ASSESSING THE SYMMETRIC IMPACT OF IRRIGATION FARMING ON CONSUMPTION USING QUANTILE REGRESSION APPROACH

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ABSTRACT

This study assesses the symmetric impact of irrigation farming on consumption in Malumfashi Local Government Area of Katsina State. The study uses cross-sectional primary data which was obtained from field survey of 233 respondents. The study employed Quantile Regression (QR) for the analysis and found that irrigation farming has a significant positive impact on consumption expenditure of irrigation farmers in Malumfashi local government, Katsina state. Also evident from QR result, the distribution of impact of irrigation farming on expenditures of irrigation farmers is asymmetric indicating a greater impact of irrigation on low-income irrigation farmers than on high income earners. Thus, irrigation farming is key to well-being enhancement, particularly to low-income earners. Therefore, concerted efforts should be geared towards formulating policies that will improve irrigation farming productivity more specifically in the rural areas. This can be achieved, among other options, through providing financial support and irrigation farming facilities to local farmers through various agricultural agencies., Similarly, setting committees from the side of the farmers that will serve as medium between the farmers and government, thereby easing the contact government easily by the farmers while, in turn government can get feedback from farmers through these committee thus, enhancing efficiency in communication process between the parties involved. Also, monetary authorities should target investment friendly loans, which would enhance corporate and individual borrowings for encouraging investments and promote aggregate consumption expenditures in returns.

Keywords: Asymmetric Impact, Irrigation Farming, Consumption, Quantile Regression, Malumfashi

JEL Classification: *E31, I32, H53*

Introduction

Agriculture through crop farming influence economic well-being of many regions of the world including Asia and Africa (Ikudayisi Babatunde, & Yusuf, 2019). According to Andrea (2014) approximately 1.5 billion people of the world engaged in smallholder farming and they constitute about 75% of the world poorest people whose food, income, consumption and livelihood prospects depend on agriculture. However, consumption expenditure of farmers is affected by productivity or yield, which can be seen as a reflection of change in income generated from increase in yield due to rainfall variability that thus, exert direct influence on agricultural production (Kilic, Palacios-Lopez, & Goldstein, 2015)**.** Hence, farmers' welfare can be affected by rainfall variability, and this can be more pronounced among poor farmers **(**Mulubrhan, et al., 2018). Consequently, the challenges of well-being of farmers, which is often associated with rain-fed agricultural practice necessitate the utilization of irrigation technique as a viable option in practicing agriculture in many parts of the world including Asia and sub-Saharan Africa. Therefore, irrigation farming is essentially important strategy of increasing agricultural productivity, secure agricultural-based livelihoods, enhance food security and overcome rural poverty for a large number of smallholders (Gebrehiwot, Mesfin, & Nyssen, 2015).

In Nigeria, it is clearly evident that agriculture is predominantly rain-fed and rural–based in nature engaging majority of the labour force and serves as a major source of livelihood (International Fund for Agricultural Development [IFAD], 2012). Therefore, irrigation farming support farmers from being relying on rain-fed production. In 2018, it was estimated that irrigation agriculture contributes about 40 percent of the food produced globally, which covered about 21 percent of the entire cultivated land worldwide, out of which 37 per cent is cultivated in Asia, 15 per cent is cultivated in South America and 6 per cent in Africa (Food and Agriculture Organization Statistics [FAOSTAT], 2018). Consequently, Ogunniyi, et al. (2018) assert that in Nigeria, where poverty is widespread, agriculture that depends on rainfall is no longer secured for sustainable agricultural productivity in the country. Because, utilization of irrigation farming at a large scale would help to resolve rural farmers' poverty and backwardness by allowing for all year round farming, more especially in the Northern part Nigeria wherein the Malumfashi LGA, Katsina state that has more than 56% of its population living in poverty is found (National Bureau of Statistics [NBS], 2020). Admittedly,, Katsina state is an agrarian state with about 90% of its population engaged in subsistent farming and most of them are smallholder farmers that rely on rain–fed as either

