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भारत में कृषि के लिए संस्थागत ऋण गतिशीलता की मॉडलिंग

Modelling dynamics of institutional credit to agriculture in India

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद
Agrisearch with a human touch

हरीश कुमार एच.वी.	Harish Kumar H.V. (PI)
शिवास्वामी जी.पी. (01.10.2021 तक)	Shivaswamy G. P. (Co-PI: till 01.10.2021)
अनुजा ए.आर. (23.01.2021 तक)	Anuja A.R. (Co-PI: till 23.01.2021)
अचल लामा	Achal Lama (Co-PI)

पूर्वानुमान एवं कृषि प्रणाली मॉडलिंग प्रभाग
Division of Forecasting and Agricultural Systems Modelling

भा.कृ.अनु.प.-भारतीय कृषि सांख्यिकी अनुसंधान संस्थान
लाइब्रेरी एवेन्यु, पूसा, नई दिल्ली – 110 012
ICAR-Indian Agricultural Statistics Research Institute
Library Avenue, PUSA, New Delhi – 110 012

https://iasri.icar.gov.in

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PREFACE

Agriculture and its allied sectors are the major source of livelihood in India with a significant contribution to country's GDP. Credit is an important and most basic input in agriculture plays significant role in farmer's welfare. Growing institutional source of credit for agriculture helping farming community to come out of informal lenders clutches who are charging usurious interest rates with unethical or immoral terms. The post independent major credit policy initiatives right from initial emphasis for priority sector lending to present day supply driven targeted ground level credit and interest subvention schemes have yielded this commendable transition in the field of agricultural credit.

However even with this impressive growth still lot of farm households indebted to non-institutional sources at higher interest rates since institutional sources is scanty, insufficient and involves cumbersome procedure. Hence alternatively the institutional source lending needs to be further encouraged. In this direction there is a need for the policy interventions to revamp the access and utilization of institutional source of credit in agriculture.

This void intrigued us to take up the present investigation and document our findings. In this study we focused on grass root level response of credit in terms its growth to the various policy reforms at regional level by identifying the structural breaks in the agricultural credit series. The report also documents the determinants of institutional credit to agriculture, models for forecasting agricultural credit and estimation process of direct agricultural credit at district level which helps in forming counterproductive policy of first estimation of agricultural credit requirements depending on crop patterns and later meeting the requirements through effective policies.

Project Team

प्रस्तावना

देश के सकल घरेलू उत्पाद में महत्वपूर्ण योगदान के साथ कृषि और इसके संबद्ध क्षेत्र भारत में आजीविका का प्रमुख स्रोत हैं। कृषि में ऋण एक महत्वपूर्ण और सबसे बुनियादी इनपुट है जो किसान कल्याण में महत्वपूर्ण भूमिका निभाता है। कृषि के लिए ऋण के बढ़ते संस्थागत स्रोत से कृषक समुदाय को अनौपचारिक ऋणदाताओं के चंगुल से बाहर निकलने में मदद मिलती है जो अनैतिक या अनैतिक शर्तों के साथ ब्याज दर वसूल रहे हैं। स्वतंत्र प्रमुख ऋण नीतिगत पहलों ने प्राथमिक क्षेत्र को उधार देने के लिए प्रारंभिक जोर देने से लेकर वर्तमान समय में आपूर्ति संचालित लक्षित जमीनी स्तर के ऋण और ब्याज सबवेंशन योजनाओं को कृषि ऋण के क्षेत्र में यह सराहनीय परिवर्तन प्रदान किया है।

हालांकि इस प्रभावशाली वृद्धि के बावजूद अभी भी बहुत से कृषि परिवार गैर–संस्थागत स्रोतों से उच्च ब्याज दरों पर ऋणी हैं क्योंकि संस्थागत स्रोत कम, अपर्याप्त हैं और इसमें बोझिल प्रक्रिया शामिल है। इसलिए वैकल्पिक रूप से संस्थागत स्रोत उधार को और प्रोत्साहित करने की आवश्यकता है। इस दिशा में कृषि में ऋण के संस्थागत स्रोत की पहुंच और उपयोग को सुधारने के लिए नीतिगत हस्तक्षेप की आवश्यकता है।

इस अंतर ने हमें वर्तमान जांच शुरू करने और अपने निष्कर्षों का दस्तावेजीकरण करने के लिए प्रेरित किया। इस अध्ययन में हमने कृषि ऋण श्रृंखला में संरचनात्मक विराम की पहचान करके क्षेत्रीय स्तर पर विभिन्न नीतिगत सुधारों के संदर्भ में ऋण की जमीनी स्तर की प्रतिक्रिया पर ध्यान केंद्रित किया। रिपोर्ट में कृषि के लिए संस्थागत ऋण के निर्धारकों, कृषि ऋण की भविष्यवाणी के लिए मॉडल और जिला स्तर पर प्रत्यक्ष कृषि ऋण की आकलन प्रक्रिया का भी दस्तावेजीकरण किया गया है जो फसल पैटर्न के आधार पर कृषि ऋण आवश्यकताओं के पहले आकलन की प्रतिउत्पादक नीति बनाने और बाद में आवश्यकताओं को पूरा करने में मदद करता है। प्रभावी नीतियां।

परियोजना दल

Chapter 1: Introduction

1.1 Introduction

Institutional credit has significant role in Indian agriculture. It is supplementary for improving the agricultural productivity, augmenting capital formation in agriculture, increasing agricultural GDP and improving farmer's welfare (Bisaliah and Dev, 2010; Chand and Kumar, 2004). The reach of institutional credit to agriculture has increased from 10.20 per cent in 1951 (RBI, 1954) to 72 per cent in 2015 (NABARD, 2018). Institutional/formal source of credit for agriculture in India comes from both Scheduled Commercial Banks (SCBs) and co-operatives (Fig 1). Non-institutional/ informal credit players are private money lenders, land lords, traders, input suppliers, relatives and friends etc. During 2017-18, institutional source of credit for agriculture in India was majorly from SCBs (87.26 %) which include nationalised banks, state bank of India, regional rural banks, private sector banks including foreign banks and remaining is from cooperative banks (12.74 %) which works through either as three-tier or two-tier structure.

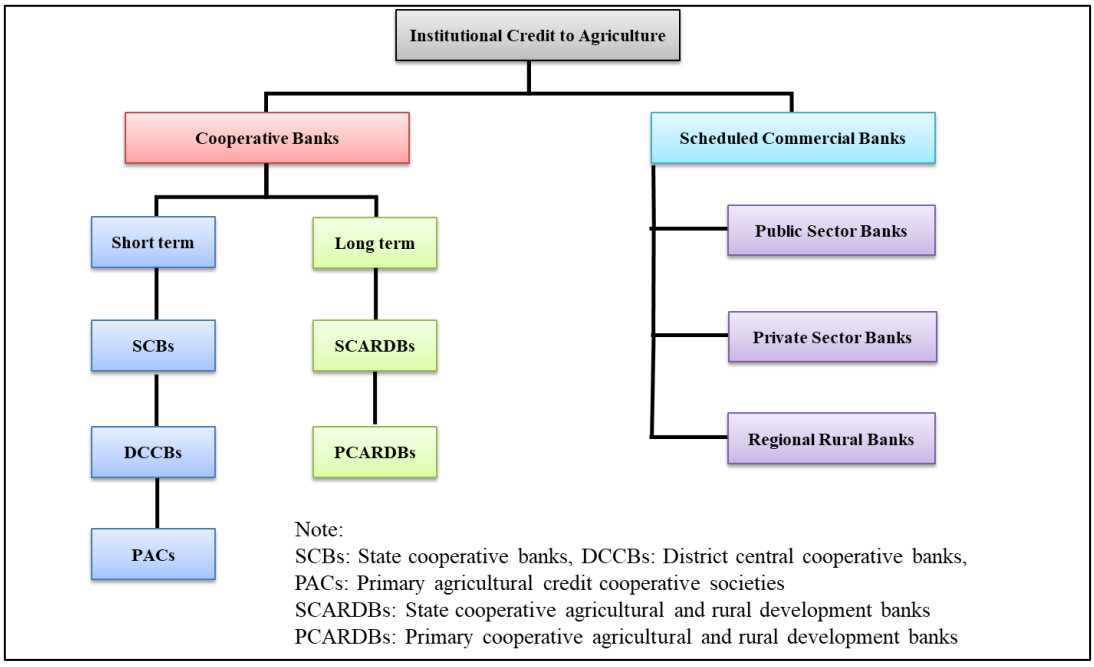


Fig 1: Institutional arrangement for agricultural credit in India

Agricultural credit in India has seen transitions over the years in regard to amount of credit supply, sources of supply and mode of supply etc. owing to various policy reforms in the credit system. Pervading effects of these reforms/interventions helped the farmers of the country to reap the benefits of cheaper credit from institutional sources by gradually reducing

their dependence on costlier non-institutional sources (Hoda and Terway, 2015). Even though with this impressive growth still for every 1000 number of cultivator households, 338 households indebted to institutional sources and 215 households indebted to non-institutional sources indicating that still significant number cultivators are depended non-institutional sources which is an costly affair since the incidence of indebtness of households in rural India was reported high in the more than 30 per cent interest rate category (GOI, 2014). Rural households do depend on non-institutional sources even at higher interest rates as agricultural credit supply from institutional sources is insufficient and cumbersome (Mishra, 2008). Alternatively the institutional source of borrowing needs to be encouraged and there is a need to know what kind of policies have played significant role in this transition from non-institutional source dependence to institutional source. Hence this study is focussed to identify the structural breaks in the agricultural credit series and to check the growth in agricultural advances at grass root level (district) during different phases.

Coming to the post independent road map of major credit policy initiatives related to agriculture in India, firstly the emphasis was given for Priority Sector Lending (PSL) as per recommendations of National Credit Council (NCC) in 1968 (Fig 2). Further it is strengthened by nationalising 14 banks in 1969 and introduction of the Lead Bank Scheme (LBS) for co-ordinating the efforts of all credit institutions in each districts. In 1974, RBI mandated the PSL and announced PSL targets as 33.33 % to achieve by March, 1979 and increased it to 40 % to achieve by March 1985. Additionally Regional Rural Banks (RRBs) were established to serve rural mass with basic banking and credit facility for agriculture and other rural sectors. Second round of nationalization of 6 more commercial banks carried in 1980 for effective and controlled credit delivery to all sections of the society. Furtherance, to promote agriculture and rural development National Bank for Agriculture and Rural Development (NABARD) was established in 1982. In 1989, service area approach and annual credit plan are introduced to make a bank branch accountable for meeting the needs of bank credit of its service area. RBI deregulated the interest rates in 1990s and it has continued gradually to strengthen the competitive forces and improve the operational efficiency of banks. Meanwhile in the same year first and major nationwide farm loan waiver was undertaken at the cost of ₹ 10,000 crore (RBI, 2019).

In 1995, Rural Infrastructure Development Fund (RIDF) was established with NABARD for funding of rural infrastructure projects and also to act as agency for corpus

deposition to the extent of shortfall in achieving the PSL target by SCBs. In 1998, a major breakthrough scheme called Kisan Credit Card (KCC) was introduced to deliver hassle free credit to farming community. In 2004, Ground Level Credit (GLC) policy is announced and as per this policy GLC targets for agriculture and allied sector to be announced in the union budget every year need to be achieved by banks during that financial year. Another key policy of 2004-05 was aimed to double the volume of credit to agriculture by 2006-07. To enable farmers to avail credit at lower interest rates Interest Subvention Scheme (ISS) for short term crop loans was announced in 2006 by subsidising 2 per cent. Additional subvention of 3 per cent was announced as Prompt Repayment Incentive (PRI) in 2009-10 to encourage regular renewals as the effective rate of interest was brought down to 4 per cent. In 2008 Agricultural Debt Waiver and Debt Relief Scheme (ADWDRS) was launched at a cost of Rs. 52,000 crores to address the financial indebtedness of the farmers of the country. Later the state level farm loan waivers were announced by states like Andhra Pradesh, Telangana, Uttar Pradesh, Maharashtra, Punjab, Madhya Pradesh Rajasthan and Karnataka (RBI, 2019).

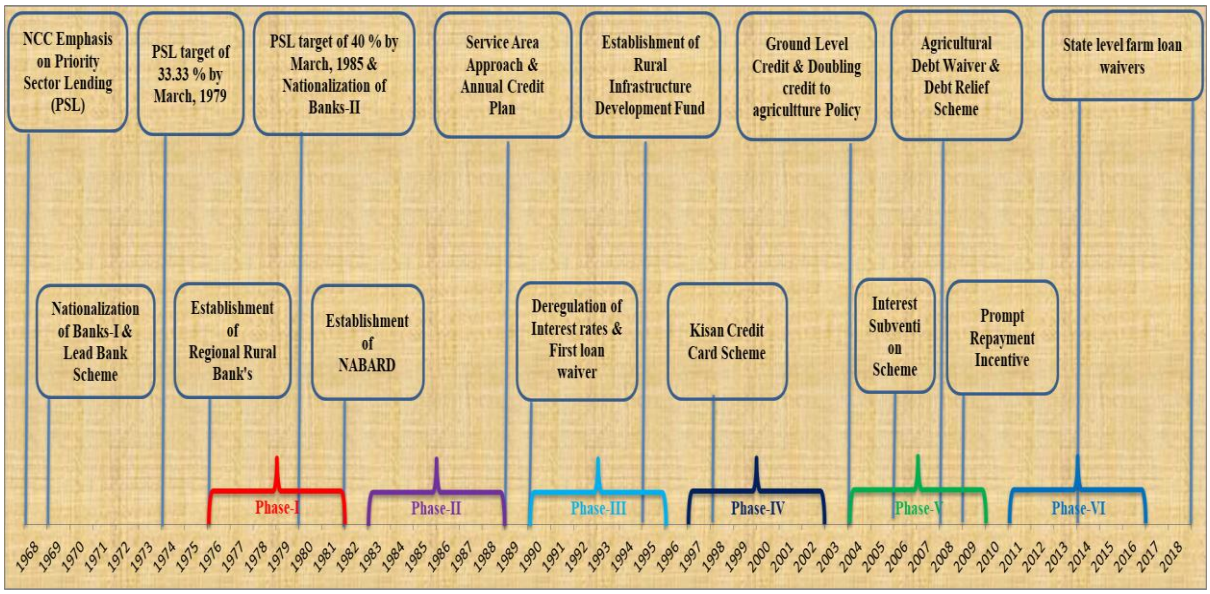


Fig 2: Road map of major credit policy initiatives in India

In the current era of price instabilities, the net returns of most of the agricultural commodities is tumbling and in many cases turned to negative or not profitable. So the costlier non-institutional credit will become burden and will lead agrarian distress and farmer suicides. Hence the low cost institutional credit needs to be promoted and the current status of the agricultural credit supply needs to be appraised.

1.2 Motivation:

There is limited empirical evidence about the status of institutional credit to agriculture at district level in India. Of course there are a good number of studies focused on productivity of credit to agriculture, determinants of institutional credit to agriculture, incidence of indebtedness etc. It is almost half decade that a major reform in banking sector has taken place i.e. nationalization of banks and there after so many reforms which aimed to increase institutional credit to agriculture sector viz., mandating priority sector lending to financial institutions, set up of RRBs, establishment of NABARD, introduction of KCC scheme, revival of rural co-operative credit institutions, measures to double the flow of agricultural credit during the period 2004-05 to 2006-07, interest subvention scheme etc. But the influence of these policies on agricultural credit at grass root level i.e. district level is not clearly depicted. Hence it is very much important to know about the growth of agricultural credit and factors influencing its supply at district level which helps in framing policies to minimize the regional imbalance and achieve the goal of sufficient credit which in turn helps in realising the national goals like doubling farmers income, increasing the agricultural productivity, reducing the agrarian distress and farmer suicides by increasing the institutional credit supply.

In this direction the project was proposed to address the following objectives.

1. To analyze the dynamics of institutional credit to agriculture
2. To study the drivers of institutional credit to agriculture
3. To forecast the institutional credit to agriculture
4. To estimate the district wise demand for institutional credit to agriculture

1.3 Review of literature

Dynamics and drivers of institutional credit to agriculture

Singh et al. (2017) studied the extent and distribution of indebtedness among farmers and agricultural labourers of Punjab by using field survey data of three districts for the period 2014-15. The study highlights that the more than 80 per cent of sample households were indebted irrespective of size of holdings with an average amount of debt Rs. 5,52,064/- per indebted household. The proportion of non-institutional source of debt was high among the marginal and small farmers compared to other size of holdings. The study also identifies that the cost of debt with more than 15 per cent is high among the marginal and small size holding farmers.

Kumar et al. (2015) studied the patterns and determinants of rural credit in India using the unit level data of debt and investment survey carried out by NSSO during 1992 (48th round), 2003 (59th round) and 2013 (70th round). The study emphasized the changing structure of credit market with the increasing share institutional credit. But, the study also revealed still persistence of regional disparity and existence of informal agencies in the rural credit market. The determinants like education, caste affiliation, gender and assets ownership were identified to be significantly influence the access institutional credit by rural households.

Singh et al. (2014) examined the magnitude and determinants of indebtedness among farmers of Punjab using primary data of sample households. The total debt burden on farmers of the states was estimated to be Rs. 22,943 crores with a Rs. 2,18,092/- debt per farm household. 40.13 to 48.86 per cent of marginal, small and semi medium farmers were availed credit from non-institutional sources. Major portion of loan outstanding among institutional borrowers was availed at an interest rate below 14 per cent, whereas major portion of loan outstanding among non-institutional borrowers was availed at an interest rate higher than 14 per cent. The study identified per cent of non-institutional credit along with level of education, non-farm income, farm size as major determinants of farmers' indebtedness. Further the author's details that the problems in availing institutional credit along with exorbitant non-institutional sources of credit drive the farmers towards debt trap. The study emphasized the need for strengthening the existing credit delivery system to cease the never-ending debt trap.

Pradhan (2013) emphasized the persistence of non-institutional source of credit in rural areas by using the data from various rounds of All-India Debt and Investment Survey. The assessment of the proportion of total outstanding debt was evidenced a decreasing trend during the period 1950-2002 with various financial inclusion initiatives of the RBI and legislations regulating moneylenders. The study evidenced still persistence of dependence on non-institutional credit to the tune of 20 per cent. The study highlights the further scope for financial inclusion and financial education for bringing the non-institutional borrowers under institutional frame work.

Kamath et al. (2010) highlighted their findings from all India debt investment survey, 2004 survey data that Bihar and UP were having least access to institutional source of finance and low shares in institutional borrowing in total borrowing. While Maharashtra, West

Bengal and Gujarat states were identified to be having high access to institutional sources and high share of institutional borrowing in total borrowing. States like Punjab, Haryana and Tamil Nadu had relatively high institutional access but yet low shares of institutional loans in total loans outstanding. The study majorly focused on increasing access to institutional source finance by targeting the financial inclusion policies.

