Vol.36, No.2, pp.77-86, 2024

Journal of Agricultural, Life and Environmental Sciences

RESEARCH ARTICLE

pISSN 2233-8322, eISSN 2508-870X
https://doi.org/10.22698/jales.20240007

Impact of Agricultural Credit on the Productivity and Income of Small-Scale Maize Farmers in Kaduna State, Nigeria

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Received: 14 February 2024
Revised: 23 April 2024
Accepted: 7 May 2024

A B S T R A C T

In this study, we investigated the impact of agricultural credit on the productivity and income of smallholder maize farmers in Kaduna State, Nigeria. The objectives of the study are to ascertain the impact of agricultural credit on the income and productivity of small-scale maize farmers and examine the factors that affect their ability to access agricultural credit. A structured questionnaire was used to collect the primary data from 108 beneficiaries and 137 non-beneficiaries of agricultural credit among smallholder maize farmers using a structured questionnaire. Propensity score matching and a logit regression model were used to analyze the data. The most comprehensive score specification was used to generate the average treatment effect on the treated (ATT) estimates for collecting outcome variables. The ATT estimates with an alternative score specification were used as a reliable measure wherein each line corresponds to a separate estimation. Three different matching methods, i.e., nearest neighbor matching, stratification matching, and radius matching, were used to evaluate the robustness of estimation. The results revealed that smallholder maize farmers who were the beneficiaries of agricultural credit exhibited significantly higher mean productivity and income at the 1 and 5% probability levels, respectively than those exhibited by the non-beneficiaries, suggesting that credit positively impacted farmers' revenue and productivity. We also observed that the farmers' gender and marital status were not particularly important in determining their access to agricultural credit. Whether single or married, male or female, their prospects of obtaining credit were similar. Age, educational attainment, farming experience, farm size, and cooperative membership were significant factors that affected their ability to access agricultural credit at the 5% probability level, except for the farmers' income status, which was significant at the 10% probability level. The two most important factors influencing access to agricultural credit were the distance from the source of credit and extension contact, which were significant at a 1% probability level.

Keywords: Logit regression, Nearest neighbor matching, Propensity score matching, Radius matching, Stratification matching

Introduction

Agriculture is crucial since it produces most of the food for the world's population and strengthens the economy (Abdulrahman et al. 2016). It shares 26.2 percent of Nigeria's Gross Domestic Product (GDP), with 43 percent of the labour force working in the industry directly (Osagioduwa et al., 2022). Despite its significant contributions, agriculture is unable to provide the population's basic needs for food as well as to eradicate poverty in Nigeria (Oyinbo, 2014). Maize/corn is the most consumed staple food in Nigeria, and it is widely used for human consumption, animal feed, pharmaceutical companies, food makers, breweries, flour mills, and other businesses (Onumah et al., 2021). Nearly 80 percent of the maize grain is used for human consumption and animal feed with the remaining 20 percent utilized for industrial processing of diverse products (Onumah et al., 2021). Maize is largely cultivated by smallholder farmers with over 6.5 million hectares of land across diverse agro-ecological zones of the country (FAOSTAT, 2022; Onumah et al., 2021). These smallholder farmers are low-income individuals who reside in rural regions of the nation. One of the main factors contributing to rural farmers' low income and their poverty is lack of access to agricultural credit to assist their business and productivity (Ugbede, 2019). Farm productivity is significantly influenced by the availability of financing for agriculture (Mouhamadou et al., 2020). Pre-planting and harvest productivity are enhanced by the use of Agricultural Credit. Nigeria government had tried to make credit services accessible at reasonably priced to the majority of rural communities. Financial institutions such as Nigeria's Microfinance Banks (MFB), Bank of Agriculture (BOA), and other commercial banks are being encouraged to extend more loans to the agricultural sector. However, smallholder farmers still have limited access to credit. Ultimately, it makes it quite challenging for farmers to obtain sufficient inputs especially capital input to adopt modern agricultural innovations. Their inability to meet financial institution requirements, such as those pertaining to collateral and other requirements makes it difficult for them to get loans from banks or other lenders and hence causes low productivity and income of the small-scale maize farmers. Several studies have shown that expanding financial services to rural areas will significantly boost output, which will in turn lower poverty and improve their livelihood. Research on the effects of agricultural credit on farmers' yield and output shows that agricultural credit considerably increases agricultural productivity. This is due to the fact that having credit availability enables farmers to buy the cutting-edge inputs they require to boost output, such as machinery, fertiliser, improved seeds, etc. This entire situation supports the grounds that in order to improve the livelihood and income of these small-scale maize farmers, then there is need to make agricultural credit easily available and accessible since this will translate to higher productivity and income of the small-scale maize farmers. The study also aims to demonstrate the relationship between the availability of agricultural credit and the decline in rural poverty, suggesting that bringing financial services to these areas might greatly increase agricultural productivity and income levels. In the end, the research recommends policy changes to increase smallholder maize farmers' access to agricultural credit, which will help them adopt contemporary agricultural advances and eventually improve their standard of living and income levels.