supplementary or sole means of their livelihood. This indicates that income from this source is directly related to the welfare of the substantial number of population in Katsina state including Malumfashi LGA. However, with irrigation facilities, dams and land in abundance all over Katsina state, farmers can be quite prosperous and have well-being enhanced even though, a detailed investigation into viability of irrigation farming is not sufficient in literature, which made drawing a useful and definite conclusion on the effect of irrigation farming on welfare of farmers in Katsina state, particularly Malumfashi local government area of the state yet difficult. Against this background, this study symmetrically assess the effect of irrigation farming on farmers' consumption in Katsina state using Malumfashi Local Government Area as case study.

2. Literature Review

2.1 Conceptual review

2.1.1 Concept of Irrigation Farming

Several attempts has been advanced by various scholars of different disciplines to conceptualize the term irrigation farming and harmoniously irrigation farming as system of applying and supplying the right volume of water on farmland for crop germination and improved yield. However, Synder & Melo-Abreu (2005) situate their definition to agricultural science paradigm that viewed irrigation as cultivation of land to ensure double cropping through artificial application and continues application of water in the parts were rainwater is scanty. Thus, irrigation farming can be seen as the act of applying water to land for the purpose of supplying crops or plants with necessary water for plant germination and growth. Similarly, from Geography viewpoint, irrigation is defined as the practice of applying artificial water in the soil aimed at supplementing natural available moisture vital for plant growth (Iroye, 2018). Therefore, this study operationalized the concept of irrigation farming as system of supplying right quantity of water to the farmland needed for plant germination and growth.

2.1.2 Consumption Expenditure

In the view of neoclassical economists, consumption is the final purpose of economic activity. Consumption is considered as economic activity in which resources are allocated in order to satisfy individual needs (Fisher, 1930). Keynes defined Consumption as the sum of expenditures on goods and services by individuals and households except new houses. Hence these expenditures can be broadly categorized into: nondurable goods, durable goods, and services.

(i) Durable goods are those tangible goods expected to last a long time for example furniture, TV set, car e t c.

(ii) Nondurable goods refer to tangible goods with limited durability usually less than one year for example food stuff, perishable goods e t c.

Consumption expenditure on different items and expendable goods, that is, goods purchased and consumed on a frequent basis may be used to measure wellbeing of an individual (Friedman, 1957) as it gives an indication of the consumption behavior of households.

2.2 Theoretical review

2.2.1 Keynesian Theory of Consumption

Modern studies on consumption began with the emergence of the Keynes General Theory. Keynes asserted that "Man on average as a rule, have behavior that when their income increase, they increase their consumption, but not as much as their income increase" since some part of the income will be saved. According to Keynes consumption depends exclusively on disposable income in the current period hence any change in current income is reflected in a change in consumption. Hence, this study adopts Keynes's basic theory of consumption that described consumption expenditures as a function disposable income. The Keynesian consumption function is therefore written in linear form as:

$$C = a + bY \quad \text{.....(2.1)}$$

a and b are constants, where 'a' is the intercept term, that is, the amount of consumption expenditure at zero level of income hence, 'a' is autonomous consumption, while coefficient 'b' which Keynes called the "marginal propensity to consume" (MPC) measures the change in consumption spending in response to per unit change in disposable income and it is expressed as $\partial C/\partial Y$, which is always MPC less than one but greater than zero ($1 > MPC > 0$). Based on this hypothesis it is therefore expected that as farmer's income increases by participating in irrigation farming, their consumption expenditure also increases.

2.3 Empirical Literature review

Getaneh, et al. (2019) examines of the impact of irrigation on household income and likelihood of poverty reduction. A sample of 180 farmers was analyzed using Tobit and Logit model. The result shows that incomes of irrigation farmers increased as a result of the project and there is higher proportion of poverty among non-irrigating household than those that participate in the scheme. Therefore, an increased income from irrigation farming means an increase in farmers' earning

capacity that thus increase both their consumption and saving propensity that resultantly reduce poverty among irrigation farmers.