Das et al. (2009) estimated the role of direct and indirect agriculture credit in the agriculture production taking care of the regional disparities in Indian agriculture. The study highlights the existence of wide regional disparities in the disbursement of agricultural credit by scheduled commercial banks. An immediate positive and significant effect of the direct agriculture credit on agriculture output was recognized. The number of accounts of the indirect agriculture credit was also recognized to be having a positive and significant impact on agriculture output, with a year lag. The results of the study emphasized the critical role of agriculture credit in supporting agriculture production in India even in the current situation of inadequate provision of credit to small and marginal farmers and paucity of medium and long-term lending.

Sahu (2007) examined the factors behind the variation in the credit flow to the agricultural sector across the states using panel data regression model in his empirical study on supply analysis of institutional credit to agriculture for major states in India. The Hausman test statistics indicated the appropriateness of the Fixed Effect model over random effect model. The percentage of irrigated area to gross cropped area (AIR), density of bank branches per 1,000 farmers (DBB), credit-deposit ratio (CDR) were found to be significantly influencing the supply of the institutional credit. AIR and DBB were found to be influencing positively, as 1 per cent increase AIR and DBB has led to 2.85 and 1.42 per cent increase in the credit obtained per hectare of gross cropped area. The study established that in general the farmers in the irrigated area or/and with high density of bank branches were most likely to benefit from formal financial institutions.

Forecast of and demand for institutional credit to agriculture

Haque and Goyal (2021) studied access to institutional credit by farmers of eastern India. The demand for short term credit was said to be induced by the rise in wage rates which in turn increases the input cost. They have attributed that the further rise in the wage

rate also induces the farmers to substitute labour with machines which increase the demand for investment credit.

RBI (2019) in its report on internal working group to review agricultural credit suggested some recommendations useful in improving the credit flow to agriculture sector by taking into account the credit extended for both production and investment purposes. The concern over credit is used for the intended purpose (principle of productive purpose) as their exists skewedness in distribution towards few states especially Andhra Pradesh, Kerala, Goa, Telangana, Tamil Nadu, Uttarakhand and Punjab which are said to be getting significantly high credit against their input cost requirement. Jharkhand, NE states, West Bengal, Chhattisgarh, Bihar, Odisha, Maharashtra, Uttar Pradesh and Rajasthan reported to be not getting credit even to meet their input requirements.

Sidhu et al. (2008) attempted to study the dynamics of institutional agricultural credit and growth in Punjab during the period 1995-96 to 2005-06. The demand-supply situation of short-term institutional credit in Punjab was examined under different scenarios during the two periods and was found to be surplus during 2005-06 in all scenarios which was deficit during 1995-96. The study also found highly significant relationship between variable inputs usage and disbursement of production credit. Two folds of growth in supply of production credit was observed during the period 2001-02 to 2003-04, where in which took more than 15 years to double from 1984-85 to 2000-01. The demand for institutional short term credit for agriculture in Punjab state is worked out to be Rs. 5522.87 crores during 2005-06 in a scenario. The study suggests for first estimating the demand for agricultural credit in each state/region, depending on cropping patterns and current inputs and capital requirements in relation to targeted output growth-rate and to frame the policy later to meet those requirements, instead of increasing the credit supply uniformly across the board in all the states/regions of the country.

Gulathi and Bhathla (2002) addressed issues like incidence of defaults in Indian rural credit, rejuvenation of rural financial institutions through micro finance and ways to achieve a higher rate of growth of agricultural economy through rural financial institutions. Authors have recommended to strengthen the rural financial institutions should be for accelerating the flow of credit to meet the credit demands of the agricultural sector and bring overall development in the rural economy.

Chapter 2: Dynamics of institutional credit to agriculture

This chapter presents the scenario of agency wise, state wise and region wise distribution of institutional credit to agriculture. Also grouping of the districts based on clustering and examination of structural breaks in the time series data and growth in agricultural advances of selected districts is presented here in this chapter under respective sub headings.

Data source

The study is based on the secondary data on district wise outstanding agricultural credit by Scheduled Commercial Banks (SCBs) extracted from various volumes (1976-2017) basic statistical returns of SCBs published by Reserve Bank of India (RBI). For the selection of the districts, we used the triennium average of credit outstanding to agriculture for the period 2015-16 to 2017-18.

Methodology

The study has considered the all states and union territories of the country which are grouped under six regions as listed below in the table 1. The regions used in this study are as classified by RBI. Since there is limited empirical evidence on analysis of dynamics institutional credit to agriculture at district, in this study analysis is made at grass-root level i.e. district.

Table 1: Classification of states under different regions and selection of study districts

Sl No	Region	States	No. of study districts
1	Northern region	Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab, Rajasthan, Chandigarh and Delhi	15+2 UTs
2	North eastern region	Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura	21
3	Eastern region	Bihar, Jharkhand, Odisha, Sikkim, West Bengal and Andaman and Nicobar	15+1 UT
4	Central region	Chattisgarh, Madhya Pradesh, Uttar Pradesh and Uttarkhand	12
5	Western region	Goa, Gujarat, Maharashtra, Dadra and Nagar Haveli and Daman and Diu	6+3 UTs
6	Southern region	Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Lakshadweep, Puduchery and Telangana	18+1 UT

Note: States are classified into regions as per Reserve Bank of India, Government of India

Scheduled commercial banks (Nationalised banks, State bank of India, Regional rural banks, private sector banks and foreign banks) formed 87.26 per cent of institutional credit to agriculture in India during 2017-18. Whereas, cooperatives covered the rest of the portion. The time series data on district-wise outstanding credit by cooperatives is not available in public domain. So the available time series data on district-wise outstanding credit by SCBs is used for achieving the objectives of the study as they are the major lenders to agriculture.

Cluster analysis: The Influence of major reforms aimed to increase institutional credit to agriculture is captured at district level. Three districts from each state is selected using cluster analysis of district-wise data on average credit outstanding by SCBs to agriculture during TE ending 2017-18. Ward's hierarchical clustering technique has been employed to cluster the districts based on outstanding agricultural credit by SCBs at national and state level. The analysis was carried out in R software. The cluster analysis has grouped the districts of each state into three clusters and they are called three scenarios in this study representing high, medium and low exposure districts to agricultural credit. The time series data on outstanding credit of (SCBs) to agriculture across the districts representing different scenarios behave differently during different periods due to various interventions introduced to increase the institutional credit to agriculture. Hence one district from each scenario in each state is selected to address the objectives of the study. UT's are analyzed at UT level.

Bai and Perron test: In general this test is used to identify the unknown multiple breaks in the time series data. In this study it is used to know the unknown breaks in the outstanding credit to agriculture by SCBs across the districts. Advantage with this test is that it makes use of the heteroskedastic and autocorrelation consistent variance technique and corrects itself for the serial correlation in the time series data (Bai and Perron, 2003). The analysis was carried out in R software using package "strucchange".

The structural form of the test is as follows,

$$y_t = z_t' \delta_j + u_t$$

where,

$t = T_1, \ldots, T_m, T_1, \ldots, T_m$ are break years explicitly regarded as unknown,

m is the number of breaks,

y_t is the observed dependent variable at time t

z_t $(q \times 1)$ are vector of covariates and δ_j is the corresponding vector of coefficients

u_t is the disturbance term at time t wherein, the variance of u_t need not be constant.

Compound Annual Growth Rate (CAGR): CAGR is used to find the growth in the time series data on outstanding credit to agriculture by SCBs across the districts during various phases/periods.

The formula for estimation of compound annual growth rate is $Y_t = ab^t e^{ut}$

where,

Y_t is credit outstanding to agriculture sector by SCBs at time 't'

a is intercept

b is regression coefficient

t is time variable

u_t is error term corresponding to t^{th} observation

The above equation is estimated by logarithmic transformation $\ln Y_t = \ln a + t \ln b + u_t$

r = {antilog ($\ln b$)-1}*100, where, r = CAGR (%) (Kumar and Reddy, 2017).

Garrett ranking technique: This technique is employed to rank the phases based on growth rate of credit outstanding to agriculture in districts of each category (high, medium and low). For each district the phases are ranked in such a way that highest rank 1 is assigned to the phase where the growth is high and the next highest growth phase was ranked 2 and similarly for the rest of the phases ranks are assigned in ascending order. Further the ranks are converted to per cent positions using the formula.

$$\text{per cent position} = \frac{100 * (R_{ij} - 0.5)}{N_j}$$

where,

R_{ij} = Rank assigned for i^{th} phase corresponding to j^{th} district

N_j = Number of phases ranked for j^{th} district.

The per cent position of each rank was converted into scores by referring to the table given by Garrett and Woodworth (1969). Then for each phase, the scores of individual districts were summed up and divided by the total number of districts. The mean scores for all the phases were ranked; following the decision criterion that higher valued phase will secure the first rank and so on.

Results and discussion

Results and discussions thereof are presented under sub headings in this section.

Agency-wise share of credit to agriculture in India

Public sector banks and private banks including foreign banks are the commercial banks (~ 75%) operating in India and are the major financiers to the agriculture sector in the recent years (Fig 3). The share of cooperative banks has declined from 16.43 per cent to 12.74 per cent during 2013-18. Despite of diminishing stake of cooperative bank, they still have the largest outreach at the grassroots level especially small and marginal farmers (Mehrotra, 2011).The share of RRBs in credit flow to agriculture sector is on par with the cooperative banks. Hence in this study the district wise analysis of only advances by SCBs (commercial banks and RRBs together) are presented as the data of district wise advances by cooperative banks is not available in the public domain.

Region-wise share of credit flow to agricultural sector by SCBs in India

Analysing region wise share of agricultural credit helps in knowing existing pattern of credit distribution and to address disparity if any. The triennium average of 2015-16 to 2017-18 is presented in the pie chart (Fig 4) where Southern region itself received more than one third of credit flow to agriculture in India. Northern (21 %) and Central (19 %) region also received a considerable chunk of credit. North-eastern (1%) and eastern regions (8%) have claimed to be having low share in total credit flow to agriculture. The reasons for this regional imbalance are difference in cultivable area, wide-ranging potential for agriculture and allied activities, varied levels of deposits, credit-deposit ratio and functioning SCBs branches (RBI, 2019). Similarly the share of different regions in direct and indirect agricultural credit components of total agricultural advances is presented in figure 5. There is no much difference in the regional share of direct and total, however in the indirect agricultural credit component the southern regional share is relatively low and western region is relatively high. Because Maharashtra state has ranked 4^{th} in the indirect advances and it has contributed for the relatively higher share of western region in indirect advances component. Hence regional disparity in the disbursement of rural credit is still persistent (Kumar et al., 2015).

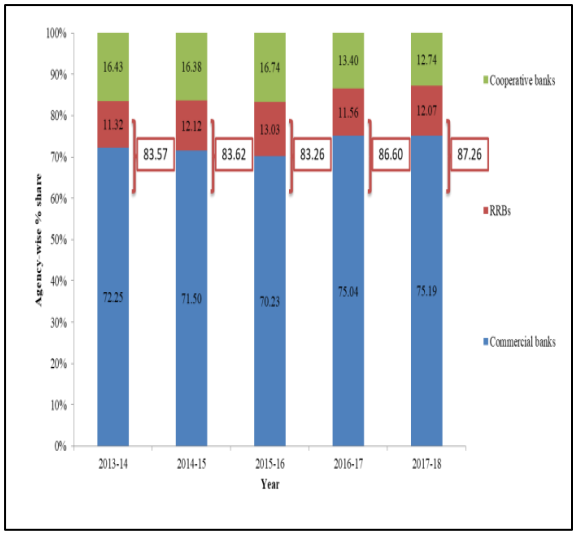


Fig 3: Agency-wise share of credit flow to Agricultural sector in India

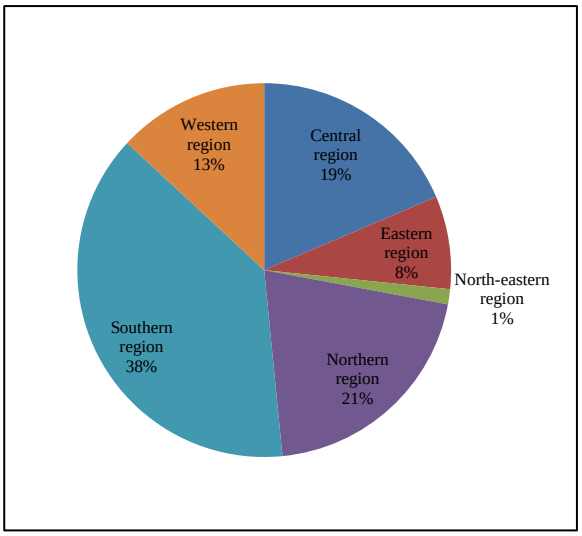
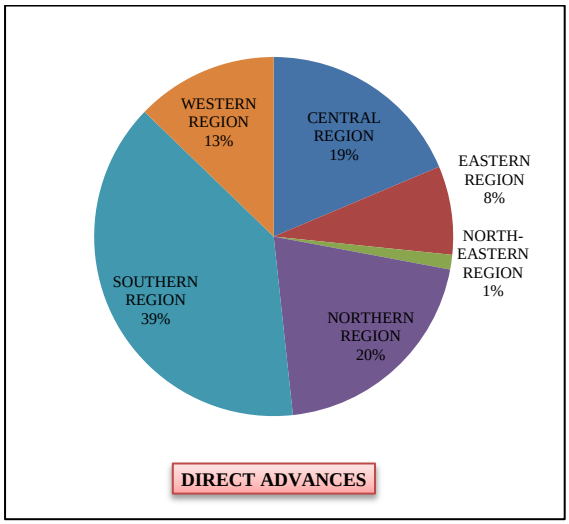


Fig 4: Region wise share in total outstanding credit of SCBs to agriculture (TE avg 2015-18)



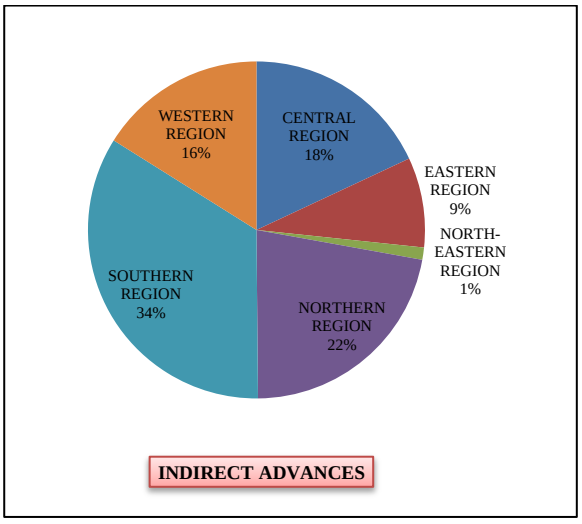


Fig 5: Region wise share in direct and indirect outstanding credit of SCBs to agriculture (TE average 2015-18)

State wise outstanding credit of SCBs to agriculture (TE average 2015-16, 2017-18)

Individual state wise analysis of total credit outstanding to agriculture helps in addressing the regional disparity. Tamil Nadu, Uttar Pradesh, Karnataka, Andhra Pradesh and Maharashtra are the major states to receive credit from SCBs to agriculture during TE ending 2017-18 (Fig 6). UT's like Lakshadweep, Daman & Diu, Dadra & Nagar Haveli and Andaman & Nicobar and North-eastern states like Arunachal Pradesh, Nagaland, Mizoram and Manipur have received least advances to agriculture. As most of the UTs are predominantly urban areas and do not have significant potential for agriculture and allied activities, hence least credit penetration for agricultural sector is observed (RBI, 2019). There

is no much difference in the ranks of states/UTs in total as well direct outstanding credit of SCBs to agriculture (Fig 7 & 8). Whereas in the indirect component of agricultural advances NCT of Delhi ranked first because of the significant potential for indirect agriculture and allied activities of urban area with industrial establishments.

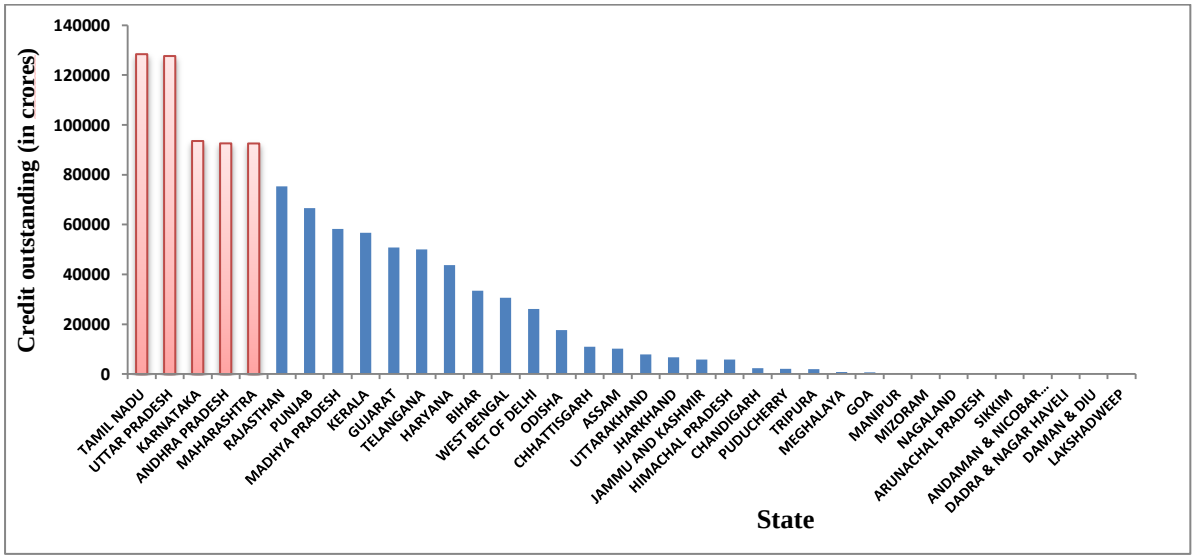


Fig 6: State wise total outstanding credit of SCBs to agriculture (TE average ending 2017-18)