Material and Methods

Kaduna State of Nigeria is where the study was conducted. The state is located in the northwest of the country. In the Nigerian census of 2006, Kaduna had 760,084 residents. Since 2005, there has been a rapid increase in urbanization, leading to a population that is expected to reach 1.1 million by 2023 (Wali et al., 2023). There are 23 Local Government Areas (LGAs) in the state. With an annual temperature range of 14.6°C to 36°C, the mean annual rainfall of 1,524 mm falls over seven to nine months. Numerous crops can be produced due to the favourable temperature and soil conditions (NAERLS, 2011). According to the Kaduna Agricultural Development Project (KADP, 2007), the state borders the following states: Katsina and Kano to the north; Abuja and Nasarawa state to the south; Plateau state to the east; and Niger and Zamfara states to the west. Majority are Peasant farmers who grow both food and cash crops make up a large portion of the indigenous population in Kaduna state (KADP, 2007). Continuous cropping with a wide range of crops such as maize, rice ginger, ground nut, millet, guinea corn, sugar cane, tobacco, potatoes, yam, cassava, cowpea is as a result of physical properties of the soil that is moderately good (NAERLS, 2011). The state is divided between two guinea savannas: one in the north and other in the south. A significant portion of the state's farming households engage in irrigation farming alongside many significant rivers and dams, including the Kangimi, Bogoma, and Zaaria dams, during the dry season (KADP, 2014).

The decision to conduct the study in Kaduna State was influenced by its status as the leading producer of maize, contributing approximately 1,006 million metric tons (MMT) to the total production. This significant maize output made Kaduna State an ideal location for the research, providing a rich and relevant context for examining the various factors affecting maize production and the livelihoods of farmers in the region.

Table 1 shows the sample size and methodology. Primary data were used in this investigation. The instruments used to gather the data include organized survey with the assistance of trained enumerators. The socioeconomic details of the farmers are included in the data, along with information on weather variability, amount of revenue from maize production, age, sex, household size, education level, farm size, farming experience, and off-farm work. Data was collected on institutional elements such as association of membership, extension contact, and credit availability. In a similar vein, inputs and its associated cost such as: seed, fertilizer, agrochemical, farm size and risk information were obtained. To select study participants, a multiphase sampling procedure was used. First step involved a purposive selection of Kaduna state been the leading Corn (maize) producing state in Nigeria. Then, two zones were chosen at random in the second step through balloting on a piece of paper card and that includes; Maigana and Lere out of four existing zones namely; Maigana, Samaru, Lere and Birnin Gwari. Thirdly, two Local Governments Areas from each zone repectively (Giwa, Kudan and Lere, Kubau) was used as the study area by random selection. In the fourth stage, the list of every LGA's villages was acquired. Thereafter, a random selection of the villages was done and a total of 10 villages were used for this study. The fifth stage involved a stratified sampling method for the selection of maize farmers with and without agricultural credit (Loan) from each of the villages. Therefore, a combination of both purposive and random selection that is hundred (100%) percent of the maize farmers with agricultural credit was purposively selected thus given a total of 108 maize farmers' agricultural