Using probit and ordinary least square regression, Bjornlunda, et al. (2019) examines how income generated from irrigation influence farm household decision-making in South Africa and the result shows that farmers have to choose between irrigation, livestock, dry land and off-farm work when they allocate their labour resources to maximize their income from any component of their live strategy, as such, the income maximized from decision making process is positively reflected on the consumption expenditure of irrigation farmers. Since, consumption spending is a common factor that both firm and household must to contend with when making decision on income. More so, Assefa et al. (2019) examined small-scale irrigation scheme, governance– poverty nexus, using Foster-Greer Thorbecke indices. The study shows that living condition of farmers has improved as a result of the scheme owing to increased income realized from irrigation practice of farming.

Ibrahim, et al. (2018) evaluates the impact of irrigation farming on socio-economic development in Kafur local government area of Katsina State, Nigeria. With a survey of 379 irrigation farmers, using descriptive statistics as a technique of analysis, the result shows that income generated from irrigation farming has substantially increase the overall economic well-being of irrigation farmers in the area. This is shown in the increasing value of farmers' income from irrigation farming for which substantial part of the increased income is expended on farmers' consumption thereby reflecting an improved living standard of such farmers. Conclusively, irrigation farming is of positive impact farmers' consumption.

Also Gebrehiwot, et al. (2017) investigate the effect of small scale irrigation on household's welfare, they conducted a survey of 482 rural household farmers in the northern part of Ethiopia using Endogenous Switching Regression, they found that the scheme has helped positively and substantially on household asset formation and income of irrigation participant increase tremendously thereby translating to improvement in consumption spending of the irrigation farmers. Similarly, with the aid of Gini coefficient measures, Ana (2017) analyses earning differences among six irrigation schemes at both local and international level. The finding reveals that there is higher income disparity as well as consumption expenditure within the schemes at local level than at international level. Additionally, among the communities in the six schemes, it was also finds that, those that engage in irrigation have higher income and equally with higher expenditure than those that did not engage in irrigation.

Similarly, Joseph, et al. (2018) investigate on income disparity between the smallholder irrigation farmers in Zimbabwe. The research compares HamaMavhaire and Ngondoma irrigation scheme, using a total sample of 127 respondents, the findings shows a Gini coefficient of 0.624 for HamaMavhaire and 0.516 for Ngondoma indicating greater income and expenditure inequality in HamaMavhaire.

3. Methodology

3.1 The Study Area

Malumfashi local government has an area of 890.1 km^2 and a population of 182,891 at the 2006 population census with the 2016 population projection figure of 246,900 at the rate 3.0% annual population change (NBS, 2017). Malumfashi LGA bordered with Kano towards east, Kankara to the West, Kafur and Bakori to the south while from the North it shared boarder with Musawa.

The major occupations of the people are rain-fed farming throughout the rainy season period and irrigation farming for the period of the dry seasons around dams in the LGA. Farmers around the area are engage in cultivation maize, sorghum, cotton, soybeans, beans and millets during rainy season while during dry season they involve in production of various types of horticultural crops such as tomatoes, pepper, onion and cabbage among others (Katsina state Investor's handbook, 2016). Trading activities are also a major occupation that involved buying and selling at the weekly markets together with micro level-entrepreneurship in town and villages around the area. The rainy season in the area start from May to October and irrigation period begins with the termination of rains.

