Impact of Constraints and Credit On the Probability of Participation: Evidence from Fish Producers in Nigeria

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Abstract

Farming in Nigeria tends to be dependent on the onset of the wet season as more than 70% of those involved in farming have no access to irrigation facilities, including those in the capture and culture fishery sector. Culture fish production is not well-developed owing to the need for high capital injection into the business. That is why this study investigated the connection between constraints faced, credit obtained and probability of participation in the fish value chain by fish producers in Nigeria in order to ensure sustainable fish availability to consumers. The study involved 643 fish producers in Niger and Kebbi States and data analyzed using Garrett ranking, Structural Equation Modelling (SEM) and regression. The results obtained indicated that 48 variables out of the 65 described by the actors were considered a constraint based on the mean and the five latent factors determined were retrieved for analysis. The latent variables exhibited positive bi-directional relationship between one another indicating that the factors are not isolated occurrences. From the Propensity Score Matching (PSM) and regression, a number of policy variables were obtained which may call for further investigation. Particularly, the tendency of low probability of participation in the face of low educational acquisition. There is also a very strong indication that the actors are conducting their businesses with low capital which has further devalue the level of participation. Ultimately, doing business with adequate capital can increase participation by up to 15% and as such, can increase outputs, income, profits and enhance livelihoods.

1. Introduction

Agriculture in Nigeria is climate and weather-based as such farming activities are replete with a number of constraints. Farming tends to be dependent on the onset of the wet season as more than 70% of those involved in farming have no access to irrigation facilities. The same situation exists in the fish sector, where most of those involved in the value chain prefer capture fishery rather than culture. This is in spite of the fact that there has been significant drop in the amount of capture in recent years. It would have been reasonable to expect that those involved in the capture node would have transformed into the culture node for stable, enhanced and sustainable means of livelihood since production the node can be all-year round as it does not depend on climate or weather (Ebiloma *et al.*, 2018., Obasi, & Adeoye, 2022., Apata, 2011., Faleke, Nwabeze & Buhari, 2023., Jalali *et al.*, 2023). The capture node has less capital and technology requirements but unreliable, whereas, the culture requires a huge amount of sunk capital in addition to high cost of operations. In that wise, the availability of credit at affordable rates should encourage the transformation of resources to the culture node (Subasinghe *et al.*, 2021).

Capture fishery still remains the main source of supplies of fish and fish products to Nigerian consumers and the supply is a far cry from demand, leading Nigeria to expend huge sums for importation of fish and fish products (Obasi,

& Adeoye, 2022). This situation calls for insight into the issues that needs either policy re-orientation or re-alignment in order to ensure that food and nutrition security is assured while at the same time making the business profitable and attractive to both investors and practitioners. If the sector is well-aligned to national goals and development targets, unemployment will reduce particularly among the teaming youths whose unemployment rate is as high as 30% in recent times (World Bank, 2024). Therefore, it is the aim of this research to ascertain the critical constraints faced by fish producers in Nigeria and investigate the relationship between the constraints and credit. The study described the various constraints expressed by the fish producers and ranked them in order of importance. The number of latent factors inherent in the constraints' structure were determined and the values recovered. Then, whether the latent variables affect the sum of credit obtained by the fish producers was also investigated. Finally, the treatment effects and the rate of impact on the probability of participation in the value chain by fish producers were estimated.

2. Materials and Methods

The research was undertaken in Niger and Kebbi States in central and north-west of Nigeria. They lie between latitudes 8°11′N and 13°15′N and longitudes 3°30′E and 7°15′E (Fig. 1) with a combined land area and population of 112,592km^2 and 10,120,576 respectively. They are bounded by Benin Republic to the east, Sokoto, Zamfara and Kaduna states to the North and the Federal Capital Territory (FCT), Kogi and Kwara states to the south. The two States have a total of 46 Local Government Areas (LGAs). The major languages spoken in the two states apart from the formal language of communication include Nupe, Gwari, Koro, Kadara Lelna, Bussawa, Dukawa, Kambari and Kamuku. The states experience dry and wet seasons with annual rainfall varying from 1,200mm in the north to 1,600mm in the south; the wet season is up to 210 days starting at about Mid-March to early April but the season is only fully established in June. The maximum temperature can be up to 40°C, especially when the rainy season approaches. Although the major occupation in the two states is agriculture-based involving crop and livestock farming by more than 70% of the population, they are also involved in fish production, processing and marketing owing to the fact that River Niger criss-crosses them, in fact Niger State derived her name from the river. Also, Niger State is also criss-crossed with River Kaduna and her various tributaries, including Gurara, Gbako and Lavun Rivers. There are three hydro-electric dams (Shiroro, Kaiji and Jebba) and one under construction (Zungeru) in Niger State and they also support fishing activities. Kebbi State is home to one of the biggest fishing festivals in Nigeria-the Argungu Fishing Festival. (NAMDA (Niger State Agricultural Mechanization and Development Authority), 2013; NPC, 2006; Jirgi, 2013).

For this study, 643 respondents, sampled purposively to include all the nodes and the various actors in the fish value chain along the course of the various rivers in the two states were interviewed to obtain the data for this study (Table 1). The data, on various socio-economic and socio-cultural characteristics as well as the various constraints faced by the fish producers, were collected between April 2022 and February 2023 through structured questionnaire administered by well-trained enumerators. The data collection procedure involved real-time online methodology using kobotoolbox software (https://www.kobotoolbox.org/), which enabled continuous monitoring of the enumerators on the field.

The Garrett ranking technique was used to rank the 65 constraints described by the respondents. The Garrett ranking helps to arrange the constraints in the order of severity. The procedure is to convert the ranks given to each constraint by the respondents to what is called 'Garrett Point'. To do that, the ranks are converted to Garrett Value given by equation 1.

$$GP = 100 \left(\frac{R_{ij} - 0.5}{N_j}\right)$$

eq. 1

Where GP = Garrett Point, R_{ij} = Rank given to ith constraint by the jth individual, N_j = Number of constraints ranked by the jth individual. Associated with each GP is a is a Garret Value (GV) which is obtained from the Garrett Ranking Conversion Table. The GV is then multiplied by the total number of ranks for each constraint to obtain Total Garrett Score (TGS). The TGS is then divided by the total ranks to obtain Mean Score (MS). The Mean Score is used to rank the constraint in ascending order of the ranks (Bhavani, Ravinder & Srinivasulu, 2021; Garret and Woodworth, 1969; Joshi, Upadhyay *et al.*, 2020).

In order to determine the latent variables inherent in the expressed constraints by the respondents, the constraints were subjected to factor analysis using PCA and the inter-relationship between the latent variables were established using SEM, which is a combination of multivariate analysis, factor analysis and regression analysis and the coefficients were displayed using path diagrams. After the latent variables were determined, their values were recovered for use in the PSM and DiD. The model for PSM, DiD and Regression is specified in equation 2 (Ho, Imai, King Stuart, 2011; Fox, Nie & Byrnes, 2022; Epskamp, 2022; Revelle, 2023).

$$Y = f(X_1, X_2, ..., X_{19})$$

eq. 2

Where:

Y = Nodes which take a value of 1 if the respondents is in capture node and 0 if respondent is in culture node (logistic model)

Y = Amount of credit obtained in Naira by the respondents (linear model).