Table 1. Sample size and sample methodology

Zone	LGA	Villages Selected	Name of villages	Credit beneficiary's maize farmers sample frame	Credit beneficiary's maize farmers sample size (100%)	Non-credit beneficiary's farmers sample frame	Non-credit beneficiary's farmers sample size (9%)
Maigana	Giwa	4	Tashanzomo	12	12	159	14
			Yakawada	9	9	149	13
			Shika	14	14	160	14
			Danmahawayi	11	11	145	13
	Kudan	2	Taban-Sani	7	7	158	14
			U/Shekarau	18	18	177	16
Lere	Lere	2	Yarkasua	8	8	165	15
			U/Bawa	15	15	144	13
	Kubau	2	Dutsenwai	8	8	157	14
			Kargi	6	6	121	11
Total		10		108	108	1,544	137

credit (loan) beneficiaries while nine (9%) percent of the maize farmers' without access to agricultural credit (loan) were randomly selected using ballot techniques and thus, given a total of one hundred and thirty seven (137) maize farmers without access to credit. The last stage involves for determining sample size using the limited population correction factor, 95% confidence interval, and 5% predicted margins of error. Finally, a total of two hundred and forty five (245) maize farmers with and without agricultural credit (loan) were used for this study.

Analytical Techniques

Using propensity scores matching (PSM), a non-parametric technique (Kopeinig and Caliendo, 2008), the average effect of a certain treatment variable is assessed. The PSM is employed to mitigate the problem of self-selection bias resulting from non-random participation in a programme. The outcome of the treatment can be compared by utilising socioeconomics variables to match the treatment group (access to credit) to the ideal comparison group (no access to credit). The X stands for a collection of observable traits that influence credit eligibility. Selection bias is thus significantly lessened or eliminated. Using PSM to estimate Probit Model was used to determine propensity scores, which indicate how credit affects productivity. The average impact of treatment on those getting treatment (ATT) is then determined by utilising the propensity scores to match smallholder maize farmers with access to credit to those without using the Nearest Neighbour Matching (NNM) algorithm. Other matching algorithms, such as Stratification Matching (SM) and Radius Matching (RM), were also used to guarantee the results' robustness. Assuming that $D_i = 1$ denotes access to agricultural credit and $D_i = 0$ denotes no access to agricultural credit, the PSM framework is developed. Table 2 represents summary statistics for selected covariates between the beneficiaries and non-beneficiaries.

Table 2. Descriptive summary statistics for agricultural loan beneficiaries and non-beneficiaries

Variables	Beneficiaries					Non-beneficiaries				
	Obser-vation	Mean	Standard Error	Min.	Max.	Obser-vation	Mean	Standard Error	Min.	Max.
Gender	108	0.80	0.40	0.00	1.00	137	0.77	0.42	0.00	1.00
Age	108	41.46	6.44	29.00	62.00	137	43.76	6.94	29.00	57.00
Marital Status	108	0.81	0.40	0.00	1.00	137	0.77	0.42	0.00	1.00
Level of Education	108	1.63	1.21	0.00	4.00	137	1.03	1.16	0.00	4.00
Household Size	108	6.33	4.80	1.00	25.00	137	6.10	4.02	0.00	17.00
Farming Experience	108	11.94	5.85	3.00	28.00	137	9.08	5.08	2.00	26.00
Cooperative	108	0.66	0.48	0.00	1.00	137	.68	0.47	0.00	1.00
Extension Contact	108	0.94	0.25	0.00	1.00	137	0.20	0.40	0.00	1.00
Distance to Credit	108	0.17	0.37	0.00	1.00	137	0.90	0.30	0.00	1.00
Farmers total Income	108	608736.00	261864.10	249500.00	1505000.00	137	573100.90	225459.10	282650.00	1449000.00
Farm Size	108	4.28	0.96	1.00	5.50	137	2.25	1.59	0.40	5.50
Seed	108	21.84	8.93	5.00	50.00	137	26.99	25.66	10.00	250.00
Fertilizer	108	1068.89	1394.20	100.00	6200.00	137	2021.68	2692.63	75.00	25000.00
Agro-chemicals	108	21.91	13.28	2.00	84.00	137	37.31	20.45	2.00	80.00
Labour	108	82.21	35.62	11.00	189.00	137	35.86	31.72	3.00	189.00
Output	108	4334.12	4348.04	160.00	19000.00	137	3673.07	1951.20	250.00	16000.00
Income	108	216510.60	96494.11	95000.00	650000.00	137	190330.70	66674.35	74700.00	500000.00

According to Rosenbaum and Rubin (1983), if a potential outcome is independent of a treatment conditional on a vector of covariates, X (CIA: conditional independence assumption), the outcome is independent of the treatment conditional on the propensity score, the probability of receiving treatment. It can be expressed as:

$$y_{0,}y_{1,}|P(X) \Rightarrow y_{0,}y_{1,}|p(X) \tag{1}$$

Where y_0 is outcome for the control group and y_1 is outcome for the treatment group, $P(X)$ is the propensity score, X represents observable characteristics and D denotes treatment.