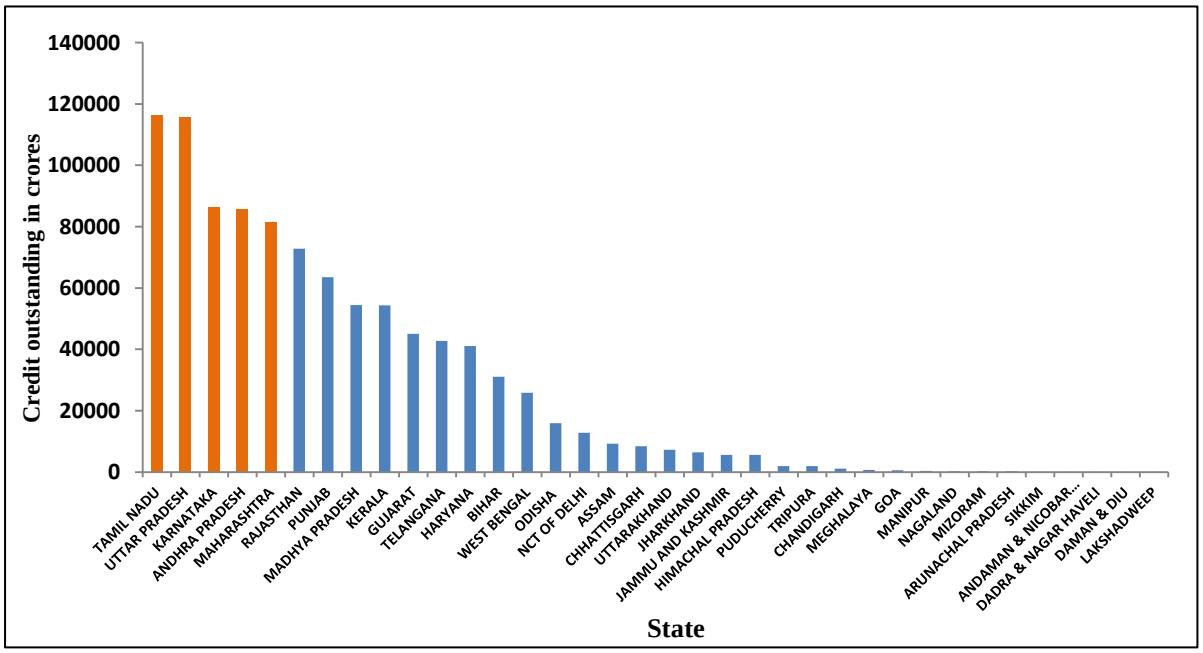


Fig 7: State wise direct outstanding credit of SCBs to agriculture (TE average ending 2017-18)

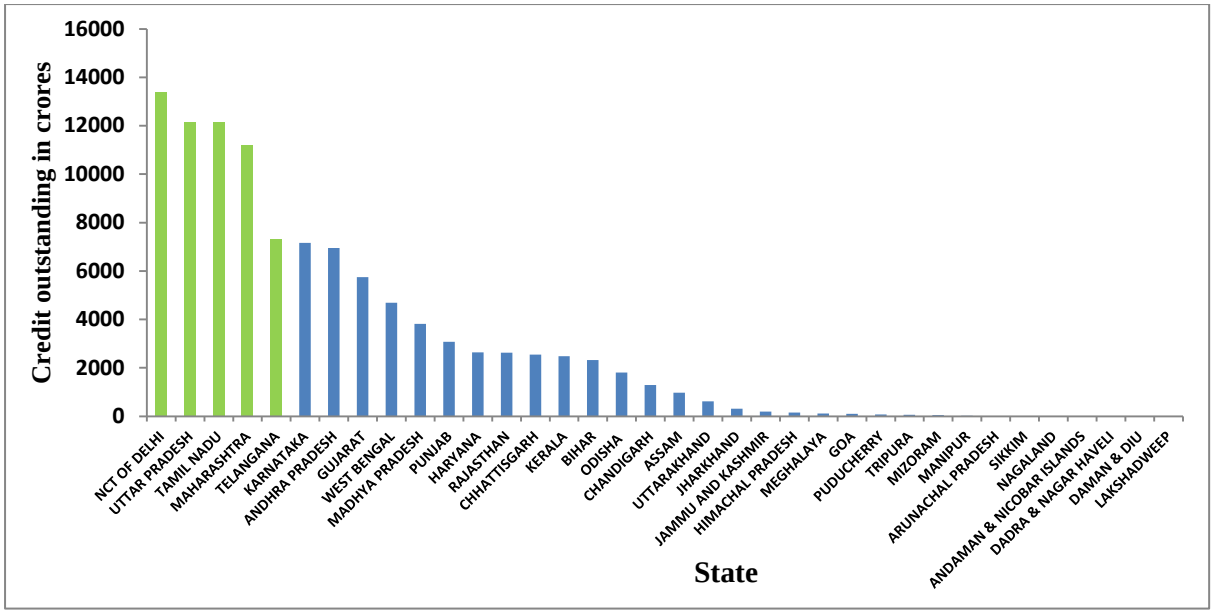


Fig 8: State wise indirect outstanding credit of SCBs to agriculture (TE average ending 2017-18)

Clustering of districts

Impact of credit policies related to agriculture can be better understood only by analysing the growth at grass root level i.e. district. Firstly the districts are grouped based on their extent of agricultural credit exposure i.e. triennium (TE 2015-18) average agricultural credit outstanding by SCBs of 651 districts outstanding agricultural credit of SCBs by subjecting to cluster analysis. Based on Euclidean distance, cluster analysis has grouped the districts of the country into three distinct clusters.

First cluster consisting of just 50 districts itself forms nearly countries one third of advances to agriculture by SCBs (Table 2 and Fig 9). Top ten districts are from Southern region only of which five are from Andhra Pradesh (Fig 10). High irrigation coverage favoured significant direct finances in districts like West Godavari (90.05 %), East Godavari (70.32 %), Guntur (58.85 %) and Krishna (51.32 %). Indirect finance formed a significant share in districts with metropolitan cities like Mumbai (45.03 %), Hyderabad (30.14 %), Bangalore Urban (28.44 %) and Pune (14.18 %) because of their potential. Second cluster composed of 181 districts has shared almost half of the agricultural advances by SCBs. Remaining 420 districts are in third cluster with a share of just 22 per cent (Fig 9).

Table 2: Clustering of districts of the country

Cluster	Range (in Crore ₹)	Number of districts
I	4645.57-11751.23	50
II	1623.38-4518.45	181
III	0.53-1590.34	420

Note: Clustering is based on triennium (TE 2015-18) average outstanding agricultural credit by SCBs for 651 districts

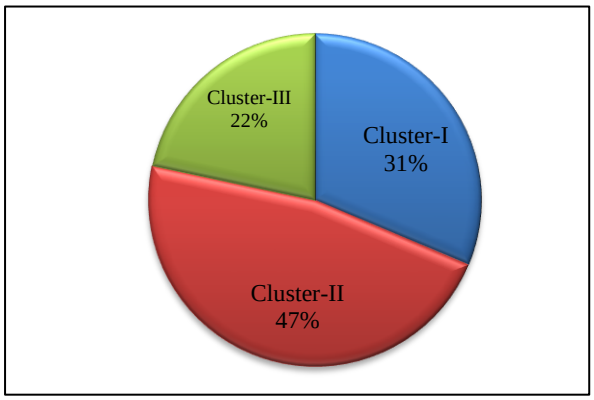


Fig 9: Cluster wise share of agricultural credit outstanding by SCBs

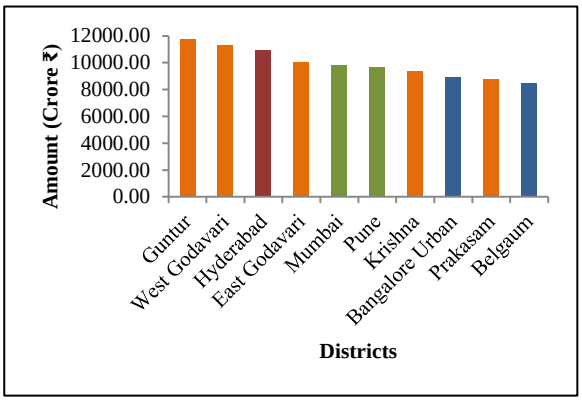


Fig 10: Top ten districts in terms of agricultural credit outstanding by SCBs

Accordingly, the districts of each state are grouped into 3 clusters representing high, medium and low exposure to agriculture credit based on Euclidean distance. From each cluster one district is selected which is no or least disturbed in terms of geographical area. To avoid the misclassification that could occur by using a single year data, triennium average of district wise outstanding credit is arrived which nullifies the problem of extremities in weather which would have occurred in a single year. Further analysis is carried out on these study districts which are listed in tables 3-8.

Structural breaks and Growth of agricultural credit outstanding by SCBs

Bai-Perron test was employed to identify the multiple structural breaks in the time series data of each district. The test has identified five major and most common breaks viz., 1983, 1990, 1997, 2004 and 2011 (Annexure 1-3). Based on the identified breaks the district wise agricultural credit outstanding time series is subdivided into six phases viz., Phase-I (1976-1982), Phase-II (1983-1989), Phase-III (1990-1996), Phase-IV (1997-2003), Phase-V (2004-2010) and Phase-VI (2011-2017). Further phase-wise CAGR was worked out for the selected districts across the region to know the rate of growth in outstanding agricultural advances in each period.

Table 3: Phase-wise CAGR of selected districts of Southern Region

Phase	State / UT	Districts		
		High	Medium	Low
Phase-I (1976-1982)	Telangana	Hyderabad (31.32**)	Mehbubnagar (42.95**)	Adilabad (36.40**)
	Puducherry	Puducherry (19.77**)	Karaikal (18.18**)	Yanam (12.81^{ns})
	Tamil nadu	Coimbatore (9.79**)	Dharmapuri (20.14**)	Nilgiris (24.85**)
	Kerala	Ernakulam (20.97**)	Kozhikode (18.36**)	Idukki (43.87**)
	Karnataka	Belgaum (20.11**)	Gulbarga (42.91**)	Uttar kannad (37.08**)
	AP	Guntur (6.88*)	Cuddapah (24.66**)	Srikakulam (17.81**)
	Lakshadweep	Lakshadweep (24.16*)		
Phase-II (1983-1989)	Telangana	Hyderabad (24.53**)	Mehbubnagar (14.47**)	Adilabad (2.90^{ns})
	Puducherry	Puducherry (16.41**)	Karaikal (18.22**)	Yanam (20.45**)
	Tamil nadu	Coimbatore (25.27**)	Dharmapuri (24.94**)	Nilgiris (16.48*)
	Kerala	Ernakulam (20.40**)	Kozhikode (15.66**)	Idukki (14.16**)
	Karnataka	Belgaum (18.35**)	Gulbarga (22.12**)	Uttar kannad (17.72**)
	AP	Guntur (17.58**)	Cuddapah (16.22**)	Srikakulam (13.02**)
	Lakshadweep	Lakshadweep (42.01**)		
Phase-III (1990-1996)	Telangana	Hyderabad (12.19^{ns})	Mehbubnagar (12.67**)	Adilabad (14.61**)
	Puducherry	Puducherry (5.21^{ns})	Karaikal (13.74**)	Yanam (16.82**)
	Tamil nadu	Coimbatore (6.54**)	Dharmapuri (11.57**)	Nilgiris (7.23**)
	Kerala	Ernakulam (14.28**)	Kozhikode (8.25**)	Idukki (6.31**)
	Karnataka	Belgaum (9.99**)	Gulbarga (10.30**)	Uttar kannad (4.65^{ns})
	AP	Guntur (5.41*)	Cuddapah (8.15**)	Srikakulam (7.15**)
	Lakshadweep	Lakshadweep (3.40^{ns})		
Phase-IV (1997-2003)	Telangana	Hyderabad (10.92**)	Mehbubnagar (10.53**)	Adilabad (17.51**)
	Puducherry	Puducherry (-7.29^{ns})	Karaikal (-9.40^{ns})	Yanam (0.68^{ns})
	Tamil nadu	Coimbatore (12.62**)	Dharmapuri (9.77**)	Nilgiris (7.23**)
	Kerala	Ernakulam (13.53**)	Kozhikode (12.41**)	Idukki (17.92**)
	Karnataka	Belgaum (13.20**)	Gulbarga (16.16**)	Uttar kannad (11.94**)
	AP	Guntur (18.69**)	Cuddapah (12.52**)	Srikakulam (17.13**)
	Lakshadweep	Lakshadweep (6.06^{ns})		
Phase-V (2004-2010)	Telangana	Hyderabad (25.42**)	Mehbubnagar (30.76**)	Adilabad (30.05**)
	Puducherry	Puducherry (30.58**)	Karaikal (36.80**)	Yanam (38.70**)
	Tamil nadu	Coimbatore (36.01*)	Dharmapuri (26.05**)	Nilgiris (29.45**)
	Kerala	Ernakulam (42.70**)	Kozhikode (21.95**)	Idukki (26.26**)
	Karnataka	Belgaum (27.17**)	Gulbarga (31.51**)	Uttar kannad (20.90**)
	AP	Guntur (26.78**)	Cuddapah (27.07**)	Srikakulam (26.18**)
	Lakshadweep	Lakshadweep (14.47^{ns})		
Phase-VI (2011-2017)	Telangana	Hyderabad (2.97^{ns})	Mehbubnagar (17.90**)	Adilabad (24.73**)
	Puducherry	Puducherry (16.35**)	Karaikal (16.95**)	Yanam (35.28**)
	Tamil nadu	Coimbatore (11.51**)	Dharmapuri (15.46**)	Nilgiris (13.07**)
	Kerala	Ernakulam (4.08^{ns})	Kozhikode (18.47**)	Idukki (18.71**)
	Karnataka	Belgaum (18.66**)	Gulbarga (13.96*)	Uttar kannad (15.77**)
	AP	Guntur (11.81**)	Cuddapah (15.98*)	Srikakulam (17.23**)
	Lakshadweep	Lakshadweep (4.56^{ns})		

Note: Calculated using data from Reserve Bank of India, Government of India

**: significant @ 1%, *: significant @ 5%, NS: non-significant; values in the parenthesis are CAGR in percentage

There is a significant and positive growth in credit outstanding across all the districts of southern region in all the phases except a few (Table 3). Further to rank the phases based on the CAGR of districts Garrett ranking technique was engaged. For each district the phases are ranked in ascending order and mean Garrett scores are obtained by using per cent position formula and Garrett table (Table 9). Across all the categories of districts, Phase-V (2004-10) is ranked first based on mean Garrett score. Hyderabad, Mehbubnagar and Adilabad are the selected districts of Telangana state under high, medium and low exposure categories where agricultural credit outstanding by SCBs has grown at a CAGR of 25.42 per cent, 30.76 per cent and 30.05 per cent, respectively in Phase-V. The stimulus behind the high growth in this phase can be attributed to the policy measures undertaken during that period. GLC policy framework for achieving the stated targets at regional, state, agency level was one such measure. Another policy aimed at doubling the volume of credit to agriculture in just three years from 2004-05 was a major stimuli behind this high growth in that phase. Along with these volume based policies ISS scheme has triggered the credit borrowing behaviour of farmers as credit was made cheaper through this scheme. Additional incentive from PRI scheme has further inculcated the behaviour of regular renewals and availing the higher credit limits at least cost of capital i.e. 4 per cent. All these schemes have contributed significantly for the growth of agricultural advances by SCBs across the three categories of districts in southern region. This growth was recorded in spite of 4–6 per cent decline in the number of new loans because of announcement of ADWDRS scheme in 2008 which is undertaken to give relief to the farmers who are caught under vicious cycle of credit and financial indebtedness to avail fresh loans (Gine and Kanz, 2018).

Next highest growth is seen in phase-I (1976-82) across all three categories of districts. During this phase the phenomenal growth can be attributed to the establishment of RRBs to magnify the credit facility for agriculture and to meet the basic banking needs of rural mass. Increase of PSL targets to 40 % from existing 33.33 also stimulated the reported growth along with the branch expansion move from the 6 newly nationalised banks in 1980. Phase-III (1990-96) reported to be phase with least growth when compared to other phases. The reason for the negligible growth is that there are no major policies were announced for increasing of advances to agriculture directly or indirectly. And also the first ever nationwide farm loan waiver is also commencing with this phase.

In western region, there is difference in the ranks across three scenarios. The phase with highest growth is varied across the high (phase-V), medium (phase-I) and low (phase-IV) credit exposure scenarios (Table 10). Overall in the western region highest growth is seen in phase-I (1976-82) which witnessed the establishment of RRBs, increase of PSL targets to 40 % from existing 33.33 along with the branch expansion move from the 6 newly nationalised banks in 1980. UT's like Goa, Daman & Diu and Dadar & Nagar Haveli have registered significant growth with a CAGR of 33.03, 138.54 and 30.55 per cent, respectively in phase-I (Table 4).

In central region also there is difference in ranks across three scenarios. In medium and low exposure districts growth is high in phase-I, whereas in high exposure districts growth is high in phase-II (Table 11). Least exposure districts like Chamoli, Ballia, Mandla and Bastar the outstanding credit to agriculture has significantly grown at a rate of 89.75, 37.26, 73.76 and 71.15 per cent, respectively in phase-I (Table 5).

In the eastern and north-eastern region districts the growth in initial phases i.e. Phase-I & II outweighed the growth of recent phases as seen from the CAGR & garrett scores (Table 6, 7, 12 & 13). So the policy interventions like establishment of RRBs, increase of PSL targets to 40 % from existing 33.33, second round of nationalization of six banks have stimulated the reported growth during initial phases. In north region the growth is high during phase-I across all the regions followed by phase-V as seen from garrett score rankings (Table 14). High credit exposure districts like Jaipur, Ludhiana, Baramulla, Simla and Karnal have posted a significant growth of 35.93, 38.51, 53.46, 58.04 and 30.33 per cent respectively during phase-I (Table 8).

So overall next to phase-I, in phase-V also significant growth in agricultural advances was observed (Table 15). So recent policies like doubling agricultural package and ground level credit policy have played significant role in the growth of agricultural advances.