X_1, X_2, …., X_{19} are explanatory variables as presented in Table 2. Furthermore, the summary statistics of the continuous variables are presented in Table 3 and the distribution of the categorical variables before and after PSM is presented in Table 4.

PSM is undertaken in order to reduce the likelihood of a biased results which may be the outcome if we try to determine the effect of analysing the impact of an experiment using linear regression only. After PSM, the exposed and unexposed observations with similar measured covariates are aligned and the unmatched observations not included (Fig. 2 and Table 5). In this way, the regression results are robust and more stable for further analysis (Vable *et al*., 2019; Wan, Colditz & Sutcliffe, 2021).

Table 1. Sampling distribution of fish producers in the study area

State	Actor	Node	Frequency	%
Kebbi	Fisherman	Capture	39	6.07
Kebbi	Marketer (Wholesaler & Retailer)	Capture	38	5.91
Kebbi	Processor	Capture	38	5.91
Kebbi	Input Dealer	Capture	34	5.29
Kebbi	Feed Miller	Capture	1	0.16
Sub-total			150	23.33
Kebbi	Marketer (Wholesaler & Retailer)	Culture	40	6.22
Kebbi	Processor	Culture	34	5.29
Kebbi	Fish producer	Culture	26	4.04
Kebbi	Feed Miller	Culture	25	3.89
Kebbi	Input Dealer	Culture	25	3.89
Kebbi	Fisherman	Culture	13	2.02
Sub-total			163	25.35
Niger	Fisherman	Capture	48	7.47
Niger	Marketer (Wholesaler & Retailer)	Capture	32	4.98
Niger	Processor	Capture	32	4.98
Niger	Input Dealer	Capture	31	4.82
Niger	Feed Miller	Capture	1	0.16
Niger	Fish producer	Capture	1	0.16
Sub-total			145	22.55
Niger	Marketer (Wholesaler & Retailer)	Culture	40	6.22
Niger	Input Dealer	Culture	35	5.44
Niger	Processor	Culture	35	5.44
Niger	Feed Miller	Culture	33	5.13
Niger	Fish producer	Culture	30	4.67
Niger	Fisherman	Culture	12	1.87
Sub-total			185	28.77
Total			643	100.00
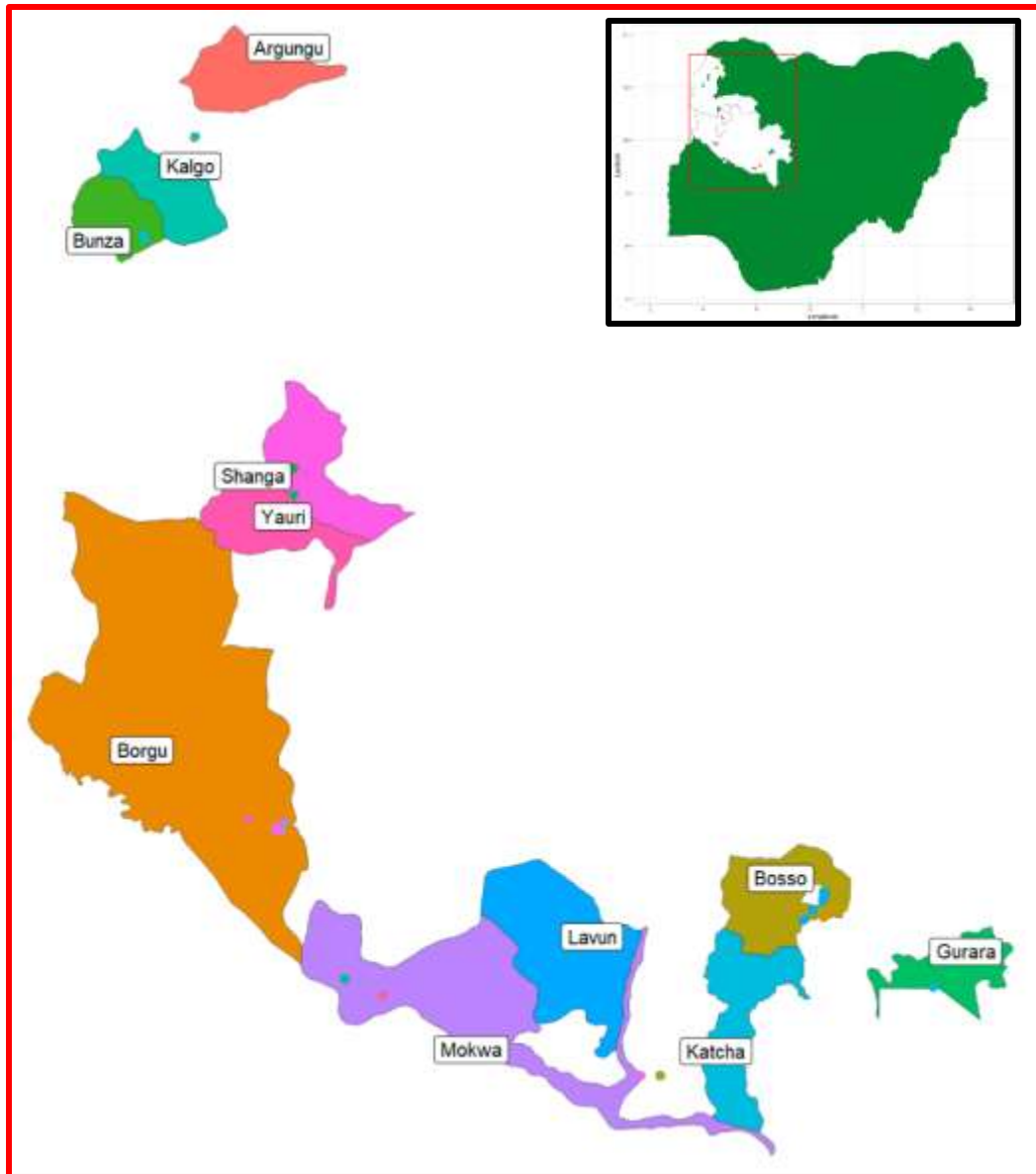
Figure. 1 Map of Nigeria showing the states and locations of data collection

The data were analyzed using descriptive and analytical techniques. The descriptive techniques included frequency distribution, percentages and Garrett ranking. The analytical techniques included Principal Component Analysis (PCA), which is an Exploratory Factor Analysis (EFA); Structural Equation Modelling (SEM) which is a Confirmatory Factor Analysis (CFA); Propensity Score Matching (PSM); regression, and Difference-in-Difference (DiD) method.

