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Determinants of Formal Agricultural Credit Flow to Districts in India: An Econometric Analysis

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Authors' contributions

This work was carried out in collaboration among all authors. Author HKHV designed the study, performed the statistical analysis, wrote the protocol, and first draft of the manuscript. Author AAR and Author SGP managed the analyses. Author SGP managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: This study investigates the determinants of formal agricultural credit flow at the district level in India, using region-wise fixed effects models.
Study Design: Panel data regression technique.
Place and Duration of Study: Data from districts across Indian states from 2000 to 2021 were analyzed.

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Methodology: Districts categorized into high, medium, and low credit exposure groups based on average outstanding agricultural credit by Scheduled Commercial Banks (SCBs) through a clustering technique. One district from each category in each state was selected for analysis. The study examined outstanding agricultural advances by SCBs, the number of SCB branches, gross sown area, gross irrigated area, area under commercial crops, and annual rainfall using an unbalanced panel model.

Results: The findings reveal that an increased number of SCB branches in a district significantly enhances agricultural credit availability. The share of gross irrigated area positively impacts credit flow, especially in the southern, western, and central regions, highlighting the importance of irrigation in accessing credit for high-value crops. In contrast, a higher share of area under commercial crops negatively affects credit flow in the southern and western regions, possibly due to limited financing for rainfed commercial crops. Rainfall was found to have no significant impact on agricultural credit at the district level. Additionally, there is a noticeable trend of increasing urban branches, particularly in the southern, northern, and northeastern regions, alongside a decline in rural branches in most regions except the eastern region.

Conclusion: The study emphasizes the need for targeted policy measures to improve agricultural credit distribution. Policymakers should focus on the number of SCB branches, the share of irrigated area in total sown area, and address the rural-urban branch shift while considering region-specific agricultural requirements to ensure equitable and efficient credit allocation.

Keywords: Formal credit; fixed-effect model; scheduled commercial bank; panel data; Hausman test.

1. INTRODUCTION

Access and availability of credit, along with other farm inputs and services at reasonable costs, are crucial for the prosperity of the farming community. Over the past two decades, India has witnessed significant growth in institutional credit flow to the agricultural sector, reaching ₹18.60 lakh crore in 2021-22, compared to ₹62,054 crore in 2001-02. The government has already set a target of ₹20 lakh crores for agricultural credit flow in 2023-24 as part of its credit policy (GoI, 2023). However, despite the commendable increase in institutional credit, a substantial portion of cultivators in rural India, approximately 33% as of June 30, 2018, still rely on non-institutional credit sources such as professional moneylenders, relatives, and friends. This dependence on non-institutional credit is a concern, especially due to the high interest rates charged by such sources, which can burden cultivators (NSSO, 2019). To address this issue, there is a need to promote institutional advances through scheduled commercial banks (SCBs) and cooperative banks, offering reasonable interest rates. Currently, SCBs provide the majority (89%) of the credit needs of the agriculture sector in 2022-23, while cooperative banks contribute the remaining share (11%) (Kumar et al, 2010, National Bank for Agriculture and Rural Development, 2022).

While previous studies have focused on analyzing household-level socio-demographic factors to understand formal credit availed by farmers, the influence of macroeconomic or unit-level factors on flow of formal credit to agriculture to districts has often been overlooked (Kumar et al, 2015). To bridge this gap, the present study aims to examine the impact of unit-level factors using district-level data, specifically focusing on agricultural credit outstanding by SCBs. These banks have consistently maintained a significant share in agricultural lending. Understanding the determinants of formal agricultural credit flow is crucial for policymakers to design effective strategies that address the needs and challenges faced by farmers. By identifying and addressing the macroeconomic and unit-level factors influencing credit flow, policymakers can create an enabling environment that ensures equitable access to affordable credit and supports the growth and development of the agricultural sector in all districts of India.

