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Impact of Policy Packages on Beef Cattle Breeding in China: Evidence from 297 Beef Cattle Farmers

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Abstract: Based on survey data from 297 beef cattle farmers in five provinces, Hunan, Ningxia, Inner Mongolia, Shandong and Gansu, the impact of the package of support policies on farmers' beef cattle production was assessed by means of propensity score matching (PSM). The results showed that the package of support policies, the education level of the household head, participation in beef cattle professional cooperatives and taking out loans for beef cattle farming had significant positive impacts on farmers' inventories of beef cattle and breeding cows. The current package of beef cattle support policies implemented by the national and local governments has significantly promoted the production of beef cattle by farmers, and the effects of the policy implementation have been positive. The implementation of the relevant support policies led to increases in farmers' inventories of approximately 17 head of beef cattle and approximately 9 head of breeding cows. The contribution rates of the policy implementation to the beef cattle and breeding cow inventories reached 52.96% and 67.30%, respectively.

Keywords: beef cattle farming; supportive policies; evaluation; propensity score matching

1. Introduction

The beef cattle industry is an important part of the development of China's livestock industry, and its sound development is related to farmers and herders steadily increasing their income and urban and rural residents stabilizing their consumption of meat. Bound by traditional agricultural production methods, China's cattle industry has long concentrated mainly on service, supplemented by the provision of meat. At the beginning of the reform and opening up, the State Council promulgated "The State Council on the Protection of Farm Cattle and Adjusted Slaughter Policy Notice" and at the same time encouraged agricultural mechanization to ensure sufficient animal power. In addition to breeding bulls and breeding cows, beef cattle, mixed breeds and other beef cattle can be fattened at any age and sold for slaughter, marking the official start of China's beef cattle industry. Since then, the state has issued many policies to encourage the development of the beef cattle industry, which has been more prominent since the turn of the century, such as the "National Beef Cattle Genetic Improvement Program (2011-2025)" issued in 2011, the "Ministry of Agriculture's Guiding Opinions on Promoting the Accelerated Development of Grass-fed Livestock Husbandry" issued in 2015, and the "Five-Year Action Program for Promoting the Development of Beef Cattle, Sheep and Goat Production" issued in 2021.

With the continuous emphasis on national policies, local governments have also begun to increase their support of beef cattle breeding policies and introduced a series of policies and regulations. Given the current implementation of China's series of beef cattle industry support policies, what is the ultimate effect? Have policy implementation goals been achieved? Can the relevant policies effectively promote the stable development of the beef cattle breeding industry? To answer these questions, a systematic assessment of the effectiveness of the implementation of policies to support the beef cattle industry is of great theoretical and practical significance for the improvement and implementation of existing policies, the formulation and introduction of new policies, and the sustainable development of beef cattle.

Research in China on beef cattle industrial policy has focused mainly on the macrolevel; microlevel research is lacking, as is empirical analysis to assess the effect of relevant support policies.

It has been argued that the market development and marketing methods are continually being innovated and China's beef cattle industry is comprehensively and rapidly developing owing to the improvement of China's agricultural mechanization level, changes in production policy and circulation policy, and economic and social development of beef cattle production and consumption, coupled with the use of science and technology in feed and product processing and accompanied by gradually increasing attention to standardized breeding of beef cattle in large counties, the gradual improvement of subsidies for beef cattle breeding, the beef reserve system, and the policy of regional deployment in the production areas [1-7].

Among the many problems in the beef cattle industry, environmental protection pressure, the decline in the inventory of cows, the low level of breeding technology, the unsound state of market regulation, insufficient policy support, and low international competitiveness are prominent [8-13]. In addition, in studying the regional beef cattle industry in Heilongjiang and Jilin, scholars have concluded that one important reason for the lagging development of the beef cattle industry is the ineffectiveness of policy support [14,15].

Regarding the different policies, the implementation of the grassland ecological protection subsidy policy has, to a certain extent, promoted the transformation and development of beef cattle farming in pastoral areas, especially the shift from grazing to stall feeding, as well as the improvement in the productivity of beef cattle farming by professional fattening farm households [16,17]. The implementation of the beef cattle breeding subsidy policy has played a positive role in improving the level of beef cattle breeding and driving the construction and improvement of the beef cattle breeding system [18,19]. With regard to the "Food-fodder Change" subsidy policy, some scholars considered that the implementation of the policy had slowed down the obvious increase in feed costs for beef cattle breeding, and that the cost efficiency of beef cattle breeding in most provinces had improved to varying degrees, and others considered that the implementation of the policy, which increased the subsidy standard, led to only small changes in the farm income and dietary structure of beef cattle farmers, and the effect of relying only on the farm benefits generated by the increase in the subsidy standard to increase income was not significant [20,21].