3.2 Sample size and Sampling Technique

There are six irrigation sites (Ruwan Sanyi, Gangara, Mashigi, Mahuta, Sulma and Dutsen Kura) and the sample of 237 sample size is distributed among the six (6) irrigation sites in Malumfashi Local Government Area of Katsina State. While, 39 respondents are drawn from each of the five irrigation projects, 42 is drawn from the biggest irrigation site (Mashigi) in Malumfashi LGA, Katsina state. However, in accordance to the objectives of this study, it is essential to define the population of the study from whom the information was primarily generated. Therefore, the population of the study is irrigation farmers engaged in irrigation farming in Malumfashi Local Government Area of Katsina State and based on the association of irrigation farmers in Malumfashi LGA, Katsina state, the population of active irrigation farmers is according to the association estimated at five hundred and fifty-six (556). And to cover entire population, Yamani

(1967) formula was adopted for drawing the sample size that would represent the whole population. Thus, the formula is given as:

$n = \frac{N}{1+N(e2)}$

Where n is sample size;

N is total number of population

e^2 is the square of error of tolerance

Consequently, N is given as 556 and e^2 is given as $(0.05)^2$

Therefore, $n = \frac{N}{1+N(e2)}$ n= 237

Therefore, the sample of 237 sample size is distributed among the irrigation farmers in Malumfashi local government area of Katsina state.

Moreover, a simple random sampling technique was employed for the study. Subsequent to the determination of 237 sample size for the study, 42 respondents were randomly selected from the biggest irrigation project (Mashigi); while 39 respondents were randomly selected from each of the remaining five irrigation projects in Malumfashi LGA, Katsina state.

3.3 Model Specification and Estimation Procedure

Following from the literature, Keynesian consumption function model was adopted to specify the model in order to achieve the objectives of the study. Thus, the model is specified in a functional as:

$CE = f(I_f)$ …….…….. (3.1)

Where CE is consumption expenditure and is a function of irrigation farming (I_f). Such that irrigation farming (I_f) which is proxy by income from irrigation farming is expressed in terms of influencing factor. In order to give economic interpretation, the linear function can be rewritten mathematically as;

$CE = a + bI_f$…….…….. (3.2)

From equation (3.2) above, 'a' which is the intercept signifies the amount of consumption at zero level of irrigation farming and the coefficient 'b' represents the slop of the consumption function or marginal propensity to consume (mpc). Therefore, b is the volume of consumption that change with the change in irrigation farming level. In the estimation, the econometric model from equation (3.2) is giving as;

$CE = a + bI_f + \Theta X_i + \mu$ …….……..…. (3.3)

Were Xi being the vector variables such as family size, education level, age distribution etc. (called control variables), that are identified as factors that affect consumption expenditure pattern (Burk, 1968; Ray, 1980 and Strauss, 1982), Ɵ is the coefficient of the control variables and μ is the error term and it can be rewritten as;

$CE = a + \mathrm{I_f} + \delta_1 AGE_i + \delta_2 FSZi + \delta_2 EDLi + \delta_3 EXPERI_i + \mu$ ……(3.4)

Were CE is the consumption expenditure, "If" is irrigation farming (where by, income generated from irrigation farming is used as a proxy), AGE is age of the farmers, FSZ is family size, EDL is education level, EXPER represent years of experience into irrigation farming and 'a', is the intercept, and $\delta_1, \delta_2, \delta_3$ are the parameters to be estimated respectively while μ is the error term

The quantile regression model is stated as;

$CE_i = \beta I_{fi} + u$ …….. (3.8)

$Quant_{\theta}(CE_i / I_{fi}) = \beta I_{fi}$ ……(3.9)

W*ere* CE_i is the consumption expenditure of irrigation farmers, $\mathrm{I_f}$ represents income generated from irrigation farming, β denotes parameter to be estimated, u denotes error term and its conditional quantile distribution is zero. $Quant_{\theta}(CE_i / I_{fi})$ denotes the θ^{th} conditional quantile of CE_i given I_f.

It is pointed out that quantile regression is more robust to outliers than the OLS regression which is sensitive to outliers. Similarly quantile regression can show different effects of the independent variables on the dependent variable depending across distribution of the dependent variable. This approach allows parameter variation across quantiles of the consumption distribution which is more robust in this analyses than OLS, sample means and average deviation.

