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Factors influenceed the monthly per capita consumption expenditure of milk and milk products in Kamrup district of Assam

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Abstract
The consumption level of milk and milk products was quite heterogeneous across the households in the Kamrup district of Assam, the Newey-West HAC (Heteroskedasticity and Autocorrelation Consistent) approach with up to four lags and a Pooled Ordinary Least Squares model had been employed to study the effects of various factors. The analysis of MPCE had indicated that cereal; pulses, fruits and vegetables were the significant predictors with positive effect of MPCE on milk and milk products, with a coefficient of 0.486, 1.381 and 0.204 respectively. This suggested that households with higher expenditure on cereals, pulses, fruits and vegetables also tend to spend more on milk and milk products, possibly due to complementary dietary habits. Out of number of Socio-economic variables only family size and age were found to be significant. Family size has a significant negative relationship with MPCE on milk and milk products, with a coefficient of -90.022, significant at the 10% level ($p<0.1$). Age also had a similar significant negative effect on milk and dairy expenditure, with a coefficient of -5.133 ($p<0.05$), implied that as the average age of household members increased, the per capita expenditure on milk along with its products decreases. The estimated coefficients of the model where income showed a positive influence on milk expenditure (26.36, $p< 0.01$), indicated that higher income levels were associated with increased spending on milk. Vegetarian households demonstrated a significant preference for milk (82.39, $p < 0.05$) while exhibited reduced spending on curd (-21.92), which could reflected the dietary choices.

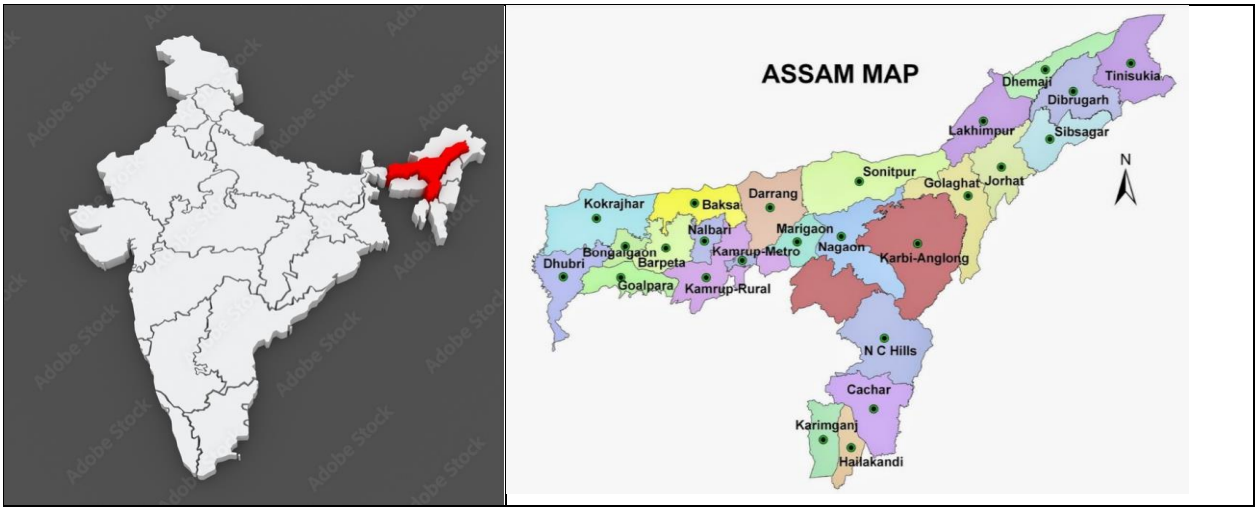
Keywords: MPCE, Socio economic variable, Newey-West HAC, Kernel based Regularized Least Square