At the microlevel, in exploring regional differences in total factor productivity in beef cattle farming, Li Junru [22] concluded that government support policies have a strong influence and that factors such as agricultural mechanization, transport conditions, traffic conditions, pasture and grain production, construction of livestock and veterinary teams in townships, and large-scale farming also have an impact on the total factor productivity of the beef cattle industry. To promote the sustainable development of beef cattle in China in the future, national macropolicy guidance and financial support are essential [23-27].

Overall, research in China on beef cattle industry support policies has been conducted mostly at the macrolevel for more standardized discussion and analysis. The effects of policy on the industry or the impact on the main body of farming and the policy effects of systematic assessment have been understudied, particularly in terms of empirical analysis based on primary microdata. Based on the current situation of industrial development and the deficiencies of previous studies, the research group visited Hunan, Ningxia, Inner Mongolia, Shandong, Gansu and five other provinces (autonomous regions) and 10 counties (cities, flags, districts) to conduct research among local beef cattle farmers. Based on these primary data and the propensity score matching (PSM) method, the impact of the current package of support policies on beef cattle farming is systematically assessed. Finally, countermeasures are proposed to assist in decision-making.

2. Methods and Materials

2.1. Methods

To assess the impact of beef cattle-related support policies on farmers' beef cattle production, this study utilizes the PSM method for empirical analysis. Prior to PSM, a brief analysis is conducted by constructing a linear regression model with the help of the ordinary least squares (OLS) method to determine the impacts of relevant factors such as support policies, household head characteristics

and family characteristics on the production behavior of beef cattle farmers. The following econometric model is constructed in this study:

$$Y = \alpha + \beta X + \gamma Z + \phi \Xi + \varepsilon \tag{1}$$

The formula, Y is the indicator of beef cattle production; X, Z and Ξ are the characteristic variables, which are the characteristics of the head of the household, family characteristics and environmental characteristics that affect beef cattle breeding, respectively. The specific selection of the model variables is briefly explained in the following section. α, β, γ, and ϕ are the estimated parameters of the model; ε is the random error term.

On this basis, the effects of beef cattle support policies are then evaluated using PSM. To assess the effect of a program or policy after its implementation, Rubin [28] proposed a counterfactual framework known as the Rubin causal model. Considering the effect of the support policy on beef cattle farming, the model expression is as follows:

$$Y_i = \begin{cases} y_{1i} & \text{if } D_i = 1 \\ y_{0i} & \text{if } D_i = 0 \end{cases} \tag{2}$$

where y_{0i} denotes the future size of the farm when the farmer i does not benefit from the support policy and y_{1i} denotes the future size of the farm when the farmer i benefits from the support policy. To determine the causal effect of the support policy for the farmer i, it is necessary to calculate ($y_{1i} - y_{0i}$), but since the farmer is in only one state, it is not possible to observe y_{0i} and y_{1i} at the same time. Equation (2) can be expressed using the segmented function as follows:

$$y_i = (1 - D_i)y_{0i} + D_i y_{1i} = y_{0i} + (y_{1i} - y_{0i})D_i \tag{3}$$

Based on the above equation, the expected value of the treatment effect, i.e., the average treatment effect, can be calculated. It represents the expected treatment effect of a randomly selected individual from the overall population but does not define whether the individual receives policy support. The formula for the average treatment effect in this case is as follows:

$$\text{ATE} \equiv E(y_{1i} - y_{0i}) \tag{4}$$

Based on the limitations of ATE, it is possible to consider the average treatment effect of farmers receiving support policies, an indicator that is important for policy makers, as it measures the benefits that farmers receive from policy support. The specific formula for this indicator is as follows:

$$\text{ATT} \equiv E(y_{1i} - y_{0i} | D_i = 1) \tag{5}$$

To measure the above indicators, it is necessary to use the idea of a correlation matching estimator to find a farmer j in the control group (farmers not benefiting from the beef cattle support policy) who is as similar as possible to a farmer i in the treatment group (farmers benefiting from the beef cattle support policy), i.e., with $x_i \approx x_j$, where x is the farmer's correlation characteristics such as head of the family, family characteristics, and external environmental characteristics. Rosenbaum et al. [29] proposed a propensity score to measure the matching distance between different farmers, which defines the propensity score of a farmer i as the conditional probability that farmer i enters the treatment group under the following x_i condition:

$$p(x_i) \equiv P(D_i = 1 | x = x_i) \tag{6}$$

In Eq. (6), for $p(x)$ can be obtained using parametric and nonparametric estimation, and the parameter estimation usually utilizes logit and probit estimation. Matching with the propensity score as a distance function is called PSM. The steps to calculate the average treatment effect of policy-supported beef cattle breeding by this method are as follows: ① select covariates; ② estimate the propensity score, which is usually obtained by using logit regression; ③ perform PSM; and ④

calculate the average treatment effect based on the matched samples. At this point, the average treatment effect obtained can be expressed as follows:

$$ATT \equiv \frac{1}{N_1}\sum_{i:D_{i=1}}\left(y_i - \hat{y}_{0i}\right) \tag{7}$$

where $N_1 = \sum_i D_i$ is the number of farmers in the treatment group and $\Sigma_{i:D_i=1}$ denotes the summation of individual farmers in the treatment group. For PSM, various methods can be utilized, such as K-nearest neighbor matching, Radius matching, Nearest-neighbor matching within caliper, Kernel matching, Local linear regression matching and Spline matching [30]. In this study, Nearest-neighbor matching was used for analysis and robustness testing with the help of Kernel matching and Mahalanobis matching.

2.2. Materials

2.2.1. Indicator Selection and Description

To assess the impact of the package of support policies on beef cattle farmers, this study selected the inventories of beef cattle and breeding cows as the objects of investigation; i.e., it assessed the impact of the implementation of the policies on farmers' inventories of beef cattle and breeding cows.

The policy variable is a 0-1 discrete variable that indicates whether or not a farmer receives policy support. The field research on beef cattle farmers revealed that there are many different types of beef cattle support policies in different regions, and they are complicated, so it is difficult to select samples to examine one policy alone. Therefore, this study aimed to systematically evaluate the package of support policies. The results showed that the support policies mainly include subsidies for foundation cows, subsidies for straw cattle raising demonstration projects, subsidies for the construction of breeding districts, subsidies for the construction of barns, subsidies for cattle raising machinery, incentives for large beef cattle breeders, subsidies for large-scale breeding farms, the food basket project, subsidies for frozen semen, rocky desertification control projects, scientific and technological demonstration projects, and subsidized interest rates on loans.

The covariates selected for the policy evaluation were (1) characteristics of the household head, mainly his/her age and education level; (2) characteristics of the family, including whether any family members served as cadres at the village level or above, the number of people in the family, and the number of years the family had been engaged in the beef cattle breeding industry; and (3) characteristics of the environment, including whether any family members had received training in beef cattle breeding, participated in a professional cooperative for the breeding of cattle, or taken out loans for beef cattle breeding. Dummy variables were used for Hunan, Inner Mongolia, Ningxia and Shandong.

2.2.2. Data Sources and Description

Considering the vast geographical area of China's beef cattle farming and the wide variations in the actual situation of farmers, this study investigates beef cattle farmers in five provinces and regions, Hunan, Ningxia, Inner Mongolia, Shandong and Gansu, with two counties (cities, flags and districts) selected to represent each province and approximately 30 households randomly selected for in-depth research in each county. Specific areas surveyed were Xinhua County and Lianyuan City in Hunan Province, Jingyuan County and Xiji County in Ningxia Autonomous Region, Kezuo Houqi and Kezuo Zhongqi in Inner Mongolia Autonomous Region, Gaomi City and Gaocheng County in Shandong Province, and Ganzhou District and Linze County in Gansu Province. A total of 297 effective sample households of beef cattle farming were collected in the study, with 61 households in Hunan, 59 in Ningxia, 58 in Inner Mongolia, 59 in Shandong and 60 in Gansu.