Table 2. Description of the variables used for PSM, DiD and regression

Variable	Unit of Measure	a priori
State	Niger, Kebbi	+
LGA	Argungu, Birnin Kebbi, Borgu, Bosso, Bunza, Gurara, Kalgo, Katcha, Lavun, Mokwa, Shanga, Yauri	+
Nodes	Capture = 1, culture = 0	+
Producer	fisherman or fish farmer = 1 and 0 otherwise	+
Actors	Feed Miller, Fish producer, Fisherman, Input Dealer, Marketer (Wholesaler/Retailer), Processor	+
Age	Years	+
Gender	Male, Female	+
Marital status	Divorced, Married, Separated, Single, Widowed/Widower	+/-
Primary source of capital	Commercial banks, Contribution Rotating Credit, Cooperative thrift society, Friends and relatives, Microfinance banks, None, Personal savings	+/-
Number of years in value chain	Number	+
Education (level)	Adult education, None, Primary, Qur'anic, Secondary, Tertiary (e.g., OND, NCE, HND, Degree, Post Degree), Vocational Skills acquisition	+
Primary occupation	Agro Trading, Artisan, Civil Servant, Crop farming, Driver, Feed milling, Fish farming, Fish marketing, Fish processing, Hunting, Input dealer, Livestock farming, Petty Trading, Transport services	+/-
Credit obtained	Naira	+
Interest on the credit obtained	%	-
MR1	Latent variable	-
MR2	Latent variable	-
MR3	Latent variable	-
MR4	Latent variable	-
MR5	Latent variable	-

Table 3. Summary statistics of the continuous variables in the models

Description	Age	Number of years in the value chain	Credit obtained	Interest on the credit obtained	MR1	MR2	MR3	MR4	MR5
Mean	39.81	10.99	3.67	3.34	39.29	22.43	53.04	8.03	1.58
SD	9.26	9.53	5.52	6.83	12.85	7.77	14.37	3.11	0.52
SE. Mean	0.37	0.38	0.22	0.27	0.51	0.31	0.57	0.12	0.02
Min	20.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Median	40.00	10.00	0.00	0.00	44.63	23.12	55.64	8.73	1.96
Max	70.00	50.00	14.91	30.00	49.26	30.23	63.60	11.27	1.96
Q1	34.00	3.00	0.00	0.00	35.62	17.91	50.62	6.30	1.47
Q3	46.00	15.00	10.91	1.00	49.26	30.23	63.03	10.82	1.96
Skewness	0.18	0.83	0.86	1.97	-1.74	-1.11	-2.46	-0.87	-1.52
Kurtosis	-0.22	0.43	-1.22	2.63	2.49	1.09	6.06	-0.01	1.80
Nobs	643.00	643.00	643.00	643.00	643.00	643.00	643.00	643.00	643.00

Table 4. Distribution of the categorical variables in the models

Variable	Eligible: Before	Ineligible: Before	Eligible: After	Ineligible: After
N	474	169	455	135
Actors				
X-Feed Miller	60 (12.7)	0 (0.0)	48 (10.5)	0 (0.0)
X-Fish producer	0 (0.0)	57 (33.7)	0 (0.0)	23 (17.0)
X-Fisherman	0 (0.0)	112 (66.3)	0 (0.0)	112 (83.0)

Variable	Eligible: Before	Ineligible: Before	Eligible: After	Ineligible: After
X-Input Dealer	125 (26.4)	0 (0.0)	122 (26.8)	0 (0.0)
X-Marketer (Wholesaler/Retailer).	150 (31.6)	0 (0.0)	147 (32.3)	0 (0.0)
X-Processor	139 (29.3)	0 (0.0)	138 (30.3)	0 (0.0)
Education....				
X-Adult education	4 (0.8)	1 (0.6)	4 (0.9)	1 (0.7)
X-None	44 (9.3)	7 (4.1)	41 (9.0)	6 (4.4)
X-Primary	46 (9.7)	20 (11.8)	45 (9.9)	20 (14.8)
X-Qur'anic	143 (30.2)	44 (26.0)	143 (31.4)	37 (27.4)
X-Secondary	147 (31.0)	52 (30.8)	135 (29.7)	46 (34.1)
X-Tertiary (e.g., OND, NCE, HND, Degree, Post Degree)	78 (16.5)	42 (24.9)	75 (16.5)	24 (17.8)
X-Vocational Skills acquisition	12 (2.5)	3 (1.8)	12 (2.6)	1 (0.7)
Primary source of capital				
X-Commercial banks	4 (0.8)	4 (2.4)	4 (0.9)	4 (3.0)
X-Contribution Rotating Credit	1 (0.2)	2 (1.2)	1 (0.2)	2 (1.5)
X-Cooperative thrift society	3 (0.6)	2 (1.2)		
X-Friends and relatives	3 (0.6)	0 (0.0)	2 (0.4)	0 (0.0)
X-Microfinance banks	3 (0.6)	0 (0.0)	3 (0.7)	0 (0.0)
X-None	5 (1.1)	6 (3.6)	5 (1.1)	6 (4.4)
X-Personal savings	455 (96.0)	155 (91.7)	440 (96.7)	123 (91.1)
Producer-1	0 (0.0)	169 (100.0)	0 (0.0)	135 (100.0)
Gender-Male.	70 (14.8)	2 (1.2)	67 (14.7)	1 (0.7)
Marital status				
X-Divorced	2 (0.4)	0 (0.0)	2 (0.4)	0 (0.0)
X-Married	392 (82.7)	143 (84.6)	381 (83.7)	119 (88.1)
X-Separated	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.7)
X-Single	77 (16.2)	25 (14.8)	71 (15.6)	15 (11.1)
X-Widowed Widower	3 (0.6)	0 (0.0)	1 (0.2)	0 (0.0)
Primary occupation				
X-Agro Trading	2 (0.4)	0 (0.0)		
X-Artisan	0 (0.0)	2 (1.2)	0 (0.0)	1 (0.7)
X-Civil Servant	13 (2.7)	0 (0.0)	13 (2.9)	0 (0.0)
X-Crop farming	29 (6.1)	36 (21.3)	29 (6.4)	31 (23.0)
X-Driver	1 (0.2)	0 (0.0)		
X-Feed milling	50 (10.5)	4 (2.4)	40 (8.8)	4 (3.0)
X-Fish farming	2 (0.4)	86 (50.9)	1 (0.2)	58 (43.0)
X-Fish marketing	141 (29.7)	34 (20.1)	140 (30.8)	34 (25.2)
X-Fish processing	124 (26.2)	2 (1.2)	123 (27.0)	2 (1.5)
X-Hunting	0 (0.0)	4 (2.4)	0 (0.0)	4 (3.0)
X-Input dealer	106 (22.4)	1 (0.6)	105 (23.1)	1 (0.7)
X-Livestock farming	2 (0.4)	0 (0.0)	2 (0.4)	0 (0.0)
X-Petty Trading	3 (0.6)	0 (0.0)	1 (0.2)	0 (0.0)
X-Transport services	1 (0.2)	0 (0.0)	1 (0.2)	0 (0.0)
State...Niger....	239 (50.4)	91 (53.8)	223 (49.0)	76 (56.3)
LGA....				
X-Argungu	36 (7.6)	12 (7.1)	36 (7.9)	8 (5.9)
X-Birnin Kebbi	36 (7.6)	11 (6.5)	36 (7.9)	8 (5.9)
X-Borgu	56 (11.8)	37 (21.9)	53 (11.6)	31 (23.0)
X-Bosso	50 (10.5)	12 (7.1)	49 (10.8)	11 (8.1)
X-Bunza	36 (7.6)	20 (11.8)	34 (7.5)	20 (14.8)
X-Gurara	1 (0.2)	0 (0.0)	1 (0.2)	0 (0.0)
X-Kalgo	29 (6.1)	6 (3.6)	29 (6.4)	6 (4.4)
X-Katcha	34 (7.2)	12 (7.1)	31 (6.8)	9 (6.7)
X-Lavun	40 (8.4)	11 (6.5)	37 (8.1)	6 (4.4)

