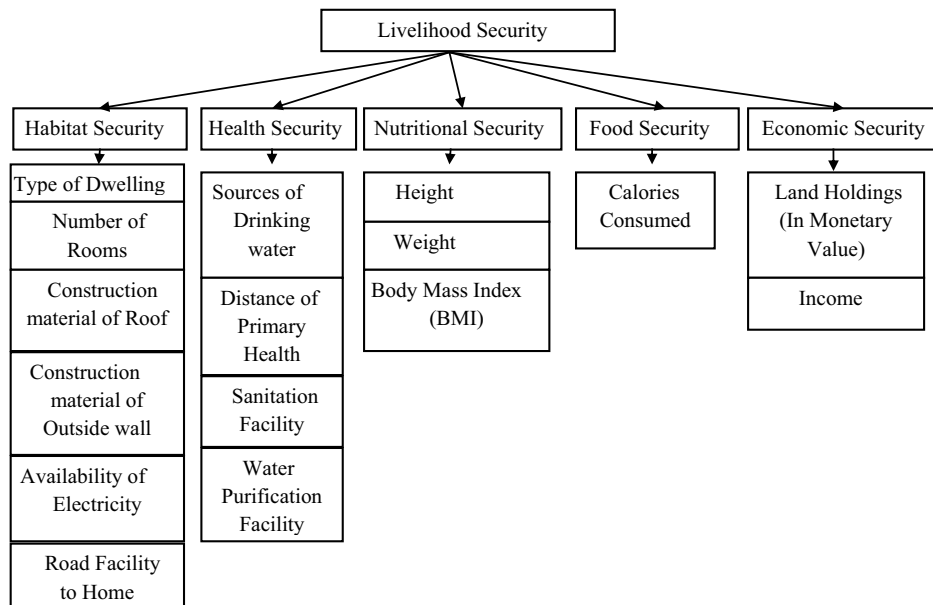
In the present study, a majority of both beneficiaries and non-beneficiaries are poor with low household income affecting not only their consumption but also the education of their children. Consumption of quality food is essential in maintaining a balanced life failing which will affect the health (Mishra et al., 2020). This economic scenario entails to include food security, economic security, health security, and educational security. On the contrary, the literacy rate in study area was found to be better than the state’s literacy rate. Therefore, the study drops educational security as one dimension of livelihood security. Thus, the study proposes to include economic security, health security, empowerment, and food security as the dimensions of livelihood security. Along with the above, based on the results of the pilot study [5] habitat security was taken as an additional variable and dropped empowerment as one dimension. The study follows Mishra (2017b) and considers the sub-indicators to measure the habitat security. Details on indicators and sub-indicators undertaken to construct the LSI are presented in Figure 2.

After the identification of indicators and sub-indicators, indices of individual dimensions were computed using the equations presented below.

$$d_i = \frac{A_i - m_i}{M_i - m_i} \tag{1}$$

Where,  $d_i$  is the index of  $i^{\text{th}}$  dimension and  $A_i$ ,  $M_i$ , and  $m_i$  are the actual value, maximum value, and minimum value in  $i^{\text{th}}$  dimension. The overall index of livelihood security is computed as

**Figure 2. Indicators and sub-indicators of livelihood security.**





**Table 2. Livelihood Security Index (LSI) among sample households**

Livelihood Security Index	Beneficiaries	Non-beneficiaries	Total
Low	19 (16%)	-	19 (9%)
Medium	92 (77%)	72 (72%)	164 (75%)
High	9 (7%)	28 (28%)	37 (16%)
Total	120	100	220

Notes: Figures in the parenthesis are in the % of the column total.

$$LSI_i = \sum_{i=1}^4 W_i d_i \tag{2}$$

Where,  $LSI_i$  represents the overall livelihood security index of  $i^{th}$  individual and  $W_i$  stands for the weight allotted to each dimension. Here, equal weights are given to each dimension, so  $W_1 = W_2 = W_3 = W_4$ . The present study gives equal weights to all the dimensions following Samanta and Nayak (2015).