The propensity score, $P(X)$, can be estimated by a logit model for the likelihood of being assigned into the treatment group with a set of explanatory variables that may affect the likelihood (equation (2)):

$$P(X) = Prob(D = 1|X) = E(D|X) \tag{2}$$

Which is the conditional probability of accessing agricultural credit given pre-treatment characteristics X. The nearest neighbour matching algorithm is employed and we use one-to-one matching and sampling with replacement. A calliper is the distance that is acceptable for any match. If an observation is outside of the calliper, it is dropped from the sample. Even though a large number of observations are likely to be dropped from the sample

as the calliper gets small, the small calliper allows a researcher to match observations with better precision (Bellemare and Novak, 2016).

We estimate the effect of agricultural credit on smallholder maize farmers' productivity and income after matching our samples with the estimated propensity score, $Prob(D=1|X)$. The estimated effect of the treatments on their income and productivity after matching, is analogous to the average treatment effect on the treated (ATT) per the propensity score theorem and CIA (equation (1)).

The purpose of the logit regression model was to investigate the factors that influence maize farmers ability to obtain credit. In this instance, the dependent variable is agricultural loan, a binary variable that only had one possible value (1) if a household is found to be agricultural loan beneficiary, and zero (0) if otherwise. Independent variables includes Gender of the head of the household, Household head's age (years), Head of household's marital status [Married = 1, Otherwise = 0, The level of education attained by the head of the household (number of years of formal education), Farming Experience (Number of years involved in farming), Extension Contact (Number of times with extension contact), Distance to credit in kilometres (km), Farm sizein hectres (ha), Farmer's Income Status (Farm and Non-farm income), and Member of cooperative (Member =1, non-Member = 0).

To guarantee that the impact estimate is reliable, the balancing property test was carried out both before and after matching. Table 3 shows the balance tests before and after matching. Afterward to guarantee that the pre-exposure traits of agricultural credit recipients and non-recipients are comparable. If the balancing test was applied to ascertain whether the differences between the variables of the two groups in the matched sample have been eliminated, then a matched comparison group can be considered a credible counterfactual (Ali and Abdulai, 2010). The t-test was used to assess the quality of the matching procedure. The t-tests showed that t-values of seven (7) covariates before matching were significant indicating that the significance of covariates was accepted.

Table 3. Equality test of the variable means before and after matching

Variable	Before Matching			After Matching		
	Credit Beneficiaries	Non-Credit Beneficiaries	Diff: t-stat	Credit Beneficiaries	Non-Credit Beneficiaries	Diff: t-stat
Gender	0.80	0.77	0.42	0.59	0.74	-1.20
Age	41.46	43.76	-2.65***	41.79	39.97	1.12
Marital Status	0.81	0.77	0.74	0.76	0.95	-2.13**
Education	1.63	1.03	3.94***	1.48	1.22	0.73
Farm Xprnc	11.94	9.08	4.10***	10.97	11.28	-0.21
Ext. contact	0.94	0.20	16.49***	0.83	0.30	0.89
Dist. to Credit	0.17	0.90	-16.87***	0.31	0.35	-0.31
Farm size	4.28	2.25	1.69*	4.09	4.69	-2.24**
Income	13.24	13.20	0.89	13.13	13.22	-1.09
Cooperative	0.66	0.35	4.99***	0.50	0.60	-0.73

Note: Asterisks ***, ** and * denote significance at the 0.001, 0.05 and 0.10 levels respectively

Nevertheless, upon matching, the covariates' significance was disregarded because of their insignificance and the two (2) covariates that, with the exception of one variable that remains significant even after matching, exhibit no discernible difference before and after matching. The t-statistics found in Table 3 shows that good matching quality was obtained for the majority of the covariates that were included of the model and as such, any differences in outcome variable (productivity) between the beneficiaries and non-beneficiaries of agricultural credit can be attributed to the agricultural loans.