Variable	Eligible: Before	Ineligible: Before	Eligible: After	Ineligible: After
X-Mokwa	58 (12.2)	19 (11.2)	52 (11.4)	19 (14.1)
X-Shanga	54 (11.4)	16 (9.5)	53 (11.6)	9 (6.7)
X-Yauri	44 (9.3)	13 (7.7)	44 (9.7)	8 (5.9)
Nodes-1	207 (43.7)	88 (52.1)		

Source: Data (Field survey 2023), Table (Yoshida & Bartel, 2022)
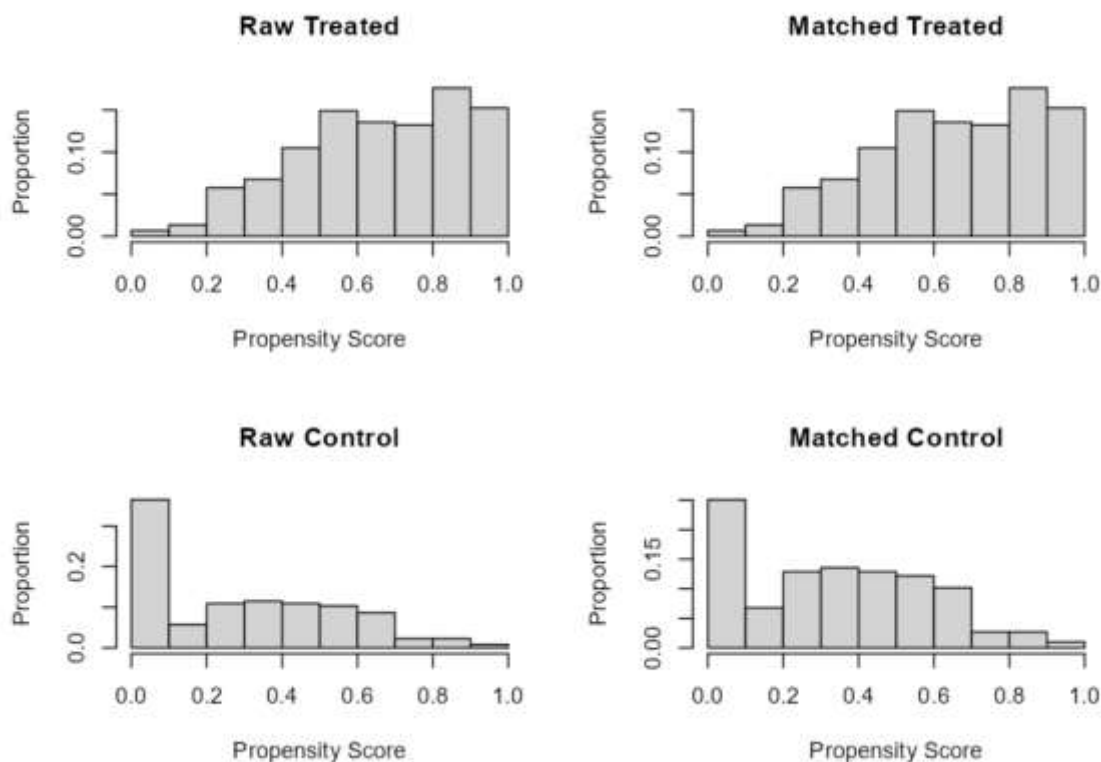
Figure. 2 Distribution of the respondents based on the PSM experiment
Source: Data (Field survey, 2023) Graphics (Wickham, 2016)

Table 5. Matching statistics of fish producers in Niger and Kebbi States

Variable	Control	Treated
All (ESS)	348.00	295.00
All	348.00	295.00
Matched (ESS)	295.00	295.00
Matched	295.00	295.00
Unmatched	53.00	0.00
Discarded	0.00	0.00

In order to determine the impact of credit on the probability of participation of the producers in the value chain, a treatment of mean credit taken is applied as the intervention on Kebbi producers while Niger producers are the control. The intervention was carried out before and after PSM was undertaken. The difference in credit is the impact on the treated. The nearest method was used to carry out the PSM. All the estimation and analysis were carried out in R with various functions (R Core Team, 2023).

3. Results and Discussion

The results of the Garrett ranking of the constraints is expressed in Table 6 while in a bid to analysis the inter-relationship between the constraints and their latent variables, a path diagram was produced as shown in Fig.3. Table 7 shows the coefficients estimates of the logistic and linear regression models for estimation of DiD before and after PSM. Fig. 4 is the distribution of the fish producers based on the probability of participation. Finally, Table 8 show the treatment Effects of the fish producers and Fig. 5 presents the impact the experiment had on the fish producers. The results of the PSM indicated that 590 of the respondents were matched while 53 respondents were not matched. This really means that 92% of the respondents possessed similar measured covariates and would produce stable regression outcomes for prediction and policy analysis.

The result in Table 6 indicated that out of the 65 observed variables described by the 643 respondents, 48 were considered constraints (mean > =3.1) while 17 were not constraints (mean <3.1). However, when the variables were ranked based on Garrett mean score, one of the variables considered not a constraint, i.e., lack of insurance against pilfering/theft, moved nine points up and placed within variables marked constraints. This tend to suggest that Garrett ranking is more stringent with individual scores than merely using the mean although Garrett method does not give a procedure for marking the variables either 'constraint' or 'not constraint'. The effect of this variable needs to be investigated further as may be revealed presently. The results in Table 5 further reveal that EFA created five latent variables from the 65 that were described by the farmers. The five latent variables were code-named MR1 (Production constraints), MR2 (Institutional constraints), MR3 (Storage and processing constraints), MR4 (Marketing constraints) and MR5 (Input cost constraints). The variable item with the highest mean value is the best indicator of the latent factor, which usually have the least error variance left over. A closer look at the latent factors indicated that of all the MR1, two are not constraints whereas of the 13 MR2 factors, only 4 were considered constraints. Most of MR3 factors were constraints but only one MR4 is constraint. Surprisingly, the only variable in MR5 is constraint. From the foregoing, we observed that descriptive and exploratory analysis did not give uniform outcome which necessitate the need to investigate the variables further. However, the result in Fig. 3, depicting the analysis of covariance, i.e., correlation and directional path, shows that the factor constructs were significantly correlated with one another through some dynamic connections between all the factors based on the CFA factors loadings. For example, it can be observed from Fig. 3 that 0.78 is the estimated coefficient that dynamically connects MR1 and MR3. This is the bi-directional relationship and the rate of change of either by the other in a positive way.