### 4.3. Livelihood security amongst sample households

After calculating the index of livelihood security, the difference of livelihood security among beneficiaries and non-beneficiaries was assessed. The livelihood security index has been categorised into three types – low, medium, and high. When we look at medium level livelihood security index, the percentage of beneficiaries is more than non-beneficiaries. But, in the low-level index, the percentage of non-beneficiaries is more than beneficiaries. High level of livelihood security index is found only among beneficiaries. The result is presented in Table 2.

## 5. Impact evaluation of the NRLM on livelihood security

### 5.1. Selection of method

The evaluation of a policy is based on two theories, the structural approach and the treatment effect approach. The former is applicable where there is universal participation, while the treatment effect approach is applicable where there are two groups: (a) a treatment group that takes part in the programme and (b) a comparison group that does not participate in the programme (Heckman & Vytlacil, 2005; Mishra & Das, 2017). Evaluation methods in empirical economics fall into five broad categories, each of which provides an alternative approach for constructing the counterfactual and helps to minimise selection bias Ravallion (2008) advocates that studies based on a randomised selection method mitigate the selection bias problem to the greatest possible extent. Randomised selection is applicable when the programme is a large one and needs to be implemented in a phase-wise manner (Gertler. et al., 2007). This method also ensures that each individual has an equal opportunity to take part in the programme. The NRLM is a flagship programme that has been implemented in a phase-wise fashion. Thus, randomisation method can be suitable in examining the impact of NRLM. On the contrary, participation in the NRLM is not random, and when the participation is not random, there is a possibility of self-selection bias, which can be addressed by creating a suitable counterfactual. This can be done by matching each programme beneficiary to a non-beneficiary with similar covariates (Mohapatra & Sahoo, 2016). Further, matching method provides similar result like randomisation method (Dehejia & Wahba, 1999). Thus, this study uses propensity score matching (PSM) as an alternative to randomisation method in examining the impact of the NRLM on livelihood security.

### 5.2. Mathematical interpretation of methodology

The mathematical methodology discussed below is borrowed from Rosenbaum and Rubin (1983), Cameron and Trivedi (2005) and Mohapatra and Sahoo (2016). In the present study, let T represent participation in the programme.  $T = 1$  indicates a particular respondent participates in the

programme (treatment/beneficiary), otherwise  $T = 0$  (control/non-beneficiary). 'LS' denotes the livelihood security.  $LS_1$  is the livelihood security of the beneficiaries and  $LS_0$  is the livelihood security of non-beneficiaries. Total sample size  $N$  is 220, of which beneficiaries ( $N^b$ ) are 120 and non-beneficiaries ( $N^{nb}$ ) are 100.  $X$  is the vector of covariates and  $P(x)$  is the propensity score.

The average impact of treatment (AIT) on the livelihood security is expressed as:

$$AIT = E(LS_1 - LS_0) \tag{3}$$

and the estimated sample AIT is:

$$\overline{AIT} = \frac{1}{220} \sum_{N=1}^{220} \Delta LS_N \tag{4}$$

The average impact of the treatment on the population may provide a biased result; therefore, there is a need of finding out the average impact of the treatment on the treated or beneficiaries (AITB).

This is expressed as:

$$AITB = E(LS_1 - LS_0/T = 1) = E(LS_1/T = 1) - E(LS_0/T = 1) \tag{5}$$

and the estimated AITB on the sample in this study is:

$$\overline{AITB} = \frac{1}{120} \sum_{N=1}^{120} \Delta LS_N \tag{6}$$

However, the second term of equation 5, i.e.,  $E(LS_0/T = 1)$  is not observable. On the other hand,  $E(LS_0/T = 0)$  is observable. But the problem is  $E(LS_1/T = 1) \neq E(LS_0/T = 0)$ , which is due to selection bias. Therefore, the observed outcome given the participation is:

$$LS = (1 - T)LS_0 + T * LS_1 = LS_0 - T * LS_0 + T * LS_1 = LS_0 + T(LS_1 - LS_0) \tag{7}$$

In the present programme, participation is not random. This leads to the presence of self-selection bias, for which the estimation of the average impact of treatment on beneficiaries (AITB) and AIT are not feasible. This is feasible under conditional independence assumption of PSM. The conditional independence assumption ensures that the selection is solely based on a set of observable covariates ( $X$ ) (Wooldridge, 2002). Symbolically,  $LS_0 \perp T/X$ , where  $\perp$  denotes independence. The common support or overlap condition ensures that the person with the same  $X$  values have a positive probability of being beneficiary and non-beneficiary (Heckman, LaLonde, & Smith, 1999).