2. MATERIALS AND METHODS

2.1 Data Type and Data Source

The current study utilizes unit-level data to analyze the outstanding agricultural advances by SCBs, the number of SCB branches, gross sown area (GSA), gross irrigated area (GIA), area under commercial crops (AUC), and annual rainfall (AR). The district is considered as the unit of analysis in this study. To group the districts, a clustering technique is employed, categorizing them into high, medium, and low exposure districts based on the triennium (TE 2015-18) average of outstanding agricultural credit by SCBs. Subsequently, one district from each exposure category is selected within each state, and data on the aforementioned unit-level factors is collected for the period spanning from 2000 to 2021. A panel data structure is created using this district-wise data across the time series. The data on unit-level factors is sourced from various volumes of basic statistical returns of SCBs by the Reserve Bank of India (RBI, 2021), rainfall statistics volumes by the India Meteorological Department (IMD, 2021), and land use categories by the Directorate of Economics and Statistics (DES, 2021).

The area under commercial crops (AUC) encompasses crops such as sugarcane, fiber crops (primarily cotton), oilseeds, tobacco, and plantations like coffee, tea, and rubber. To address the issue of multicollinearity, ratio variables are used as independent variables in the panel data regression framework. These ratio variables include the share of GIA in GSA, the share of AUC in GSA, along with the number of branches and rainfall. They are regressed against a proxy variable for formal credit to agriculture, represented by outstanding agricultural advances by SCBs. The states are grouped into regions according to the classification provided by the Reserve Bank of India (RBI). The southern region includes Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Lakshadweep, Puducherry, and Telangana. The western region consists of Goa, Gujarat, Maharashtra, Dadra and Nagar Haveli, and Daman and Diu. The central region comprises Chhattisgarh, Madhya Pradesh, Uttar Pradesh, and Uttarakhand. The eastern region includes Bihar, Jharkhand, Odisha, Sikkim, West Bengal, and Andaman and Nicobar. The northeastern region encompasses Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura. Lastly, the northern region includes Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Chandigarh, and Delhi.

2.2 Analytical Tools

2.2.1 Panel data regression technique

In the study, the impact of unit-level factors on institutional credit to agriculture was quantified using panel data regression techniques. Two models were fitted for the data, and the best model was selected based on the Hausman selection test.

The fixed-effect model (FE) was employed to explain the relationship between the independent variables and the dependent variable, where each individual entity (district) has a significant role in predicting the outcome (Patra and Padhi, 2016). In this model, each cross-sectional unit (district) has its own fixed intercept value. The FE model used in this study can be represented as:

$$Y_{it} = \alpha_{1i} + \beta X_{it} + u_{it}$$

Where,

Y_{it} is the credit outstanding, for i^{th} district; i=1,…m and t^{th}year; t=1,…n,
X_{it} is the vector of exogenous variables for i^{th} district; i=1,….m and t^{th}year; t=1,…n
α_{1i} is the unknown intercept; $\beta$is a vector of model parameters
$u_{it}$is the combined time series and cross-section error component.

On the other hand, the random-effects model (RE) assumes that the variation across entities (districts) is random and uncorrelated with the independent variables (Patra and Padhi, 2016). The RE model used in this study can be represented as:

$$Y_{it} = \alpha_1 + \beta X_{it} + w_{it}$$

Where,

$$w_{it} = \varepsilon_i + u_{it} \; and \; \alpha_{1i} = \alpha_{1+}\varepsilon_i$$

$\varepsilon_i$is the random error term,
$u_{it}$is the combined time series and cross-section error component
$Y_{it}$is the credit outstanding, for i^{th} district; i=1,…m and t^{th}year; t=1,…n
α_1 is the common mean value for intercept (remains fixed),
X_{it} is the vector of exogenous variables for i^{th} district; i=1,….m and t^{th} year; t=1,…n
β is a vector of model parameters.

This test statistic helps in knowing the superiority of fixed and random effect models over each other (Hausman, 1978).

$$m = q'(var\hat{\beta}_{FE} - var\hat{\beta}_{RE})^{-1}\, q$$

Where,

$q = \hat{\beta}_{FE} - \hat{\beta}_{RE}$.