The meanings and values of the main variables selected for this study and their descriptive statistics can be found in Table 1. The table shows that the average beef cattle inventory in the sample households in the study was 32.46, with a maximum value of 582 and a minimum value of 1. The

average number of breeding cows was 13.46, with a maximum value of 248, and the majority of the farm households had no breeding cows inventory. The mean value of the education level of the household head was 3.02, which meant that the average education level was approximately middle school level. In addition, the average household size of the research sample was 4.66 persons, and the average number of years engaged in beef cattle farming was 9.73; most of the farmers were involved in professional cooperatives for beef cattle farming and had received training in beef cattle farming. Farmers did not only rely on themselves as sources of funds for beef cattle farming; most of them had taken out loans. Other relevant information on the variables is provided in Table 1.

Table 1. Variables and their descriptive statistics.

Variable	Meaning and description of values	Average value	Maximum value	Minimum value	Standard deviation
Cattle	Farmers' beef cattle inventory (in head)	32.4579	582.0000	1.0000	57.2436
Cow	Farmers' inventory of breeding cows (in head)	13.4613	248.0000	0.0000	27.1211
Policy	Whether beef cattle farming benefits from relevant support policies (Yes=1; No=0)	0.3569	1.0000	0.0000	0.4799
Age	Age of head of household (in years)	44.7710	70.0000	18.0000	9.1090
Education	Educational level of head of household (no education = 1; primary education = 2; lower secondary education = 3; upper secondary education/secondary education/vocational/technical education = 4; university/college and above = 5)	3.0202	5.0000	1.0000	0.7967
Leader	Whether a family member serves as a cadre at the village level and above (Yes = 1; No = 0)	0.1582	1.0000	0.0000	0.3656
Population	Number of persons in the household (in persons)	4.6599	15.0000	2.0000	1.5797
Year	Number of years the family has been involved in cattle farming (in years)	9.7273	36.0000	1.0000	7.8789
Cooperative	Participation in professional beef cooperatives (Yes=1; No=0)	0.4276	1.0000	0.0000	0.4956
Train	Whether family members have received training in beef cattle farming (Yes = 1; No = 0)	0.7643	1.0000	0.0000	0.4251

Loan	Whether loans have been taken out for beef cattle farming (Yes=1; No=0)	0.5791	1.0000	0.0000	0.4945
Dhn	Whether the farmer is in Hunan (Yes=1, No=0)	0.2054	1.0000	0.0000	0.4047
Dnx	Whether the farmer is in Ningxia (Yes=1, No=0)	0.1987	1.0000	0.0000	0.3997
Dnm	Whether the farmer is in Inner Mongolia (Yes=1, No=0)	0.1953	1.0000	0.0000	0.3971
Dsd	Whether the farmer is in Shandong (Yes=1, No=0)	0.1987	1.0000	0.0000	0.3997

3. Results and Discussion

3.1. Model Estimation and Matching Effect Analysis

3.1.1. Model Estimation Results

Prior to PSM, the effects of the relevant covariates on farmers' beef cattle and breeding cow inventory were estimated using OLS regression, and the propensity score was then estimated with the help of Nearest-neighbor matched logit regression. The results of the OLS regression on beef cattle and beef cow inventory and the results of the PSM logit estimation are provided in Table 2, where the results of the OLS regression are only briefly discussed.

Table 2. Estimated results of the model.

Variable	Beef cattle inventory		Breeding cows inventory		Propensity score matching	
	Estimated parameters	Standard error	Estimated parameters	Standard error	Estimated parameters	Standard error
Cons	-22.6106	38.2988	-3.3380	17.8741	-3.6914***	1.4033
Policy	17.6458**	8.6605	10.0699**	4.2314	—	—
Age	-0.4212	0.4999	-0.1817	0.2507	-0.0028	0.0188
Education	14.0252**	6.5800	7.1507**	3.1948	0.6011**	0.2350
Leader	9.5384	9.7516	-0.4161	4.3564	0.2478	0.4089
Population	-0.6499	2.6344	-1.3802	1.4302	0.0485	0.1020
Year	0.0591	0.4371	-0.0183	0.1933	0.0236	0.0202
Cooperative	15.6630*	8.2454	6.6224*	3.6123	0.9178***	0.3313
Train	-2.9692	5.6593	-3.8913*	2.1489	-0.3964	0.4395
Loan	18.7055*	9.8721	10.0255**	4.1259	0.6302*	0.3591
Dhn	32.6989*	16.7686	16.0405*	8.8185	0.0315	0.5060
Dnx	-12.1103	12.6375	-9.4126	6.2721	2.7082***	0.5446
Dnm	1.0324	6.6165	-2.7812	3.9311	0.1221	0.4369
Dsd	32.4161***	11.1761	-0.6381	4.6625	-2.2658***	0.8170

Note: Beef cattle inventory and breeding cow inventory models were estimated using ordinary least squares, and propensity score matching was performed using logit estimation; ***, **, and * denote passing significance tests at the 1%, 5%, and 10% levels, respectively.