It may be noted that under conditional independence assumption and set of observable covariates ( $X$ ), both AITB and AIT are identical (Wooldridge, 2002; Mohapatra & Sahoo, 2016). Thus, estimation of AITB( $X$ ) will be sufficient for examining the effect of participation on livelihood security. The equation is presented below.

$$\begin{aligned} AITB(X) &= E(LS_1 - LS_0|X) = E(LS_1|T = 1, X) - E(LS_0|T = 1, X) \\ &= E(LS_1|T = 1, X) - E(LS_0|T = 0, X) = E(LS_1|X) - E(LS_0|X) = E(LS_1 - LS_0|X) = AIT(X) \end{aligned} \tag{8}$$

Furthermore, Rosenbaum and Rubin (1983) have proved that if conditional independence assumption holds, then replacing conditional on propensity score over conditional on observable covariates will also hold. Symbolically, (Overlap)  $0 < P(T = 1/X) < 1$ .

Hence, based on the conditional independence assumption and overlap condition, the average impact of treatment of participation is:

$$\begin{aligned} AITB(X) &= E(LS_1 - LS_0/T = 1, P(X)) = E(LS_1/T = 1, P(X)) - E(LS_1/T = 1, P(X)) \\ &= E(LS_1/T = 1, P(X)) - E(LS_0/T = 0, P(X)) \end{aligned} \quad (9)$$

and the estimated AITB for the sample is:

$$\overline{AITB} = \frac{1}{120} \sum_{N=1}^{120} (LS_{1,N} - LS_{0,N}^{PSM}) \quad (10)$$

In equation 10,  $(LS_{1,N} - LS_{0,N}^{PSM})$  is the difference between observed livelihood security of the beneficiaries and matched (PS). Following Mohapatra and Sahoo (2016), different degrees of bandwidths are also used to check the sensitivity or the presence of hidden bias in the estimate.

Further, when the outcome variable (in this case livelihood security) is continuous and treatment is a discrete variable (NRLM participation), the impact of the treatment can be evaluated by adding the estimated propensity score  $\hat{P}(X)$  in the ordinary least square (OLS) estimation (Wooldridge, 2002; Mohapatra & Sahoo, 2016). Symbolically, the regression function can be represented as

$$LS = f(P, \hat{P}(X)) \quad (11)$$

The estimated impact is said to be positive when the value of  $P$  in eq<sup>n</sup> 11 is positive and statistically significant.

### 5.3. Results

The results of the present study are obtained following the steps mentioned in Caliendo and Kopeinig (2008) for using PSM. Based on those methods, first variables are identified based on hit and trial and statistical significance method to run a binary probit model for finding out the propensity score.

The estimable regression equation is

$$Y_i = \alpha_0 + \beta_1 A_{i1} + \beta_2 DR_{i2} + \beta_3 E_{i3} + \beta_4 AH_{i4} + \beta_5 SOC_{i5} + \beta_6 PO_{i6} \quad (12)$$

In equation 12,  $A$  represents the age of the respondents,  $DR$  represents the dependency ratio (calculated by taking the total number of earning members and total number of members into account), and  $E$ ,  $AH$ ,  $SOC$ , and  $PO$  represent electricity facility, asset holdings, source of cooking, and primary occupation, respectively. Dummy variables were used for electricity (yes = 1, 0 = otherwise), livestock holding (yes = 1, 0 = otherwise), and landholding (yes = 1, 0 = otherwise). In the present study, most of the respondents reported their primary occupation as casual laborer. Thus, a dummy variable was also created for primary occupation, with 1 assigned for casual laborers and 0 otherwise. Further, the present study follows Mohapatra and Sahoo (2016) and adds source of cooking as an instrumental variable. The result is presented in Table 3. Table 3 shows that source of cooking and primary occupation are the significant factors in influencing the decision to participate in the programme.