1. Introduction
Dairy products are a key source of high-quality protein, which is crucial for muscle repair and growth. They also provide a rich array of essential vitamins and minerals, including calcium, which is vital for bone health; potassium, which helps in maintaining blood pressure; and Vitamin B12, essential for brain health and the nervous system [1]. Furthermore, dairy products contain phosphorous, magnesium, and vitamins A and D (in fortified products), which together support a wide range of bodily functions from the immune system to energy metabolism. Some common milk products include: Ghee, Curd, Butter, Ice Cream, Powder milk and Condensed milk etc. The demand for milk and milk products is rising sharply, driven by population growth, increasing incomes, and urbanization. This increased demand is expected to be met by domestic production. However, the quantity and types of milk consumed vary significantly across regions due to disparities in purchasing power across socioeconomic groups, differences in taste and dietary habits shaped by agro-climatic conditions, regional resource availability, and temporal variations in milk supply within different areas [2]. Though India is self-sufficient in milk production, there exist significant regional variation in milk production and in this regard, the North Eastern Region is deficit in milk production [3]. Assam was purposively selected for the study as the organized milk marketing is still quite small despite previous attempts to create and advance collective market mechanisms in North-East Region of India [4]. According to the 20th Livestock Census, total livestock population of Assam was recorded as 180.92 lakhs where the cattle population constitutes the largest group with 60% followed by goat population 24% and pig 12%. During 2022-23, the total milk production was recorded to be 1006.42 MT and per capita availability of milk was only 78 gm/day in Assam which is below all national average [5]. The state records only 12% per capita milk availability of milk among other North-eastern states [6].

Assamese consumers favour raw milk over processed liquid or powdered milk due to the way milk is used in the state - either as a tea whitener or in milk sweets.

2. Method and materials

The study was planned to estimate the difference in milk and its products consumption pattern and preferences by different socio-economic groups in Kamrup District, considering both Metropolitan and rural areas. The study was carried out in the Kamrup district of Assam using a multistage random sampling technique. Localities of Bhangagarh and Kahilipara were selected from the Kamrup Metropolitan area, while Palashbari and Boko were chosen from the Kamrup Rural region. A total of 50 households were sampled from each locality, resulted in 200 respondents for the study. Primary data was collected from each household using a pre-structured schedule through a personal interview method conducted between February to May 2024.



The entire sample of households was post-stratified into three distinct income groups- i.e. lower, middle and high using a cumulative square root frequency approach as follows [7]:

$$L_i = Y_{i-1} + \frac{Y_i-(Y_{i-1})}{\sqrt{f_i}} \left([i * \left(\frac{S_k}{L}\right)] - S_{i-1}\right) \ldots (1)$$

Where,

- L = no. of strata
- L_i = i[th] strata
- Y_{i-1}= lower limit of the class in which L_i ($\frac{S_k}{L}$) lies
- $\sqrt{f_i}$ = square root of the frequency of i[th] class in which L_i ($\frac{S_k}{L}$) lies
- S_{i-1} = cumulative square root of the frequency of preceding class in which L_i ($\frac{S_k}{L}$) lies
- Y_i = upper limit of the class in which L_i lies
- $Y_i - (Y_{i-1})$ = width of the class in which L_i ($\frac{S_k}{L}$) lies.

2.1 Multiple Variable Regression Analysis

Individual household's food consumption behavior was discrete and independent. However, consumption expenditure on food depends on a number of explanatory variables. To model individual household's consumption behavior, monthly per capita consumption expenditure (MPCE) had been estimated following primary data survey. Further, to model consumption behavior, multiple variable regression analysis had been adopted following the below mentioned econometric framework.

$$MPCE_{veg} = \alpha_i + \sum_{i=1}^{n} \theta_i X_i + \varphi_i D_i + \varepsilon_i$$

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where, MPCE denotes per capita monthly consumption expenditure, X denotes set of explanatory variables, D denotes set of dummy variables list.

