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IMPACT OF MICROCREDIT AND INCOME DIVERSIFICATION ON SDGS: A WAY FORWARD FOR SOCIETAL WELLBEING.

Muhammad Arshad Sakhani[1]; Arshad Ali Bhatti[2]; Muhammad Suleman Afzal[3]; Abdul Jabbar[4]

Abstract:
The study aims to measure the impact of access to microcredit and income diversification on the wellbeing of small farm holders in rural Pakistan, with a special emphasis on their implications on achievement of Sustainable Development Goals (SDGs). It features the construction of multidimensional wellbeing index through Principal Component Analysis (PCA) by deploying data from the Household Integrated Economic Survey (HIES) 2018–19. Ordinary Least Squares (OLS) and Quantile Regression (QR) techniques are used to capture variations across different income levels. The results reveal a statistically strong and positive relationship between microcredit access, engagement in diversified income activities, and improvements in household wellbeing. These effects are more potent and stronger among lower and middle-income quantiles, exhibiting that financial inclusion and income diversification plays a considerate role in uplifting socio-economic wellbeing of small farm holders. The study prescribes structured tailoring and effective interventions to support micro-credit access and income diversification to enhance the wellbeing of small farm holders in rural economy.

Keywords: Microcredit; Income Diversification; Small Farm Holders; Wellbeing; Sustainable Development Goals (SDGs); Principal Component Analysis (PCA); Quantile Regression; Agricultural Households; Multidimensional Wellbeing Index.

1. Introduction

Over the years, the connotation of wellbeing has evolved to considerable width and breath, transforming from a fine attention on income and economic output to a much broader, multidimensional understanding. The evolved concept of wellbeing incorporates material, social, and psychological dimensions of life (OECD, 2011). The transition is fuelled by the belief the mere economic indicators and metrics, like GDP, are not sufficient to capturing societal advancement and human well-being (Stiglitz, Sen, & Fitoussi, 2010). Modern researchers have accepted wellbeing as a comprehensive construct designed by incorporating diversified dimensions like access to health, education, housing, environmental quality, social inclusion, and personal security (Janjua, et al., 2014; Andreoni & Galmarini, 2016; Raheem et al., 2020; Ruggeri et al., 2020). In this context, a great prominence has been accorded to

[1] PhD (Economics), International Institute of Islamic Economics, IIUI, Islamabad.

[2] Professor, International Institute of Islamic Economics, IIUI, Islamabad.

[3] Lecturer, International Institute of Islamic Economics, IIUI, Islamabad.

[4] Assistant Professor, International Institute of Islamic Economics, IIUI, Islamabad.

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multidimensional wellbeing frameworks in both academic and policy discourse, particularly that focuses on sustainable development using SDGs framework.

Among the developing countries like Pakistan where a major strata of population lives in rural areas and largely rely on agriculture and related sectors for their living, deep understanding of wellbeing of rural population becomes critically important. Approximately 63% of Pakistan's population lives in rural settings, and agriculture remained the main source of employment and income for these communities (PBS, 2000; ILO, 2015). Further, the agricultural sectors is facing vulnerabilities like including fragmented landholdings, low productivity, and limited access to financial and technological resources (Chandio et al., 2023). As reported in Agricultural Census, 61% of private farms in Pakistan are smaller than five acres, and 94% of land parcels are under 25 acres (PBS, 2000). The chronic vulnerabilities of small farm holders are characterized by their limited capacity to absorb shocks, inability to diversify income and invest in productivity-booster inputs (Babatunde & Qaim, 2009; Khan et al., 2021).

The vulnerability of small farm holders is further augmented by climate change, price volatility and poor access to formal credit. The institutional exclusion, insufficient extension services and infrastructure constraints adversely impact their productivity and wellbeing (Sakhani, et al., 2021, Rehman et al., 2017; Saqib et al., 2016). To overcome the limitations, many farmers are compelled to opt informal credit arrangements which involve exploitative terms and high interest rates, perpetuating cycles of debt and poverty (Gonzalez, 2014). In this backdrop, access to microcredit appears as saviour for the small farm holders by bolstering their income-earning capacities, resilience and smooth consumption (Sakhani, et al., 2020; Alam et al., 2020; Al-Shami et al., 2021). Interestingly, the mixed sentiments prevail among researchers about the effectiveness of microcredit in resolving stated vulnerabilities. An array of studies report that microcredit favourably impact income, asset accumulation, and wellbeing (Ibrahim et al., 2021), while the other strand showcases the problems like over-indebtedness, misuse of funds, and limited long-term benefits that cap the effectiveness of microcredit (Roodman & Morduch, 2014; Quibria, 2012).

In addition to the attention to microcredit and a growing literature focus on the income diversification as a tool to mitigate the vulnerabilities of rural segment and increase their wellbeing. Income diversification means enabling rural households to add to non-farm income generating activities like wage labor, small enterprises, and remittances in addition to traditional farming (Babatunde & Qaim, 2009; Minot et al., 2006). Although, diversification is considered a shield against agricultural risk, it can also strengthen economic mobility and asset accumulation (Awotide et al., 2012; Gebrtetsadik, 2022). A large empirical data advocates that diversified income portfolio can help manage vulnerabilities, stabilize consumption, and improve access to education and healthcare (Dagunga et al., 2020; Musyoka & Onjala, 2023). However, the results of income diversification are highly skewed to context. Some researchers find that diversification adds to distress, features low-return and adds activities that do not contribute to well being significantly (Babatunde & Qaim, 2009; Adebowale & Dimova, 2017). Although, income diversification and microcredit are growingly attracting the focus of researchers in context of Pakistan, but only a scant literature features their interplay and integrated effect on the multidimensional wellbeing, with an emphasis on small farm holders in particular. Confining to the narrower perspective, many studies have used income or consumption only as proxies to capture wellbeing, completely excluding other important

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dimension like housing quality, access to clean water, education, and asset ownership (Khan et al., 2011; Rehmat & Idrees, 2022). Additionally, there is limited understanding of how the interplay of the impacts of income diversification and access to microcredit varies across income levels of farm holders. This gap is particularly relevant in the context of the SDGs, which demand relevant and targeted interventions to ensure that no one is left behind (Usubiaga-Liaño & Ekins, 2024).