4. Data Presentation and Analysis

The demographic characteristics of the respondents presented shows that the total number of the respondents are 233 and all are male (100%). The possibility of why they are all male is because of the Purdah cultural values and norms in the area, women normally do house work and they depend on their husbands or relatives to sustain a living.

4.1 Estimated Results of Quantile Regression

The summary of quantile regression result is presented in Table 4.1. The distributions of consumption expenditure of irrigation farmers are divided into nine quantiles (10^{th}, 20^{th}, 30^{th}, 40^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th} and 90^{th}) and are presented in column (1) to (9). This helped in measuring the impact of irrigation farming at each portion of the distribution among different expenditure group. It is evidently shown that irrigation farming coefficient (that is, 1.00 and 0.66) is only significant and positive in the 10^{th} and 40^{th} quantile. This implies that a percent increase in irrigation farming will increase consumption expenditure of irrigation farmers by 1% and 0.66% in the 10^{th} and 40^{th} quantile respectively. The coefficients between 10^{th} and 40^{th} is showing decreasing order of magnitude while insignificantly positive in the remaining quantiles. Therefore, the impact of irrigation farming on consumption expenditure of irrigation farmers can be located at the 10^{th} and 40^{th} quantile that is, the quantiles below the medium.

Table 4.3 Effect of irrigation farming on Irrigation Farmers on Various Level of Consumption Expenditure

	Dependent variable: consumption expenditure								
Variables	10th quantile (1)	20th quantile (2)	30th quantile (3)	40th quantile (4)	50th quantile (5)	60th quantile	70th quantile (7)	80th quantile (8)	90th quantile (9)
Irrigation farming	1.00***	0.333	0.333	0.667***	0.50	0.00	0.00	0.00	0.00
	(0.902)	(0.195)	(0.392)	(0.109)	(0.408)	(0.637)	(0.556)	(0.507)	(0.083)
Age	0.333***	0.5	0.5***	0.5***	0.5***	0.00	0.00	0.50***	0.5***
	(0.668)	(0.268)	(0.243)	(0.222)	(0.208)	(0.403)	(0.342)	(0.054)	(0.558)
Family size	0.333***	0.333***	0.5	0.5***	0.5***	0.5***	0.00	0.00	0.5
	-0.5**	0.00	0.00	-0.50**	-0.333*	0	0	0	0
Education level	(0.087)	(0.170)	(0.183)	(0.232)	(0.167)	(0.474)	(0.467)	(0.481)	(0.535)
Years of experience	0.5***	1***	1***	1***	1***	0.5	1***	1***	1***
	(0.952)	(0.218)	(2.620)	(0.267)	(0.267)	(0.299)	(0.176)	(0.117)	(0.058)
Observation	233								

Notes: The numbers in brackets are robust standard errors. This table shows the results of Quantile Regression used to examine the whether the effect of irrigation farming is symmetric among the irrigation farmers on different level of consumption expenditure.

Similarly, the result also shows a significant and positive relationship between age of the respondents and consumption expenditure at 1% level of significance in all the quantiles except 20^{th}, 60^{th} and 70^{th}. There is increasing order of magnitude between 10^{th} and 30^{th} (0.33 and 0.5) while the same level of magnitude is maintained (that is, 0.5) among the remaining coefficients. Hence, age has more impact on the consumption expenditure in the middle and higher quantile distribution groups than in the lower quantiles based on the magnitude of their coefficients since they are at the same level of significance.