Table 4: Phase-wise CAGR of selected districts of Western Region

Phase	State / UT	Districts		
		High	Medium	Low
Phase-I (1976-1982)	Maharashtra	Mumbai (10.17*)	Yavatmal (34.56**)	Ratnagiri (17.15**)
	Gujarat	Banas kantha (21.99**)	Bhavnagar (29.36**)	Dangs (89.14**)
	Goa	Goa (33.03**)		
	Daman Diu	Daman & Diu (138.54**)		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (30.55*)		
Phase-II (1983-1989)	Maharashtra	Mumbai (3.89^{ns})	Yavatmal (15.27**)	Ratnagiri (18.76**)
	Gujarat	Banas kantha (26.23**)	Bhavnagar (28.23**)	Dangs (25.66**)
	Goa	Goa (12.05**)		
	Daman Diu	Daman & Diu (12.04**)		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (11.64^{ns})		
Phase-III (1990-1996)	Maharashtra	Mumbai (36.53**)	Yavatmal (12.09**)	Ratnagiri (6.83*)
	Gujarat	Banas kantha (11.81**)	Bhavnagar (10.01**)	Dangs (16.88**)
	Goa	Goa (0.74^{ns})		
	Daman Diu	Daman & Diu (-0.17^{ns})		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (6.84^{ns})		
Phase-IV (1997-2003)	Maharashtra	Mumbai (25.63**)	Yavatmal (6.39**)	Ratnagiri (39.30*)
	Gujarat	Banas kantha (9.84**)	Bhavnagar (22.43**)	Dangs (9.64*)
	Goa	Goa (1.79^{ns})		
	Daman Diu	Daman & Diu (8.67^{ns})		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (-0.57^{ns})		
Phase-V (2004-2010)	Maharashtra	Mumbai (11.16^{ns})	Yavatmal (34.00**)	Ratnagiri (36.16**)
	Gujarat	Banas kantha (42.19**)	Bhavnagar (23.75^{ns})	Dangs (55.19*)
	Goa	Goa (18.14*)		
	Daman Diu	Daman & Diu (7.58^{ns})		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (-11.78^{ns})		
Phase-VI (2011-2017)	Maharashtra	Mumbai (2.48^{ns})	Yavatmal (19.29**)	Ratnagiri (13.10**)
	Gujarat	Banas kantha (16.26**)	Bhavnagar (17.09**)	Dangs (-17.31^{ns})
	Goa	Goa (10.77^{ns})		
	Daman Diu	Daman & Diu (16.00^{ns})		
	Dadra & Nagar Haveli	Dadra & Nagar Haveli (28.18**)		

Note: Calculated using data from Reserve Bank of India, Government of India
**: significant @ 1%, *: significant @ 5%, NS: non-significant
Values in the parenthesis are CAGR in percentage

Table 5: Phase-wise CAGR of selected districts of Central Region

Phase	State / UT	Districts		
		High	Medium	Low
Phase-I (1976-1982)	Uttarkhand	Udham singh nagar[#]	Haridwar[#]	Chamoli (89.75**)
	Uttar pradesh	Agra (26.60**)	Gonda (33.63**)	Ballia (37.26**)
	Madhya pradesh	Indore (15.13**)	Datia (37.83**)	Mandla (73.76**)
	Chattisgarh	Raipur (25.02**)	Durg (24.42**)	Bastar (71.15**)
Phase-II (1983-1989)	Uttarkhand	Udham singh nagar[#]	Haridwar[#]	Chamoli (11.51[ns])
	Uttar pradesh	Agra (18.16**)	Gonda (39.33**)	Ballia (14.38**)
	Madhya pradesh	Indore (29.13**)	Datia (9.72**)	Mandla (16.22**)
	Chattisgarh	Raipur (18.25**)	Durg (31.53**)	Bastar (29.97**)
Phase-III (1990-1996)	Uttarkhand	Udham singh nagar[#]	Haridwar (14.89[ns])	Chamoli (7.75[ns])
	Uttar pradesh	Agra (2.58[ns])	Gonda (13.57**)	Ballia (9.01**)
	Madhya pradesh	Indore (9.80*)	Datia (12.57**)	Mandla (9.39**)
	Chattisgarh	Raipur (6.54**)	Durg (9.52**)	Bastar (0.89[ns])
Phase-IV (1997-2003)	Uttarkhand	Udham singh nagar (32.88**)	Haridwar (12.40*)	Chamoli (10.56*)
	Uttar pradesh	Agra (17.12**)	Gonda (6.34[ns])	Ballia (9.79**)
	Madhya pradesh	Indore (24.45*)	Datia (27.20**)	Mandla (9.75**)
	Chattisgarh	Raipur (8.71**)	Durg (5.89*)	Bastar (10.88[ns])
Phase-V (2004-2010)	Uttarkhand	Udham singh nagar (32.07**)	Haridwar (38.07**)	Chamoli (18.97**)
	Uttar pradesh	Agra (29.09**)	Gonda (21.81**)	Ballia (27.60**)
	Madhya pradesh	Indore (14.40**)	Datia (20.33**)	Mandla (20.12**)
	Chattisgarh	Raipur (48.11**)	Durg (31.16**)	Bastar (29.25**)
Phase-VI (2011-2017)	Uttarkhand	Udham singh nagar (17.22**)	Haridwar (11.07**)	Chamoli (11.83[ns])
	Uttar pradesh	Agra (18.14**)	Gonda (23.36**)	Ballia (12.98**)
	Madhya pradesh	Indore (15.16**)	Datia (18.74**)	Mandla (16.85**)
	Chattisgarh	Raipur (2.22[ns])	Durg (13.05**)	Bastar (13.18**)

Note: Calculated using data from Reserve Bank of India, Government of India

**: significant @ 1%, *: significant @ 5%, NS: non-significant and values in the parenthesis are CAGR in percentage

#: CAGR is not calculated because of non-availability of data during that period or the district was not formed by that time

Table 6: Phase-wise CAGR of selected districts of Eastern Region

Region	State / UT	High	Medium	Low
Phase-I (1976-1982)	Sikkim	East sikkim[#]	South sikkim[#]	North sikkim[#]
	West bengal	Kolkata (10.06 [ns])	Hugli (25.29**)	Puruliya (13.20**)
	Odisha	Khurda[#]	Keonjhar (69.81**)	Sambalpur (39.21**)
	Jharkhand	Ranchi (19.87**)	Dhanbad (51.02*)	Koderma[#]
	Bihar	Patna (32.15**)	Bhagalpur (30.40**)	Munger (44.21**)
	A & N Island	Andaman & Nicobar (35.04*)		
Phase-II (1983-1989)	Sikkim	East sikkim (57.98*)	South sikkim (44.54 [ns])	North sikkim (26.48*)
	West bengal	Kolkata (22.89 [ns])	Hugli (14.27**)	Puruliya (34.90**)
	Odisha	Khurda[#]	Keonjhar (24.56**)	Sambalpur (30.58*)
	Jharkhand	Ranchi (11.78**)	Dhanbad (20.90**)	Koderma[#]
	Bihar	Patna (9.39 [ns])	Bhagalpur (16.72**)	Munger (18.75**)
	A & N Island	Andaman & Nicobar (24.54*)		
Phase-III (1990-1996)	Sikkim	East sikkim (10.56[ns])	South sikkim (9.62 [ns])	North sikkim (7.99 [ns])
	West bengal	Kolkata (6.31 [ns])	Hugli (4.85 [ns])	Puruliya (12.31**)
	Odisha	Khurda[#]	Keonjhar (8.74**)	Sambalpur (-5.06 [ns])
	Jharkhand	Ranchi (48.74**)	Dhanbad (7.17 [ns])	Koderma[#]
	Bihar	Patna (-0.77 [ns])	Bhagalpur (6.45 [ns])	Munger (2.25 [ns])
	A & N Island	Andaman & Nicobar (8.09**)		
Phase-IV (1997-2003)	Sikkim	East sikkim (11.33 [ns])	South sikkim (-7.63 [ns])	North sikkim (7.22 [ns])
	West bengal	Kolkata (38.42**)	Hugli (10.50**)	Puruliya (0.20 [ns])
	Odisha	Khurda (22.78*)	Keonjhar (8.88**)	Sambalpur (5.70 [ns])
	Jharkhand	Ranchi (-3.86 [ns])	Dhanbad (1.86 [ns])	Koderma (11.59*)
	Bihar	Patna (8.89 [ns])	Bhagalpur (0.64 [ns])	Munger (-5.61*)
	A & N Island	Andaman & Nicobar (58.56**)		
Phase-V (2004-2010)	Sikkim	East sikkim (50.42**)	South sikkim (42.58**)	North sikkim (4.13*)
	West bengal	Kolkata (14.56 [ns])	Hugli (34.93**)	Puruliya (31.45**)
	Odisha	Khurda (49.19**)	Keonjhar (30.25**)	Sambalpur (38.94**)
	Jharkhand	Ranchi (9.16 [ns])	Dhanbad (22.94**)	Koderma (28.71**)
	Bihar	Patna (26.54**)	Bhagalpur (21.25**)	Munger (20.71**)
	A & N Island	Andaman & Nicobar (-6.89[ns])		
Phase-VI (2011-2017)	Sikkim	East sikkim (16.57**)	South sikkim (11.53*)	North sikkim (5.97 [ns])
	West bengal	Kolkata (0.51 [ns])	Hugli (14.08**)	Puruliya (11.37 [ns])
	Odisha	Khurda (-1.95 [ns])	Keonjhar (12.11**)	Sambalpur (4.63 [ns])
	Jharkhand	Ranchi (12.60*)	Dhanbad (17.51**)	Koderma (19.57**)
	Bihar	Patna (28.54*)	Bhagalpur (20.62**)	Munger (22.67**)
	A & N Island	Andaman & Nicobar (24.50*)		

Note: Calculated using data from Reserve Bank of India, Government of India

**: significant @ 1%, *: significant @ 5%, NS: non-significant and values in the parenthesis are CAGR in percentage

#: CAGR is not calculated because of non-availability of data during that period or the district was not formed by that time

Table 7: Phase-wise CAGR of selected districts of North-Eastern Region

Region	State / UT	High	Medium	Low
Phase-I (1976-1982)	Tripura	West Tripura (40.94**)	South Tripura (24.71**)	North Tripura (21.67**)
	Nagaland	Kohima (48.98**)	Mokokcheng (80.00*)	Tuensang (276.00 ns)
	Mizoram	Aizawl (113.57*)	Lunglei#	Lawngtlai#
	Meghalaya	EK hills (82.74*)	WG hills (87.46**)	EG hills (-26.66 ns)
	Manipur	Imphal west#	Thoubal#	Chandel#
	Assam	Kamrup (7.12 ns)	Sibsagar (0.58 ns)	N C hills (172.38*)
	Ar Pradesh	Papumpare#	East Siang (108.69**)	Tirap (83.73*)
Phase-II (1983-1989)	Tripura	West Tripura (29.70*)	South Tripura (33.80**)	North Tripura (40.71**)
	Nagaland	Kohima (27.08**)	Mokokcheng (24.08*)	Tuensang (112.72**)
	Mizoram	Aizawl (99.12**)	Lunglei (130.14**)	Lawngtlai#
	Meghalaya	EK hills (36.59**)	WG hills (58.54**)	EG hills (119.50 ns)
	Manipur	Imphal west (36.98**)	Thoubal (35.13**)	Chandel#
	Assam	Kamrup (16.97 ns)	Sibsagar (8.20ns)	N C hills (28.61**)
	Ar Pradesh	Papumpare#	East Siang (66.51*)	Tirap (24.60 ns)
Phase-III (1990-1996)	Tripura	West Tripura (7.46**)	South Tripura (6.63 ns)	North Tripura (2.98 ns)
	Nagaland	Kohima (16.00 ns)	Mokokcheng (9.36 ns)	Tuensang (9.05**)
	Mizoram	Aizawl (-2.05 ns)	Lunglei (9.83**)	Lawngtlai#
	Meghalaya	EK hills (0.61ns)	WG hills (43.86 ns)	EG hills (30.45*)
	Manipur	Imphal west (9.16**)	Thoubal (10.45**)	Chandel (-6.91 ns)
	Assam	Kamrup (10.49**)	Sibsagar (4.87 ns)	N C hills (3.99 ns)
	Ar Pradesh	Papumpare (19.25 ns)	East Siang (15.27ns)	Tirap (9.63 ns)
Phase-IV (1997-2003)	Tripura	West Tripura (0.98ns)	South Tripura (10.68**)	North Tripura (2.92*)
	Nagaland	Kohima(-21.69**)	Mokokcheng (3.29 ns)	Tuensang (9.96*)
	Mizoram	Aizawl (-3.56 ns)	Lunglei (12.94 ns)	Lawngtlai#
	Meghalaya	EK hills (5.86 ns)	WG hills (19.15*)	EG hills (-10.09 ns)
	Manipur	Imphal west (5.87*)	Thoubal (-8.05 ns)	Chandel (-24.47**)
	Assam	Kamrup (-0.19 ns)	Sibsagar (4.64 ns)	N C hills (4.17 ns)
	Ar Pradesh	Papumpare (19.86 ns)	East Siang (9.32 ns)	Tirap (12.93 ns)
Phase-V (2004-2010)	Tripura	West Tripura (33.95**)	South Tripura (21.41**)	North Tripura (25.26**)
	Nagaland	Kohima (34.79**)	Mokokcheng (57.15**)	Tuensang (34.98**)
	Mizoram	Aizawl (37.61**)	Lunglei (41.19*)	Lawngtlai (35.67**)
	Meghalaya	EK hills (12.79 ns)	WG hills (21.62 ns)	EG hills (73.23**)
	Manipur	Imphal west (28.47**)	Thoubal (57.41**)	Chandel (48.85**)
	Assam	Kamrup (14.45 ns)	Sibsagar (28.12**)	N C hills (47.29**)
	Ar Pradesh	Papumpare (38.25**)	East Siang (16.58**)	Tirap (33.31*)
Phase-VI (2011-2017)	Tripura	West Tripura (22.61*)	South Tripura (12.70*)	North Tripura (13.09 ns)
	Nagaland	Kohima (10.95 ns)	Mokokcheng (21.75**)	Tuensang (2.67 ns)
	Mizoram	Aizawl (7.69 ns)	Lunglei (12.54 ns)	Lawngtlai (25.06*)
	Meghalaya	EK hills (25.32*)	WG hills (22.69*)	EG hills (2.63 ns)
	Manipur	Imphal west (9.86**)	Thoubal (12.17**)	Chandel (-9.80 ns)
	Assam	Kamrup (15.19**)	Sibsagar (26.49**)	N C hills (5.80 ns)
	Ar Pradesh	Papumpare (23.98**)	East Siang (21.58**)	Tirap (-19.87 ns)

Note: Calculated using data from Reserve Bank of India, Government of India

**: significant @ 1%, *: significant @ 5%, NS: non-significant and values in the parenthesis are CAGR in percentage. EK: East Khasi, NC: North Cachar, WG: West Garo, EG: East Garo

Table 8: Phase-wise CAGR of selected districts of Northern Region

Region	State / UT	High	Medium	Low
Phase-I (1976-1982)	Rajasthan	Jaipur (35.93**)	Nagaur (52.27**)	Dungarpur (24.13**)
	Punjab	Ludhiana (38.51**)	Kaparthala (61.41**)	Rupnagar (37.43**)
	J&K	Baramulla (53.46**)	Jammu (53.28**)	Poonch (92.18**)
	HP	Simla (58.04**)	Kullu (49.22**)	Lahul & spiti (130.21**)
	Haryana	Karnal (30.33**)	Jind (58.25**)	Gurgaon (20.99**)
	Delhi	Delhi (41.88**)		
	Chandigarh	Chandigarh (11.33*)		
Phase-II (1983-1989)	Rajasthan	Jaipur (11.81**)	Nagaur (10.44**)	Dungarpur (40.36**)
	Punjab	Ludhiana (7.67 ^{ns})	Kaparthala (4.14 ^{ns})	Rupnagar (14.54 ^{ns})
	J&K	Baramulla (3.94 ^{ns})	Jammu (-3.36 ^{ns})	Poonch (30.84**)
	HP	Simla (14.00**)	Kullu (17.36**)	Lahul & spiti (4.81 ^{ns})
	Haryana	Karnal (2.27 ^{ns})	Jind (17.76 ^{ns})	Gurgaon (11.65**)
	Delhi	Delhi (-4.08^{ns})		
	Chandigarh	Chandigarh (-23.63**)		
Phase-III (1990-1996)	Rajasthan	Jaipur (4.08^{ns})	Nagaur (1.05 ^{ns})	Dungarpur (7.02**)
	Punjab	Ludhiana (4.09*)	Kaparthala (2.80 ^{ns})	Rupnagar (4.72**)
	J&K	Baramulla (5.62 ^{ns})	Jammu (8.24 ^{ns})	Poonch (10.64**)
	HP	Simla (-1.39 ^{ns})	Kullu (4.63*)	Lahul & spiti (11.09 ^{ns})
	Haryana	Karnal (1.03 ^{ns})	Jind (5.48**)	Gurgaon (0.85 ^{ns})
	Delhi	Delhi (30.36*)		
	Chandigarh	Chandigarh (7.15^{ns})		
Phase-IV (1997-2003)	Rajasthan	Jaipur (41.24**)	Nagaur (17.23**)	Dungarpur (16.74**)
	Punjab	Ludhiana (16.43**)	Kaparthala (19.15**)	Rupnagar (23.08*)
	J&K	Baramulla (45.04 ^{ns})	Jammu (10.66**)	Poonch (8.76**)
	HP	Simla (24.88**)	Kullu (17.68**)	Lahul & spiti (16.72 ^{ns})
	Haryana	Karnal (13.55**)	Jind (13.43**)	Gurgaon (17.42)
	Delhi	Delhi (46.11**)		
	Chandigarh	Chandigarh (39.61**)		
Phase-V (2004-2010)	Rajasthan	Jaipur (25.85**)	Nagaur (29.97**)	Dungarpur (40.54**)
	Punjab	Ludhiana (23.20**)	Kaparthala (24.22 ^{ns})	Rupnagar (2.85 ^{ns})
	J&K	Baramulla (29.73)	Jammu (31.44**)	Poonch (72.28**)
	HP	Simla (33.61*)	Kullu (27.68**)	Lahul & spiti (52.07**)
	Haryana	Karnal (32.01*)	Jind (22.99**)	Gurgaon (6.06 ^{ns})
	Delhi	Delhi (24.70**)		
	Chandigarh	Chandigarh (37.55**)		
Phase-VI (2011-2017)	Rajasthan	Jaipur (12.92**)	Nagaur (23.41**)	Dungarpur (12.36**)
	Punjab	Ludhiana (15.55**)	Kaparthala (14.09*)	Rupnagar (21.13**)
	J&K	Baramulla (33.53**)	Jammu (4.49*)	Poonch (29.17**)
	HP	Simla (13.64**)	Kullu (22.11**)	Lahul & spiti (18.84**)
	Haryana	Karnal (15.68**)	Jind (16.26**)	Gurgaon (13.83*)
	Delhi	Delhi (2.48^{ns})		
	Chandigarh	Chandigarh (-16.75**)		

Note: Calculated using data from Reserve Bank of India, Government of India

**: significant @ 1%, *: significant @ 5%, NS: non-significant and values in the parenthesis are CAGR in percentage.

Table 9: Phase-wise Garrett score across different scenarios of Southern Region

Phase	High		Medium		Low		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	56.67	2	63.17	2	65.67	2	61.83	2
Phase-II	54.17	3	54.33	3	43.17	4	50.56	3
Phase-III	30.67	6	30.00	6	31.50	6	30.72	6
Phase-IV	44.17	4	31.50	5	36.83	5	37.50	5
Phase-V	74.67	1	72.33	1	70.00	1	72.33	1
Phase-VI	39.67	5	48.67	4	52.83	3	47.06	4

Table 10: Phase-wise Garrett score across different scenarios of Western Region

Phase	High		Medium		Low		UT's		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	50.00	3	77.00	1	61.50	2	77.00	1	67.56	1
Phase-II	50.00	4	35.50	5	54.00	3	54.00	3	53.22	3
Phase-III	57.00	2	49.00	3	34.50	5	30.67	6	37.22	6
Phase-IV	43.00	5	34.50	6	76.00	1	35.33	5	41.67	5
Phase-V	65.50	1	39.50	4	25.00	6	45.67	4	56.78	2
Phase-VI	34.50	6	64.50	2	49.00	4	57.33	2	43.56	4

Table 11: Phase-wise Garrett score across different scenarios of Central Region

Phase	High		Medium		Low		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	57.33	3	64.67	1	77.00	1	67.40	1
Phase-II	61.67	1	59.00	2	52.25	3	57.10	3
Phase-III	27.67	6	41.75	5	23.00	6	31.09	6
Phase-IV	53.75	4	38.25	6	37.00	5	43.00	5
Phase-V	60.25	2	59.00	3	60.75	2	60.00	2
Phase-VI	38.50	5	43.25	4	50.00	4	43.92	4