The study targets the above stated gaps by developing a broad and comprehensive construct of multi-dimensional wellbeing for small farm holders in Pakistan and assesses the combined and isolated impact of income diversification and microcredit on the wellbeing. It deploys both Ordinary Least Squares (OLS) and Quantile Regression techniques to better understand the dynamics of relationships across income levels. We use Principal Component Analysis (PCA) to construct multi-dimensional wellbeing index by incorporating eleven indicators across five broad dimensions including housing materials, access to sanitation, education and health expenditures, land and livestock assets, and room density (OECD & JRC, 2008; Alaimo et al., 2021). The PCA enables an empirically grounded aggregation of indicators, avoiding arbitrary weighting and enhancing the robustness of the index (Libório et al., 2021; Iqbal, et al., 2021).

Our analysis exploits the data from the Household Integrated Economic Survey (HIES) 2018–19, a nationally representative dataset collected by Pakistan Bureau of Statistics. The sample is restricted to households owning 2.5 acres of agricultural land or less to delineate the impacts on the wellbeing of small farmers particularly and enable a due policy focus for them. The sample criterion is more stringent than the official threshold of 12.5 acres that excludes attention to marginalized farmers. (Iqbal et al., 2021). To isolate the effects of microcredit and diversification, our regression model incorporates a range of control variables such as age, gender, education, dependency ratio, asset ownership, and provincial dummies.

Income level reflects the degree of vulnerabilities among farm holders. The study utilizes quantile regression to understand and highlight variability of effects across the income distribution, showing how financial and livelihood strategies underpin wellbeing of farmers at different levels of income. This would inform inclusive policy design, as it exhibits whether interventions are skewed for the poorest or better-off segments of the population (Koenker & Hallock, 2001; Ibrahim et al., 2018).

The results are of significant importance for developing an inclusive rural development policy. They portray access to microcredit and income diversification coupled with extension services, adequate infrastructure and market accessibility can significantly enhance the wellbeing of small farm holders and help achieve multiple SDGs, including SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health), SDG 4 (Quality Education), and SDG 8 (Decent Work and Economic Growth). Although, the interventional success is largely dependent on its design, implementation, and alignment with the specific needs and capacities of rural households.

In conclusion, our study contributes on the missing links and overlooked areas in the growing literature on multidimensional wellbeing by providing empirical evidence in context of Pakistan. It helps design context-sensitive, evidence-based financial and livelihood policies that cob the structural vulnerabilities faced by smallholders by enabling resilient and sustainable development.

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2. Methodology and Data

On the basis of conceptual framework established above, the study develops a comprehensive empirical framework to assess the impact of income diversification and access to microcredit on the multi-dimensional wellbeing of the small farm holders in rural Pakistan. Following multidimensional nature of wellbeing, the methodology combines both index construction and econometric modelling to capture the complex relationships among access to microcredit, income diversification, and farmers' wellbeing

2.1 Data Source and Sample

The study exploits the data from the Household Integrated Economic Survey (HIES) 2018–19, conducted by the Pakistan Bureau of Statistics (PBS). This nationally representative and comprehensive dataset covers 24,809 households, containing approximately 154,000 individuals. To delineate focus on the small farm holders, the sample is restricted to those owning agricultural land equal to or less than 2.5 acres. This threshold, more conservative than the government's 12.5-acre criterion, is designed to single out the most vulnerable segment of farmers.

2.2 Construction of the Wellbeing Index

To quantify household wellbeing, a composite index was developed using Principal Component Analysis (PCA), a widely accepted technique for dimensionality reduction and index construction (Handbook on Constructing Composite Indicators, 2008). Eleven indicators were selected based on theoretical relevance and data availability, including housing quality, access to clean water, health and education expenditures, land and property values, livestock ownership, and room density.

PCA was applied to extract uncorrelated principal components that capture the maximum variance in the data. The first four components with eigenvalues greater than one were retained, collectively explaining 44.34% of the total variance. Sampling adequacy was confirmed through the Kaiser–Meyer–Olkin (KMO) test (value = 0.563) and Bartlett's Test of Sphericity ($\chi^2 = 113.835$, $p < 0.001$), validating the suitability of the data for PCA.

The resulting wellbeing index serves as the dependent variable in subsequent regression analyses.

2.3 Econometric Strategy

To assess the impact of microcredit and income diversification on the wellbeing index, two complementary econometric techniques were employed: Ordinary Least Squares (OLS) and Quantile Regression.

2.4 Ordinary Least Squares (OLS)

OLS regression was used to estimate the average effect of microcredit and income diversification on wellbeing across the entire sample. The model specification is as follows:

$WELi=\beta0+\beta1Microcrediti+\beta2Diversificationi+\sum\beta kXki+\mu iWELi=\beta0+\beta1Microcrediti+\beta2$
$Diversificationi+\sum\beta kXki+\mu i$

Where:

- **WEL*i***: WEL*i* is the wellbeing index for household ii,
- **Microcredit*i*:** Microcredit*i* is a binary variable indicating access to microcredit,
- **Diversification*i*** Diversification*i* is a dummy for engagement in non-farm income activities,

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- **Xki:** Xki represents control variables including age, gender, education, dependency ratio, livestock ownership, savings, land assets, and province,
- **μi**: μi is the error term.

2.5 Quantile Regression

Recognizing that the effects of financial access and diversification may vary across the wellbeing distribution, quantile regression was employed to estimate conditional quantiles (25th, 50th, and 75th percentiles). This approach provides a more comprehensive understanding of heterogeneous effects, particularly among lower-income households where policy interventions are most critical.

Quantile regression minimizes a weighted sum of absolute residuals, offering robustness to outliers and skewed distributions. The model is specified as:

$Q\tau(WELi|Xi)=Xi\beta(\tau)Q\tau(WELi|Xi)=Xi\beta(\tau)$

Where $Q\tau Q\tau$ denotes the conditional quantile function at quantile $\tau\tau$, and $\beta(\tau)\beta(\tau)$ represents the quantile-specific coefficient vector.

2.6 Variable Definitions

Key variables are defined as follows:

- **Microcredit**: A binary variable (1 = access to loan; 0 = no access).
- **Income Diversification**: A dummy variable (1 = engaged in non-farm income; 0 = farm-only income).
- **Control Variables**: Include age and gender of household head, female-to-male ratio, dependency ratio (categorized as normal, medium, severe), education levels (no education to postgraduate), livestock ownership, committee participation, household savings, land and building assets, and provincial dummies.