The statistic m is distributed $\chi 2(k)$ degrees of freedom under the null hypothesis of RE is superior FE, where k is the dimension of β.

To determine the superiority of the fixed and random effects models, the Hausman test statistic is employed. The statistic is distributed as chi-square with degrees of freedom equal to the dimension of β. This test helps in deciding whether the RE or FE model is more appropriate.

The panel data regression technique was implemented using the "plm" package in R, which allows for various types of analyses such as Pooled OLS, Between estimation, First differences estimation, Fixed Effect Model (FEM), and Random Effect Model (REM). LM tests were performed using the "plmtest" function to decide between REM and Pooled OLS, and the "pFtest" function to decide between FEM and Pooled OLS. The analysis utilized an unbalanced panel model due to the presence of missing values in the independent variables.

2.2.2 Compound Annual Growth Rate (CAGR)

CAGR was used to measure the growth in the number of SCB branches (urban, rural, semi-urban and overall) across regions. The CAGR formula calculates the growth rate over a specific time period. In this study, CAGR was calculated using the logarithmic transformation of the equation and then applying the antilog to obtain the percentage growth.

3. RESULTS AND DISCUSSION

3.1 Determinants of Formal Agricultural Credit Flow to Districts across the Regions

The findings of the fixed-effect (FE) model, which was determined to be consistent and suitable compared to the random-effect (RE) model based on the Hausman test, are presented in Table 2. The FE model examines the relationship between key variables at the district level (such as the number of SCB branches, share of GIA in GSA, share of AUC in GSA, and rainfall) and the dependent variable, which is the outstanding agricultural advances by SCBs in crore rupees (proxy for formal credit flow to the district). The table presents the region-wise estimates of parameters from the Fixed Effect Model (FE) in the panel regression analysis.

The coefficient estimates for the variable branches represent the effect of the number of SCB branches on outstanding agricultural advances by SCBs. The coefficients are statistically significant for all regions. Specifically, the coefficient for the number of branches is highest in the southern region, followed by the northern and central regions, and lowest in the eastern, western, and north-eastern regions. For example, in the Southern region, each additional branch is associated with an increase of 22.21 crore Rs. in outstanding agricultural advances, holding other variables constant. These findings highlight the importance of the presence and expansion of SCB branches in facilitating agricultural credit flow. Increasing the number of branches can potentially enhance access to institutional credit and contribute to the growth and development of the agricultural sector in various regions.

The coefficients for the variable "Share of GIA in GSA" represent the impact of the proportion of gross irrigated area (GIA) in gross sown area (GSA) on agricultural advances. The coefficients are statistically significant for the Southern, Western, and Central regions. This suggests that the availability of irrigation facilities in these regions plays a crucial role in facilitating agricultural credit flow. The presence of irrigation facilities enables farmers to cultivate high-value crops that require adequate water supply. These crops often receive higher financing, as they have the potential for greater returns. Therefore, regions with a higher share of irrigated areas tend to have a greater demand for institutional credit compared to regions with limited access to irrigation (Haque and Goyal, 2021). This suggests that the level of irrigation infrastructure and its coverage directly influence the demand for and availability of institutional credit for agriculture. For example, in the Western region, a one-percentage-point increase in the share of GIA in GSA leads to an increase of 48.70 crore Rs. in agricultural advances, holding other variables constant. In the Eastern, Northern and North-eastern regions, the coefficients are not statistically significant (NS).