The results of the estimates in Table 7 giving the factors affecting credit obtained (LM) and the factors affecting the probability of participation (GLM) of fish producers in the two nodes shows that the results after the PSM is a significant improvement over the results before PSM. The coefficients were better and more policy variables, that is variables acting against a priori expectation, have been determined.

First, it was found that those respondents that are not producers tends to suppress participation either in the capture and culture nodes since they are in the other related chains. Perhaps, this is in a bid to avoid the risks associated with direct production but then that would mean that they would be dealing with limited opportunities. Not only that, respondents are more likely to participate in the capture node (Fig. 4) than in the culture mode, again, given an indication of risk-aversion, since the capture node requires less capital that would warrant application of credit. This seems to give credence to the issue of concerns being raised about the absence of insurance cover which was alluded earlier, since a credible and thriving insurance market would reduce the need for risk-avoidance, however, credit did not play any significant role in the probability of participation. This is in spite of the findings of Mufato (2021) in which they asserted that credit use is an important factor that significantly affects the level of participation in pond fish production.

Figure. 3 The dynamic relationships between the constraints and their latent variables
Source: Data (Field survey, 2023), Graphics (Epskamp, 2022)

One of the big upsets of the results is the effect of primary source of capital and education on credit. They were expected to promote the use of credit; as more knowledge is acquired through education, it is expected that the actors would learn to operate as a business and the primary source of capital would promote their capacity to either seek credit or manage what they seek. Well, the reason for this may not be far-fetched. Most of the actors did not acquire more than secondary education and almost all, in fact 90% of Niger State and 97% of Kebbi State, are sourcing their capital from their personal savings (see Table 4). So, more efforts are needed by policy people to encourage farmers to seek appropriate knowledge for managing their businesses and they should imbibe the culture of raising capital for their businesses through the correct way, including credit and loans as well as equity/capital markets. Personal savings are to be used for family welfare, education of their children and family leisure and vacations which will also promote livelihoods. This line of argument perfectly aligns with Twumasi et al. (2020), that assurance of credit availability and accessibility by fishermen will not only improve their productivity but also their welfare as a whole.

The coefficients of States and LGAs' effect on credit behaved well according to a priori expectation except Bosso. The result about Bosso is a very important issue which should be further investigated, after all, Bosso houses one of the largest culture colonies at Lapai-Gwari community in Niger Sate. However, it must be understood that Bosso is not directly along the course of the rivers criss-crossing Niger State. In the same vein, the latent variables produced.

Table 6. Structure, latent factors and Garrett ranking of constraints expressed by fish producers in Nigeria

S/No	Description	Latent factor	Total	Mean	Total Garrett Score	Mean score	Rank	Remark*
63	Diseases and pests (insects) infestation	MR1	614	3.59	53493	87.12	1	C
60	Use of chemicals for harvesting	MR1	605	3.48	52609	86.96	2	C
43	Lack of raw materials to build and repair fishing vessels	MR1	613	3.49	53174	86.74	3	C
44	Sales of immature fish	MR1	605	3.42	52444	86.68	4	C
39	Low and unattractive prices for produce	MR1	604	3.39	52303	86.59	5	C
40	Distance of the extension staff's office to the village/ farm	MR1	604	3.39	52295	86.58	6	C
57	Seasonality of fishing	MR1	611	3.38	52867	86.53	7	C
7	Scarcity of brood-stocks	MR1	605	3.36	52310	86.46	8	C
32	Challenges of land acquisition/land tenure system	MR1	603	3.35	52136	86.46	9	C
17	Youth restiveness	MR1	608	3.37	52557	86.44	10	C
55	Inadequate access to capital	MR1	607	3.35	52456	86.42	11	C
5	Covid-19 Pandemic	MR1	604	3.35	52194	86.41	12	C
25	High mortality rate	MR1	614	3.41	53058	86.41	13	C
8	Poor quality fish products	MR3	602	3.33	52019	86.41	14	C
4	Lack of technical know-how	MR1	602	3.33	52003	86.38	15	C
24	High cost of fish feeds	MR1	610	3.38	52666	86.34	16	C
18	Multiple or high tax prices	MR1	612	3.36	52816	86.3	17	C
23	Unstable market prices	MR1	609	3.35	52551	86.29	18	C
9	Non-availability / High cost of quality fish seeds	MR1	608	3.31	52437	86.25	19	C
19	Poor processing methods/ Poor post-harvest technologies	MR3	601	3.28	51833	86.24	20	C
21	Inadequate market information	MR1	609	3.35	52518	86.24	21	C
36	Poor level of education/illiteracy	MR1	601	3.27	51812	86.21	22	C
10	Poor market outlets	MR3	602	3.28	51894	86.2	23	C
62	Inadequate motivation from extension officer	MR3	602	3.26	51853	86.13	24	C
20	Frequent fish cannibalism	MR1	608	3.31	52367	86.13	25	C
64	Perishability of fish products	MR3	601	3.25	51757	86.12	26	C
30	Poor / high cost of transportation	MR1	603	3.27	51924	86.11	27	C
31	Inability access to input and output market due to disturbances (communal-clash/herdsmen/banditry/kidnapping/insurgency)	MR1	605	3.27	52080	86.08	28	C
54	Access to fingerlings	MR3	603	3.22	51850	85.99	29	C
2	High cost of labour	MR3	605	3.23	52020	85.98	30	C
27	Inadequate storage facilities	MR3	602	3.20	51728	85.93	31	C
35	Shortage of raw materials to build and repair fishing vessels	MR3	600	3.19	51552	85.92	32	C
58	Poaching / Predators	MR3	601	3.19	51620	85.89	33	C
12	Inadequate extension and farm advisory services	MR1	610	3.22	52392	85.89	34	C
37	Insufficient labour	MR3	603	3.20	51789	85.89	35	C
13	Inaccessibility to modern technologies	MR1	609	3.22	52301	85.88	36	C
59	High cost of fishing inputs and construction equipment	MR3	603	3.19	51762	85.84	37	C
22	Lack of standard unit of measurement	MR4	614	3.21	52699	85.83	38	C
33	Seasonal flooding and storm	MR1	604	3.19	51790	85.75	39	C
51	High cost of feed ingredients	MR5	614	3.22	52628	85.71	40	C
34	Poor/shortage of veterinary services	MR2	601	3.15	51511	85.71	41	C
42	Low capacity for production of high-quality feeds	MR3	612	3.19	52453	85.71	42	C
6	Lack of insurance against pilfering/theft	MR4	601	3.09	51482	85.66	43	NC
26	Availability of modern equipment	MR2	605	3.13	51808	85.63	44	C
56	Inadequate access to credit	MR3	603	3.13	51628	85.62	45	C
61	Perennial shortage of water during dry season (drought)	MR2	601	3.12	51456	85.62	46	C
46	Many sellers in the market	MR2	600	3.10	51352	85.59	47	C
53	Lack of knowledge resulting in poor management practices	MR1	615	3.19	52623	85.57	48	C
29	Dependence on imported feed ingredients	MR2	600	3.09	51295	85.49	49	NC
1	Seasonality of fishing	MR2	602	3.09	51433	85.44	50	NC