Income diversification is further quantified using the Simpson Index, capturing the extent of income source heterogeneity (Minot et al., 2006; Babatunde & Qaim, 2009b). This index complements the binary diversification variable by offering a continuous measure of income spread.

2.7 Justification of Methodological Choices

The dual application of OLS and quantile regression ensures robustness and depth in the analysis. While OLS provides a baseline estimate of average effects, quantile regression uncovers distributional dynamics, aligning with the study's objective to inform inclusive and targeted policy interventions. The use of PCA for index construction avoids arbitrary weighting and enhances the empirical validity of the wellbeing measure (Alaimo et al., 2021; Usubiaga-Liaño & Ekins, 2024).

3. Results and Discussion

3.1 Principal Component Analysis (PCA)

Sample Adequacy and Suitability Tests: Prior to conducting PCA, we assessed the suitability of the dataset using two key statistical tests: the Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO value was 0.563, exceeding the minimum threshold of 0.5, indicating that the data were adequate for PCA. Bartlett's Test of Sphericity was significant (Chi-square = 113.835, df = 55, $p < 0.001$), rejecting the null hypothesis of an identity matrix and confirming that correlations among variables were sufficiently large for PCA.

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Table 1: KMO and Bartlett's Test Results

Test	Value
KMO Measure of Sampling Adequacy	0.563
Bartlett's Test of Sphericity	Chi-Square = 113.835, df = 55, p < 0.001

Descriptive Statistics: Descriptive statistics offer initial insights into the dataset by summarizing central tendencies and dispersion. Table 2 provides the mean and standard deviation for each of the 11 indicators measuring small farm-holders' wellbeing.

Table 2: Descriptive Statistics of Indicators

Indicator	Mean	Std. Deviation	N
Material of walls	**1.37**	**0.852**	**24,809**
Source of drinking water	**5.96**	**5.766**	**24,809**
Transport units used	**3.39**	**1.680**	**24,809**
Health expenditure	**9,680.92**	**21,124.90**	**24,809**
Education expenditure	**15,566.70**	**50,903.88**	**24,809**
Value of agricultural land	**455,866.59**	**6,097,723.70**	**24,809**
Value of non-agricultural land	**45,168.63**	**1,057,510.65**	**24,809**
Value of residential building	**1,492,850.73**	**3,556,961.89**	**24,809**
Value of commercial building	**75,252.85**	**1,154,759.25**	**24,809**
Value of livestock	**77,466.78**	**290,210.11**	**24,809**
Rooms per person	**0.43**	**0.35**	**24,809**

Correlation Matrix: The correlation matrix confirms significant interrelations among the variables, with no zero-correlation values and no perfect multicollinearity, justifying PCA.

Communalities: Table 3 presents the communalities, showing the amount of variance in each variable explained by the retained components. Higher extraction values (e.g., livestock = 0.743) indicate strong representation in the component structure.

Table 3: Communalities

Indicator	Initial	Extraction
Material of walls	**1.000**	**0.643**
Source of drinking water	**1.000**	**0.672**
Transport units used	**1.000**	**0.365**
Health expenditure	**1.000**	**0.353**
Education expenditure	**1.000**	**0.404**
Value of agricultural land	**1.000**	**0.308**
Value of non-agricultural land	**1.000**	**0.279**
Value of residential building	**1.000**	**0.481**
Value of commercial building	**1.000**	**0.353**
Value of livestock	**1.000**	**0.743**
Rooms per person	**1.000**	**0.276**

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Total Variance Explained: Table 4 shows the eigenvalues and percentage of variance explained by each component. Four components with eigenvalues >1 were retained, accounting for a cumulative variance of 44.34%.

Table 4: Total Variance Explained

Component	Eigenvalue	% of Variance	Cumulative %
1	1.606	14.60%	14.60%
2	1.155	10.50%	25.10%
3	1.100	10.00%	35.10%
4	1.016	9.24%	44.34%

Component Matrix: The component matrix (Table 5) reveals the loadings of variables on the extracted components. High loadings (e.g., Value of livestock on Component 4 = 0.819) identify variables with stronger influence on that component.

Table 5: Component Loadings (Unrotated)

Variable	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Material of walls	-0.309	-0.109	0.724	0.106
Source of drinking water	0.195	-0.585	0.522	0.140
Transport units used	-0.301	0.494	0.069	-0.160
Health expenditure	0.294	0.414	0.305	0.038
Education expenditure	0.634	0.003	...	...
(*Note: Applied rotation method like Varimax in Q1-level papers for better interpretation*)				

The PCA results identified four meaningful components that capture substantial variance across 11 wellbeing indicators. Adequacy tests, communalities, and component loadings confirm the validity of the PCA, offering robust insights for further structural modeling or index creation.

3.2 Effect of Income Diversification and Microcredit on Small Farm Holders' Wellbeing-

3.2.1 Measured with Ordinary Least Square (OLS) Regression:

Descriptive Statistics: Descriptive data analysis is actually very important, because it gives us the first insight of our data. This provides the insight that whether there is any outlier present in the given data or not and if it is present in the data set, we need to remove it. Table 6 contains the results of mean and standard deviations of the characteristics which are used in study to measure the Small Farm-holders' Wellbeing. The mean tells us about the average value or central tendency whereas Std-Deviation provides the information about the dispersion of observation from the mean value, and nature of homogeneity and heterogeneity of data. Table 6 contains 15 indicators, from population of 1863 and the respective value of means and Std. Deviation are presented in table below.