After the estimation of propensity score, the common support region was identified and was found to be [0.28, 0.92]. This implies that propensity scores below 0.28 and greater than 0.92 were eliminated based on the maxima and minima approach. This elimination results in the loss of seven respondents (both beneficiaries and non-beneficiaries). The balancing property test is carried out to assess the matching quality using pseudo  $R^2$  and the likelihood ratio test (LR  $\chi^2$ ). The matching quality is said to be good when the pseudo  $R^2$  value decreases (Sianesi, 2004) and

**Table 3. Estimation of propensity score using probit model**

Explanatory variables	Coefficients	Robust standard error
Age	-0.07	0.012 (-0.59)
Dependency ratio	0.817	0.727 (1.06)
Electricity	0.399	0.196 (0.99)
Asset holding	0.149	0.08 (1.60)
Source of cooking	0.313	0.174 (1.80)*
Primary Occupation (casual labourer = 1)	-0.253	0.230 (1.88)*
Log likelihood	-140.9	
Pseudo R <sup>2</sup>	0.0523	
Chi-square statistics	15.56*	
Iteration completed	3	
Number of observations	220	

**Note:** Absolute Z values are in the parenthesis. \* represents significance at 5% level.  
**(Source:** Authors' calculation).

**Table 4. Assessing matching quality**

Treatment	Pseudo R <sup>2</sup>	LRchi <sup>2</sup>	Pchi <sup>2</sup>
Before matching	0.0523	15.56	0.001
After matching	0.0378	11.03	0.123

(Source: Authors' calculation).

likelihood ratio test becomes insignificant (Smith & Todd, 2005). In the present study, the pseudo R<sup>2</sup> value decreases from the raw to the matched sample and that the likelihood ratio test becomes insignificant. This signifies that the matching performance appears to be good (Table 4).

In the next step, after determining the propensity score, a matching algorithm was used to estimate the impact. The present study used kernel matching as a matching estimator because it provides a better estimate in comparison to the nearest neighbor and interval matching (Mohapatra & Sahoo, 2016). The robustness result mentioned in Table 4 shows the coefficient of participation in NRLM is positive (0.16) and also statistically significant. Therefore, based on eq<sup>n</sup> (11), it is inferred that participation in NRLM is found to have positive and significant effect on livelihood security. The results obtained from the study are also found to be robust (Table 5).

**Table 5. Impact estimation using Kernel matching method**

Bandwidths	$\overline{AITP}$	Standard Error
0.05	0.234*	0.032
0.10	0.276*	0.025
0.15	0.299*	0.028
0.20	0.308*	0.031
Robustness check :		
$LSI = -0.603^{**} + 0.18^{**}P + 0.61^{*}\hat{P}(X)$		

**Notes:** \* and \*\*represent significance at 5% and 1 % level, respectively.  
 (Source: Authors' calculation).

#### 5.4. Discussion

The present study was carried out with the objective of examining the impact of NRLM on livelihood security. In the process of examining the impact, the study examined the determinants which affect the participation decision using probit model and found that respondents' whose primary occupation was casual labourer and who were using firewood and chips as their source of cooking had a greater possibility of participation in the programme. Moreover, though source of cooking was taken as an instrumental variable, the study finds that households with the occupation of casual labourer were using firewood and chips as their source of cooking due to their short-term engagement resulting in lower income. This situation indicates their level of vulnerability. That means, poor people are more interested to participate in the programme. From this outcome, it can be inferred that correct identification of poor for the programme was done in Sonapur district of Odisha, India. Furthermore, the present study reveals a positive impact of NRLM on livelihood security. That means, participation helps the beneficiaries in securing their economic security, food security, health security and habitat security. The outcome of the present study is in line with the past literature (Kurian, 1987; Derze, 1990; Paul, 1998; Ray, 2008; Panda et al., 2012) in terms of providing positive impacts on the outcome variables <sup>[6]</sup>. Thus, to meet the sustainable development goals, government should bring more vulnerable people into the NRLM network to alleviate poverty, make the nation hunger free, and provide education, and clean sanitation; as NRLM provides livelihood security through which all these goals can be achieved.

#### 6. Conclusion

In post-independence India, several policies have been implemented to alleviate poverty.