The OLS regression results showed that the factors significantly affecting farmers' beef cattle inventory were support policies, the education level of the head of household, whether farmers had participated in beef cattle professional cooperatives, and whether they had taken out loans; the factors significantly affecting the inventory of breeding cows were whether family members had received training in beef cattle breeding in addition to the four factors mentioned above. The model estimation results showed significant positive effects of national and local governments' policy support aimed at promoting farmers' beef cattle production. This indicates that the current package of beef cattle support policies has achieved a certain effect and implies that the evaluation of the impact of the package on beef cattle breeding has a theoretical and practical basis. Educational level has a positive impact on beef cattle breeding, indicating that in the current process of continuous development of the beef cattle industry, the quality of the producer is critical, as beef cattle breeding is no longer performed in the traditional way of rough loose breeding. A large-scale, standardized and modernized breeding model is urgently needed to improve the professionalism of farmers.

Participation in beef cattle professional cooperatives had a significant positive impact, indicating that the construction of new business subjects is extremely important. Farmers participated in professional cooperatives and studied other new business subjects, which helped them improve their production management level, absorb new farming techniques, obtain timely access to beef cattle market information, enhance their funding and capacity to receive socialized services, and comprehensively reduce the disadvantages of small-scale single-farm beef cattle production. In the family beef cattle breeding process, it is inevitable that loan behavior and beef cattle breeding require a high input threshold, and in the breeding process, feed, technology, epidemics and other costs are very high. Loans can effectively alleviate many problems in the process of beef cattle breeding and enable farmers to have a significant positive impact on the production of beef cattle.

3.1.2. Sample Matching Effect

When matching propensity scores, it was necessary to conduct a balance test between the treatment group (farmers who benefited from the beef cattle support policy) and the control group (farmers who did not benefit from the beef cattle support policy) of policy-supported beef cattle farming in order to ensure that there were no differences in the characteristics of the head of the household or in the scale of the farming, i.e., the amount of beef cattle and breeding cow inventories in the different groups after the policy support. Covariates such as household characteristics and environmental characteristics did not differ significantly or systematically. The results of the balance test for the main covariates before and after PSM are provided in Table 3.

Table 3. Balance test of propensity score matching.

Variable	Typology	Average value		T test	
		Process group	Control group	T-statistics value	P-statistic value
Age	Prematch	43.1700	45.6600	-2.2700	0.0240
	After the match	43.0950	41.6900	0.9000	0.3690
Education	Prematch	3.0472	3.0052	0.4300	0.6650
	After the match	2.9643	3.0000	-0.2500	0.7990
Leader	Prematch	0.2076	0.1309	1.7400	0.0830

	After the match	0.2024	0.2500	-0.7300	0.4640
	Prematch	5.0377	4.4503	3.1200	0.0020
Population	After the match	5.0595	4.9881	0.2600	0.7920
	Prematch	11.2830	8.8639	2.5600	0.0110
Year	After the match	11.3570	10.6070	0.5700	0.5690
	Prematch	0.6415	0.3089	5.8400	0.0000
Cooperative	After the match	0.5595	0.5714	-0.1500	0.8770
	Prematch	0.7642	0.7644	0.0000	0.9960
Train	After the match	0.7738	0.7976	-0.3700	0.7090
	Prematch	0.7736	0.4712	5.2700	0.0000
Loan	After the match	0.7262	0.7976	-1.0800	0.2800
	Prematch	0.1698	0.2251	-1.1300	0.2600
Dhn	After the match	0.2143	0.2619	-0.7200	0.4720
	Prematch	0.4717	0.0471	10.1800	0.0000
Dnx	After the match	0.3333	0.3095	0.3300	0.7430
	Prematch	0.1793	0.2042	-0.5200	0.6050
Dnm	After the match	0.2262	0.2143	0.1900	0.8530
	Prematch	0.0189	0.2984	-6.1200	0.0000
Dsd	After the match	0.0238	0.0238	0.0000	1.0000

As shown in Table 3, before PSM, the age of the head of the farming household, whether family members are cadres, the number of family members, the number of years engaged in beef cattle farming, whether they had participated in cooperatives, whether they had taken out loans, and the two regional dummy variables for Ningxia and Shandong all had high T-statistic values and passed the significance test; only the education level of the head of the household, whether family members had received training in beef cattle farming, the two regional dummy variables for Hunan and Inner Mongolia and the two other regional dummy variables did not pass the significance test. This suggests that there were significant differences in most of the characteristic variables between the two groups of sample households that benefited or did not benefit from the beef cattle support policy and that there was a significant bias between the treatment and control groups.