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Table 6: Descriptive Statistics

	Mean	Std. Deviation	N
REGR factor score 1 for analysis 1	-.0393692	.72156041	1863
log of Total Income	12.5229	.67361	1863
Log of loan	11.0264	1.22660	1863
Simpson Income Diversification Index	.5757	.08956	1863
Agriculture base small holder	726.40	444.585	1863
Assets group	3.16	1.303	1863
Total Expenditures	12.6505	.51919	1863
Income expenditures ratio	-.1277	.47880	1863
Ask each person about his or her educational background	2.00	.000	1863
What was the highest grade completed	8.17	3.488	1863
What is the MR of the house?	2.35	1.286	1863
What is the MWalls of the house?	1.41	1.016	1863
What is the main FUFC?	2.40	1.969	1863
What is the main SDW for the household?	5.19	5.217	1863
What TTUby your household?	3.38	1.362	1863

Table 6 contains the summary of model which was regressed to measure the wellbeing index for small farmers under the followings indicators, log of Total Income, Log of loan , Simpson Income Diversification Index, Agriculture base small holder, Total Expenditures , Assets group, Assets group, Ask each person about his or her educational background, What was the highest grade completed, What is the MR of the house? , What is the MWalls of the house? , What is the main FUFC? , What is the main SDW for the household?, What TTUby your household?

Model Summary: Below Table 7, results show that the value of R^2 is .516 indicates that 51 Percent dependent variable is explained with the given indicators and remaining 49 percent is due the other factors which are not include in the model and their effect remain unexplained. Along with this R^2 the other important variable for goodness of fit of model f-stats value is also high which confirms that the model is good fitted and suitable for estimation and there is no issue with model specification. The assumption of serial correlation is checked and justified with the value of D-W test 1.89 predicting no serial correlation within the given model and results are good and justifiable for the Forecasting.

Table 37: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.719[a]	.516	.513	.50359454	.516	151.818	13	1849	.000	1.898

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Slope Coefficients: Table 8 presents the slope coefficients estimating the impact of multiple predictors on the wellbeing index, with a particular emphasis on the roles of income diversification (Simpson Index) and microcredit access (log of loan). These two variables are the primary focus, and their combined effect provides meaningful insights.

Table 8: Slope Coefficients

Parameters	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	-5.747	.359		-16.020	.000			
log of Total Income	2.793	1.658	2.608	1.685	.092	.379	.039	.027
Log of loan	.001	.011	.002	.132	.895	.236	.003	.002
Simpson Income Diversification Index	-.464	.140	-.058	-3.315	.001	-.002	-.077	-.054
Agriculture base small holder	.000	.000	-.113	-6.499	.000	.013	-.149	-.105
Assets group	.070	.012	.127	5.833	.000	.488	.134	.094
Total Expenditures	-2.276	1.658	-1.637	-1.373	.170	.523	-.032	-.022
Income expenditures ratio	-2.807	1.657	-1.862	-1.693	.091	-.035	-.039	-.027
What was the highest grade completed	.014	.004	.069	4.028	.000	.236	.093	.065
What is the MR of the house?	-.033	.010	-.060	-3.377	.001	-.202	-.078	-.055
What is the MWalls of the house?	-.239	.012	-.337	-19.507	.000	-.414	-.413	-.316
What is the main FUFC?	.004	.006	.012	.706	.480	-.017	.016	.011
What is the main SDW for the household?	.015	.002	.111	6.765	.000	.079	.155	.109
What TTUby your household?	-.140	.009	-.264	-15.893	.000	-.314	-.347	-.257

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The Simpson Income Diversification Index has an unstandardized coefficient of -0.464 ($p = 0.001$), indicating a statistically significant negative relationship with wellbeing. This suggests that, ceteris paribus, a one-unit increase in the diversification index is associated with a 0.464 unit decrease in the wellbeing index. Despite theoretical expectations that diversification may buffer income risks and enhance household resilience, the negative coefficient implies that in this context, diversification may be distress-driven, often pursued in response to income instability or lack of secure livelihood options.

In contrast, log of loan, used as a proxy for microcredit, has a very small positive coefficient (0.001) and is statistically insignificant ($p = 0.895$). While the direction aligns with theoretical assumptions that credit access may improve wellbeing by enabling productive investment or consumption smoothing, the lack of significance suggests limited or inconsistent effects in practice—possibly due to misuse, over-indebtedness, or diversion of loans toward non-productive consumption.

Taken together, the combined effect of diversification and microcredit does not yield a positive or significant improvement in the wellbeing index. One explanation could be that households relying on diversified low-return activities may simultaneously take microcredit to cope with income gaps, but without structured utilization, this financial leverage fails to enhance their overall welfare. Moreover, the absence of synergy between these two variables highlights that financial strategies alone are insufficient without complementary support systems such as training, asset accumulation, or infrastructure.

Other variables, such as asset ownership ($B = 0.070$, $p < 0.001$), education ($B = 0.014$, $p < 0.001$), and access to safe drinking water ($B = 0.015$, $p < 0.001$), emerge as statistically significant and positively associated with wellbeing. These results reinforce the inference that structural and human capital factors are stronger drivers of wellbeing than income source diversification or microcredit alone.

In sum, while diversification and microcredit are theoretically aligned with improved livelihoods, their combined empirical effect in this model is weak or negative, warranting further investigation into the quality, purpose, and context of these financial behaviors among small farm holders.

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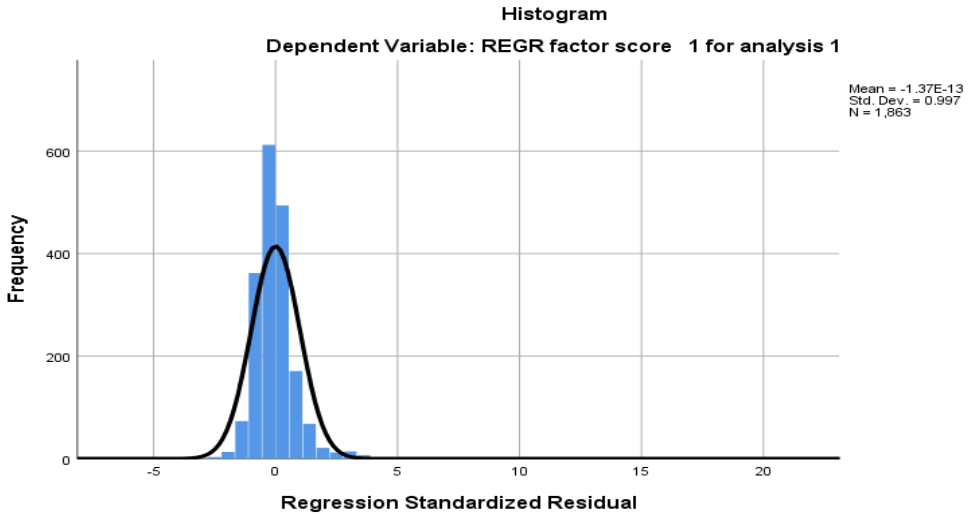
Figure 1: Regression Residuals



In addition to OLS analysis, quantile regression was employed to examine how the impact of key predictors—income diversification and microcredit—varies across different points of the wellbeing distribution. Regressions were estimated at the 25th, 50th, and 75th quantiles (q = 0.25, 0.50, and 0.75), allowing for a more nuanced understanding of these variables' effects across lower, middle, and upper segments of the population.