S/No	Description	Latent factor	Total	Mean	Total Garrett Score	Mean score	Rank	Remark*
28	Lack of infrastructures like access roads, electricity and water	MR3	602	3.03	51340	85.28	51	NC
16	High interest rate on borrowed funds	MR1	611	3.03	52090	85.25	52	NC
41	Poor management skills	MR1	610	3.03	51967	85.19	53	NC
48	High cost of acquiring credit facilities	MR2	605	2.96	51448	85.04	54	NC
45	Inadequate processing facilities	MR3	605	2.98	51442	85.03	55	NC
49	Decline in supply	MR2	607	2.99	51604	85.01	56	NC
3	High exchange rate	MR3	599	2.92	50877	84.94	57	NC
11	Lack of well-trained boat builder	MR2	605	2.87	51193	84.62	58	NC
65	Inadequate access to quality water	MR2	608	2.87	51443	84.61	59	NC
50	Lack of trained personnel	MR2	613	2.89	51831	84.55	60	NC
52	Poor feed quality	MR2	607	2.87	51312	84.53	61	NC
47	Middlemen exploitation	MR4	609	2.80	51444	84.47	62	NC
38	Employees inability to come to work because of disturbances (communal-clash/herdsmen/banditry/kidnapping/insurgency)	MR2	606	2.81	51117	84.35	63	NC
15	Lack of Co-operative Societies or Fish Farmers Associations	MR4	600	2.59	50369	83.95	64	NC
14	Reduction in walk-in customers to the farm due to disturbances (communal-clash/herdsmen/banditry/kidnapping/insurgency)	MR4	611	2.67	51288	83.94	65	NC

Table 7. Coefficient estimates of the DiD before and after PSM of fish producers in Nigeria

Variable	LM1 After	GLM1 After	LM After	GLM After	LM1 Before	LM before	GLM1 Before	GLM Before
(Intercept)	3.280***	0.495+	-5.873	22.375	3.382***	9.655*	0.076	13.517
	(0.330)	(0.264)	(4.435)	(2058.245)	(0.317)	(4.245)	(0.235)	(3892.963)
Nodes1	0.198		0.055		0.130	0.412		
	(0.456)		(0.250)		(0.437)	(0.299)		
Producer1	0.987+				0.871+			
	(0.543)				(0.495)			
State-Niger			4.100***	-0.868		0.609		-0.628
			(0.933)	(0.924)		(1.066)		(0.797)
State-Kebbi × Producer0		-0.602*					-0.203	
		(0.287)					(0.261)	
State-Niger × Producer0		-0.858**					-0.539*	
		(0.276)					(0.249)	
State-Kebbi × Producer1		0.152					-0.094	
		(0.376)					(0.320)	
State-Niger × Producer1				0.446				0.582
				(0.814)				(0.770)
MR1 (Production constraints)			-0.087+	-0.005		-0.138**		-0.004
			(0.045)	(0.041)		(0.052)		(0.041)
MR2 (Institutional constraints)			-0.405***	0.135		0.045		0.097
			(0.086)	(0.107)		(0.096)		(0.073)

Variable	LM1 After	GLM1 After	LM After	GLM After	LM1 Before	LM before	GLM1 Before	GLM Before
MR3 (Storage and processing constraints)			0.442***	-0.115		0.060+		-0.083**
			(0.038)	(0.071)		(0.035)		(0.030)
MR4 (Marketing constraints)			-0.831***	0.163		-0.104		0.113
			(0.131)	(0.147)		(0.142)		(0.113)
MR5 (Input cost constraints)			0.876	-0.290		0.522		-0.205
			(0.534)	(0.494)		(0.615)		(0.474)
Credit obtained	0.015			0.073			0.012	0.052
	(0.017)			(0.054)			(0.016)	(0.034)
LGA-Birnin Kebbi			0.767	-0.035		0.024		-0.016
			(0.572)	(0.517)		(0.662)		(0.514)
LGA-Borgu			0.538	-0.082		0.632		-0.074
			(0.795)	(0.704)		(0.928)		(0.705)
LGA-Bosso			-6.320***	1.015		-2.060+		0.699
			(1.038)	(1.098)		(1.194)		(0.925)
LGA-Bunza			8.569***	-2.200		-0.746		-1.513**
			(0.826)	(1.431)		(0.674)		(0.524)
LGA-Gurara			-0.389	1.090		5.285		35.421
			(3.886)	(2058.243)		(4.035)		(4652.512)
LGA-Kalgo			2.376***	-0.870		-1.220		-0.633
			(0.711)	(0.769)		(0.798)		(0.588)
LGA-Katcha			3.348***	-0.651		1.675+		-0.471
			(0.844)	(0.827)		(0.980)		(0.762)
LGA-Lavun			4.584***	-0.842		2.124*		-0.640
			(0.922)	(0.948)		(1.064)		(0.833)
LGA-Shanga			-0.814	0.158		0.368		0.102
			(0.543)	(0.488)		(0.618)		(0.473)
LGA-Yauri			-0.202	-0.029		-0.305		-0.016
			(0.536)	(0.478)		(0.620)		(0.477)
Actors-Fish producer			6.800***	-2.673		-1.325		-2.155
			(1.129)	(2.207)		(1.040)		(1.604)
Actors-Fisherman			-18.251***	5.599+		-1.190		4.224***
			(1.375)	(2.915)		(0.963)		(1.119)
Actors-Input Dealer			-5.833***	2.591+		1.721		2.129+
			(1.098)	(1.550)		(1.136)		(1.226)
Actors-Marketer (Wholesaler & Retailer)			-9.990***	3.520+		-0.684		2.788*
			(1.040)	(1.838)		(0.995)		(1.114)
Actors-Processor			-13.087***	4.428+		0.433		3.418**
			(1.289)	(2.319)		(1.133)		(1.198)
Age			0.045*	-0.009		0.003		-0.006
			(0.017)	(0.016)		(0.020)		(0.015)