Table 12: Phase-wise Garrett score across different scenarios of Eastern Region

Phase	High		Medium		Low		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	62.00	1	73.50	1	69.33	1	68.80	1
Phase-II	57.50	2	56.60	3	63.00	2	58.85	2
Phase-III	40.50	6	32.00	5	41.50	5	37.54	5
Phase-IV	45.40	4	29.00	6	34.60	6	36.33	6
Phase-V	54.80	3	65.20	2	54.80	3	58.27	3
Phase-VI	44.20	5	48.40	4	45.40	4	46.00	4

Table 13: Phase-wise Garrett score across different scenarios of North-Eastern Region

Phase	High		Medium		Low		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	69.00	1	63.40	2	61.60	3	64.67	1
Phase-II	64.33	2	63.71	1	65.00	1	64.28	2
Phase-III	39.00	5	37.43	5	40.67	4	38.95	5
Phase-IV	25.86	6	31.14	6	36.00	6	30.75	6
Phase-V	59.00	3	58.86	3	63.14	2	60.33	3
Phase-VI	50.29	4	49.29	4	37.86	5	45.81	4

Table 14: Phase-wise Garrett score across different scenarios of Northern Region

Phase	High		Medium		Low		UT's		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	71.40	1	77.00	1	72.40	1	58.50	2	71.82	1
Phase-II	36.00	5	37.60	5	46.40	5	23.00	6	38.00	5
Phase-III	25.80	6	27.60	6	34.20	6	50.00	4	31.65	6
Phase-IV	58.80	3	47.40	3	48.20	4	77.00	1	54.47	3
Phase-V	60.60	2	63.00	2	49.80	2	54.50	3	57.41	2
Phase-VI	47.40	4	47.40	4	49.00	3	37.00	5	46.65	4

Table 15: Phase-wise Garrett score across different scenarios in India

Phase	High		Medium		Low		UT's		Overall	
	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank	Mean Garrett Score	Rank
Phase-I	62.50	1	68.92	1	68.12	1	67.71	1	66.67	1
Phase-II	54.08	3	53.25	3	53.27	3	48.43	3	53.11	3
Phase-III	35.00	6	34.66	6	34.48	6	36.00	6	34.81	6
Phase-IV	43.72	5	34.86	5	41.11	5	54.71	2	41.00	5
Phase-V	62.41	2	62.14	2	57.86	2	46.14	5	59.71	2
Phase-VI	43.83	4	48.90	4	46.62	4	47.00	4	46.49	4

In high credit exposure districts the share of urban branches is relatively more across all the regions in the recent period and it has shown increasing trend in southern, northern and north-east region. The trend is decreasing in eastern, western and central region. Whereas in medium credit exposure districts during the recent period the relative share of rural branches is more across the regions except in southern. When it comes to the trend during the two periods in southern, western and eastern region it is increasing and in regions like central, northern and north-eastern it is decreasing. Coming to the low credit exposure districts the share of rural branches is relatively higher than urban and semi-urban branches across the regions except southern and northern regions. It is interesting to note that the trend is decreasing in all regions except eastern region. Share of semi-urban branches in southern and urban branches in northern is galloping in these low credit exposure districts (Fig 11).

Five year average of the recent period (2013-17) indicates that the direct advances forms the major part of agricultural advances across all the regions. Among high credit exposure districts in regions like western, central and eastern the share of indirect advances is almost one third of the total advances to the agriculture. Whereas in southern region indirect advances forms one sixth of the total advances to agriculture. In medium exposure districts the share of indirect agricultural advances is lower than 10 per cent except in eastern region. Similarly in low credit exposure districts the share of indirect advances is negligible across the regions except in eastern and north-eastern region. (Fig 12).

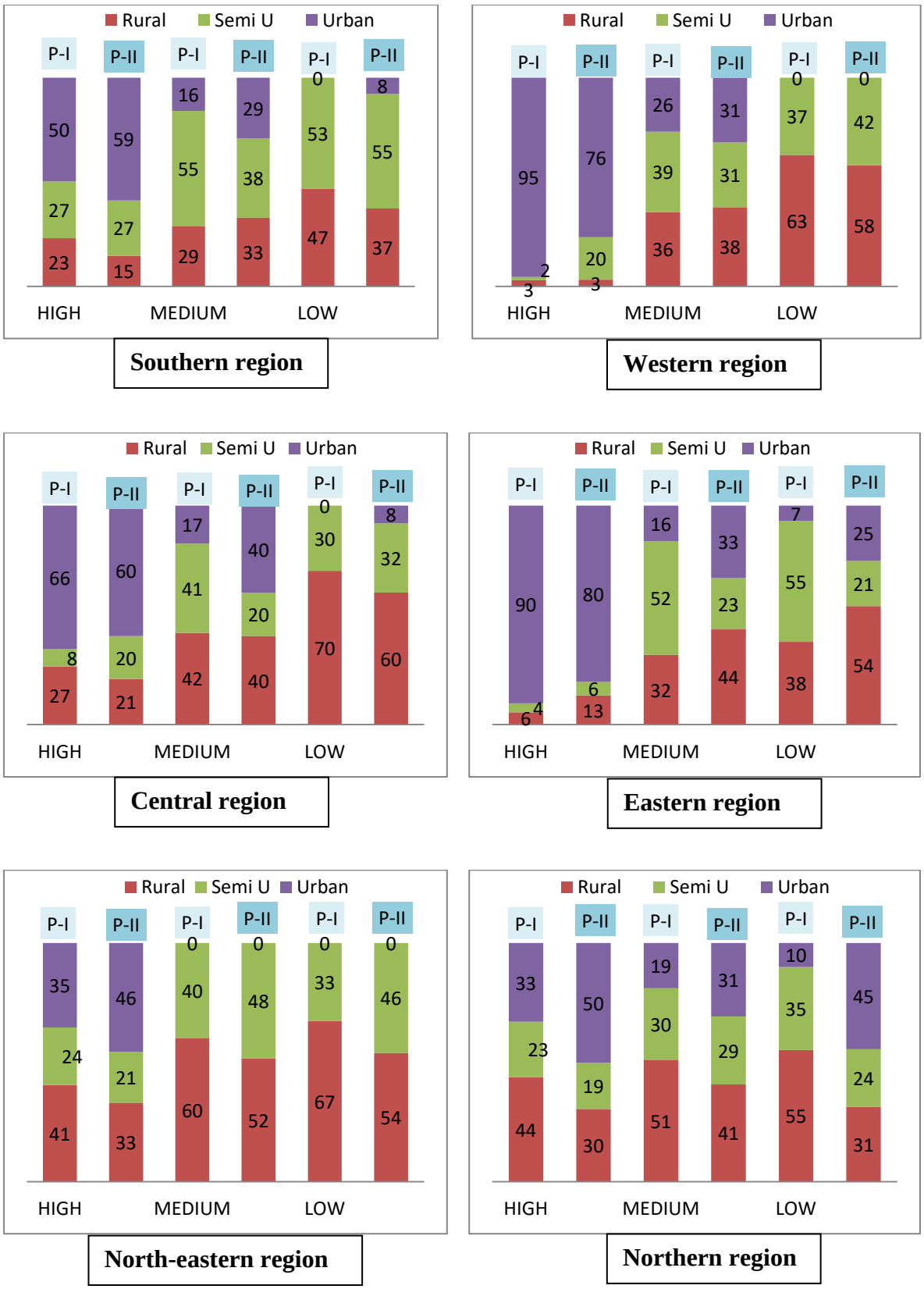


Figure 11: Region-wise share of rural, semi-urban and urban branches during Period-I (Five year average 1972-76) and Period-II (Five year average 2013-17) across three scenarios

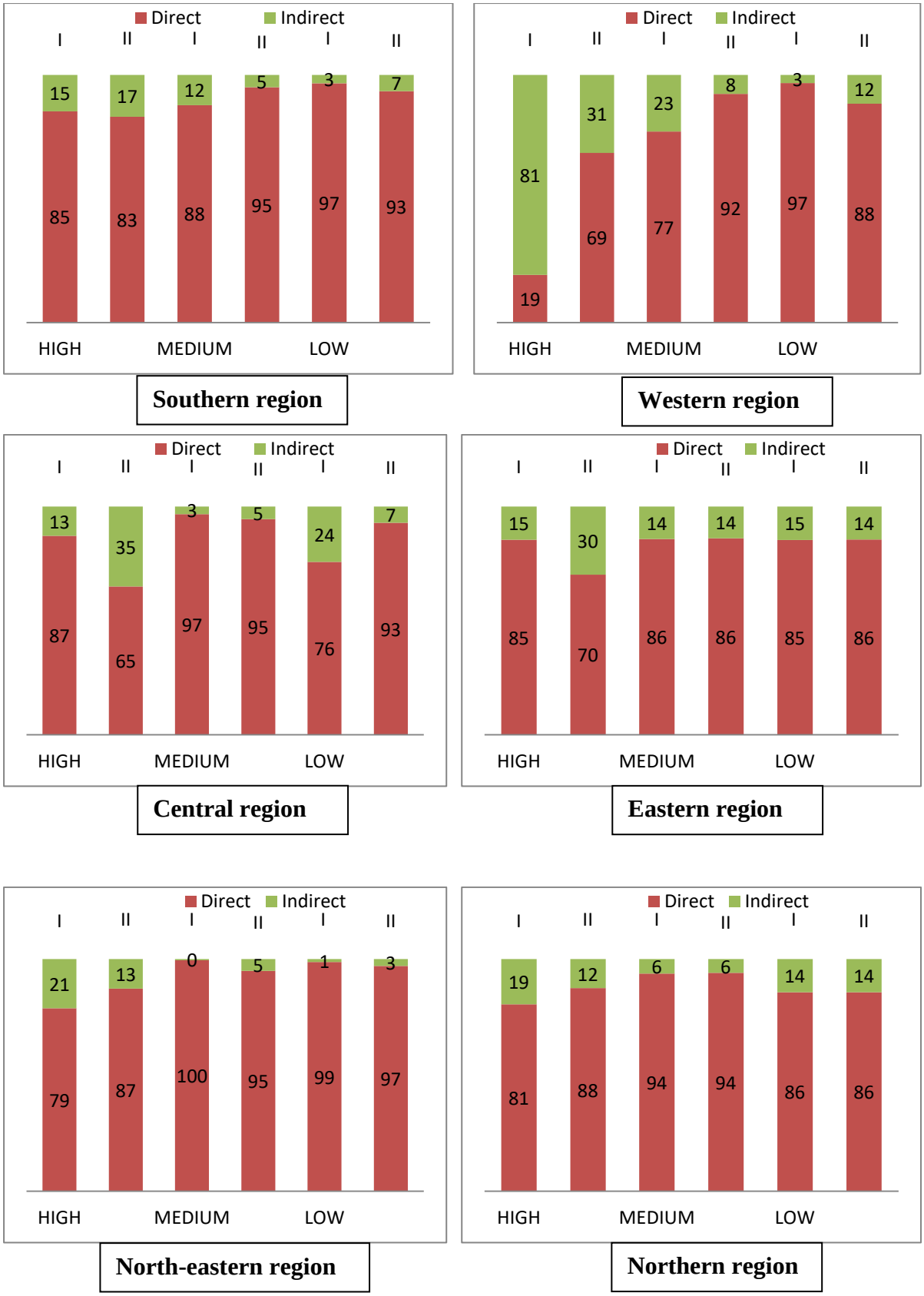


Figure 12: Region-wise proportion of type of advances to agriculture across 3 categories of districts during Period-I (Five year average 1972-76) and Period-II (Five year average 2013-17)

Conclusion

Multiple structural breaks in the time series data of each district owing to various policy reforms in the field of agricultural finance are identified using Bai-Perron test (Most commonly 1983, 1990, 1997, 2004 and 2011). The time series further subdivided into six phases viz., Phase-I (1976-1982), Phase-II (1983-1989), Phase-III (1990-1996), Phase-IV (1997-2003), Phase-V (2004-2010) and Phase-VI (2011-2017) and phase-wise CAGR was worked out for all districts to know the rate of growth in outstanding agricultural advances in each period. Garrett ranking technique was employed to identify the phase with high growth in six regions of the country. Phase-I is identified as the phase with high rate of growth in agricultural advances in selected districts across all regions except southern. So the policies like setting of priority sector lending targets and establishment of regional rural banks have played crucial role in the growth of agricultural advances during initial periods. Next to phase-I, in phase-V also significant growth in agricultural advances was observed in all regions except eastern and north-eastern regions. So recent policies like doubling agricultural package and ground level credit policy have played significant role in the growth of agricultural advances. In the eastern and north-eastern region districts the growth in initial phases outweighed the growth of recent phases.

Chapter 3: Drivers of institutional credit to agriculture

In this chapter an attempt was made to analyze the drivers of institutional credit to agriculture at regional level, scenario wise and at all India level using district-level data.

Data source:

Institutional credit to agriculture by SCBs in a district is influenced by various factors. Based on peer review, the following factors are identified as some important factors which may influence institutional credit to agriculture.

1. Number of Scheduled Commercial Banks (SCB) branches
2. Gross Sown Area (GSA)
3. Gross Irrigated Area (GIA)
4. Area Under Commercial crops (AUC)
5. Annual Rainfall (AR)

Panel data of these variables for the period of 2000-2017 is created by collecting data from following sources.

Variable	Source
Outstanding agricultural advances by SCBs	Various volumes of Basic Statistical Returns (BSR) of SCBs, Reserve Bank of India
Number of Scheduled Commercial Banks (SCB) branches	Various volumes of Basic Statistical Returns (BSR) of SCBs, Reserve Bank of India
Gross Sown Area (GSA)	Directorate of Economics and Statistics (DES)
Gross Irrigated Area (GIA)	Directorate of Economics and Statistics (DES)
Area Under Commercial crops (AUC)	Directorate of Economics and Statistics (DES)
Annual Rainfall (AR)	India Meteorological Department (IMD)

This information is extracted and compiled for 7 UTs and 87 districts representing all states (3 districts from each state representing scenarios viz., high, medium and low exposure to agricultural advances). Considering multicollinearity problem ratio variables viz., share of GIA in GSA, share of AUC along with other variables namely number of branches and rainfall are modeled as independent variables.

Methodology

Panel data regression technique

The impact of these drivers at region level and scenario wise is quantified using panel data regression technique. Two models are fitted for the data and the best model is selected based on selection criteria.

a) Fixed-effect model (FE)

The fixed effect model explains the relationship between independent variable and dependent variable where each individual entity has significant role in predicting the outcome in the system (Patra and Padhi, 2016). In FE model each cross sectional unit will have its own fixed intercept value.

The fixed effect model used in the study is

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

where,

Y_{it} is the credit outstanding, for i^{th} district; i=1,…m and t^{th} year; t=1,…n,

α_{1i} is the unknown intercept

X_{it} is the exogenous variables for i^{th} district; i=1,….m and t^{th} year; t=1,…n

β is a vector of model parameters

u_{it} is the combined time series and cross-section error component.

b) Random-effect model (RE)

The random effect model differs from the fixed effects model as the variation across entities is assumed to be random and uncorrelated with the independent variables included in the model (Patra and Padhi, 2016).

The random effect model used in the study is

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

where,

$$w_{it} = \varepsilon_i + u_{it}$$

$$\alpha_{1i} = \alpha_{1+}\varepsilon_i$$

ε_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 exogenous variables for i^{th} district; i=1,….m and t^{th} year; t=1,…n

β is a vector of model parameters.

c) Hausman test statistic

Hausman test statistic helps in knowing the superiority of fixed and random effect models over each other.

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

where,

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

The statistic *m* is distributed *χ2 (k)* degrees of freedom under the null hypothesis of RE is superior FE, where *k* is the dimension of β (Hausman, 1978).

Panel data regression technique was carried out using "plm" package in R. Estimates are obtained by employing different analysis like "Pooled OLS", "Between estimation", "First differences estimation", "Within estimation or Fixed Effect Model (FEM)", "Random Effect Model (REM)" to exploit the features of panel data. LM test was employed using "plmtest" function to decide between REM and Pooled OLS. LM test is also employed using "pFtest" function to decide between a FEM and Pooled OLS. Hausman test is employed using "phtest" function to decide between REM and FEM. Unbalanced panel model was employed in the analysis because of missing values of independent variables as the data for few years was not available in the public domain. The results of the model suggested by the Hausman test are presented in this chapter.

Results and discussion

Panel data regression results

At region-wise, credit exposure category wise and at country level the FEM is found to be consistent and suitable than REM as per Hausman test. Hence the estimates of FEM are presented in this chapter.

Region wise estimates of parameters from fixed effect model are tabulated in table 16. District wise key variables like number of branches, share of GIA in GSA (%), share of AUC in GSA (%) and rainfall received in mm are regressed on dependent variable i.e. outstanding agricultural advances by SCBs (in crore rupees). Across all the regions the model is found to be significant and R^2 statistic is satisfactory. It is highlighted in the panel data estimates that the number of branches operating in a district is turned to be very significant and positively influencing variable across all the regions. The coefficient is found to be high in southern region followed by northern and central region and least in western, north-eastern and Eastern region. For every increase in one operating branch in a district in the southern region the outstanding agricultural advances by SCBs will increase by 21.19 crore rupees. Based on state

wise estimates the response of credit outstanding to the number branches is captured and the panel data regression coefficient of number of branches variable is ranked accordingly where the states like Andhra Pradesh, Karnataka, Chhattisgarh, Tamil Nadu and Paducherry are found to be more responsive (Fig 10). Hence branch expansion in these states has helped in increasing advances to agriculture sector. Whereas states like Arunachal Pradesh, Mizoram, Nagaland, Jammu & Kashmir and Jharkhand the response of branch expansion to credit outstanding is found to be least (Fig 11).

Share of GIA in GSA is found to be positively and significantly influencing the outstanding agricultural advances by SCBs in southern and central region. Irrigated areas will have greater demand for institutional credit than un-irrigated areas so percentage area irrigated turned out to be a statistically significant determinant of inter-state variation in institutional credit per hectare (Haque and Goyal, 2021). Share of AUC in GSA is found to be significant and positively influencing the outstanding agricultural advances by SCBs in regions like central and northern regions and negatively influencing in western region. Rainfall is not a significant variable influencing the advances to agriculture at district level as it is not significant in any regions except in central region where it is negatively influencing. Hence access to institutional credit agriculture is influenced by a number of socio-economic, institutional and policy factors (Kumar et al., 2015).

Table 16: Region wise estimates of parameters from Fixed Effect Model

[*Y*= Outstanding agricultural advances by SCBs (In Crore Rs.)]