NRLM, a self-employment programme was implemented with the objective of providing secured livelihood to rural poor. Using primary data, this study attempted to examine the impact of NRLM on livelihood security. The present study captures the livelihood security through an index, livelihood security index taking habitat security, health security, food security and economic security into account.

Participation in NRLM is voluntary or self-selecting. In that case, the socio-economic factors that determine the participation decision were studied. A binary probit model was used to examine the participation decision. The result showed that occupation and source of cooking had significant effect on participation. Additionally, the impact of NRLM was examined using propensity score matching method and found a significant positive impact of NRLM on livelihood security.

Irrespective of this positive impact, the findings of the study are not free from limitations. First, it relies on a purposive sample with a relatively small sample size. Second, for the computation of food security, data on consumption of foods were collected from respondents on a recall basis, which may entail inaccuracies. Notwithstanding any limitations, this study provides solid evidence that the NRLM positively affects the livelihood security of the rural poor in the study area. Irrespective of the positive impact of the programme, Mishra (2017b) identifies that the restriction clause imposed in the programme in terms of age, hindrance the programme in achieving its outcome. Therefore, in line with Mishra (2017b), this study too provides suggestion to policy makers in relaxing the rigidity clause imposed in terms of age for providing secured livelihood to rural poor to a great extent. This is one of the early studies on examining the impact of NRLM on livelihood security in a backward region. The study documents a positive and significant effect of people participation in the programme on their livelihood security. This could be helpful to policy makers to design suitable policy through which the participation in the programme will increase, which in turn, will enhance livelihood security.

#### Author details

Abhisek Mishra<sup>1</sup>  
Byomakesh Debata<sup>2</sup>  
E-mail: [byomakesh.debata@gmail.com](mailto:byomakesh.debata@gmail.com)

<sup>1</sup> School of Management, G.M. University, Odisha, India.

<sup>2</sup> Assistant Professor, Department of Economics & Finance, Bits Pilani, Pilani, India.

#### Citation information

Cite this article as: Livelihood security among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India, Abhisek Mishra & Byomakesh Debata, *Cogent Economics & Finance* (2021), 9: 1978705.

#### End notes

- [1] Backward region is one having high incidence of poverty and which is deprived of social and economic infrastructure.
- [2] Here, non-beneficiaries for the study include poor who do not participate in the programme with equal characteristics with beneficiaries in terms of age, income and asset holding.
- [3] Counterfactual means, what could have been the outcome; if the programme participants would not have participated in the programme.
- [4] The government requires huge amount of funds and manpower to implement the programme intensely across all districts of the state. For that reason, the blocks are segregated as intensive and non-intensive. Further, in due course of time government is bringing more blocks into intensive category.
- [5] A pilot study was conducted taking the interviews of 50 respondents. Reliability and the validity tests were conducted taking the pilot data into consideration. From the pilot study lack of housing was found among the respondents. Therefore, habitat security was considered as an additional dimension to measure livelihood security. Further, in consistent with Mohapatra and Sahoo (2016), the study had prepared the questionnaire on women empowerment considering autonomy, economic empowerment and gender empowerment and had collected data in the pilot study. It was found from the pilot study that all the respondents were empowered in the dimension of autonomy, 83% were empowered in economic dimension, 65% were empowered in gender dimension and 80% were empowered in both autonomy and economic dimensions. Overall 82% respondents were empowered considering all the three dimensions. Therefore, based on the above result, the present study dropped the empowerment dimension for measuring livelihood security.
- [6] The outcome variables considered in the past literature and the outcome variable of the present study are different. The past literatures were confined to the impact assessments of self-employment programmes in terms of income generation and agricultural production, which are few dimensions of livelihood security. The present study considering a broader concept overcomes the limitations of past literature.

#### Disclosure statement

No potential conflict of interest was reported by the author(s).

#### Funding

The authors received no direct funding for this research.

#### References

Basant, R. (1984). Attached and casual labour wage rates. *Economic and Political Weekly*, 19(9), 390–396.