Variable	LM1 After	GLM1 After	LM After	GLM After	LM1 Before	LM before	GLM1 Before	GLM Before
Gender-Male			-4.403***	1.112		-0.311		0.807*
			(0.524)	(0.725)		(0.538)		(0.403)
Marital status-Married			5.977*	-14.549		-0.879		-32.624
			(2.819)	(1455.398)		(2.611)		(2854.366)
Marital status-Separated			4.231	-3.162		-3.360		-19.002
			(3.860)	(2058.244)		(4.118)		(4878.398)
Marital status-Single			8.436**	-15.155		-1.294		-33.041
			(2.891)	(1455.398)		(2.648)		(2854.366)
Marital status-Widowed/Widower						0.491		-51.208
						(3.435)		(3760.574)
Number of years in the value chain			-0.236***	0.060		0.004		0.042**
			(0.022)	(0.038)		(0.019)		(0.015)
Primary source of capital-Contribution/Rotating Credit			-10.700***	3.068		-1.894		2.402
			(2.017)	(2.939)		(2.321)		(2.604)
Primary source of capital-Cooperative/thrift society						-0.411		-14.112
						(2.019)		(1417.135)
Primary source of capital-Friends and relatives			-8.031***	2.255		-1.268		1.612
			(2.240)	(2.150)		(2.399)		(1.799)
Primary source of capital-Micro-finance banks			-6.509**	2.113		0.668		1.533
			(2.118)	(2.300)		(2.488)		(2.035)
Primary source of capital-None			-9.410***	2.119		-2.042		1.528
			(1.417)	(1.655)		(1.601)		(1.215)
Primary source of capital-Personal savings			-7.455***	1.942		-1.006		1.388
			(1.148)	(1.438)		(1.273)		(1.019)
Education-None			-7.669***	2.294		0.150		1.587
			(1.376)	(1.810)		(1.537)		(1.268)
Education-Primary			-10.951***	3.349		0.721		2.318+
			(1.469)	(2.297)		(1.528)		(1.271)

Variable	LM1 After	GLM1 After	LM After	GLM After	LM1 Before	LM before	GLM1 Before	GLM Before
Education-Qur'anic			-10.598***	3.192		0.641		2.208+
			(1.439)	(2.200)		(1.493)		(1.243)
Education-Secondary			-9.138***	2.732		0.191		1.883
			(1.384)	(1.995)		(1.500)		(1.249)
Education-Tertiary (e.g., OND, NCE, HND, Degree, Post Degree)			-8.565***	2.535		0.230		1.742
			(1.383)	(1.924)		(1.514)		(1.265)
Education-Vocational/Skills acquisition			-7.697***	2.149		0.801		1.465
			(1.509)	(1.845)		(1.679)		(1.382)
Primary occupation-Artisan						-9.601**		16.796
						(3.335)		(2647.230)
Primary occupation-Civil Servant			6.179*	-11.704		-1.963		15.587
			(2.820)	(1455.398)		(2.427)		(2647.216)
Primary occupation-Crop farming			1.704	-11.101		-5.216*		15.962
			(2.703)	(1455.398)		(2.355)		(2647.216)
Primary occupation-Driver						-14.956***		-0.413
						(3.935)		(4760.159)
Primary occupation-Feed milling			9.168**	-13.408		-6.085*		14.297
			(2.896)	(1455.398)		(2.426)		(2647.216)
Primary occupation-Fish farming			7.680**	-12.862		-4.071+		14.533
			(2.762)	(1455.398)		(2.431)		(2647.216)
Primary occupation-Fish marketing			7.583**	-12.860		-5.493*		14.728
			(2.774)	(1455.398)		(2.457)		(2647.216)
Primary occupation-Fish processing			10.194***	-13.524		-5.954*		14.265
			(2.887)	(1455.398)		(2.584)		(2647.216)
Primary occupation-Hunting			0.642	2.306		-3.848		31.262
			(3.098)	(1614.040)		(2.949)		(3272.961)

Variable	LM1 After	GLM1 After	LM After	GLM After	LM1 Before	LM before	GLM1 Before	GLM Before
Primary occupation-Input dealer			0.006	-10.960		-7.340**		16.058
			(2.870)	(1455.398)		(2.454)		(2647.216)
Primary occupation-Livestock farming			-0.586	-11.005		-7.380*		16.055
			(3.380)	(1455.399)		(3.428)		(2647.216)
Primary occupation-Petty Trading			-14.769**	-7.884		-8.461*		0.594
			(4.781)	(2520.824)		(3.298)		(3196.087)
Primary occupation-Transport services			-17.949***	5.186		-11.414**		33.303
			(3.886)	(2058.245)		(4.005)		(4760.159)
Interest on the credit obtained			0.752***	-0.087		0.549***		-0.061*
			(0.024)	(0.058)		(0.023)		(0.028)
distance			28.127***	-2.002				
			(1.839)	(3.788)				
subclass			0.002+	0.000				
			(0.001)	(0.001)				
Num.Obs.	590	590	590	590	643	643	643	643
R2	0.007		0.798		0.005	0.705		
R2 Adj.	0.003		0.778		0.002	0.678		
AIC	3683.7	809.7	2846.6	731.9	4025.0	3348.6	890.3	736.7
BIC	3701.2	831.6	3087.5	972.8	4042.9	3603.2	912.6	991.3
Log.Lik.	-1837.843	-399.829	-1368.317	-310.933	-2008.501	-1617.296	-440.141	-311.373
F	1.928				1.640			
RMSE	5.45	0.49	2.46	0.43	5.50	2.99	0.50	0.41