Variables	Southern (N = 262)	Western (N = 86)	Central (N = 195)
Branches (No.)	21.19*** (0.59)	2.74*** (0.40)	12.42***(0.54)
Share of GIA in GSA (%)	11.20** (4.62)	3.31^{NS} (6.67)	17.07***(3.96)
Share of AUC in GSA (%)	-8.72^{NS} (7.48)	-20.20***(2.91)	2.19 ** (0.86)
RF (mm)	0.016^{NS} (0.11)	0.038^{NS} (0.04)	-0.25** (0.09)
R^2	0.85	0.59	0.83
F-statistic	329.18***	26.91***	222.45***
	Eastern (N=147)	North-Eastern (N=207)	Northern (N=245)
Branches (No.)	5.86*** (0.26)	4.50*** (0.49)	12.65*** (0.47)
Share of GIA in GSA (%)	-4.62^{NS} (4.06)	-0.31^{NS} (0.60)	-0.29^{NS} (0.30)
Share of AUC in GSA (%)	-4.53^{NS} (8.16)	1.10^{NS} (2.00)	47.01*** (18.00)
RF (mm)	0.06^{NS} (0.09)	0.0002^{NS} (0.007)	0.05^{NS} (0.28)
R^2	0.79	0.32	0.76
F-statistic	128.84***	21.78***	183.14***

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics and India Meteorological Department, Government of India

Figures in the parenthesis are respective standard errors

"***" Significant @ 1% LoS, "**" Significant @ 5% LoS, "NS" Non-Significant

Across all kinds of districts i.e. high, medium and low exposure districts number of branches operating in the district found to be significantly influencing the dependent variable. In medium credit exposure districts the share of AUC in GSA is found to be significantly and negatively influencing dependent variable. The influence of number of operating branches is relatively more among middle exposure districts followed by high and low exposure districts (Table 17).

Table 17: Credit exposure category wise estimates of parameters from Fixed Effect Model

[*Y*= Outstanding agricultural advances by SCBs (In Crore Rs.)]

Variables	High (N=359)	Medium (N=362)	Low (N=344)
Branches (No.)	12.61***	14.05***	5.95***
	(0.43)	(0.69)	(0.42)
Share of GIA in GSA (%)	-0.07^{NS}	0.008^{NS}	-0.14^{NS}
	(0.34)	(0.32)	(2.14)
Share of AUC in GSA (%)	6.56^{NS}	-8.37**	0.11^{NS}
	(3.44)	(3.34)	(0.76)
RF (mm)	-0.10^{NS}	-0.08^{NS}	0.044^{NS}
	(0.09)	(0.07)	(0.034)
R^2	0.72	0.58	0.40
F-statistic	211.48***	113.62***	54.43***

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics and India Meteorological Department, Government of India
Figures in the parenthesis are respective standard errors
"***" Significant @ 1% LoS, "**" Significant @ 5% LoS, "NS" Non-Significant

At country level the district wise panel data regression revealed that number of operating branches in the district is the only variable found to be having positive influence on the credit outstanding to agriculture by SCBs (Table 18).

Table 18: Estimates of parameters at country level from Fixed Effect Model

[*Y*= Outstanding agricultural advances by SCBs (In Crore Rs.)]

Variables	India (N=1142)
Branches (No.)	12.86***
	(0.26)
Share of GIA in GSA (%)	-0.07^{NS}
	(0.23)
Share of AUC in GSA (%)	1.38^{NS}
	(1.44)
RF (mm)	-0.035^{NS}
	(0.04)
R^2	0.69
F-statistic	596.56***

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics and India Meteorological Department, Government of India
Figures in the parenthesis are respective standard errors
"***" Significant @ 1% LoS, "**" Significant @ 5% LoS, "NS" Non-Significant

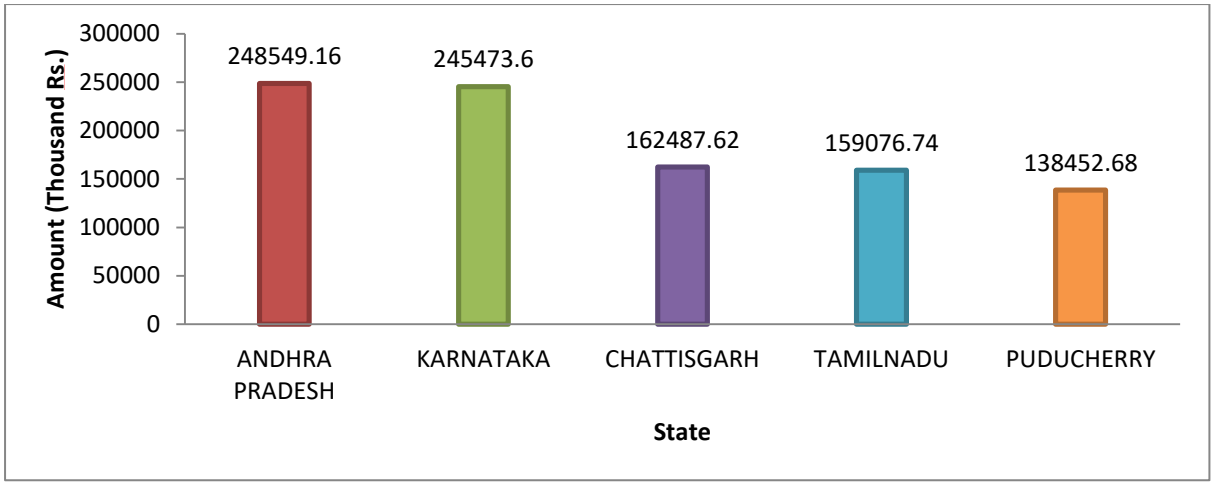


Figure 13: States with high response of agricultural advances to branch expansion

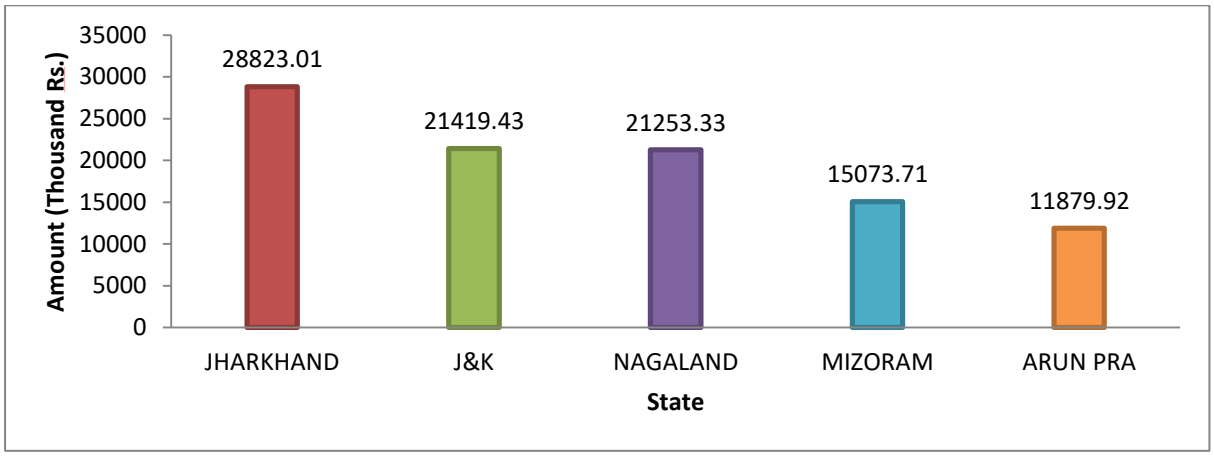


Figure 14: States with low response of agricultural advances to branch expansion

Conclusion

Factors like number of scheduled commercial bank branches, share of GIA in GSA, share of AUC in GSA and annual rainfall are regressed on district wise outstanding agricultural credit by SCBs. The impact of these important drivers on institutional credit to agriculture is quantified at region level, credit exposure category wise and at national level by employing panel data regression technique using "plm" package in R. In all categories the fixed effect model is found to be consistent and suitable than random effect model as per Hausman test. At country level the district wise panel data regression revealed that number of operating branches in the district is found to be having positive influence. Institutional credit to agriculture is found to be more responsive for branch expansion in Andhra Pradesh, Karnataka, Chhattisgarh, Tamil Nadu and Paducherry.

Chapter 4: Forecasting of the institutional credit to agriculture

In this chapter various models with different structural form were used to forecast the institutional credit to agriculture by SCBs and the performance of each model is evaluated. This chapter contains degree of optimal model and the best fit model as well five year ahead forecast of the districts with highest and lowest credit exposure to agriculture by SCBs across all the states of various regions.

Data source:

Data on outstanding credit of scheduled commercial banks (SCBs) to agriculture for the period 1976-2017 was made used for model fitting and performance evaluation.

Variable	Source
Outstanding agricultural advances by SCBs	Various volumes of Basic Statistical Returns (BSR) of SCBs, Reserve Bank of India
Number of Scheduled Commercial Banks (SCB) branches	Various volumes of Basic Statistical Returns (BSR) of SCBs, Reserve Bank of India

Methodology

a) Box-Jenkins Autoregressive Integrated Moving Average (ARIMA)

ARIMA model can be written:

$$\emptyset(B)(1-B)^d y_t = \theta(B)\varepsilon_t$$

$\emptyset(B)=1-\emptyset_1 B-\emptyset_2 B^2-\ldots..-\emptyset_p B^p$ (Autoregressive parameter)

$(B)=1-\theta_1 B-\theta_2 B^2-\ldots..-\theta_q B^q$ (Moving average parameter)

ε_t=White noise or error term

d= Differencing term (the number of differences required to make a series stationary)

B= Backshift operator i.e. B^{α}

$y_t = y_{t-\alpha}$

y_t=Response variable at time t

ARIMA models consist of three components:

1. Lagged values of the variable (the autoregressive component, AR),

2. Lagged values of the error term (the moving average component, MA)

3. The degree of integration (the number of differences required to make a series stationary) (Vatansever, 2013).

b) ARIMA-Intervention model

It is time series intervention modeling employed in situations where it may be known that certain exceptional external events called 'interventions' (in our case policy interventions) could affect the time series phenomenon under study. 2004 is considered as change point in ARIMA intervention model as policy interventions Viz., ground level credit policy and doubling agricultural credit scheme were implemented in that year. This model can explain the magnitude and periodic of each event effected.

ARIMA intervention model can be written:

$$Y_t = \frac{\omega(B)}{\delta(B)} B^b I_t + \frac{\theta(B)}{\emptyset(B)} \varepsilon_t$$

where,

Y_t is response variable at time *t*

I_t is indicator variable coded according to the type of intervention. The intervention type of step function starts from a given time till the last time period. Mathematically, the intervention type of step function is written as: I_t=0 if $t \neq T$, 1 if $t \geq T$ with *T* is time of intervention when it first occurred

$\delta(B)$=1+ $\delta_1 B$+ $\delta_2 B^2$+…..+ $\delta_r B^r$ (Slope parameter has different meanings different types of intervention. In case of step intervention, if δ is near to zero, the effect of the intervention remains constant over time and if δ is near to one, the effect of intervention increases over time)

$\omega(B)$=1+ $\omega_1 B$+ $\omega_2 B^2$+…..+ $\omega_s B^s$ (Impact parameter which implies change (either positive or negative) due to intervention)

$\emptyset(B)$=1-$\emptyset_1 B$-$\emptyset_2 B^2$-…..-$\emptyset_p B^p$ (Autoregressive parameter)

(B)=1- $\boldsymbol{\theta}_1 B$- $\boldsymbol{\theta}_2 B^2$-…..- $\boldsymbol{\theta}_q B^q$ (Moving average parameter)

$\boldsymbol{\varepsilon_t}$ is white noise or error term

D is differencing term

B is backshift operator i.e. $B^{\alpha} Y_t = Y_{t-\alpha}$

B is delay parameter usually takes value 0, 1 or 2; *b*=0 implies that the effect of intervention has occurred at the time of intervention itself, *b*=1 implies, the effect of intervention is felt after a delay of one period and so on (Ray et al., 2014).

c) Autoregressive Integrated Moving Average with Explanatory variable- ARIMAX Model

The ARIMA model is extended into ARIMA model with explanatory variable (*X*), called ARIMAX (*p,d,q*). ARIMAX includes important explanatory variable into the model and many studies suggested it for improving forecasting performance of the model. Number of scheduled commercial banks branches was used as important explanatory variable in this study.

Specifically, ARIMAX (*p,d,q*) can be represented by

$$\emptyset(B)(1-B)^d \, y_t = \Theta(B)x_t + \theta(B)\varepsilon_t$$

where,

$\emptyset(B)=1-\emptyset_1 B-\emptyset_2 B^2-\ldots..-\emptyset_p B^p$ (Autoregressive parameter)

$(B)=1-\theta_1 B-\theta_2 B^2-\ldots..-\theta_q B^q$ (Moving average parameter)

ε_t=White noise or error term

d= Differencing term (the number of differences required to make a series stationary)

B= Backshift operator i.e. $B^{\alpha} \, y_t = y_{t-\alpha}$

x_t= Explanatory variable

$\Theta(B)$ = Explanatory variable parameter (Kongcharoen and Kruangpradit, 2013).

Results and discussion

Optimal model for forecasting agricultural advances by SCBs

Time series data on outstanding credit of SCBs to agriculture for the period 1976-2017 was used for model fitting and performance evaluation. Time series models like ARIMA, ARIMAX and ARIMA intervention are fitted for the data and the performance of each model was evaluated. Based on Akaike Information Criterion (AIC) criteria the best model is selected. Degree of the optimum model, AIC values and five year ahead forecast in high credit exposure districts (Table 18) and least credit exposure districts (Table 19) is tabulated and presented here in this chapter.

In the previous chapter we have identified number of scheduled commercial banks branches as one of the important variables significantly influencing the agricultural advances made by SCBs in a district. Hence it is used as an important explanatory variable in ARIMAX model. The year 2004 is one of the significant year in the history of agricultural credit as the policies like ground level credit policy and doubling agricultural credit scheme

were implemented in that year. In the second chapter the structural break analysis has identified year 2004 as one of the major break point of the credit time series. Hence the year 2004 is considered as change point in ARIMA intervention model.

ARIMA Model is said to be performing better in most of the districts based on model AIC values. Only in case of Metropolitan districts viz, Hyderabad, Kolkata and other districts with major cities like Jaipur, Indore, Guntur, Raipur, Patna, Ernakulum etc… ARIMAX model is found to be performing relatively better (Table 19). ARIMA Intervention Model is found to be performing better in low exposure districts like Lahul&Spiti, Baramulla, North Cachar Hills, Munger, Sambalpur, Paruliya, North Sikkim, Ratnagiri, Srikakulam and Uttar Kannada (Table 20). Significance of government interventions like doubling credit to agriculture and ground level credit policy in low credit exposure districts was emphasized from ARIMA Intervention model.

Conclusion

Proposed models like ARIMA, ARIMAX and ARIMA Intervention are fitted for the data and the performance of each model was evaluated. District wise best model was identified and forecasted the institutional credit supply to agriculture at district level for the next five years. Number of SCB branches used as important explanatory variable in ARIMAX model and year 2004 is considered as change point in ARIMA intervention model as policy interventions based on analysis in the previous chapters. Based on AIC values ARIMA model is performing better in most of the districts. Whereas ARIMAX model is relatively better performing in metropolitan districts and other districts with major cities. Performance of ARIMA intervention model better in low exposure districts, demonstrating the significant impact of government interventions like doubling credit to agriculture and ground level credit policy on agricultural advances.

Table 19: Degree of optimum model, AIC values and five year ahead forecast in high credit exposure districts

District	Degree of optimum model			AIC			Forecast				
	p	*d*	*q*	ARIMA	ARIMAX	ARIMAI	2018	2019	2020	2021	2022
Hyderabad	1	2	1	1488.27	1487.69	1490.19	98065444	98372506	105838738	108685870	114513247
Puducherry	1	2	0	1236.12	1237.8	1238.05	15026604	16948681	18065878	19756307	21038482
Coimbatore	0	2	1	1400.92	1402.91	1397.06	80005206	83306985	86608764	89910543	93212321
Ernakulam	0	2	1	1444.74	1439.5	1446.74	60046813	62017727	63988641	65959555	67930469
Belgaum	4	2	2	1331.74	1332.02	1330.03	89800588	95196769	105666339	114377207	124066081
Guntur	0	2	2	1445.62	1445.22	1447.58	124439880	133026776	141613673	150200569	158787466
Mumbai	2	1	2	1598.53	1598.92	1599.2	74185576	84595982	116838514	91206113	82949843
Banas Kantha	0	2	2	1345.58	1347.48	1345.79	52257630	57355975	62454319	67552663	72651007
Agra	1	2	0	1306.11	1307.14	1308.11	55424801	61815315	68721120	75234262	82046622
Indore	1	2	1	1350.65	1326.46	1352.33	38925531	40869393	44310435	46900551	49974292
Raipur	1	1	0	1493	1491.45	1494.95	48151714	49716654	51281496	52846338	54411180
East Sikkim	1	1	0	945.95	946.89	947.95	629407.6	630751.5	630580.4	630602.2	630599.4
Kolkata	1	1	0	1518.7	1516.53	1518.18	69326213	67785616	70887891	72102738	74084865
Ranchi	1	2	0	1260.5	1262.41	1260.52	8279674	8384498	8785250	8979275	9317714
Patna	0	1	1	1464.89	1439.58	1467.33	34733162	37695647	40658132	43620617	46583102
West Tripura	0	2	2	1268.46	1239.94	1270.36	6694384	8086980	9479576	10872172	12264768
Kohima	0	1	1	1237.96	1239.12	1239.82	754714.5	754714.5	754714.5	754714.5	754714.5
Aizawl	1	1	0	977.36	978.84	978.96	1276348	1276630	1276649	1276650	1276650
East Khasi Hills	1	1	0	1181.55		1184.97	3947358	2671536	3818242	3048657	3794914
Imphal West	3	2	0	875.05	877.05	876.94	2410247	2390434	2513045	2730781	2972456
Kamrup	0	2	2	1259.93	1259.96	1261.24	10180530	11028241	11875952	12723663	13571375
Jaipur	0	2	1	1434.02	1429.4	1435.37	82893994	90971698	99049402	107127106	115204810
Ludhiana	0	2	3	1388.12	1388.43	1388.89	73345920	71587424	74878819	78170213	81461608
Baramulla	0	2	3	1245.7	1244.99	1241.3	11256978	11933099	12460865	12988631	13516397
Simla	0	2	1	1265.12	1267.12	1265.91	13752476	14896293	16040111	17183928	18327746
Karnal	0	2	3	1376.24	1378.19	1377.3	50441465	55871803	61643273	67414743	73186214

Table 20: Degree of optimum model, AIC values and five year ahead forecast in low credit exposure districts

District	Degree of optimum model			AIC			Forecast				
	p	*d*	*q*	ARIMA	ARIMAX	ARIMAI	2018	2019	2020	2021	2022
Adilabad	1	2	0	1323.87	1324.83	1325.76	41580072	50957995	60341023	69724571	79108172
Yanam	0	2	1	908.73	904.98	910.64	724415.1	759858.4	795301.6	830744.9	866188.2
Nilgiris	1	2	0	1210.6	1212.37	1212.56	11399887	11995274	12556935	13136448	13706511
Idukki	0	2	1	1311.09	1309.41	1313.07	27840162	29973931	32107700	34241469	36375238
Uttar Kannad	1	2	2	1214.76	1216.63	1212.95	10116018	11276979	12330348	13435488	14515717
Srikakulam	0	2	3	1327.77	1329.3	1324.02	30058055	32869206	35602235	38335265	41068294
Ratnagiri	0	2	2	1296.83	1294.61	1283.27	10004133	10757157	11510182	12263206	13016230
Dangs	1	1	0	1228.61	1230.17	1230.61	287753.6	287706	287707.5	287707.5	287707.5
Chamoli	0	1	1	974.2	975.63	976.2	381994.6	381994.6	381994.6	381994.6	381994.6
Ballia	0	2	2	1241.8	1243.6	1243.01	8752325	9525076	10297826	11070577	11843327
Mandla	0	2	1	1082.41	1083.78	1084.4	2219854	2415914	2611973	2808033	3004093
Bastar	1	1	0	1209.78	1211.38	1211.78	2687572	2687834	2687846	2687846	2687846
North Sikkim	1	1	0	652.01	652.23	651.85	25656.75	25635.52	25633.05	25632.76	25632.73
Puruliya	0	1	3	1347.27	1349.16	1343.57	1835436	2138435	2089640	2089640	2089640
Sambalpur	0	2	2	1223.38	1225.3	1222.6	4790602	4852347	4914092	4975837	5037582
Munger	0	2	2	1197.18	1198.87	1194.36	4821069	5498293	6175517	6852741	7529964
North Tripura	0	2	1	1155.09	1153.57	1156.79	1829933	1927894	2025855	2123815	2221776
Tuensang	1	1	0	850.6	855.07	855.27	172209.9	181365.2	182654	189815.3	192592.6
East Garo Hills	1	1	0	1004.94	1004.3	1006.94	38922.61	53285.32	110655.24	146349.65	168558
North Cachar Hills	1	1	2	987.68	989.91	986.35	394872.8	391847.2	390568.1	390027.4	389798.8
Tirap	1	1	0	835.4	837.34	837.36	16262.66	16274.57	16274.06	16274.08	16274.08
Dungarpur	0	2	1	1151.94	1151.31	1153.17	4152922	4389773	4626625	4863477	5100329
Rupnagar	0	2	1	1289.76	1291.27	1291.76	17482136	18909385	20336635	21763884	23191134
Poonch	1	1	0	989.66	985	991.55	354958.7	360552.7	365225.2	369153.7	372457.7
Lahul & Spiti	0	2	2	861.71	861.01	858.71	403110.3	424167	445223.6	466280.3	487336.9
Gurgaon	2	2	0	1299.89	1301.18	1301.02	13447360	11340702	12559043	14678766	13477941

Chapter 5: Estimation of demand for institutional credit to agriculture

In this chapter an attempt was made to estimate the demand for institutional credit to agriculture at district level using district-level data.