<https://www.epw.in/journal/1984/9/special-articles/attached-and-casual-labour-wage-rates.html> (accessed on 13th September 2021)

Bhandari, B.S. & Grant, M. (2007). Analysis of livelihood security: A case study in the Kali-Khola watershed of Nepal. *Journal of Environmental Management*, 85(1), 17–26. <https://doi.org/10.1016/j.jenvman.2006.07.010>

Bradshaw, T. K. (2007). Theories of poverty and anti-poverty programs in community development. *Community Development*, 38(1), 7–25. <https://doi.org/10.1080/15575330709490182>

Breitkreuz, R., Stanton, C.-J., Brady, N., Pattison-William, J., King, E.D., Mishra, C., & Swallow, B. (2017). The Mahatma Gandhi National Rural Employment Guarantee Scheme: A policy solution to rural poverty in India? *Development Policy Review*, 35(3), 397–417. <https://doi.org/10.1111/dpr.12220>

Caliendo, M., & Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching. *Journal of Economic Surveys*, 22(1), 31–72. <https://doi.org/10.1111/j.1467-6419.2007.00527.x>

Cameron, A. C. & Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications*. New York: Cambridge University Press.

Chamber, R. (1995). Poverty and livelihoods: Whose reality counts? *Environment and Urbanization*, 7(1), 73–204. <https://www.archidev.org/IMG/pdf/p173.pdf> (accessed on 13th September 2021).

Das, S. (2016). Impact of MGNREGA on the livelihood security of rural poor in India: A study using national sample survey data. *Oxford Development Studies*, 44(1), 420–440. <https://doi.org/10.1080/13600818.2016.1246658>

Dash, S. P. (2007). Development and poverty in an Indian state: A study of KBK districts of Odisha. *Social Change*, 37(2), 76–98. <https://doi.org/10.1177/004908570703700206>

Dehejia, R., & Wahba, S. (1999). Causal effects in non-experimental studies: Reevaluating the evaluation of training programs. *Journal of the American Statistical Association*, 94, 1053–1062. <https://www.jstor.org/stable/2669919>

Deining, K., & Liu, Y. (2009). *Longer-term economic impacts of self-help groups in India*, (World Bank Working Paper 4886), Policy Research Working papers 4886, World Bank. Retrieved from [http://www.ruralfinanceandinvestment.org/sites/default/files/1270045576004\\_Economic\\_impacts\\_of\\_SGH\\_in\\_India\\_2.pdf](http://www.ruralfinanceandinvestment.org/sites/default/files/1270045576004_Economic_impacts_of_SGH_in_India_2.pdf) (accessed on 18th July 2017).

Deining, K., & Liu, Y. (2013). Economic and social impacts of an innovative self-help group model in India. *World development*, 43, 149–163. <https://doi.org/10.1016/j.worlddev.2012.09.019>

Derze, J. (1990). Poverty in India and the IRDP delusion. *Economic and Political Weekly*, 25(39), A-95-A-104. <https://www.epw.in/journal/1990/39/review-agriculture-uncategorised/poverty-india-and-irdp-delusion.html> (accessed on 13th September 2021)

Desai, R. M., & Joshi, S. (2012). *Collective action and community development: Evidence from women's self-help groups in rural India*. Policy Research Working Paper no.6547, World Bank. <http://www.isid.ac.in/~pu/seminar/31072012Paper.pdf>. (accessed on 23rd July, 2017).

Dreze, J., & Sen, A. (2014). *Uncertain glory: India & its contribution*. New Delhi: Penguin Books.

Frankenberger, T., & Mccaston, M. K. (1998). The household livelihood security concept. *Food, nutrition and agriculture*, 30–35. <http://www.fao.org/3/X0051T/X0051t05.htm>

Gebrehiwot, T., & Van der veen, A. (2015). Estimating the impact of a food security programme using