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
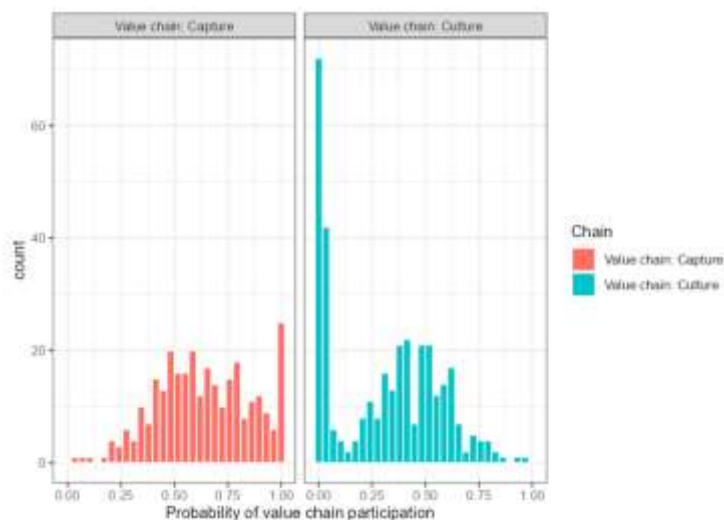
A. Before PSM
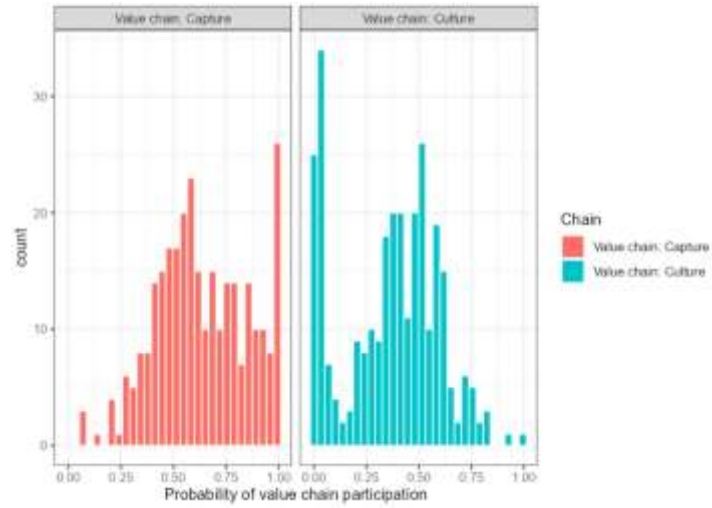
B. After PSM
Figure. 4 Distribution of the fish producers based on the probability of participation
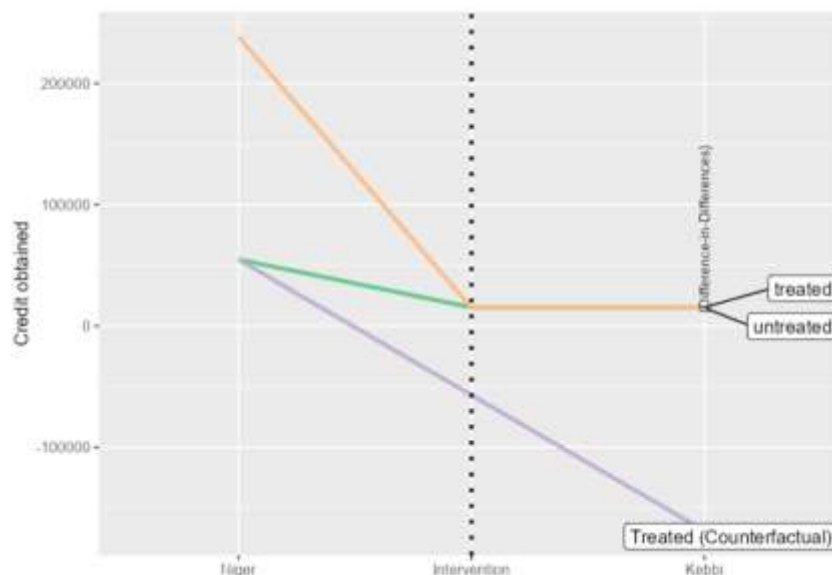Source: Data (Field survey, 2023) Graphics (Wickham, 2016)

Table 8. Treatment Effects of fish producers in Nigeria

ATE	Before matching	After matching
Treated Kebbi before experiment	74082.10	54797.99
Control Niger before experiment	224641.45	238550.11
Treated Kebbi after experiment	20264.16	15329.95
Control Niger after experiment	14779.82	14977.73
Treated counterfactual (Kebbi)	-135779.53	-168774.38
Average Treatment Effect on the Treated (ATT)	156043.69	184104.33
Impact (%)	0.00	15.24
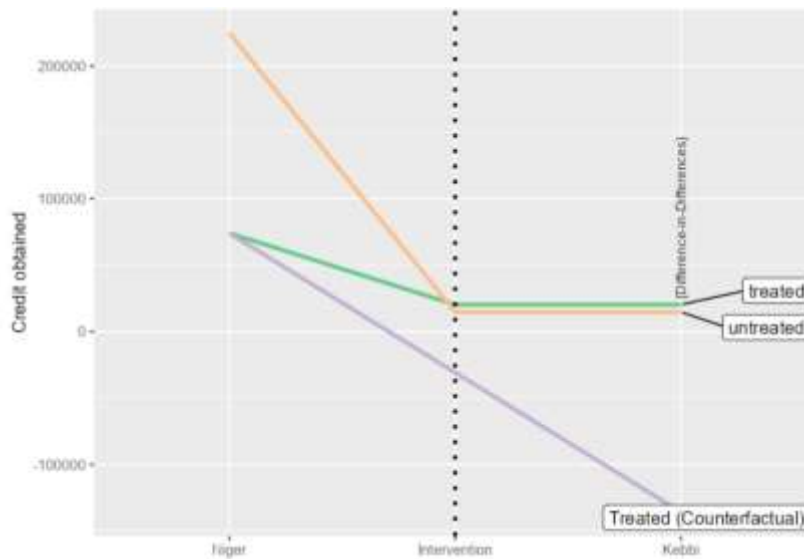
A. Before PSM

B. After PSM
Figure. 5 Impact of the PSM experiment of credit availability for fish producers
Source: Data (Field survey, 2023) Graphics (Wickham, 2016)

Expected results except MR3 (Storage and processing constraints) which tend to have positive effect on credit. This is understandable because the more credit is available, the more likely the processors would adopt modern methods of fish preservation, processing and storage (Ajayi, 2023) which would have positive effect on health and wellness of the consumers. MR4 which houses the variable 'lack of insurance against pilfering/theft' is not significant but it really means that the absence of insurance cover is a serious concern of producers. Insurance cover against various production threats (Anonymous, 2024) in addition to banditry, kidnapping of farmers, insurgency perpetuated by non-state actors would also reduce the fear of producers to invest in the value chain thereby increasing supply, enhancing income and improving livelihoods. In any case, a robust and stable insurance markets, which are poorly developed in Nigeria, are needed to promote fish value chain businesses. In the view of Twumasi et al. (2020), fisherman's ability to secure credit can affect the optimization of output supply by enabling fishermen to use satisfactory levels of inputs for production and also make use of modern technologies.

On the experiment conducted with mean credit, the results in Table 8 and Fig. 5 shows that participation can be improved by up to 15% in the presence of credit to the producers. The mean interest on credit (Table 2) is less than 4% which can easily be offset by the increase in participation, since increase in participation would increase output, income and profit thus given enduring livelihoods to the producers.

4. Conclusion and Recommendation
Investigating the connection between constraints faced by fish producers in Nigeria and the credit they obtained on the probability of participation in the fish value chain is critical in line with the desire to ensure sustainable fish availability to consumers. In view of this, a number of analytical tools; including Garrett ranking, SEM and regression; were utilised to unravel what the connection looks like. In order to analyse the connections, data were collected from 643 fish value chain actors in Niger and Kebbi States in Nigeria between April 2022 and February 2023. These two states have access to Rivers Niger, Shiroro and Kaduna and their various tributaries. From the results obtained, 48 variables out of the 65 described by the actors were considered a constraint based on the mean and five latent factors were determined and the values retrieved for further analysis. The latent variables exhibited positive bi-directional relationship between one another which is an indication that the factors are not isolated occurrences. From the PSM and regression, a number of policy variables were obtained which may call for further investigation but needs to be adequately addressed. Particularly, the tendency of low probability of participation in the face of low educational acquisition. There is also a very strong indication that the actors are conducting their businesses with low capital which

has further devalue the level of participation. Ultimately doing business with adequate capital can increase participation by up to 15% and as such, can increase outputs, income, profits and enhance livelihoods.

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