2.2 Kernel Based Regularized Least Square

The consumer preferences towards milk and milk products was assessed by non-parametric Kernel-based Regularized Least Squares (KRLS) framework in the study. KRLS is an advanced non-parametric regression technique that allows for flexible modeling of complex relationships between predictors and outcomes. It is particularly suited for this analysis, as it captured the non-linear effects of various factors on household preferences for milk and its products [8]. This method assumed that the target function (i.e., the relationship between the outcome and explanatory variables) could be expressed as:

$$\boldsymbol{y = f(x)}$$

Here, *y* is the outcome of interest i.e., milk or any milk product, and *x* represents the explanatory variables. The KRLS method then approximates the function *f(x)* as a weighted sum of kernel functions, as shown below:

$\boldsymbol{f(x) = \sum_{i=1}^{N} c_i k(x, x_i)}$ where $k(x,x_i)$ represented the kernel function, which captured the similarity between the point of interest x and the covariate vector x_i, where *i* ranges from 1 to N. The weight c_i is assigned to each kernel function based on its contribution to the overall approximation [9]. Essentially, this approach helps estimate how similar inputs x_i affect the target variable *y*, allowing the KRLS framework to flexibly model non-linear relationships.

3. Results and Discussion

3.1 Cameron Trivedi decomposition Analysis

To depict and identify factors affecting milk and milk products monthly per capita consumption expenditure, first

consumption level of milk and milk products was analysed and checked for heterogeneity. Cameron Trivedi decomposition was adopted to analyse the source of data variability [10]. Based on the overall result of the test statistic showed in Table 1 with P=0.001, the assumptions of homoskedastic cannot be accepted. It was observed in Table 1 that, the consumption level of milk and milk products was heterogeneous across the households in Kamrup district. Hence, the normal Ordinary Least Square (OLS) method would provide inefficient though unbiased result. To overcome this, Newey West HAC estimator had been adopted to estimated unbiased and efficient values of the selected parameters.

3.2 Factors determining consumption expenditure of milk and milk products

The variation in per capita expenditure on milk and milk products was influenced by various factors, including the family's monthly income and consumer spending habits [11]. Other determinants of milk expenditure included expenditures on substitute as well as complementary goods, along with the household's dietary preferences. Previous research had shown that the consumption patterns of milk were mainly shaped by consumers' socio-economic characteristics, such as income level, occupation, education, gender, age, and geographic location [12]. The analysis had considered the monthly per capita expenditure on milk and milk products as the dependent variable. The independent variables included monthly per capita expenditures on cereals, pulses, fruits and vegetables, meat, fish, egg, income, family size, age, residential location, dietary pattern, and employment status, among the households [13]. The results indicated that MPCE on cereal (Fig 1), pulses (Fig 2), fruits and vegetables (Fig 3) was a significant positive predictor of MPCE on milk and milk products, with a coefficient of 0.486, 1.381 and 0.204 respectively across all lags (Table 2). This suggested that households with higher expenditure on cereals, pulses, fruits and vegetables also tend to spend more on milk and milk products, possibly due to complementary dietary habits. Socio-economic variables like family size and age were also found to be significant (Fig 4). Family size has a significant negative relationship with MPCE on milk and milk products, with a coefficient of -90.022, significant at the 10% level ($p<0.1$). This finding suggested that larger households tend to spend less per capita on dairy products, potentially due to budget constraints or the need to distribute resources across a larger number of members. Age also had a similar significant negative effect on milk and dairy expenditure, with a coefficient of -5.133 ($p<0.05$), implied that as the average age of household members increased, the per capita expenditure on milk along with its products decreases. This could reflect changing dietary preferences of older individuals due to various health problems. However, the vegetarian dietary pattern had a highly significant positive effect on MPCE for milk and milk products, with a coefficient of 407.857 ($p<0.01$). This was consistent with notion that vegetarians, relied more heavily on dairy as a source of protein, spend significantly more on milk and related products. Households with members in self-employment showed a significant positive relationship with MPCE, with a coefficient of 182.043 ($p<0.1$), suggested that self-employed households allocate more to milk and milk products, possibly due to higher autonomy in managing household budgets. The model's R-squared value for the pooled OLS was 0.441, indicated that around 44% of the variance in MPCE for milk and milk products were explained by the included variables. Validation of estimated econometric model was carried out by Tukey-Pregibon test [14] as the estimated hat square value was 0.0001375 with SE= 0.0000775 and numerical value of t statistic was observed as 1.77 with Prob > t = 0.078