Data source:

Data of below important parameters for the period of 2016-17 is collected from the following sources.

Variable	Source
Area under crops	Directorate of Economics and Statistics (DES)
Scale of finance	Respective SLBCs
Unit cost	NABARD
State level area under drip & sprinkle irrigation	agriindiastat
District wise land use classification	Directorate of Economics and Statistics (DES)
District-wise farm power availability	WAPCOS
District wise data on livestock population is obtained from	Livestock census-2012.
Number of Scheduled Commercial Banks (SCB) branches	Various volumes of Basic Statistical Returns (BSR) of SCBs, Reserve Bank of India

Methodology

Institutional credit to agriculture includes both direct and indirect finance made to agricultural sector.

In 1983, RBI has categorized agricultural credit into direct and indirect. Estimation of indirect finance to agriculture is not logical, whereas estimation of direct agricultural credit is of most practical relevance. Since indirect finance to agriculture includes components which needs to be assessed at branch level and it includes components like credit for financing the distribution of fertilisers, pesticides, seeds and other types of indirect finance.

Other side direct agricultural credit composes of short term agricultural advances and term agricultural advances (investment loans). Short-term loans are advanced for raising crops under kisan credit card scheme and against pledge/hypothecation of agricultural produce not exceeding 3 months. Term agricultural advances include both medium and long-term loans provided directly to farmers for financing production and development needs.

Results and discussions

In this chapter an attempt was made to develop a procedure for estimation of direct agricultural credit requirement of a district and is presented here under the results headings.

Primarily direct agricultural credit composes of short term agricultural advances and term agricultural advances (investment loans).

Estimation of short term agricultural advances

Short-term loans are advanced for raising crops against pledge/hypothecation of standing crops. In finance institutions the crop loan requirement of a farmer is arrived by multiplying the area under cultivation of a crop with its scale of finance. So in order to obtain the short term loan requirement of a district the area under different crops is multiplied with its scale of finance. Considering the fact that not all farmers may require loan facility and they may have their own capital for crop production. So we have used 4 scenarios where 100, 75, 50 and 25 per cent of gross sown area under different crops (irrigated as well rainfed) is financed and is summarised in the table 20. First the individual crop wise calculation is made and later it is summed for the district.

$$\text{Crop loan component} = \sum_{i=1}^{n} [\text{Area under cultivation of } i\text{th crop (in hectares)} * \text{Scale of finance of } i\text{th crop (in rupees)}]$$

Short term credit requirement= Crop loan component + 30 % of crop loan component

Note: Of the 30 per cent, 10 per cent is towards post-harvest/household/ consumption requirements and remaining 20 per cent is towards repairs and maintenance expenses of farm assets, crop insurance and/or accident insurance including PAIS, health insurance & asset insurance (RBI, 2019).

Estimation of term agricultural advances

Term agricultural advances include both medium and long-term loans provided directly to farmers for financing production and development needs of the farmer. Following are the activities considered for financing under term agricultural advances.

Code	Sectors / activity	Sub-activities
A	Minor Irrigation	Dug well, Bore well with motor pump, IP Sets, Drip and Sprinkler Irrigation
B	Land Development	Land Reclamation, Bunding & Soil conservation, Watershed development/farm pond, Water Management/Channels/Lining, Land levelling & CADA/OFD and Miscellaneous
C	Farm Mechanisation	Tractor, Power Tillers and Miscellaneous (Sprayers/Threshers/Combined harvesters)
D	Plantation & Horticulture	Cashew nut, pomegranate, Mango, Coconut, Grapes, Guava, Rubber, Spices and Miscellaneous (Coffee, tea, Flowers & Vegetables)
E	AH-Dairy Development	Cross breed cows, Indigenous cows, Buffaloes and Miscellaneous (Choppers, Milking machines)
F	AH-Poultry	Commercial Broilers, Layers and Hatchery
G	AH- Others	Sheep, Goat, Pig, Rabbit rearing and Miscellaneous (Cattle shed)
H	Fisheries	Fish Ponds, Tank Units, Hatcheries/Nursery pond, Mechanised Boats, Gill net+Boat, Miscellaneous (cold storage)
I	Forestry & Wasteland Development	Farm Forestry, Wasteland Development
J	Storage structures	Storage units (Godown), Milk / Chilling Plants, Market Yards, Miscellaneous (Cold storage)
L	Sericulture	Mulberry, Rearing house
K	Other agriculture & allied activities	Bullock/other draught animal, Bullocks-carts, Bio-gas Plants/Solar Equipment's, Miscellaneous (Animal operated machines)

$$\text{Term loan requirement} = \sum_{i=A}^{K} \left[\begin{matrix}\text{Area/number of units under } i\text{th activity} * \\ \text{unit cost of ith activity (in rupees)}\end{matrix}\right]$$

Minor irrigation:

Under the assumption that one dug well loan is advanced by every 100 SCBs branches and 1 each bore well and IP sets are advanced by every branch of SCBs is used. For deciding the area to be financed under drip and sprinkler irrigation in a district the per cent area under drip and sprinkler irrigation is worked out. Primarily the state wise estimates percentage area under is obtained by dividing the state wise area under drip and sprinkler irrigation by net irrigated area and which is dissipated at district level for the year 2016-17. From these district level estimates 5 per cent of area under drip and sprinkler to be financed is assumed. Further the units of each activity are multiplied with respective unit costs to obtain loan requirement of the district for minor irrigation.

Land Development

Primarily total area to be developed through various land development activities is worked out at district level. i.e. total land development area =(culturable waste land+fallow lands other than current fallows). Of these total area 20 per cent to be developed in the year 2016-17 is assumed and in this 20 per cent area half of the area is assumed to be require land reclamation and remaining half of the area may be subjected to the activities like bunding & soil conservation, watershed development, water management/channels/lining, land levelling and miscellaneous activities equally. Accordingly that much area under each activities are considered for financing and are multiplied by respective unit costs to obtain the loan requirement of land development activities in that district.

Farm Mechanisation

For 1000 hectares of cultivated land, the tractors, power tillers are generally required are as 67 and 200 respectively (Sahay, 2006). Keeping this baseline district level requirement is found out using the cultivable land statistics. District-wise farm power availability during 2016-17 is obtained from WAPCOS-2018 report and the district wise gap is worked out. Assuming the 20 per cent of the gap is financed in that year and accordingly it is multiplied with respective unit costs to obtain the loan requirement of the district for farm mechanization activities. For the miscellaneous machineries the criteria of 2 units per 10 branches is financed is used.

Plantation & Horticulture

District wise area under fruits, plantation and spices is obtained from DES and considering the present day importance for high value agriculture suppose every year there is increase in the area under these horticulture crops by 5 per cent and which is assumed to be financed according to their unit costs to get the loan requirement of districts for these activities.

Animal Husbandry

District wise data on livestock population is obtained from livestock census-2012. 2016-17 figures are obtained by using compounding formula where national level growth rate in livestock population is employed. Assuming the increase half of the increased population is been financed in 2016-17, the unit costs are multiplied accordingly to obtain the loan

requirement of districts for the animal husbandry activities like cross breed cows, indigenous cows, buffaloes, sheep's, goats, pigs and rabbits. Miscellaneous activities in animal husbandry like cattle shed, choppers, milking machines are assumed to be financed 1 units by every 10 branches. Poultry activities include hatcheries, commercial broilers and layers of size 500-1000 birds. Hatcheries are assumed to be financed five for one district and commercial broilers and layers are assumed to be financed at 2 each for every 100 branches.

Fisheries

Fishery activities considered for financing includes fish ponds for fresh water fish culture of size 0.25ha, tank units of size 0.5 ha and hatcheries i.e. nursery pond of size 0.25 ha, mechanised boats, gill net with boat and cold storage with capacity of 150 metric tonnes. Fish ponds and tank units are assumed to be financed 1 unit per 10 branches in a district. Five each hatchery, mechanised boats, gill net with boat and cold storage units is assumed to be financed in every district.

Forestry & Wasteland Development

An assumption of 20 ha is been financed in every district under farm forestry activity. 2 per cent of culturable waste land is assumed to be financed under wasteland development activity. Accordingly their respective unit costs are multiplied to obtain the loan requirement by a district for forestry & wasteland development activities.

Storage structures

Storage units like godowns with capacity of 250 MT are assumed to be financed at 2 units per 50 branches and cold storages with capacity of 250 MT are assumed to be financed at 10 units in a district. Unit costs are accordingly multiplied to obtain the loan requirement by a district for Storage structures.

Sericulture

Finance made for establishment of mulberry orchard and rearing house for silk worms are the activities considered in this component. 5 per cent of the current area under mulberry is assumed to be financed and 1 each rearing house is finance by every 50 branches at district level. Respective unit costs are multiplied with the number of units to obtain the loan requirement for sericulture activities at district level.

Other agriculture & allied activities

This component includes finance for activities like bullock/other draught animal, bullocks-carts, bio-gas plants/solar equipment's and animal operated machines. For 1000 hectares of cultivated land 500 pairs of draught animals are required (Sahay, 2006). Keeping this baseline district level requirement is found out using the cultivable land statistics. District-wise draught animal availability during 2016-17 is obtained from WAPCOS, 2018 report and the district wise gap is worked out. Assuming the 20 per cent of the gap is financed in that year and accordingly it is multiplied with respective unit costs to obtain the loan requirement for the draught animal purpose. 1 bullock cart per 100 pairs of draught animal is assumed to be financed in each district. Bio-gas plants/solar equipment's and animal operated machines are assumed to be finance 1 unit each for every 10 branches. Accordingly the number of units is multiplied with respective unit costs.

To achieve this objective information on land use pattern of district, area under cultivation of all crops with extent of irrigation in the district, scale of finance and cost of cultivation of all crops and unit costs of different term activities etc. are collected from various sources. This analysis was carried out for the selected districts under highest credit outstanding to agriculture by SCBs category.

Estimated direct credit requirement of the districts for the year 2016-17

Direct credit to agriculture includes components like short term advances and term advances. Each component is estimated based on certain assumptions detailed above for the few districts under high credit exposure category where the data is available in all aspects. The estimates under different scenarios are presented in tables 21-23. Term credit requirement of the Belgaum district is estimated to be Rs. 1777.51 crores in 2016-17. Among the selected districts term credit requirement is high in southern region district i.e. Guntur (1796.59 crores) and least in north eastern region districts viz, West Tripura (33.29 crores) and Papumpure (33.40 crores).

Direct credit requirement of the district = Short term credit requirement + Term credit requirement

Table 21: Estimated direct credit requirement of the districts of southern region for the year 2016-17 (In crores)

Code	Sectors / activity	Belgaum	Guntur	Coimbatore
A	Minor Irrigation	779.04	1215.25	118.93
B	Land Development	35.2	43.67	41.08
C	Farm Mechanisation	765.02	348.97	100.41
D	Plantation & Horticulture	9.95	8.94	26.66
E	AH-Dairy Development	4.93	4.51	1.14
F	AH-Poultry	0.77	1.05	0.98
G	AH- Others	8.18	5.62	2.57
H	Fisheries	3.9	4.52	4.91
I	Forestry & Wasteland Development	1.46	3.17	1.52
J	Storage & Market yards	3.18	3.9	3.88
K	Sericulture	0.51	0.67	0.66
L	Other Agriculture & Allied activities	165.35	156.32	56.79
M. Term credit	Sub total M = Sum (A to K)	1777.51	1796.59	359.52
N. Short term credit	100% of area is financed	7371.95	6818.80	1535.21
	75% of area is financed	5528.97	5114.10	1151.40
	50% of area is financed	3685.97	3409.41	767.60
	25% of area is financed	1842.98	1704.70	383.80
O. Direct credit	100% of area is financed + M	9149.46	8615.39	1894.73
	75% of area is financed + M	7306.48	6910.69	1510.92
	50% of area is financed + M	5463.48	5206.00	1127.12
	25% of area is financed + M	3620.49	3501.29	743.32

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics, NABARD, Livestock census, Government of India

Table 22: Estimated direct credit requirement of the districts of eastern and north-eastern regions for the year 2016-17 (In crores)

Code	Sectors / activity	Khurda	Ranchi	Patna	Kamrup	Papumpure	West Tripura
A	Minor Irrigation	10.91	26.37	11.88	0.32	0.49	1.43
B	Land Development	21.88	21.57	1.49	11.41	2.40	0.13
C	Farm Mechanisation	36.04	253.65	41.23	76.95	22.52	7.98
D	Plantation & Horticulture	0.55	0.70	0.70	8.71	4.06	13.53
E	AH-Dairy Development	2.21	2.52	3.04	2.66	0.24	0.62
F	AH-Poultry	1.72	1.22	2.14	0.39	0.25	0.59
G	AH- Others	1.38	2.76	1.92	2.22	0.15	0.48
H	Fisheries	3.89	3.19	4.85	0.58	0.33	0.97
I	Forestry & Wasteland Development	2.39	3.36	0.27	1.88	0.55	0.22
J	Storage & Market yards	3.37	2.76	4.35	1.30	0.97	1.86
L	Sericulture	0.56	0.35	0.70	0.02	0.02	0.07
K	Other Agriculture & Allied activities	0.79	0.55	39.67	0.12	1.44	5.41
M. Term credit	Sub total M = Sum (A to K)	85.70	319.03	112.23	106.57	33.40	33.29
N. Short term credit	100% of area is financed	699.35	1385.79	1018.30	1339.87	152.39	516.00
	75% of area is financed	524.51	1039.34	763.72	1004.90	114.28	387.00
	50% of area is financed	349.67	692.89	509.16	669.93	76.19	258.00
	25% of area is financed	174.84	346.45	254.58	334.97	38.09	129.00
O. Direct credit	100% of area is financed + M	785.05	1704.82	1130.53	1446.44	185.79	549.29
	75% of area is financed + M	610.21	1358.37	875.95	1111.47	147.68	420.29
	50% of area is financed + M	435.37	1011.92	621.39	776.50	109.59	291.29
	25% of area is financed + M	260.54	665.48	366.81	441.54	71.49	162.29

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics, NABARD, Livestock census, Government of India

Table 23: Estimated direct credit requirement of the districts of northern and central regions for the year 2016-17 (In crores)

Code	Sectors / activity	Karnal	Shimla	Indore	Udham singh nagar	Raipur
A	Minor Irrigation	126.28	2.06	70.72	14.98	101.6
B	Land Development	3.72	15.11	3.44	4.86	22.79
C	Farm Mechanisation	65.31	88.30	130.72	0.29	93.69
D	Plantation & Horticulture	0.81	17.04	0.42	0.58	0.40
E	AH-Dairy Development	3.34	1.42	1.5	2.70	2.63
F	AH-Poultry	1.03	0.85	1.79	0.84	1.10
G	AH- Others	0.36	1.56	1.26	0.70	1.34
H	Fisheries	2.40	1.43	3.83	1.80	2.77
I	Forestry & Wasteland Development	0.35	1.73	0.45	0.54	2.62
J	Storage & Market yards	2.45	2.25	3.36	2.36	2.85
L	Sericulture	0.29	0.25	0.61	0.25	0.38
K	Other Agriculture & Allied activities	62.85	6.41	63.01	16.24	11.81
M. Term credit	Sub total M = Sum (A to K)	269.20	138.40	281.12	46.15	243.97
N. Short term credit	100% of area is financed	3674.36	6236.00	2121.68	2037.49	1002.18
	75% of area is financed	2755.77	4677.00	1591.27	1528.11	751.63
	50% of area is financed	1837.19	3118.00	1060.84	1018.75	501.10
	25% of area is financed	918.59	1559.00	530.43	509.37	250.55
O. Direct credit	100% of area is financed + M	3943.56	6374.40	2402.80	2083.64	1246.15
	75% of area is financed + M	3024.97	4815.40	1872.39	1574.26	995.60
	50% of area is financed + M	2106.39	3256.40	1341.96	1064.90	745.07
	25% of area is financed + M	1187.79	1697.40	811.55	555.52	494.52

Note: Calculated using data from Reserve Bank of India, Directorate of Economics and Statistics, NABARD, Livestock census, Government of India

Consider Belgaum district under the scenario cent per cent of the area under cultivation is financed. This is the case where all the farmers are need of credit for crop cultivation. In this case the short term credit requirement is 7371.95 crores. Under the next scenario 75 per cent area under cultivation is financed and the estimated short term credit requirement is 5528.97 crores. Suppose half of the area under cultivation needs finance then the estimated credit requirement for crop cultivation is 3685.97 crores. In the last scenario i.e. 25 per cent of the area under cultivation is assumed to be financed then the short term credit requirement is 1842.98 crores. Among the selected districts the short term credit requirement estimated to be high in southern districts viz, Belgaum and Guntur and least in Papumpure and West Tripura. Sidhu et al. (2008) also worked out the demand for institutional short term credit for agriculture in Punjab state as Rs. 5522.87 crores during 2005-06 in a scenario. Hence there is need for counterproductive policy of first estimation of agricultural credit requirements depending on crop patterns and later meeting the requirements through effective policies. In a study by Punjab state farmers commission has estimated the amount of debt in the state at Rs 21064 crore, almost 89 per cent farmers are indebted with an average debt of more than Rs 2 lakh per farmer (Singh et al., 2007), while in 1997, it was estimated at Rs 5700 crore (Shergill, 1998).