The coefficients for the variable "Share of AUC in GSA" represent the influence of the proportion of area under commercial crops (AUC) in GSA on agricultural advances. The share of AUC in GSA was found to have varying effects on the outstanding agricultural advances by SCBs across different regions. In the southern and western regions, where a significant portion of the area is dedicated to the cultivation of commercial crops such as cotton, groundnut, tobacco, and sugarcane, this variable had a negative influence on the agricultural credit provided by SCBs. This can be attributed to the fact that these crops are often cultivated under rainfed conditions and receive relatively lower scale of finance. For example, in the Southern region, a one-percentage-point decrease in the share of AUC in GSA results in a decrease of 23.79 crore Rs. in agricultural advances, holding other variables constant. In contrast, in the North Eastern region, where a substantial portion of the area is under the cultivation of commercial crops like tea, rubber, and other plantation crops, the share of AUC in GSA had a positive influence on the outstanding agricultural advances by SCBs. This can be explained by the fact that these crops usually receive higher scale of finance due to their commercial viability and potential for higher returns. However, in the central, eastern, and northern regions, the share of AUC in GSA was not found to be a significant variable. This is likely because the area dedicated to commercial crop cultivation in these regions is relatively negligible, and therefore, its impact on agricultural credit flow was not significant.

Rainfall, as a variable, did not have a significant influence on the outstanding agricultural advances by SCBs at the district level across all regions. This finding is interesting considering the significant contribution of rainfed agriculture to India's food production and the large proportion of cultivated area that relies on rainfall (CRIDA, 2011). While rainfed agriculture plays a crucial role in India's food production, it seems that the availability of institutional credit from SCBs is not directly impacted by variations in rainfall at the district level.

SCBs have consistently dominated the credit flow to agriculture, with their share at 89% in 2022-23. Conversely, the contribution of RCBs has been on a gradual decline, to a low of 11.00% in 2022-23 (Table 1). This trend indicates the growing reliance on SCBs as the primary source of agricultural credit, likely due to their wider outreach, larger financial resources, and robust infrastructure compared to RCBs.

The R-squared values range from 0.42 to 0.86 across different regions, indicating that the model explains a substantial portion of the variation in agricultural advances. The F-statistic is statistically significant for all regions, suggesting that the model is a good fit for explaining the relationship between the independent variables and agricultural advances.

The analysis conducted at the country level using district-wise panel data regression reaffirmed the positive association between the number of operating branches in a district and the credit outstanding to agriculture by SCBs. The results in Table 3 indicate that for each additional bank branch in a district, there is an expected increase of 12.83 crores in credit provided to the agriculture sector. This finding supports the notion that access to institutional credit in agriculture is influenced by various factors, including socio-economic conditions, institutional arrangements, policy frameworks, and unit-level factors (Kumar et al, 2015).

Table 1. Share of RCBs and SCBs in credit flow to agriculture in India (%)

Source/Year	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23
RCB	12.87	12.12	11.30	12.10	12.70	11.00
SCB	87.13	87.88	88.70	87.90	87.30	89.00

Note: RCB = Rural Cooperative Bank; SCB = Scheduled Commercial Bank,
Source: NABARD Annual report, 2021-22

Table 2. Region wise estimates of parameters from fixed effect model
[*Y*= Outstanding agricultural advances by SCBs (in crore Rs.)]

Variables	Southern (N = 307)	Western (N = 106)	Central (N = 225)	Eastern (N=177)	North-Eastern (N=244)	Northern (N=285)
Branches (No.)	22.21***	5.03***	13.16***	4.95***	6.20***	11.53***
	(0.59)	(1.02)	(0.49)	(0.22)	(0.50)	(0.44)
Share of GIA in GSA (%)	15.90***	48.74***	11.05***	-0.74^{NS}	0.57^{NS}	-0.25^{NS}
	(5.81)	(9.40)	(3.84)	(3.67)	(0.74)	(0.33)
Share of AUC in GSA (%)	-23.79***	-21.62***	1.92 ^{NS}	-11.75^{NS}	4.22**	33.83^{NS}
	(8.36)	(8.13)	(6.27)	(0.14)	(1.90)	(17.90)
RF (mm)	0.16^{NS}	0.13^{NS}	-0.30***	0.06^{NS}	-0.003^{NS}	0.29^{NS}
	(0.12)	(0.11)	(0.09)	(0.09)	(0.008)	(0.29)
R^2	0.84	0.42	0.86	0.76	0.46	0.73
F-statistic	377.46 ***	17.59***	310.45***	129.24***	46.38***	175.35***

Note: Figures in the parenthesis are respective standard errors
****Significant @ 1% LoS, **Significant @ 5% LoS, ^{NS}Non-Significant*

Table 3. All-India estimates of parameters from fixed effect model [*Y*= Outstanding agricultural advances by SCBs (in crore Rs.)]