- propensity-score matching. *Journal of Development and Agricultural Economics*, 7(1), 38–47. <https://doi.org/10.5897/JDAE2014.0585>
- Gertler, P., Martinez, S., Premand, P., Rawling, B. L., & Vermeersch, J. M. C. (2007). *Impact evaluation in practice*. World Bank.
- Heckman, J., & Vytlacil, E. (2005). Structural equations, treatment effects and economic policy evaluations. *Econometrica*, 73(3), 669–738. <https://doi.org/10.1111/j.1468-0262.2005.00594.x>
- Heckman, J. J., LaLonde, R. J., & Smith, J. A. (1999). The economics and econometrics of active labor market programs. *Handbook of Labor Economics*, 3(Part A), 1865–2097. [https://doi.org/10.1016/S1573-4463\(99\)03012-6](https://doi.org/10.1016/S1573-4463(99)03012-6)
- Kasthuri, A. (2018). Challenges to healthcare in India- The five A's. *Indian Journal of Community Medicine*, 43(3), 141–143. [https://dx.doi.org/10.4103%2Fijcm.IJCM\\_194\\_18](https://dx.doi.org/10.4103%2Fijcm.IJCM_194_18)
- Krantz, L. (2001). *The sustainable livelihood approach to poverty reduction: An introduction*. Swedish International Development Cooperation Agency (SIDA), available at [https://www.sida.se/contentassets/bd474c210163447c9a7963d77c64148a/the-sustainable-livelihood-approach-to-poverty-reduction\\_2656.pdf](https://www.sida.se/contentassets/bd474c210163447c9a7963d77c64148a/the-sustainable-livelihood-approach-to-poverty-reduction_2656.pdf) (accessed on 23rd February 2020).
- Kumar, N., Raghunathan, K., Arrieta, A., Jilani, A., Chakrabarti, S., Menon, P., & Quisumbing, A. R. (2019). Social networks, mobility, and political participation: The potential for women's self-help groups to improve access and use of public entitlement schemes in India. *World Development*, 114, 28–41. <https://doi.org/10.1016/j.worlddev.2018.09.023>
- Kurian, N. J. (1987, December 26). IRDP: How relevant is it? *Economic and Political Weekly*, 22(52), A161–A176. <https://www.epw.in/journal/1987/52/review-agriculture-review-issues-specials/irdp-how-relevant-it.html> (accessed on 13th September 2021).
- Lindenberg, M. (2002). Measuring household security at the family and community level in the developing world. *World Development*, 30(2), 301–318. [https://doi.org/10.1016/S0305-750X\(01\)00105-X](https://doi.org/10.1016/S0305-750X(01)00105-X)
- Mishra, A. (2017a). Self-employment programmes in India: A journey from Integrated Rural Development Programme (IRDP) to National Rural Livelihood Mission (NRLM). *International Journal of Advanced Research*, 5(7), 2036–2038. <https://doi.org/10.21474/IJAR01/4939>
- Mishra, A. (2017b). Policy design of National Rural Livelihood Mission (NRLM): A critical assessment. *International Journal of Management and Development Studies*, 6(8), 54–60. <https://www.ijmnds.in/index.php/ijmnds/article/view/304/285> (accessed on 13th September 2021).
- Mishra, A., & Das, T. K. (2017). *Methods of impact evaluation: A review*, SSRN Electronic Journal, retrieved from <https://dx.doi.org/10.2139/ssrn.2943601> (accessed on 20th August 2017).
- Mishra, A., Mishra, S. K., Baitharu, I., & Das, T. K. (2020). Food security and nutritional status among rural poor: Evaluating the impact of Rural Livelihood Mission in Odisha, India. *Journal of Reviews on Global Economics*, 9, 141–148. <https://doi.org/10.6000/1929-7092.2020.09.14>
- Mohapatra, S., & Sahoo, B. K. (2016). Determinants of participation in self-help-groups (SHG) and its impact on women empowerment. *Indian Growth and Development Review*, 9(1), 53–78. <https://doi.org/10.1108/IGDR-04-2015-0016>
- Nayak, A. K., & Panigrahi, P. K. (2020). Participation in self-help groups and empowerment of women: A structural model analysis. *The Journal of Developing Areas*, 54(1), 19–37. <https://doi.org/10.1353/jda.2020.0001>
- NRLP (2011). *National financial management manual*. Retrieved from [https://ajeevika.gov.in/sites/default/files/resources/national\\_reports/NRLP-National-FM-Manual-PART-I-A.pdf](https://ajeevika.gov.in/sites/default/files/resources/national_reports/NRLP-National-FM-Manual-PART-I-A.pdf) (accessed on 12th January 2020).