After matching, the corresponding T-statistic values of each variable, such as household head characteristics, family characteristics and environmental characteristics, were small and did not pass the significance test, indicating that there was no longer a significant difference between the covariates for the treatment group and the control group after matching. The two regional dummy variables of the household head's education level and Hunan and Inner Mongolia were met before

matching, but their T-statistic values were even smaller after matching, indicating that the differences between the two sample groups in this characteristic variable were further reduced after matching. After matching the samples of farmers, all of them passed the balance test; that is, the relevant covariates selected by the study no longer differed systematically between the treatment group and the control group, basically achieving an effect similar to that of a randomized trial.

3.2. *Average Treatment Effects and Robustness Analysis*

3.2.1. Average Treatment Effect

After the balance test, the effect of the "package" policy to support beef cattle farmers can be calculated, that is, the average treatment effect ATT value of beef cattle inventory and breeding cow inventory based on the Nearest-neighbor matching, and the specific results can be seen in Table 4.

Table 4. ATT values and robustness test of Propensity Score Matching.

Methodology	Variable	Typology	Process group	Control group	disparities	standard error	T-statistics
Nearest-neighbor matching	Inventory of beef cattle	Prematch	41.8491	27.2461	14.6030	6.8927	2.1200
		ATT	44.0595	26.8690	17.1905	8.5571	2.0100
	Inventory of breeding cows	Prematch	20.2358	9.7016	10.5343	3.2327	3.2600
		ATT	21.5714	12.5119	9.0595	4.3603	2.0800
Kernel matching	Inventory of beef cattle	Prematch	41.8491	27.2461	14.6030	6.8927	2.1200
		ATT	44.0595	28.7591	15.3004	10.7771	1.4200
	Inventory of breeding cows	Prematch	20.2358	9.7016	10.5343	3.2327	3.2600
		ATT	21.5714	12.5256	9.0458	5.0781	1.7800
Mahalanobis matching	Inventory of beef cattle	Prematch	41.8491	27.2461	14.6030	6.8927	2.1200
		ATT	41.8491	23.6344	18.2146	5.9539	3.0600
	Inventory of breeding cows	Prematch	20.2358	9.7016	10.5343	3.2327	3.2600
		ATT	20.2358	11.9009	8.3349	3.2780	2.5400

As shown in Table 4, policy support had a significant positive impact on farmers' beef cattle and breeding cow inventories. According to the results of Nearest-neighbor matching, the differences in the beef cattle inventory and breeding cow inventory between the treatment group and the control group before matching were 14.60 and 10.53, respectively. After matching, the corresponding ATT values were 17.19 for beef cattle inventory and 9.06 for breeding cow inventory, which passed the test of significance at the 10% level. The contribution rate of policy implementation was 52.96% for beef cattle inventory (average treatment effect/sample mean*100%=17.1905/32.4579*100%) and even higher for breeding cow inventory, reaching 67.30% (9.0595/13.4613*100%). The implementation of the policy prompted farmers to increase their beef cattle inventory by approximately 17 head and breeding cow inventory by approximately 9 head. In other words, the current package of beef cattle support policies implemented by the national and local governments had obviously promoted the production of beef cattle by farmers, and the effects of policy implementation were satisfactory.