Variables	India (N=1344)
Branches (No.)	12.83*** (0.26)
Share of GIA in GSA (%)	-0.01NS (0.28)
Share of AUC in GSA (%)	-4.82NS (5.02)
RF (mm)	-0.02NS (0.05)
R^2	0.65
F-statistic	588.42***

Note: Figures in the parenthesis are respective standard errors
****Significant @ 1% LoS, **Significant @ 5% LoS, NSNon-Significant*

3.2 Growth and Compositional Changes of SCB Branch Categories

The growth and compositional changes of SCB branch categories provide insights into the expansion and diversification of banking services in different regions. The classification of SCB branches into rural, semi-urban, urban, or metropolitan is based on the population size of the center where the branch is located, as defined by the Reserve Bank of India. These classifications play a significant role in agricultural lending, particularly in terms of direct finance provided to farmers. Rural and semi-urban branches primarily serve the needs of farmers by providing them with agricultural loans. On the other hand, urban branches also finance the agricultural sector, but their focus is more towards indirect finance rather than direct lending to farmers. Over time, there have been compositional changes in the categories of bank branches in India. This means that the proportion of rural, semi-urban, urban, and metropolitan branches may have shifted over the years. These changes reflect the evolving needs and priorities of the agricultural sector and the overall banking landscape in the country.

The establishment of Regional Rural Banks (RRBs) in 1975, marked a significant turning point in the composition of bank branches in India. Prior to the establishment of RRBs, SCB branches were predominantly located in urban and semi-urban areas. However, the need to include rural areas in the economic mainstream and provide adequate banking and credit facilities for agriculture and other rural sectors led to the establishment of RRBs based on the recommendations of the Narasimha Committee on Rural Credit. In this research paper, the compositional changes in bank branches during two specific periods (1972-76) were analyzed by comparing average figures over five years. The paper presents the share of different categories of SCB bank branches across the regions, highlighting the changes that occurred during the specified time periods. This analysis provides insights into the transformation of the banking sector and the expansion of banking services into rural areas, which were previously underserved. Fig. 1 visualizes the scenario-wise distribution of SCB bank branches across the regions, shedding light on the evolving composition of branch categories.

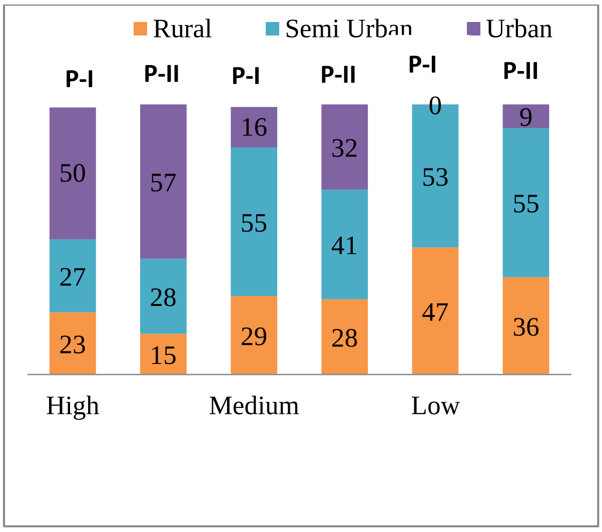
Regional imbalances in agricultural credit exposure in India are well-known and can be attributed to factors such as differences in cultivable area, agricultural potential, deposit levels, credit-deposit ratio, and the functioning of SCB branches(RBI, 2019 and Sharma, 2021). This study reaffirmed the positive association between the number of operating branches in a district and the credit outstanding to agriculture by SCBs. Hence to address regional imbalances, it is important to focus on the growth and compositional changes of bank branches and implement effective policy measures.