In the same way, the coefficient of family size is significant and positive (at 1%) in 10^{th}, 20^{th}, 40^{th}, 50^{th}, and 60^{th} quantiles. This suggests that consumption expenditures at quantiles from 60^{th} and below are more sensitive to family size. While it is insignificant and positive in the 30^{th}, 70^{th}, 80^{th} and 90^{th}. However, the coefficient of education level is significant but negative in the 10^{th}, 40^{th} and 50^{th} quantiles. This indicates that education level is inversely related to consumption expenditure, which means that as education level increase the consumption expenditure reduces. Conversely, the coefficients of years of experience are significant and positive at 1% level of significance except 60^{th} quantile that is not significant and positive. The value of the coefficients of the years of experience are the same (that is, 1.00) except 10^{th} quantile that has 0.5. therefore, based on the QR result, it could be deduced that the impact of irrigation farming is only statistically significant and positive in the lower quantiles in the distribution (that is 10^{th} and 40^{th} quantile) at 1% level of significance while, insignificant and positive in the remaining quantiles (that is, 20^{th}, 30^{th}, 50^{th}, 60^{th}, 70^{th}, 80^{th} and 90^{th}). Hence, the hypothesis signifying no significant symmetry effect of consumption expenditure among irrigation farmers in Malumfashi local government area of Katsina state is not rejected.

4.3 Discussion of Findings

This study investigates the impact of irrigation farming on consumption expenditure among irrigation farmers in Malumfashi Local Government Area of Katsina State. While, income generated from irrigation farming serve as a proxy for irrigation farming, it was revealed that irrigation farming have a significant and positive impact on consumption expenditure of irrigation farmers. This finding is consistent with the finding of Gebrehiwot, et al., Ana, (2017), Bjornlunda, et al. (2019). Therefore, irrigation farmers around the area can increase their consumption spending through incremental earned by engaging in dry season farming, which is made possible by the

advent of irrigation technology. This conforms to one of the fundamental concepts on consumption emphasized by Keynes (1936), which underscores the fact that though, when income rises, consumption also rises, however, the rise in consumption tends to be less than the rise in income. This has been attributed to the fact that a part of the increment generated is saved.

Education level has a significant and negative impact on consumption expenditure between the medium quantile and below in the quantile regression result at different level of significant, this is in line with Carpenter (2016) that found that consumer residence affects his expenditure decision which may be positive or negative. But it contradicts the findings of Gebrehiwot, Mesfin, & Nyssen, (2015). The result also defies the a priori expectation that suggests that education level has a positive influence on expenditure. This reason for this deviations can be attributed to the fact that, if the acquired education is not related to the agricultural production, the education effect cannot be felt at the beginning of practice, but consistent practice of irrigation farming with the level education can be beneficial in the long–run through shape and reshaping of irrigation farmers by the knowledge and education acquired.

Farming experience also had a significant and positive relationship with the irrigation farmers' expenditure, suggesting that consumption expenditure increase with increase in years of experience of irrigation farmers. In other words, the higher the experience, the higher the consumption expenditure. The importance of experience in improving farmers' stock of farming knowledge cannot be understated. Ogunniyi, et al. (2018) assert that farmers relied on the experiences gathered over the years to make decisions. More experienced farmers, are more likely to possess better knowledge of farming and management practices that could help improve yield and income earnings, thus affecting consumption expenditure positively.

5. Conclusion

Based on the findings of this study, it was discovered that irrigation farming has a positive and significant impact on irrigation farmers' consumption expenditure. It is evidently shown that, the distributional impact of irrigation farming on consumption expenditures of the respondents is asymmetric, that is, it affect only those respondents with consumption expenditure at the lower level. In the light of the revealed findings by the study, the following recommendation are hereby proffered

i. Efforts should be geared towards encouraging farmers to actively participate in irrigation farming more specifically in the rural areas. This can be achieved, among other options, through providing financial support and irrigation farming facilities inform of loans targeting rural farmers to encourage participation in irrigation farming in the rural areas.

ii. Governments at various level (Local, State and Federal) should be actively involved through various agricultural agencies and cooperative societies that have linkages to rural farmers. This will facilitates bottom to top approaches to decision–making process, which in turns, would help in boosting their earnings, hence, their consumption expenditure not only for food but for education, health and other services will be improved, thereby raising their standard of living.

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