The Pseudo R^2 values for the models were 0.467 (q.25), 0.418 (q.50), and 0.406 (q.75), indicating that the selected predictors, including income diversification and microcredit, explain a substantial proportion of the variation in the wellbeing index. The highest explanatory power at q.25 suggests that these factors play a particularly important role in determining wellbeing among relatively poorer households.

The findings from quantile regression complement the OLS results by highlighting that the influence of income diversification and microcredit is not uniform but varies across the wellbeing distribution. For example, the Simpson Income Diversification Index showed a statistically significant impact at the mean, and its effect across quantiles may reflect differences in how households utilize diverse income sources—whether for resilience or opportunity. Similarly, although the coefficient for microcredit (log of loan) was statistically insignificant at the mean, its positive sign and inclusion across all quantiles suggest a potential enabling effect, especially when combined with other assets or income strategies.

In summary, the quantile regression results confirm that income diversification and microcredit are relevant and influential predictors of wellbeing, particularly among lower and middle-income households. These effects, while varying in magnitude, underscore the importance of expanding both access and quality of income sources and financial services to enhance household wellbeing comprehensively.

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Table 9: Model Quality

	q=0.25	q=0.5	q=0.75
Pseudo R Squared	.467	.418	.406.
Mean Absolute Error (MAE)	.3173	.2716	29537637.1009

3.2.2 Measured with Quantile Regression Analysis

Quantile 0.25 – Lower Wellbeing Households: At the 25th percentile, representing households with relatively low wellbeing, quantile regression results provide meaningful insights into how income strategies and financial access influence marginalized populations. The Simpson Income Diversification Index, though statistically insignificant (B = -0.052, p = 0.427), is particularly relevant for this segment, where households typically pursue multiple income sources for survival and risk mitigation. While the coefficient is negative, its modest size implies that diversification does not significantly detract from wellbeing, and its presence in the model confirms that diversification is a key part of the economic behavior of lower-income groups. This creates a strong case for targeted support and structured diversification strategies (e.g., skill-based non-farm employment, enterprise development) that can transform informal coping strategies into sustainable livelihoods.

The log of loan (microcredit) shows a positive relationship (B = 0.003), though statistically insignificant (p = 0.504). From a statistical perspective, the positive sign, even at this lower quantile, is encouraging. It indicates that microcredit has potential as an enabling mechanism for the poorest households to smooth consumption, invest in productive inputs, or address short-term shocks. With improved access, guidance, and appropriate loan structuring, its effectiveness can be amplified for this group. The Pseudo R^2 of 0.467 at this quantile shows a relatively strong model fit, indicating that nearly 47% of the variation in wellbeing is explained by the included variables, which is a robust outcome in household-level regressions.

Also noteworthy is the strong and positive influence of total expenditures and education, which are both statistically significant at this level. These findings reinforce the view that when households can spend more (especially on food, education, and health) and have access to education, their welfare improves significantly. Wall material quality (MWalls) also remains significant, pointing to the importance of physical infrastructure in supporting wellbeing.

Quantile 0.50 – Median Wellbeing Households: At the 50th percentile, representing households with moderate wellbeing, income diversification begins to show a statistically significant influence on wellbeing. The Simpson Index coefficient is -0.163 (p = 0.047), indicating that while diversification is actively pursued by middle-income households, its effect on wellbeing may still be limited in its current form. However, this result should not be viewed purely negatively. Rather, it suggests that these households are at a transition stage, where diversification strategies are active, but may require capacity-building, access to technology, or better market integration to become fully effective. The significance of the coefficient highlights the central role diversification plays in these households' economic lives, and it presents a valuable opportunity for policy to intervene and upgrade these activities.

The impact of microcredit also strengthens at q.50, with a coefficient of 0.009 (p = 0.155). Although still below traditional significance levels, the increase in effect size reflects that credit becomes more useful when households have moderate asset bases and can deploy borrowed funds more productively. Statistically, the trend is consistent and positive, and from a policy

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perspective, this supports expanding access to affordable, productive, and tailored microfinance for median-income rural households.

Additional variables such as total expenditures (B = 0.233, $p < 0.001$), education, and quality of housing (MWalls) remain significant and reinforce earlier findings. The Pseudo R^2 of 0.418 confirms that the model maintains strong explanatory power even at the median, accounting for 41.8% of the variance in wellbeing.

Quantile 0.75 – Higher Wellbeing Households: At the 75th percentile, representing relatively well-off households, the Simpson Income Diversification Index remains statistically significant (B = -0.306, p = 0.019) with the highest absolute coefficient among all quantiles. While the coefficient is negative, it suggests that for higher-income households, there may be diminishing returns from engaging in too many income-generating activities or allocating labor and capital across non-core areas. However, this should be interpreted with caution; wellbeing at this level may be more influenced by asset consolidation and specialization, rather than extensive diversification. The significance of this variable indicates that diversification remains an integral economic behaviour—even among relatively better-off households—and can be made more effective through high-value, high-skill diversification strategies such as agri-processing, agribusiness, or formal sector engagement.

The microcredit variable (log of loan) remains positive (B = 0.007) and consistent in direction, although statistically insignificant (p = 0.478). Statistically, the consistency of the positive sign across all quantiles indicates microcredit's persistent potential across the wellbeing spectrum. Among higher-income households, the modest magnitude may reflect reduced dependency on credit, but it does not imply ineffectiveness. Instead, it suggests that credit programs may be more catalytic when complemented by technical assistance, market access, or value chain integration.

The Pseudo R^2 at q.75 is 0.406, slightly lower than at q.25 but still strong, reflecting the model's ability to explain wellbeing variation among relatively well-off rural households.