Over the past two decades, there has been significant growth in the number of bank branches operated by SCBs across regions, with the northern region experiencing the highest growth rate (5.40%), followed by the central (4.96%) and eastern (4.41%) regions. In contrast, the western region reported the lowest growth rate (1.91%). Despite various government policy initiatives in the eastern region, approximately half of the farm households still lack access to institutional agricultural credit(Kumar, 2020).

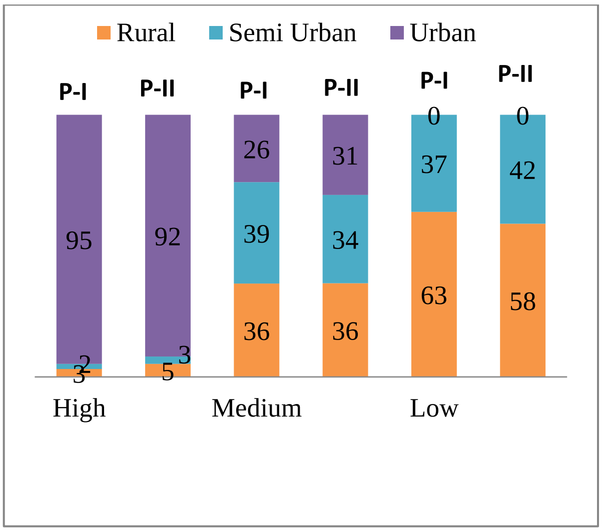
Table 4. Growth (CAGR in %) in the SCB branches during 2000-01 to 2021-22

Region	Branch category			
	Rural	Urban	Semi-Urban	Overall
Southern region	1.78*** (5.05)	4.65*** (18.58)	4.69*** (14.38)	3.94*** (15.04)
Western region	0.34NS (0.55)	-1.38NS (-0.67)	2.32NS (1.29)	1.91*** (3.15)
Central region	2.64*** (6.60)	7.02*** (17.94)	5.22*** (13.85)	4.96*** (21.18)
Eastern region	3.87*** (5.33)	3.58*** (5.30)	7.22*** (20.10)	4.41*** (19.34)
North eastern region	0.49NS (1.72)	3.58*** (4.13)	7.58*** (14.43)	3.15*** (6.78)
Northern region	3.61*** (7.40)	1.64NS (1.30)	6.20*** (14.88)	5.40*** (19.70)

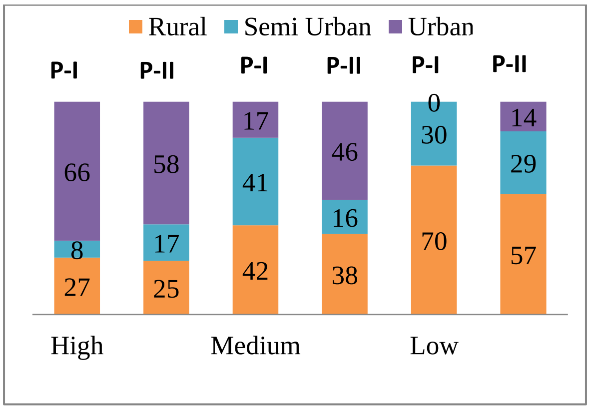
Note: Figures in the parenthesis are respective t-values
****Significant @ 1% LoS, **Significant @ 5% LoS, NSNon-Significant*