3.2.2. Robustness Test

After the average treatment effect is calculated using Nearest-neighbor matching, the corresponding average treatment effect can be further estimated with the help of Kernel matching and Mahalanobis matching for the robustness test, and the specific results are shown in Table 4. The Kernel matching results indicate that the ATT value of farmers' beef cattle inventory was 15.30, which did not pass the test of significance, and the ATT value of the corresponding breeding cow inventory is 9.05, which passed the test of significance. The results of Mahalanobis matching indicated that the ATT values for farmers' beef cattle inventory and breeding cow inventory were 18.21 and 8.33, respectively, and both passed the significance test at the 10% level. Thus, the results of Kernel matching and Mahalanobis matching showed that the implementation of the package of beef cattle support policies could enable farmers to increase their beef cattle inventory by approximately 15 to 18 and increase the number of breeding cows by 8 to 9. The estimation results were close to those of Nearest-neighbor matching, which indicated that the introduction of the relevant beef cattle policies had indeed effectively enhanced the positive impacts of beef cattle production on farmers. This suggests that the introduction of relevant beef cattle policy can effectively enhance incentives for farmers in beef cattle production and encourage them to increase their inventories of beef cattle and breeding cows. Overall, the implementation of the current package of policies to support the beef cattle industry has been effective.

4. Conclusions

Based on survey data of 297 beef cattle farmers in 10 counties (cities, flags and districts) in five provinces (regions), Hunan, Ningxia, Inner Mongolia, Shandong and Gansu, this study evaluates the policy effects of the package of support policies on farmers' beef cattle production with the help of the PSM method. The following conclusions were obtained.

First, among the characteristics of the head of household, family characteristics and environmental characteristics of beef cattle farming, the package of support policies, education level of the head of household, whether the farmer participated in beef cattle professional cooperatives, and whether the farmer had taken out loans for beef cattle farming had a significant positive impact on the inventories of beef cattle and breeding cows of farming households.

Second, matching the propensity scores of the treatment and control groups revealed that the current package of beef cattle support policies implemented by the national and local governments has significantly promoted the production of beef cattle by farmers, and the implementation effect of the policies has been satisfactory. The implementation of the relevant support policies led to increases of approximately 17 head in the inventory of beef cattle and approximately 9.5 head in the inventory of breeding cows. Thus, the contribution rates of the policy implementation to the inventories of beef cattle and breeding cows were 52.96% and 67.30%, respectively.

In response to these findings, the following policy recommendations are made for reference. First, in view of the effectiveness of the implementation of the package of support policies for beef cattle farming, active support policies should continue to be standardized and promoted at the national level. Additionally, seed subsidies, basic cow subsidies, animal disease prevention subsidies, subsidies for the purchase of breeding machinery, standardized large-scale breeding incentives and other support policies that are closely related to beef cattle breeding should be strengthened at the national level and actively combined with the "food basket" and "rice bag" production support projects. The implementation of production support projects should be continued in beef cattle farming county incentives and subsidies policy, including exploring and carrying out experimental pilot grass pasture development, pilot silage corn storage subsidies and the development of grass-fed animal husbandry combined with planting and raising the priority of the process to provide more support to the beef cattle farming industry.

At the same time, national and local governments should be encouraged to establish a sound and complete beef reserve system, continue to carry out numerous major projects, effectively construct beef cattle breeding projects, and improve the original breeding farms of beef cattle and new varieties of selection and breeding systems to ensure the upgrading of China's beef cattle

breeding base. At the local level, national policies and local conditions should be combined to provide full access to the necessary support programs for beef cattle breeding, integrate supporting funds, and comprehensively improve the quality and quantity of beef cattle production.

Second, head of household education, whether a farmer participates in beef cattle professional cooperatives, whether a farmer takes out beef cattle farming loans and other factors contributing to the positive impacts on the beef cattle and breeding cow inventories should also be considered in the promotion of beef cattle policy support. At the same time, levels of education and training, business entities and financial capitalists could be encouraged and promoted to invest in the beef cattle farming industry. A sound education and training system in animal husbandry should be established, support that focuses on beef cattle breeding should be provided, the preferential system of education for farmers and herders should be improved, relevant scientific research institutions and enterprises should be organized to provide training to farmers and herders in beef cattle breeding and management, and efficient cooperative mechanisms should be constructed for farmers and enterprises, scientific research institutions and so on.

The construction of a new management main body should be encouraged, the diversification of a beef cattle breeding main body should be promoted, and policy should support beef cattle breeding cooperatives and emphasize family farming (ranching). Additionally, the national and local governments should encourage credit guarantees, discounts, and subsidies and promote social capital associated with the beef cattle breeding industry; provide links; guide and encourage commercial banks, insurance companies and other financial institutions to provide financial support for beef cattle breeding; continue to improve the system of microcredit and joint-guarantee loans for farmers; and provide more preferential policies for professional cooperatives, family farms (ranches) and other new business subjects.

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