The propensity score density distribution for agricultural credit recipients and non-recipients was shown in the Fig. 1. The scores' distribution densities are displayed on the y-axis, or vertical axis. The distribution of propensity scores for the two groups demonstrated a high overlap.

Propensity score matching (PSM) was used to assess the effects of agricultural credit on smallholder maize farmers in the research area; Table 4 presents the results for the three (3) algorithms method that is Nearest Neighbors (NNM), Radius (RM) and Stratified Matching (SM) were used for the analysis in other to ensure

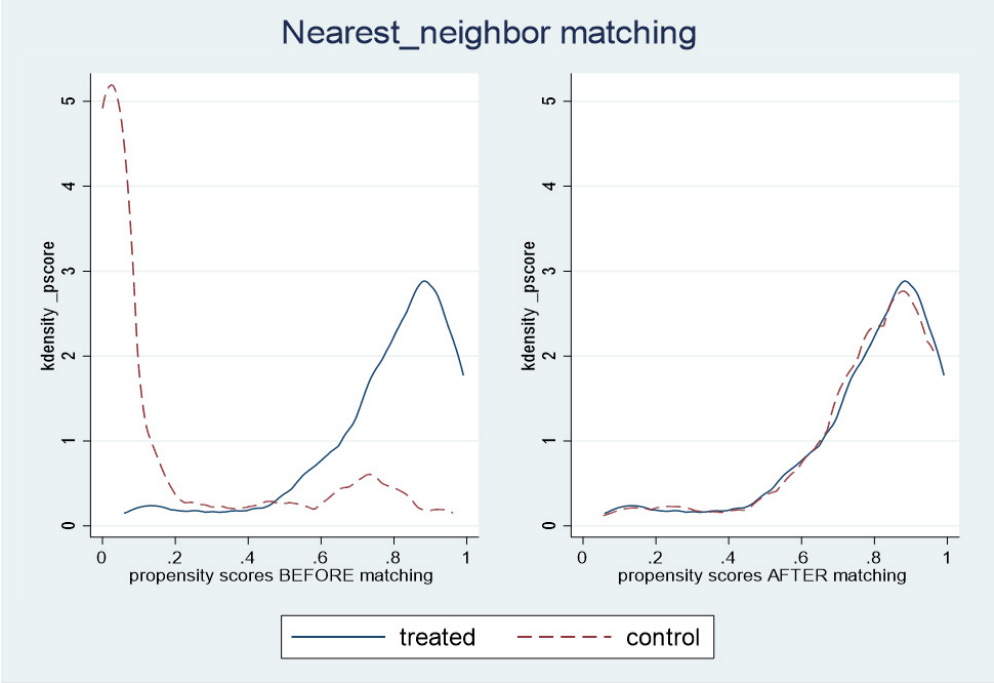

Fig. 1. Graph depicting the distributional balance of covariates.

Note: Treated mean variables for agricultural credit beneficiary smallholder maize farmers and control means variables for non-agricultural credit beneficiary smallholder maize farmers

Table 4. Impact of agricultural credit/ loans on the productivity of small-scale maize farmers

Matching estimators	ATT for outcome variables	t-test
Nearness neighbor matching	1164.50 kg/ha (19.63)	5.933***
Stratified matching	1775.80 kg/ha (13.38)	13.269***
Radius matching	1775.80 kg/ha (13.38)	13.269***

Note: Asterisks *** denote significance at the 0.001 levels

robustness of the results. The PSM results, however, indicate that the t-values for all three matching algorithms present favorable outcomes that are statistically significant at 1% probability level, and highly significant in terms of their impact on the productivity of smallholder maize farmers who get agricultural credit. The results were robust, as indicated by the values of the estimated matching techniques, which revealed little differences in the results from various algorithms. However, the stratified and the radius matching methods algorithms produce the highest bias reduction because of their low value of standard error which implies significant reduction in biasness.