3.3 Determinants of household food consumption expenditure

A multiple variable regression analysis aimed to model the household consumption behaviour considering the determinants of household monthly per capita food consumption expenditure (MPCE) across two different groups: non-vegetarian and vegetarian households was done with the same set of explanatory variables, monthly per capita expenditure on cereals, pulses, fruits and vegetables, meat, fish, eggs, household income, age, family size, number of children and presence of old-aged members etc [15]. Table 3 indicated the factors that affect MPCE of milk and milk products differently for non-vegetarian and vegetarian households. For non-vegetarian households, spending's on cereals, fruits and vegetables, and meats were significant predictors of monthly per capita expenditure (MPCE) on milk and milk products. i.e., the households that spend more on these products also spend more on milk and milk products. Conversely, in vegetarian households, significant associations were found between MPCE of milk and milk products and family size as well as the number of children. The model's explanatory power was significantly greater for vegetarian households (0.569). This suggested that the variables incorporated into the model provide a more accurate explanation of milk expenditure patterns for vegetarian households than for their non-vegetarian counterparts [16].

3.4 Kernel based Regularized Least Square model

Table 4 presented the estimated coefficients of the model where income showed a positive influence on milk expenditure (26.36, $p< 0.01$), indicated that higher income levels were associated with increased spending on milk. Conversely, expenditures on curd and sweets were negatively impacted by income, suggested the substitution effects. Vegetarian households demonstrated a significant preference for milk (82.39, $p< 0.05$) while exhibited reduced spending on curd (-21.92), which could reflected the dietary choices. The model also revealed that average family size was a crucial determinant, with a substantial negative impact on milk expenditure (-48.24, $p< 0.01$) and curd (-29.54, $p< 0.01$), highlighted the economic constraints of larger households [16]. Additionally, the presence of senior citizens in the household positively correlated with spending on sweets (12.12) indicated a preference for such products among this demographic constitution of the area. Geographically, households in Kamrup (Rural) displayed varied expenditure patterns, emphasizing regional influenced on the dairy consumption.

Table 1: Analysing consumption expenditure of milk and milk products: Cameron Trivedi decomposition

Source	χ^2	Degree of freedom	p
Heteroskedasticity	151.2	91	0.0001
Skewness	31.26	13	0.0031
Kurtosis	3.16	1	0.0753
Total	185.62	105	0.0001

H0: homoskedastic variance and normal coefficient

Table 2: Major factors for monthly per capita consumption expenditure of milk and milk products

Particulars	Newey-West				Pooled OLS
	Lag 1	Lag 2	Lag 3	Lag 4	
Cereals	0.486***	0.486***	0.486***	0.486***	0.486**
	(0.178)	(0.176)	(0.175)	(0.176)	(0.133)
Pulses	1.381***	1.381***	1.381***	1.381***	1.381***
	(0.475)	(0.463)	(0.457)	(0.456)	(0.381)
Fruits and vegetables	0.204**	0.204**	0.204**	0.204**	0.204***
	(0.083)	(0.085)	(0.085)	(0.085)	(0.073)
Meat	0.164	0.164	0.164	0.164	0.164
	(0.152)	(0.147)	(0.147)	(0.145)	(0.194)
Fish	-0.178	-0.178	-0.178	-0.178	-0.178
	(0.146)	(0.147)	(0.149)	(0.148)	(0.219)
Egg	0.159	0.159	0.159	0.159	0.159
	(1.320)	(1.292)	(1.291)	(1.277)	(2.061)
Income	-46.805	-46.805	-46.805	-46.805	-46.805
	(119.105)	(120.379)	(121.918)	(122.023)	(178.077)
Family size	-90.022*	-90.022*	-90.022**	-90.022**	-90.022*
	(48.260)	(45.968)	(44.613)	(44.029)	(39.692)
Age	-5.133**	-5.133**	-5.133**	-5.133**	-5.133*
	(2.426)	(2.312)	(2.253)	(2.197)	(2.702)
Base: Kamrup (Metropolitan)					
Kamrup (Rural)	0.253	0.253	0.253	0.253	0.253
	(75.826)	(72.396)	(71.449)	(70.522)	(92.338)
Base: Non-vegetarian					
Vegetarian	407.857**	407.857**	407.857***	407.857***	407.857**
	(169.999)	(158.495)	(147.435)	(144.754)	(148.480)
Base: Non-working					
Self- employment	182.043*	182.043*	182.043*	182.043*	182.043**
	(105.110)	(104.865)	(103.798)	(104.586)	(92.237)
Service	45.986	45.986	45.986	45.986	45.986
	(91.958)	(90.703)	(89.467)	(89.406)	(89.556)
Constant	880.152	880.152	880.152	880.152	880.152
	(610.295)	(597.172)	(589.956)	(584.891)	(898.928)
R-squared	-	-	-	-	0.441
Prob > F	0.001	0.001	0.001	0.001	0.001