- Panda, A., Mahapatra, A. S., & Samal, R. (2012). Impact evaluation of SGSY on socio-economic development of women in aquaculture in Eastern hills of Orissa. *Aquaculture International*, 20(2), 2. <https://doi.org/10.1007/s10499-011-9452-x>
- Patidar, H. (2019). Livelihood security in rural India: Reflections from some selected indicators. *Forum for Development Studies*, 46(1), 147–185. <https://doi.org/10.1080/08039410.2018>
- Paul, S. (1998). The performance of integrated rural development programme in India: An assessment. *The Developing Economies*, 35(2), 117–131. <https://doi.org/10.1111/j.1746-1049.1998.tb00213.x>
- Rao, V. & Ban, R. (2007). *The Political Construction of Caste in South India*. Processed, Washington DC: the World Bank.
- Ravallion, M. (2008). Evaluating anti-poverty programs. Chapter 59, pp. 3788–3840. In *Handbook of development economics*, Vol. 4, World Bank. available at <https://cepr.org/sites/default/files/Evaluating%20anti-poverty%20programs%20HDE4.pdf> (accessed on 23rd November 2018)
- Ray, S. (2008). Alleviating poverty through micro-finance: SGSY experience in Orissa. *Sociological Bulletin*, 57(2), 211–239. <https://doi.org/10.1177/0038022920080204>
- Reserve Bank of India (2013). *Priority sector lending - restructuring of SGSY as National Rural Livelihood Mission (NRLM)*, available at <https://www.rbi.org.in/Scripts/NotificationUser.aspx?Id=8075&Mode=0> (accessed on 25 December 2015).
- Rosenbaum, P., & Rubin, D. (1983). The Central Role of the Propensity Score in Observational Studies for Causal Effects. *Biometrika* 70(1), 41–55. <https://doi.org/10.1093/biomet/70.1.41>
- Samanta, D., & Nayak, N. C. (2015). Determinants of people's participation: A study of rural West Bengal, India. *Development in Practice*, 25(1), 71–85. <https://doi.org/10.1080/09614524.2015.986065>
- Sarma, M. (2008). *Index of Financial Inclusion*, working paper 215, Indian Council for Research on International Economic Relations. available at [http://icrier.org/pdf/Working\\_Paper\\_215.pdf](http://icrier.org/pdf/Working_Paper_215.pdf) (accessed on 23rd November, 2018).
- Satapathy, J., Nayak, N. C., & Mahakud, J. (2020). Multidimensional impact of food security on household welfare: Evidences from a household survey in three Indian states. *International Journal of Social Economics*, 47(7), 913–932. <https://doi.org/10.1108/IJSE-01-2020-0023>
- Sianesi, B. (2004). An evaluation of Swedish system of active labour market programs in the 1990s, *Review of Economics and Statistics*, 86(1), 133–155. <https://doi.org/10.1162/003465304323023723>
- Smith, J. A. & Todd, P. E. (2005). Does matching overcome LaLonde's critique of non-experimental estimators. *Journal of Econometrics*, 125(1-2), 305–353. <https://doi.org/10.1016/j.jeconom.2004.04.011>
- Soper, D. S. (2020). *A-priori sample size calculator for structural equation models [Software]*. Available at: <http://www.danielsooper.com/statcalc> Accessed on 5th July 2021
- Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. MIT Press.
- Yadav, S. S., Yadav, S. T., Mishra, P., Mittal, A., Kumar, R., & Singh, J. (2016). An epidemiological study of malnutrition among under five children of rural and urban Haryana. *Journal of Clinical and Diagnostic Research*, 10(2), LC07–LC10. <https://dx.doi.org/10.7860/2FJCDR%2F2016%2F16755.719>



© 2021 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 4.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format.

Adapt — remix, transform, and build upon the material for any purpose, even commercially.

The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.

You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

No additional restrictions

You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.



***Cogent Economics & Finance* (ISSN: 2332-2039) is published by Cogent OA, part of Taylor & Francis Group.**

**Publishing with Cogent OA ensures:**

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

**Submit your manuscript to a Cogent OA journal at [www.CogentOA.com](http://www.CogentOA.com)**