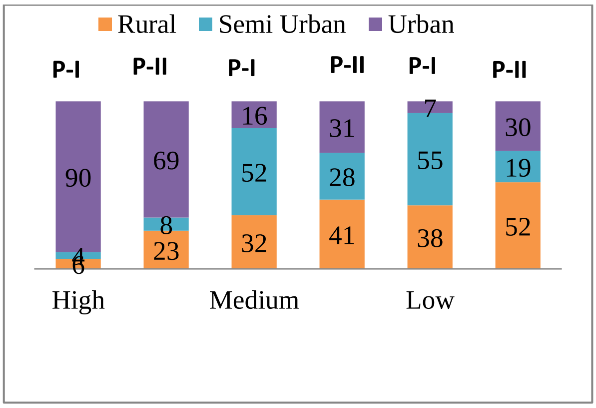
Southern region



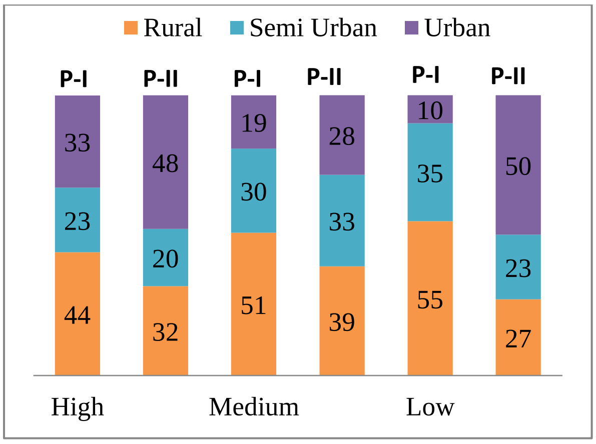
Western region



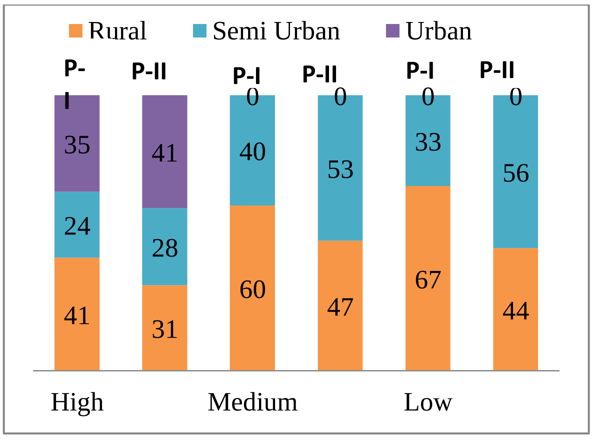
Central region



Eastern region



North-eastern region



Northern region

Fig. 1. Region-wise share of rural, semi-urban and urban branches during period-I (Five-year average 1972-76) and period-II (Five-year average 2017-21) across three scenarios

However, it is worth noting that rural branches in this region have grown at a rate of 3.87%, indicating increased access to credit and other banking services for farmers and rural households in recent years (Table 4). The increase in the number of bank branches leads to a decrease in the population served by each branch, thereby improving farmers' access to credit provided by SCBs (Hoda and Terway, 2015). These findings highlight the need for continued efforts to address regional imbalances and ensure equitable access to agricultural credit across all regions of India.

In districts with high credit exposure, there is an increasing trend of urban branches in the southern, northern, and north-east regions, while a decreasing trend is observed in the eastern, western, and central regions. In districts with medium credit exposure, rural branches have a higher share in the western, eastern, and northern regions, while semi-urban branches dominate in the southern and north-east regions. In districts with low credit exposure, rural branches have a higher share compared to urban and semi-urban branches in the western, central, and eastern regions. However, in the southern and North Eastern regions, semi-urban branches dominate. It is worth mentioning that the share of rural branches has decreased in all regions except the eastern region. In these low credit exposure districts, the share of semi-urban branches is increasing in the North Eastern region, while urban branches are growing in the northern region. These patterns highlight the regional variations in the distribution of bank branches and their impact on credit exposure levels.

4. CONCLUSION

The study highlights the significant role of SCB branches and irrigation in enhancing agricultural credit flow. The Fixed Effect model reveals a positive association between branch numbers and credit, with the impact being highest in the Southern region. Irrigation infrastructure also plays a crucial role, particularly in regions like the Southern and Western, by enabling access to higher financing for high-value crops. However, regional disparities persist, with uneven branch growth and limited credit access in underserved areas. Targeted policies to expand branch networks, improve irrigation, and address regional imbalances are essential for equitable and inclusive agricultural credit access across India.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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