Standard errors in parenthese Significant at ***(p<0.01), **(p<0.05), *(p<0.1)

Table 3: Analysis of Determinants Influencing Household Food Consumption Expenditure

Particulars	Non-Vegetarian (n=165)	Vegetarian (n=35)
Cereals	0.355***	0.100
	(0.130)	(0.450)
Pulses	0.427	2.255
	(0.290)	(1.709)
Fruits and vegetables	0.182***	0.072
	(0.060)	(0.268)
Meat	0.265**	-
	(0.124)	
Fish	-0.087	-
	(0.142)	
Egg	0.777	-
	(1.313)	
Income	-153.066	542.536
	(119.910)	(1,167.573)
Age	-1.996	-13.375
	(1.909)	(13.552)
Family size	-48.710	-384.968*
	(30.110)	(203.634)
Base: Kamrup (Metropolitan)		
Kamrup Rural	-76.634	104.566
	(68.204)	(499.277)
Base: Non-working		
Self- employment	33.438	843.821
	(67.258)	(494.904)
Service	-31.845	272.185
	(63.276)	(469.583)

No. of children	18.531	571.941*
	(41.532)	(313.160)
No. of old-aged members	24.189	141.496
	(36.507)	(281.790)
Constant	1,401.646**	-634.684
	(610.224)	(6,054.034)
Observations	165	35
R-squared	0.314	0.569

Standard errors in parentheses Significant at ***(p<0.01), **(p<0.05), *(p<0.1)

Table 4: Preference of milk and milk products assessed by Kernel based Regularized Least Square model

	Milk	**Curd**	**Ghee**	**Butter**	**Paneer**	**Ice-cream**	**Sweets**
Income	26.36**	-3.11	0.09	0.19	1.92	0.95	-7.43
	(-12.64)	(-5.73)	(-0.17)	(-0.18)	(-2.09)	(-1.93)	(-6.38)
Vegetarian	82.39*	-21.92	1.53	0.75	6.32	14.24*	51.23**
	(-42.91)	(-16.15)	(-1.28)	(-1.36)	(-8.35)	(-8.74)	(-25.52)
Average Age	-0.42	-0.22	0.01	-0.04	0.01	-0.05	-0.3
	(-0.76)	(-0.29)	(-0.02)	(-0.02)	(-0.15)	(-0.15)	(-0.44)
Average Family Size	-48.24**	-29.54**	-0.44	-0.19	-7.76**	-1.29	-11.53
	(-10.85)	(-4.33)	(-0.2)	(-0.22)	(-1.99)	(-1.97)	(-6.07)
No. of Children	-14.1	-7.11	-0.03	-0.02	2.1	4.47	-1.02
	(-17.57)	(-7.22)	(-0.34)	(-0.37)	(-3.22)	(-3.22)	(-9.84)
No. of Senior Citizens	-31.99*	-6.01	0	0.03	0.5	-0.79	12.12
	(-15.06)	(-6.17)	(-0.31)	(-0.34)	(-2.79)	(-2.82)	(-8.52)
Kamrup (Rural)	-55.54	8.92	-0.89	-1.39	-8.92	-17.36*	-5.38
	(-35.97)	(-13.24)	(-0.99)	(-1.07)	(-7.16)	(-7.6)	(-21.88)