The average treatment effect on smallholder maize farmers receiving agricultural credit ranged from 1775.80 kg/ha to 1164.50 kg/ha. This indicates a decline in productivity for non-agricultural credit beneficiary farmers that ranges between 1775.80 kg/ha and 1164.50 kg/ha. This outcome suggests that increased access to agricultural credit can enhance productivity among smallholder maize farmers, as demonstrated by the positive findings of this study. Improved maize productivity among recipients of agricultural credit do not only increases yields but also enhances economic well-being and ensures financial stability. Moreover, it promotes food security, facilitates livelihood diversification, encourages investment opportunities, and fosters social benefits and resilience to shocks, significantly impacting farmers' prosperity and community welfare. Despite previous research indicating the positive effects of agricultural credit on farmer livelihoods, contrasting results underscore the necessity of tailoring lending programs to specific crop contexts and local agricultural conditions. This is consistent with research by Owusu (2017), who employed three separate algorithms; the NNM, KBM, and Radius method and found that cassava farmers with loan access were able to raise their output by roughly 1443.76 kg/ha, 837.19 kg/Ha and 1294.83 kg/Ha respectively compared to their counterpart. Furthermore, according to Samson and Obademi (2018), the vast majority of agricultural loan recipients that is 92.30% claim that the credit they obtained has made them better off than their previously condition.

Using the propensity score matching (PSM) method, the impact of agricultural credit on the income of smallholder maize farmers in the study region was also assessed. The results were presented in Table 5 with three (3) algorithms method that is NNM, RM and SM that were used for the analysis in other to ensure robustness of the results. The PSM results on the other hand indicate that the income of smallholder maize farmers and agricultural credit are highly correlated, as evidenced by the positive and statistically significant t-values for all the three matching algorithms at 1% probability level for NNM and the 5% level for RM and SM. The results of the RM and SM algorithms were similar. However, the nearest neighbor matching (NNM) algorithms shows a significant difference in its outcome in terms of their income. This might be as a result of agricultural product price variability

Table 5. Impact of agricultural credit/ loans on smallholder maize farmers' income

Matching estimators	ATT for outcome variables	t-test
Nearest neighbor matching	75.65 USD/ha (7934.36)	4.04***
Stratified matching	30.90 USD/ha (5446.63)	2.40**
Radius matching	30.90 USD/ha (5446.63)	2.40**

Note: Asterisks ***, ** and * denote significance at the 0.001, 0.05 and 0.10 levels respectively

or other market disparity and constraint encountered in selling their goods especially when the farmers were not under cooperatives. The RM and SM algorithms produce the least bias reduction due to their low value of standard error which implies significant reduction in biasness. Therefore, the Mean treatment Impact on the Affected (ATT) maize farmers income ranges between 30.90 USD and 75.70 USD implying that the agricultural credit beneficiary farmers had an increase in their income that ranges between 30.90 USD and 75.70 USD. The implication of this is that with more income, which result from agricultural credit benefit shows that the farmers can either expand their production or diversify and improve their livelihood. In line with this, Gomina et al. (2015) stated that the dual disparity is ₦2054.77, which represents the disparity between the two average yearly per capita agricultural incomes [5051.91 − 2997.13]. It demonstrates that there was a positive value in the estimates of the twofold disparities in the annual agricultural income per capita of Savings and Credit Cooperative Societies (SACCOS) Credit users and non-recipients. A positive mean double difference in the annual farm income value per capita implies an increase in the annual farm income of the beneficiaries, indicating that the credit had a positive effect on their annual farm income per capita. This result was also in agreement with the assertion of Shah et al. (2008). The income level of agricultural loan borrower's increases, it can result from the reality that the borrowers used the suggested inputs for their crops and made timely input purchases.

Conclusion and Recommendation

Drawing from the results of this investigation, one may deduce that since the three algorithm used were all statistically significant at the probability level of 1%. Therefore, the value of ATT that ranges between 1775.80 kg/ha and 1164.50 kg/ha can be linked to how their maize output is affected by agricultural credit. Increased educational attainment, access to extension agents, and connection to agricultural credit are all ways that maize farmers might boost their production, particularly those who are unable to obtain credit for various reasons. This will enhance farmer's productivity and income with the adoption of improved production practices. Also, the investigation found that there was a huge gap between the output of agricultural loan beneficiaries and the non-beneficiaries maize farmers. Therefore, it is recommended that the extension officers should keep encouraging the farmers to form, be part and actively participate in cooperative societies where they can contribute and borrow members' money with a minimum interest rate as well as sharing of ideas so that they can increase their market bargaining power. By so doing, the farmers become self-reliance instead of depending on financial institution or any other source of credit with high interest rate.

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