Across all three quantiles, the quantile regression results underscore that income diversification and microcredit are relevant, dynamic, and quantile-sensitive predictors of household wellbeing. Although their statistical significance and magnitude vary, their directional consistency (especially for microcredit) and their recurring presence in the model highlight their centrality to rural economic strategies.

At lower quantiles, these strategies represent foundational survival tools; at the middle quantile, they are transitional enablers of economic mobility; and at the upper quantile, they are potentially powerful when targeted toward efficiency and value addition. The statistical evidence thus supports expanded and improved access to both income diversification support and microcredit services, tailored by wellbeing level. This includes skills training, market linkages, credit literacy, and sectoral support to maximize the positive welfare effects captured by the model.

These findings provide a robust empirical foundation for policy, encouraging a nuanced, stage-specific approach to rural wellbeing enhancement through income strategies and financial inclusion.

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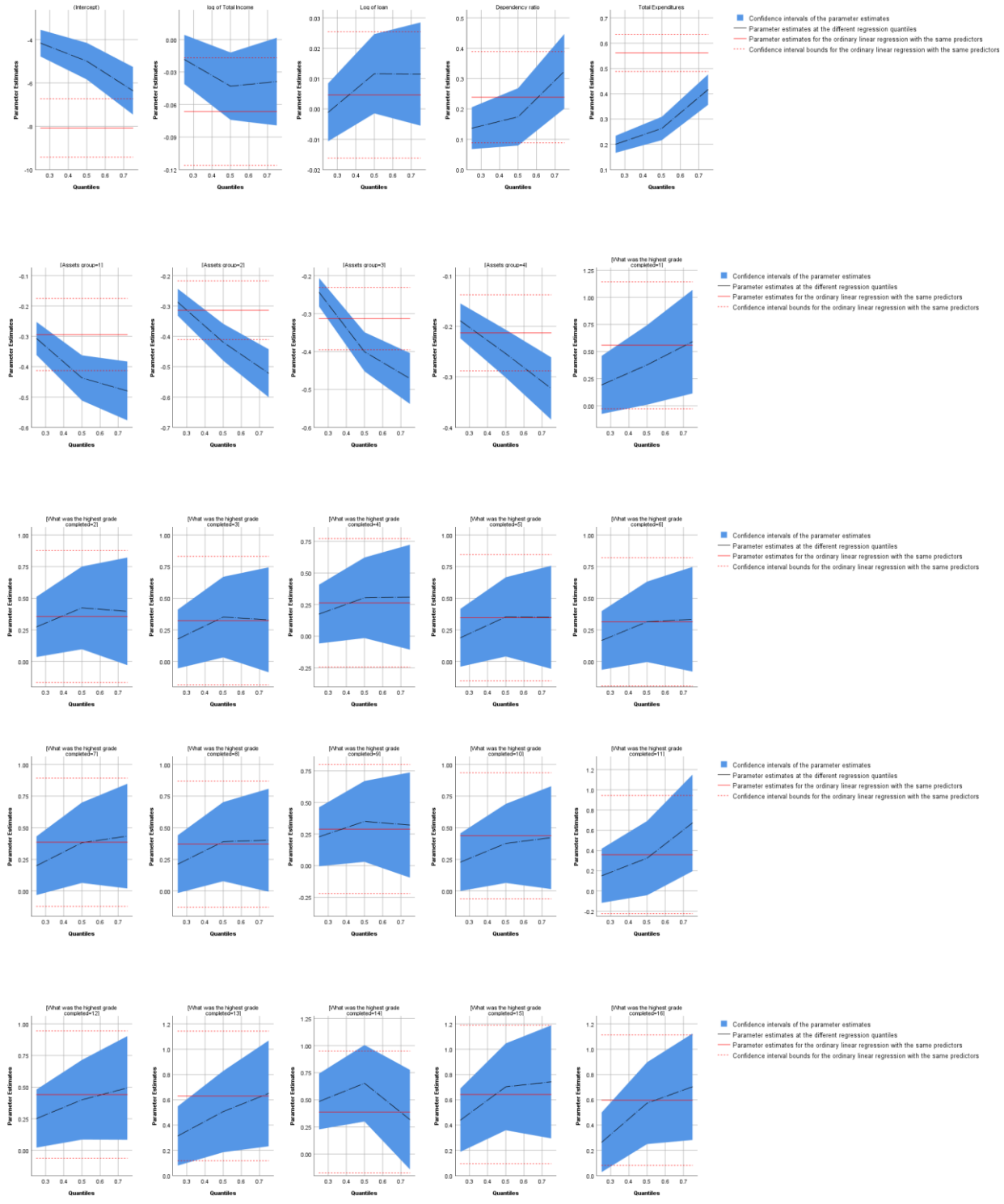
Figure 2:



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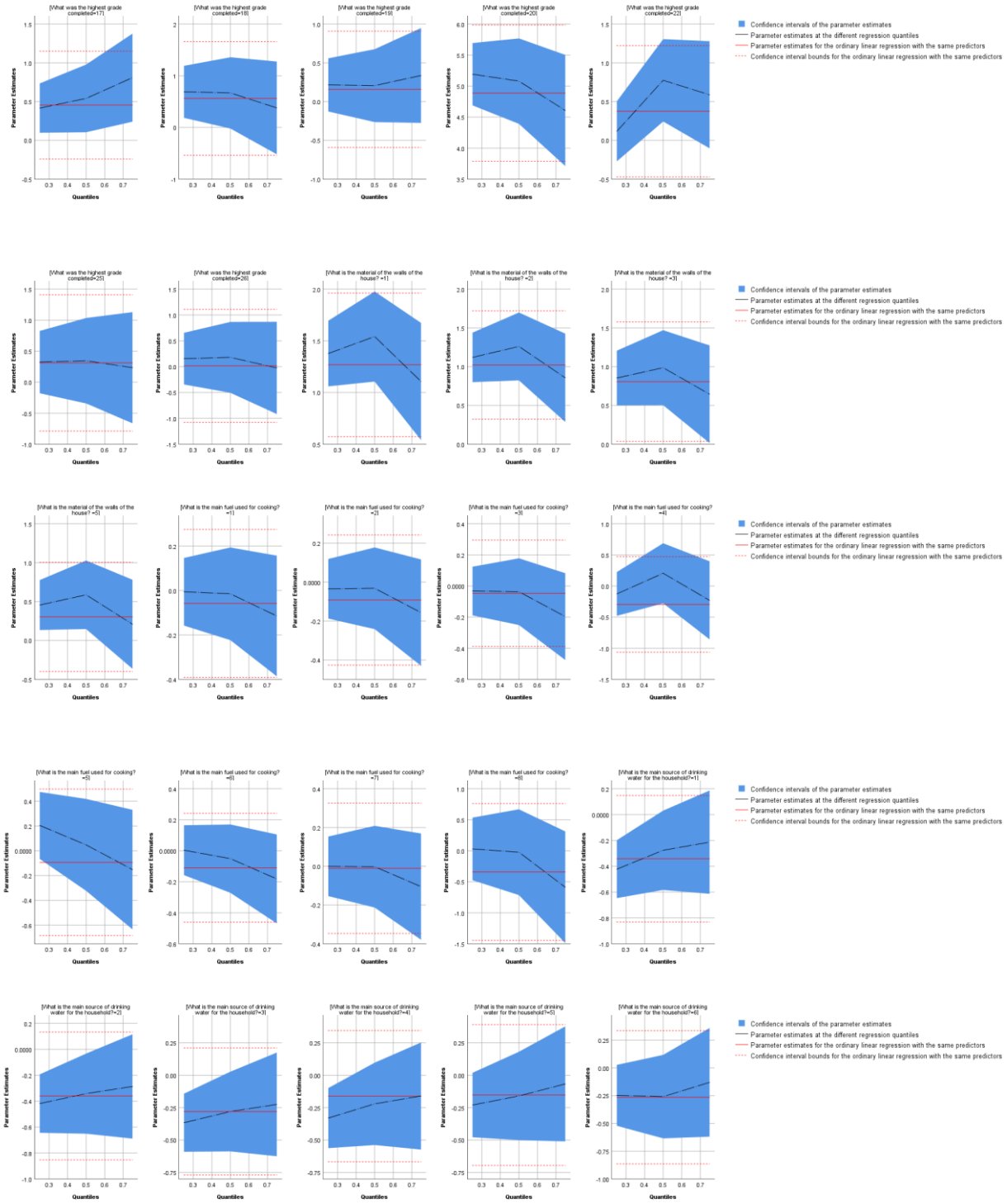

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Figure 3: Predictions at Different Quantiles