Standard errors in parentheses Significant at ***(p<0.01), **(p<0.05), *(p<0.1)

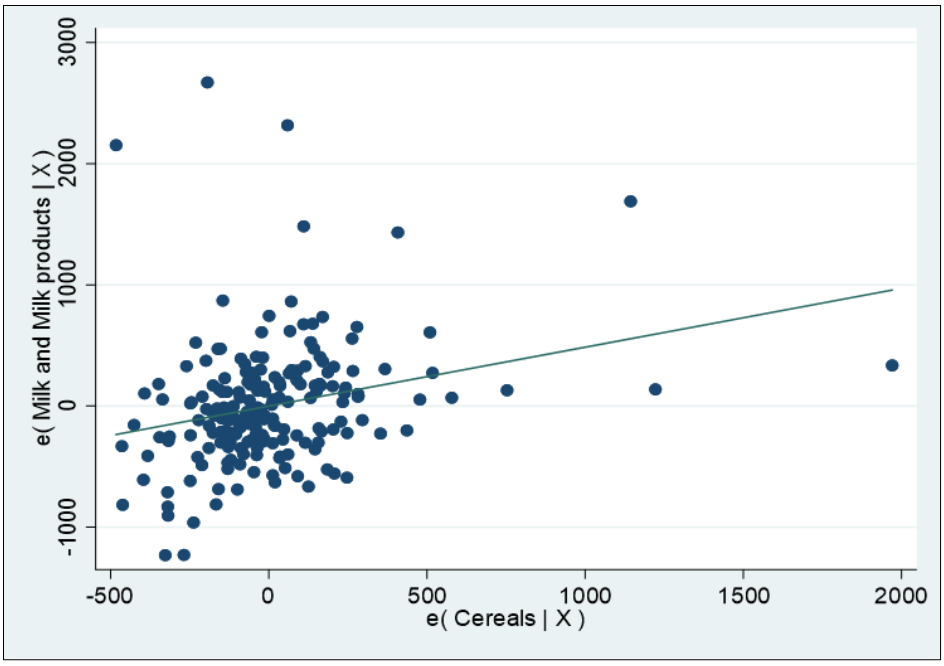

Fig 1: MPCE of milk products and households expenditure on cereal

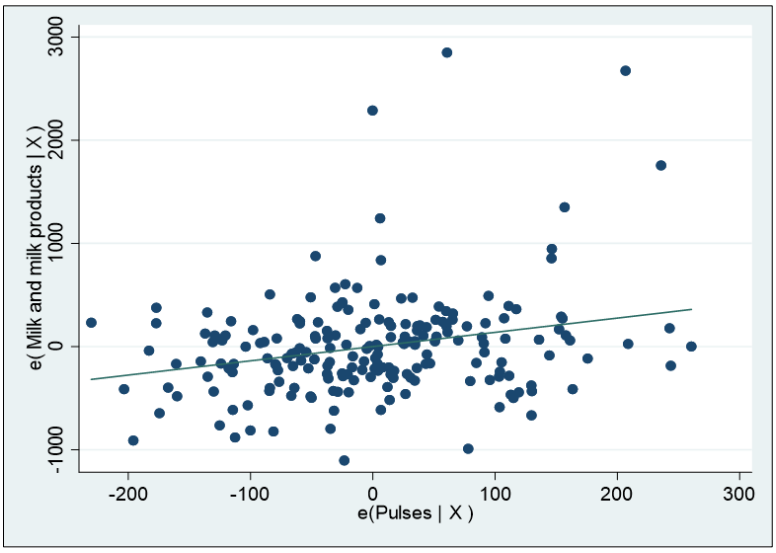

Fig 2: MPCE of milk products and households expenditure on pulses

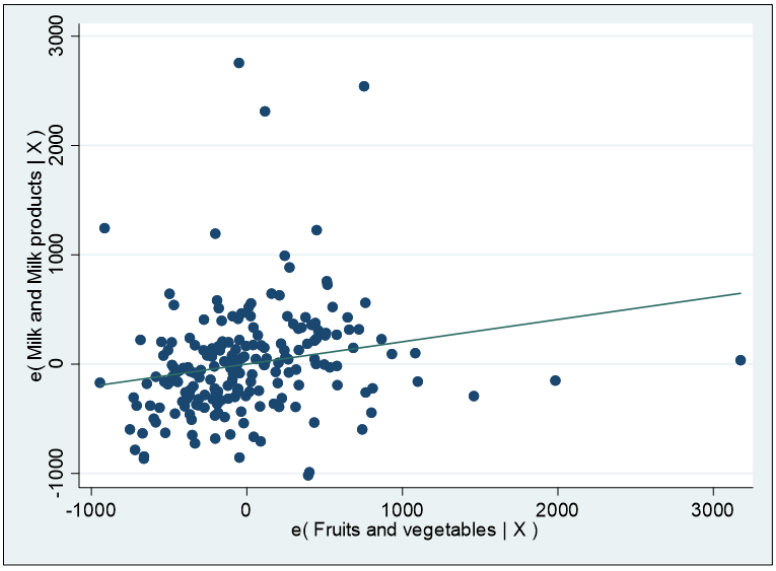

Fig 3: MPCE of milk products and households expenditure on fruits and vegetables

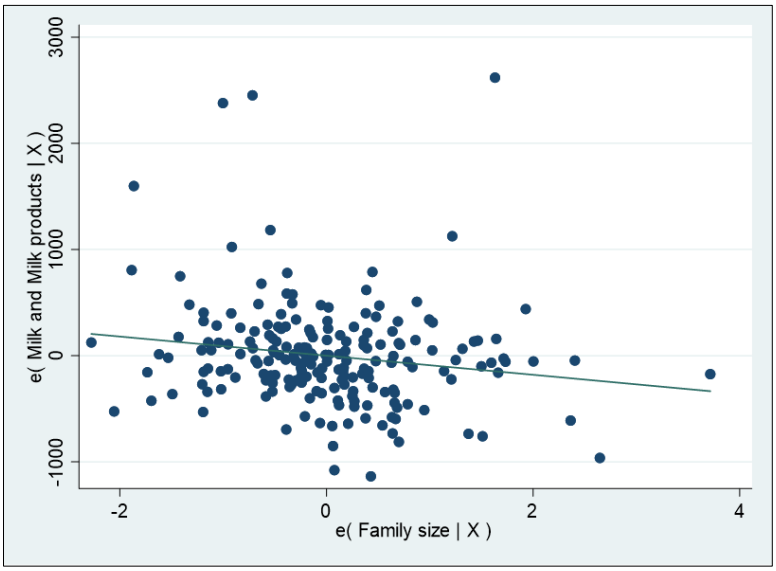

Fig 4: MPCE of milk products and family size of households

4. Conclusions

The consumption level of milk and milk products was quite heterogeneous across the households in the Kamrup district of Assam, the Newey-West HAC (Heteroskedasticity and Autocorrelation Consistent) approach with up to four lags augmented with Pooled Ordinary Least Squares model had been employed to study the effects of various factors. The analysis of MPCE had indicated that cereal, pulses, fruits and vegetables were the significant predictors with positive effect of MPCE on milk and milk products, implied that households with higher expenditure on cereals, pulses, fruits and vegetables also tend to spend more on milk and milk products, possibly due to complementary dietary habits. Family size had a significant negative relationship with MPCE on milk and milk products had pointed out that larger households tend to spend less per capita on dairy products, potentially due to budget constraints or the need to distribute resources across a larger number of members. The estimated coefficients of the model where income showed a positive influence on milk expenditure indicated that higher income levels were associated with increased spending on milk. Conversely, expenditures on curd and sweets were negatively impacted by income, suggested the substitution effects. Vegetarian households demonstrated a significant preference for milk while exhibited reduced spending on curd which could reflected the dietary choices.

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