Conclusion

Direct credit requirement for agriculture of the district is estimated based on certain assumptions. Components of direct credit include short term and term credit (medium and long) are estimated individually and summed later. Short term credit requirement is obtained by multiplying the area under different crops in the district with respective scale of finance. 30 per cent of over and above of short term credit requirement is considered for household consumption requirements and repairs and maintenance expenses of farm assets. The short term credit is presented considering four scenarios. The term credit requirement of the district is worked out by multiplying the number or hectare under particular activity with respective unit costs. Different criteria's or assumptions are used in arriving at the units or hectares under each activity under term loan requirement calculation. Among the selected districts, term credit requirement is worked out to be high in southern region districts like Guntur and Belgaum and least in north eastern region districts viz, West Tripura and Papumpure.

Summary

Credit is considered as one of the most important and basic input in agricultural production process. The prime source of agricultural credit in India has drastically shifted from non-institutional (money lenders) to institutional source in the last five decades due to various policy initiatives of Government of India. Grass root level analysis of the dynamic helps in further policy framework. Hence in this study based on district wise average outstanding agricultural credit by scheduled commercial banks (SCBs) for the TE ending 2017-18, three districts from each state indicating high, medium and low exposure categories is selected using clustering technique. For these study districts outstanding agricultural credit by SCBs was extracted (1976-2017) and analysed. From the Bai-Perron test years viz., 1983, 1990, 1997, 2004 and 2011 are identified to be most common structural breaks in the time series data of each district owing to various policy reforms in the field of agricultural finance. Based on these breaks the time series further subdivided into six phases viz., phase-I (1976-1982), phase-II (1983-1989), phase-III (1990-1996), phase-IV (1997-2003), phase-V (2004-2010) and phase-VI (2011-2017).

Phase-wise CAGR was calculated for all the districts and Garrett ranking technique is employed for further ranking of phases across six regions of the country. Phase-I is identified as the phase with high rate of growth in agricultural advances in selected districts across all regions except southern where it is ranked second. The policy initiatives of that period i.e. setting of priority sector lending targets and establishment of Regional Rural Banks have played crucial role in this growth phenomenon of agricultural advances. Further recent policies like doubling agricultural package and ground level credit policies have also played crucial role in the growth of agricultural advances at grass root level in all regions except eastern and north-eastern regions. Whereas in the eastern and north-eastern region districts the growth in initial phases was relatively better than in the recent phases indicating the effectiveness of initial policy measures in those regions.

Institutional credit to agriculture is influenced by various drivers. Hence factors like number of scheduled commercial bank branches, share of GIA in GSA, share of AUC in GSA and annual rainfall are regressed on district wise outstanding agricultural credit by SCBs. To explore the variability panel dataset was created with the above mentioned variables and the impact of these important drivers on institutional credit to agriculture is quantified at different levels (region level, credit exposure category wise and at national

level) by employing panel data regression technique. The consistency and suitability of fixed effect model over random effect model is highlighted by Hausman test. Number of operating branches in the district is one of the important variables with positive influence indicates the institutional credit to agriculture is found to be more responsive for branch expansion especially in Andhra Pradesh, Karnataka, Chhattisgarh, Tamil Nadu and Paducherry.

In this study, an attempt was made to evaluate the performance of models like ARIMA, ARIMAX and ARIMA intervention on district level agricultural credit series. In the ARIMAX model number of SCB branches in the district is used as explanatory variable and in the ARIMA intervention model year 2004 is used as intervention point. District wise best model was identified and forecasted the institutional credit supply to agriculture at district level for the next five years. We have also made an attempt to estimate the direct credit requirement for agriculture of the district under certain assumptions. Short term and term credit requirement of the district is arrived separately by using the district level data on area under crops, scale of finance and unit cost. Term credit requirement of southern region districts like Guntur and Belgaum is relatively high and in districts of north eastern region viz, West Tripura and Papumpure it is very low. Hence there is need for counterproductive policy of first estimation of agricultural credit requirements depending on crop patterns and later meeting the requirements through effective policies.

सारांश

कृषि उत्पादन प्रक्रिया में कृषि ऋण को सबसे महत्वपूर्ण और मूलभूत उत्पादक सामग्री में से एक माना जाता है. भारत सरकार की विभिन्न नीतिगत उपक्रमों के कारण पिछले पांच दशकों में भारत में कृषि ऋण का प्रमुख स्रोत गैर–संस्थागत (धन उधारदाताओं) से संस्थागत स्रोत में स्थानांतरित हो गया है. गतिकी का जमीनी स्तर पर विश्लेषण आगे नीतिगत ढांचे में मदद करता है. इसलिए 2017–18 को समाप्त त्रैवार्षिक के लिए अनुसूचित वाणिज्यिक बैंकों (एससीबी) द्वारा जिलेवार औसत बकाया कृषि ऋण के आधार पर इस अध्ययन में क्लस्टरिंग तकनीक का उपयोग करके उच्च, मध्यम और निम्न अनावरण श्रेणियों को इंगित करने वाले प्रत्येक राज्य के तीन जिलों का चयन किया गया है. इन अध्ययनों के लिए जिलों में अनुसूचित एससीबी बैंकों द्वारा बकाया कृषि ऋण (1976–2017) निकाला गया और उसका विश्लेषण किया गया. बाई–पेरोन परीक्षण वर्षों से, 1983, 1990, 1997, 2004 और 2011 को कृषि वित्त के क्षेत्र में विभिन्न नीतिगत सुधारों के कारण प्रत्येक जिले के समय श्रृंखला डेटा में सबसे आम संरचनात्मक विरामों के रूप में पहचाना जाता है. इन विरामों के आधार पर समय श्रृंखला डेटा को छह चरणों में विभाजित किया गया है, जैसे चरण– I (1976–1982), चरण– II (1983–1989), चरण– III (1990–1996), चरण– IV (1997–2003) , चरण– V (2004–2010) और चरण– VI (2011–2017).

सभी जिलों के लिए चरण–वार सीएजीआर की गणना की गई और देश के छह क्षेत्रों में चरणों की आगे की रैंकिंग के लिए गैरेट रैंकिंग तकनीक का इस्तेमाल किया गया. चरण– I की पहचान उस चरण के रूप में की जाती है, जिसमें दक्षिणी को छोड़कर सभी क्षेत्रों के चयनित जिलों में कृषि अग्रिमों में उच्च वृद्धि दर होती है, जहां यह दूसरे स्थान पर है. उस अवधि की नीतिगत पहलों अर्थात प्राथमिकता प्राप्त क्षेत्र को ऋण देने के लक्ष्य निर्धारित करना और क्षेत्रीय ग्रामीण बैंकों की स्थापना ने कृषि अग्रिमों की इस वृद्धि की घटना में महत्वपूर्ण भूमिका निभाई है. इसके अलावा हाल की नीतियों जैसे कृषि पैकेज को दोगुना करना और जमीनी स्तर की ऋण नीतियों ने भी पूर्वी और उत्तर–पूर्वी क्षेत्रों को छोड़कर सभी क्षेत्रों में जमीनी स्तर पर कृषि अग्रिमों के विकास में महत्वपूर्ण भूमिका निभाई है. जबकि पूर्वी और उत्तर–पूर्वी क्षेत्र के जिलों में प्रारंभिक चरणों में विकास हाल के चरणों की तुलना में अपेक्षाकृत बेहतर था, जो उन क्षेत्रों में प्रारंभिक नीति उपायों की प्रभावशीलता को दर्शाता है.

कृषि के लिए संस्थागत ऋण विभिन्न कारकों से प्रभावित होता है. इसलिए अनुसूचित वाणिज्यिक बैंक शाखाओं की संख्या, सकल बोया गया क्षेत्र में सकल सिंचित क्षेत्र का प्रतिशत शेयर, सकल बोया गया क्षेत्र में वाणिज्यिक फसलों के तहत क्षेत्र का प्रतिशत शेयर और वार्षिक वर्षा जैसे कारकों को एससीबी द्वारा जिलेवार बकाया कृषि ऋण पर रिग्रेशन ले लिया जाता है. परिवर्तनशीलता का पता लगाने के लिए उपर्युक्त चर के साथ पैनल डेटासेट बनाया गया था और कृषि के लिए संस्थागत ऋण पर इन महत्वपूर्ण कारकों के प्रभाव को पैनल डेटा रिग्रेशन तकनीक को नियोजित करके विभिन्न स्तरों (क्षेत्र स्तर, क्रेडिट एक्सपोजर श्रेणी के अनुसार और राष्ट्रीय स्तर पर) पर मात्राबद्ध किया गया है. हौसमैन परीक्षण द्वारा यादृच्छिक प्रभाव मॉडल पर स्थिर प्रभाव मॉडल की स्थिरता और उपयुक्तता पर प्रकाश डाला गया है. जिले में परिचालन शाखाओं की संख्या सकारात्मक प्रभाव के साथ महत्वपूर्ण चरों में से एक है, यह दर्शाता है कि कृषि के लिए संस्थागत ऋण विशेष रूप से आंध्र प्रदेश, कर्नाटक, छत्तीसगढ़, तमिलनाडु और पादुचेरी में शाखा विस्तार के लिए अधिक उत्तरदायी पाया गया है.

इस अध्ययन में जिला स्तरीय कृषि ऋण श्रृंखला पर एआरआईएमए, एआरआईमैक्स और एआरआईएमए हस्तक्षेप जैसे मॉडलों के प्रदर्शन का मूल्यांकन करने का प्रयास किया गया था. ।एआरआईमैक्स मॉडल में जिले में एससीबी बैंकों शाखाओं की संख्या का उपयोग व्याख्यात्मक चर के रूप में किया जाता है और एआरआईएमए हस्तक्षेप मॉडल वर्ष 2004 में हस्तक्षेप बिंदु के रूप में उपयोग किया जाता है. जिलेवार सर्वोत्तम मॉडल की पहचान की गई और अगले पांच वर्षों के लिए जिला स्तर पर कृषि को संस्थागत ऋण आपूर्ति का पूर्वानुमान लगाया गया. हमने कुछ मान्यताओं के तहत जिले की कृषि के लिए प्रत्यक्ष ऋण आवश्यकता का अनुमान लगाने का भी प्रयास किया है. जिले की अल्पावधि और सावधि ऋण आवश्यकता फसलों के तहत क्षेत्र, वित्त के पैमाने, इकाई लागत पर जिला स्तर के आंकड़ों का उपयोग करके अलग–अलग आंकी जाती है. दक्षिणी क्षेत्र के जिलों जैसे गुंटूर और बेलगाम की सावधि ऋण आवश्यकता अपेक्षाकृत अधिक है और उत्तर पूर्वी क्षेत्र के जिलों जैसे पश्चिम त्रिपुरा और पापमपुरे में यह बहुत कम है. इसलिए फसल पैटर्न के आधार पर कृषि ऋण आवश्यकताओं के पहले आकलन और बाद में प्रभावी नीतियों के माध्यम से आवश्यकताओं को पूरा करने की प्रतिउत्पादक नीति की आवश्यकता है।

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Annexure 1: Segment partition breaks identified by Bai-perron test in high credit exposure districts

State	Districts	*m*=1	*m*=2	*m*=3	*m*=4	*m*=5
Telangana	Hyderabad	1983	1990	1997	2004	2011
Puducherry	Puducherry	1980	1987	1996	2004	2011
Tamil nadu	Coimbatore	1981	1988	1997	2004	2011
Kerala	Ernakulam	1980	1988	1995	2002	2009
Karnataka	Belgaum	1983	1990	1997	2004	2011
Andhra pradesh	Guntur	1983	1990	1997	2004	2011
Maharashtra	Mumbai	1981	1990	1997	2004	2011
Gujarat	Banas kantha	1983	1990	1997	2004	2011
Uttarkhand	Udham singh nagar	1999	2002	2005	2008	2011
Uttar pradesh	Agra	1982	1989	1997	2004	2011
Madhya pradesh	Indore	1983	1990	1997	2004	2011
Chattisgarh	Raipur	1981	1988	1995	2002	2009
Sikkim	East sikkim	1986	1992	1998	2003	2008
West bengal	Kolkata	1980	1988	1995	2002	2009
Odisha	Khurda	2000	2003	2006	2009	2012
Jharkhand	Ranchi	1982	1990	1997	2004	2011
Bihar	Patna	1979	1986	1997	2004	2011
Tripura	West tripura	1979	1986	1996	2004	2011
Nagaland	Kohima	1983	1990	1997	2004	2011
Mizoram	Aizawl	1985	1990	1995	2003	2008
Meghalaya	East khasi hills	1982	1988	1994	2000	2006
Manipur	Imphal west	1986	1991	1996	2001	2006
Assam	Kamrup	1982	1989	1996	2003	2011
Arunachal pradesh	Papumpare	1996	1999	2002	2005	2009
Rajasthan	Jaipur	1981	1989	1997	2004	2011
Punjab	Ludhiana	1983	1990	1997	2004	2011
Jammu & kashmir	Baramulla	1983	1990	1997	2004	2011
Himachal pradesh	Simla	1979	1986	1997	2004	2011
Haryana	Karnal	1983	1990	1997	2004	2011

Annexure 2: Segment partition breaks identified by Bai-perron test in medium credit exposure districts

State	Districts	*m*=1	*m*=2	*m*=3	*m*=4	*m*=5
Telangana	Mehbubnagar	1983	1990	1997	2004	2011
Puducherry	Karaikal	1978	1986	1996	2004	2011
Tamil nadu	Dharmapuri	1983	1990	1997	2004	2011
Kerala	Kozhikode	1983	1990	1997	2004	2011
Karnataka	Gulbarga	1983	1990	1997	2004	2011
Andhra pradesh	Cuddapah	1982	1989	1997	2004	2011
Maharashtra	Yavatmal	1983	1990	1997	2004	2011
Gujarat	Bhavnagar	1983	1990	1997	2004	2011
Uttarkhand	Haridwar	1992	1997	2002	2006	2010
Uttar pradesh	Gonda	1981	1988	1997	2004	2011
Madhya pradesh	Datia	1979	1990	1997	2004	2011
Chattisgarh	Durg	1983	1990	1997	2004	2011
Sikkim	South sikkim	1986	1992	1997	2002	2007
West bengal	Hugli	1979	1987	1997	2004	2011
Odisha	Keonjhar	1983	1990	1997	2004	2011
Jharkhand	Dhanbad	1983	1990	1997	2004	2011
Bihar	Bhagalpur	1983	1990	1997	2004	2011
Tripura	South tripura	1978	1985	1993	1999	2005
Nagaland	Mokokcheng	1981	1988	1994	2000	2006
Mizoram	Lunglei	1986	1991	1996	2001	2006
Meghalaya	West garo hills	1981	1987	1993	1999	2005
Manipur	Thoubal	1988	1993	2002	2007	2012
Assam	Sibsagar	1982	1990	1997	2004	2011
Arunachal pradesh	East siang	1982	1988	1994	2000	2006
Rajasthan	Nagaur	1981	1988	1997	2004	2011
Punjab	Kaparthala	1983	1990	1997	2004	2011
Jammu & kashmir	Jammu	1981	1988	1995	2002	2009
Himachal pradesh	Kullu	1983	1990	1997	2004	2011
Haryana	Jind	1983	1990	1997	2004	2011

Annexure 3: Segment partition breaks identified by Bai-perron test in low credit exposure districts

State	Districts	*m*=1	*m*=2	*m*=3	*m*=4	*m*=5
Telangana	Adilabad	1983	1990	1997	2004	2011
Puducherry	Yanam	1985	1991	1997	2003	2008
Tamil nadu	Nilgiris	1979	1988	1997	2004	2011
Kerala	Idukki	1981	1989	1997	2004	2011
Karnataka	Uttar kannad	1982	1989	1997	2004	2011
Andhra pradesh	Srikakulam	1982	1989	1997	2004	2011
Maharashtra	Ratnagiri	1980	1988	1995	2002	2011
Gujarat	Dangs	1978	1985	1992	1999	2006
Uttarkhand	Chamoli	1981	1987	1993	1999	2006
Uttar pradesh	Ballia	1983	1990	1997	2004	2011
Madhya pradesh	Mandla	1981	1988	1997	2004	2011
Chattisgarh	Bastar	1979	1986	1997	2004	2011
Sikkim	North sikkim	1986	1992	1997	2003	2008
West bengal	Puruliya	1978	1985	1992	2004	2011
Odisha	Sambalpur	1980	1987	1994	2003	2010
Jharkhand	Koderma	1998	2003	2006	2009	2012
Bihar	Munger	1980	1987	1997	2004	2011
Tripura	North tripura	1979	1986	1993	2004	2011
Nagaland	Tuensang	1986	1991	1996	2001	2006
Mizoram	Lawngtlai	2003	2005	2007	2009	2011
Meghalaya	East garo hills	1981	1987	1993	1999	2006
Manipur	Chandel	1999	2002	2005	2009	2012
Assam	North cachar hills	1985	1991	1997	2003	2009
Arunachal pradesh	Tirap	1985	1992	1998	2005	2012
Rajasthan	Dungarpur	1983	1990	1997	2004	2011
Punjab	Rupnagar	1982	1989	1997	2004	2011
Jammu & kashmir	Poonch	1984	1990	1996	2006	2012
Himachal pradesh	Lahul & spiti	1982	1988	1994	2000	2006
Haryana	Gurgaon	1982	1989	1996	2003	2011

Annexure 4: Segment partition breaks identified by Bai-perron test in union territories

State	Districts	*m*=1	*m*=2	*m*=3	*m*=4	*m*=5
Lakshadweep	Lakshadweep	1978	1985	1995	2004	2011
Daman Diu	Daman & Diu	1979	1987	1996	2003	2011
Dadra & Nagar Haveli	Dadra & Nagar Haveli	1981	1989	1996	2003	2011
Goa	Goa	1980	1988	1995	2003	2010
Andaman & Nicobar	Andaman & Nicobar	1979	1985	1991	1997	2003
Delhi	Delhi	1978	1990	1997	2004	2011
Chandigarh	Chandigarh	1979	1986	1993	2001	2008