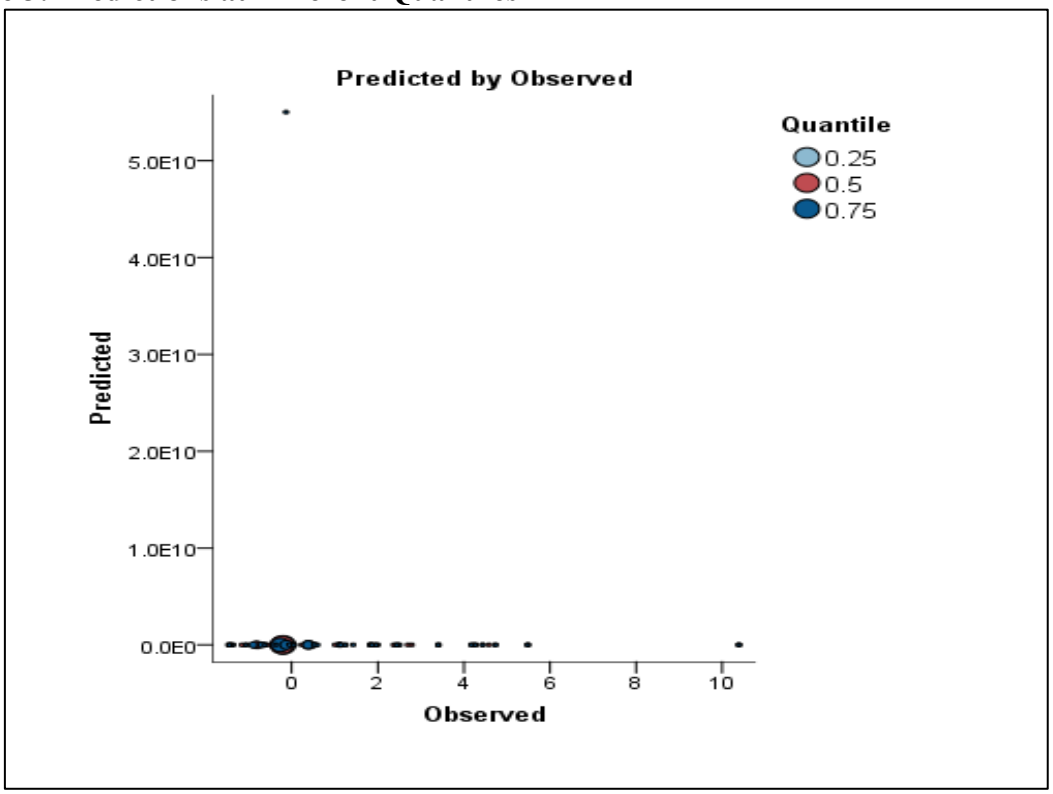

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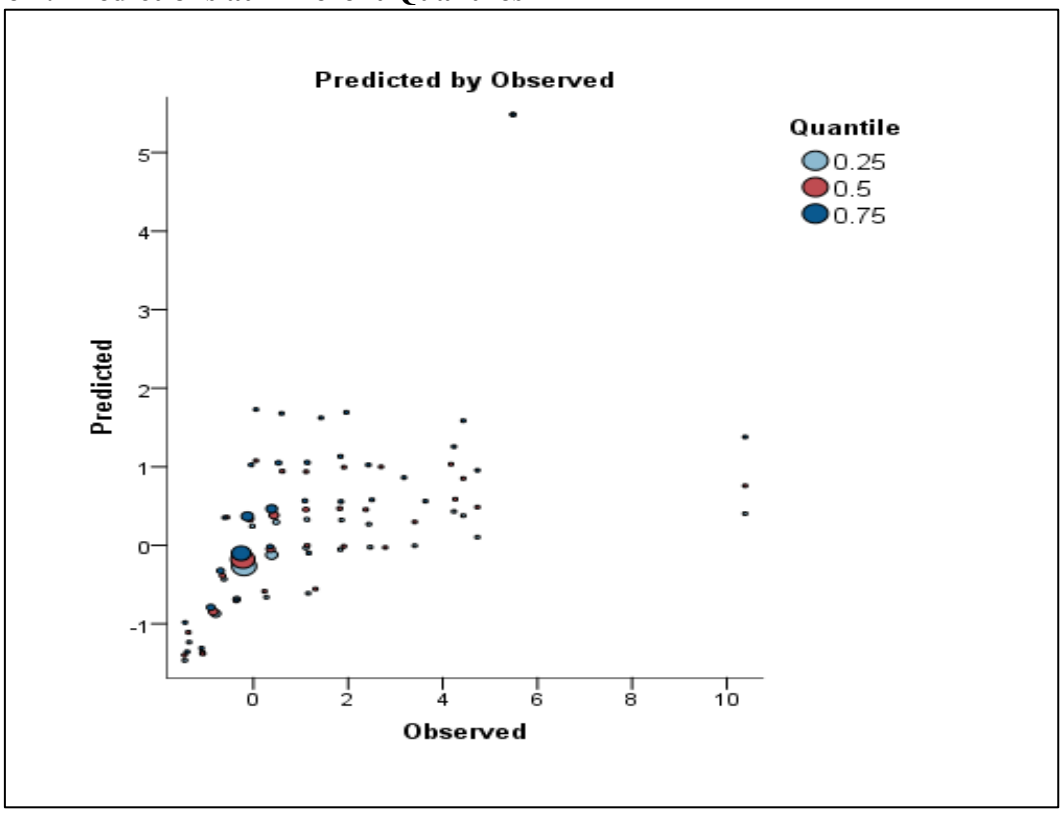
Figure 4: Predictions at Different Quantiles



4. Conclusion & Recommendations:

The study investigates the impact of access to microcredit and income diversification on the wellbeing of the small farm holders in context of Pakistan. Withing a robust methodological framework that cover the construction and empirical investigation of the above variable using most adopted and widely accepted techniques like Principal Component Analysis (PCA), Ordinary Least Squares (OLS), and Quantile Regression. A well-thought and comprehensive index of multidimensional wellbeing is formed using eleven indicators across five theoretically validated dimensions such as housing quality and access to clean water to asset ownership and education expenditure. These indicators feature the intricacies of rural livelihoods and highlight the perspectives to assess development outcomes.

The result of the PCA analysis reveal that wall material, value of residential buildings, water source, and livestock value collectively explain 44.34% of the variance in wellbeing. The result signifies both material and infrastructural dimensions of rural life and show how provision physical assets and basic services can transform well being of small farm holders.

Regression analyses further reinforce the central thesis of this study: that access to microcredit and engagement in income diversification are positively associated with improved wellbeing. While the magnitude and statistical significance of these effects vary across income quantiles, the overall directionality remains consistent. Notably, quantile regression reveals that the benefits of microcredit and diversification are most pronounced among lower and middle-income households—those most vulnerable to agricultural shocks and income volatility. This

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finding aligns with the theoretical expectation that financial inclusion and livelihood diversification serve as critical buffers against poverty and economic insecurity.

Although the OLS results indicate that the Simpson Income Diversification Index exhibits a negative coefficient, this should not be interpreted as a contradiction of the broader findings. Rather, it reflects the complex nature of diversification in rural contexts, where households may pursue multiple income streams out of necessity rather than opportunity. In such cases, diversification may be distress-driven, highlighting the need for structured and skill-based interventions that transform coping strategies into sustainable livelihoods.

Similarly, while the coefficient for microcredit is modest and statistically insignificant in the OLS model, its consistent positive sign across all quantiles suggests latent potential. The quantile-specific results indicate that microcredit becomes increasingly effective when complemented by other enabling factors such as education, asset ownership, and expenditure capacity. These findings support a more nuanced interpretation: microcredit alone may not be a panacea, but when embedded within a broader ecosystem of support, it can significantly enhance household resilience and wellbeing. There is a need for complementary interventions (e.g., training, market access) more strongly, especially given the weak standalone effect of microcredit.

Beyond the focal variables, the analysis identifies several additional determinants of wellbeing. Household expenditures, particularly on health and education, emerge as strong positive contributors. Access to clean drinking water and improved housing materials also play a critical role, reinforcing the multidimensional nature of wellbeing and the need for integrated development strategies.

Despite the robustness of the findings, the study acknowledges certain limitations. The HIES 2018–19 dataset, while comprehensive, lacks granularity in some areas specific to smallholder agriculture, such as input use, market access, and credit utilization patterns. Future research would benefit from more targeted data collection that captures these dimensions, enabling deeper insights into the mechanisms through which financial and livelihood strategies influence wellbeing.

Policy Recommendations

Drawing on the empirical evidence, the following policy recommendations are proposed to enhance the wellbeing of small farm holders and advance progress toward the Sustainable Development Goals (SDGs):

1. Diversification is not only critical for farmers well being but has far-reaching implications on the economic mobility and resilience. Enabling the non-farm income generating avenues through extension services and market linkages can help in uplifting the wellbeing of marginalized farmers.
2. It is recommended to design a contextual offering of micro-credit facilities featuring affordable pricing. Further, required trainings should be offered to ensure the productive credit utilization through adoption of state-of-the-art farming techniques to ensure success in uplifting wellbeing.
3. Governmental intervention is recommended to enable access to clean drinking water, sanitation, and safe housing schemes to enhance wellbeing. Inside the wellbeing, the intervention would improve health, education, labour productivity and shield against the vulnerabilities.

4. The study recommends specifically tailored subsidies and financing schemes for the provision of essential agricultural inputs and equipment to small farm holders. The said provision would add to their productivity and limit their dependence on low-return diversification strategies.
5. For a broader understanding of the wellbeing, it is recommended to add diverse indicators, as used in the study, into national surveys such as HIES, PSLM, and the Agricultural Census providing more impetus for effective and inclusive policy making.
6. The study recommends to map and link strategies to enhance wellbeing of farmers to SDG targets, specifically those relevant to poverty reduction (SDG 1), food security (SDG 2), health (SDG 3), education (SDG 4), and economic inclusion (SDG 8 and 10).

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