Mathematics Education Journals
Vol. 7 No. 2 August 2023

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

Canonical Correlation in Modeling Short Term Expenditure versus Poverty Levels in Informal Settlements:Assessing its Impact on Education

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Keywords:
education; canonical correlation; short-term expenditure; modeling; economy

Abstract

Populations in informal settlements grapple with poor living conditions and inability to access quality education. Expenditure behaviour especially on short term basis is one of the major causes of poverty as majority live from hand to mouth and not in position to provide their children with education. This study applied canonical correlation used in a wide range of disciplines to analyse the relationship between short term expenditure and poverty levels. The main objective was to establish the relationship between short term expenditure and poverty levels among residents of informal settlements, assess the impact of this behaviour on education and propose possible mitigation strategies to the problem. Results indicate that people in informal settlements spend as much as they earn or even more on short term basis. Therefore, they cannot save for projects, invest and educate their children. This keeps the families in unending circus of poverty in all generations.

Sirengo, J., L., & Okoth, A., W.. (2023). Canonical Correlation in Modeling Short Term Expenditure versus Poverty Levels in Informal Settlements:Assessing its Impact on Education. *Mathematics Education Journal*, 7(2), 208-215. DOI : 10.22219/mej.v7i1.28091

INTRODUCTION

Income and expenditure are the foundation of any viable economy, because a nation's economy is a direct replica of the economies of its citizens. Therefore, the concept of expenditure and income in this context was to be clearly understood. In Kenya, economic growth rebounded even more strongly in 2010, reaching 4.2%, and since 2013 has remained above 2.5% per annum (World Bank Group, 2018). This growth has however not reflected among most citizens because a good percentage of them live below the poverty line despite the government's plan of poverty reduction (Vision, 2007, Odhiambo, 2010). However, a closer interaction with informal settlement residents revealed an interesting pattern in the way they spend their hard earned cash which could have a direct impact on their way of life, given that most of them live in abject poverty. Expenditure is the act of spending or using money (according to Oxford dictionaries). It is classified into three types: Capital expenditure, Revenue expenditure and Deferred Revenue expenditure. Income on the other hand is cash or an equivalent that results from wages or salaries, rent from land or a building or interest, dividends or profit from an investment.

According to world bank, poverty is the inability to attain the minimum standards of basic needs: food, shelter, clothes, education, health and transportation. It is a global challenge and the quest to eliminate poverty is one of the greatest human endeavours of our time, (Ogunsakin, 2012). Inability to eradicate poverty

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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has greatly affected education as most children from these informal settlements, cannot afford education let alone affording a meal. This inability has been attributed to by a number of challenges: Key among them being failure to implement the formulated poverty reduction plans, Kristjanson et al., (2010). While policy makers focus mainly on reducing the national aggregate poverty incidences, it is important to note that the poor are not poor all the time and there is movement in and out of poverty, (Baulch & Dat, 2011, Yaqub, 2000).

This study was therefore premised on the need for researchers and policy makers to know more about why households move into and out of poverty, the welfare pathways along which they do so, and why it is that some households remain always trapped in poverty, (Burke et al., 2007). One key contributor to this is the individual's expenditure behaviour which this study sought to establish and relate to poverty levels.

LITERATURE REVIEW

Review Mkondiwa et al (2013), did a study in Malawi to investigate the relationship between poverty and lack of access to adequate safe water in rural Malawi. Data used in the analysis was collected from a survey covering 1,651 randomly selected households. They used Canonical Correlation Analysis (CCA) as a distinct technique for understanding the poverty-rural water access nexus. CCA results indicated that poverty in the context of low income and expenditure was positively correlated with lack of access to safe and adequate water. Integrated Rural Water Resources Management (IRWM) interventions were therefore needed to address both challenges of poverty and poor access to adequate water in rural Malawi.

Ogunsakin (2012), investigated the extent to which selected poverty related variables correlate with literacy related variables and pattern of such correlation. The poverty level was categorized into poverty by expenditure, household size and per capita expenditure while literacy level was categorized into years of formal education, educational age group. The variables were analysed using the multivariate analysis technique known as the canonical correlation analysis first described by Hotelling (1935), which is used in a wide range of disciplines to analyse the relationships between several dependent variables. Statistics software package was employed in running the analysis. The results revealed that there was a significant positive correlation between the levels of poverty and literacy. In addition, some of the levels of literacy had significant correlation with that of poverty levels when correlation matrix was employed. The results showed that literacy was one of the strong factors that determine poverty.

Muyanga and Musyoka (2014), did research on households' Incomes and Poverty Dynamics in Rural Kenya, using Panel Data Analysis. They found out that earlier studies on poverty in Kenya were static, focusing on poverty incidence, gap and severity at a point in time. The studies provided valuable information on poverty characteristics and distribution, but not necessarily in providing a good indicator of welfare stability over time. Their study is an addition to the few existing studies on poverty dynamics in Kenya. It attempted to analyse rural households' income and poverty incidence over time. The analysis used balanced panel data of 1,299 households in rural Kenya. The results revealed considerable regional welfare

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
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disparities and dynamics over time in rural Kenya. The welfare dynamics were associated with demographic factors such as dependency burdens of households, gender and the education attainment of the household heads. Households with high dependency ratios and those under single-female headship were more likely to transit into poverty. The finding underscores the increasing importance of post-secondary education in the welfare of rural households. The success of any education policy in reducing poverty is hinged on participants excelling beyond secondary schools and acquiring skills that were in demand on the job market. The results also highlighted the increasing importance of the land resource in the rural areas. However, with shrinking land sizes due to increased population pressure, access to more land is not an option. Further, disturbing finding was the effect of rainfall shocks on household welfare. Household income somehow increased depending with the amount of rainfall and rainfall variability significantly reduced incomes, thus, predisposing households to poverty. Their study showed the importance of improved access to infrastructure and markets on rural household welfare. Consequently, the capability of the devolved development programmes to pull the consistently poor out of poverty is put on spotlight.

Despite all the work done on poverty eradication, none of the previous studies sought to establish spending behaviour as a contributory factor to poverty. This study therefore sought to bring this important factor to the fore and propose some mitigation strategies which if appropriately implemented would go a long way in pulling a considerable proportion of a country's population out of poverty and create a lease of life for many families, hence greatly impacting many generations.

RESEARCH METHOD

Canonical correlation analysis (CCA) entails an analysis of expenditure which is sub grouped into Capital expenditure (Y1) and Revenue expenditure (Y2) in relation to poverty levels which is further sub-grouped into: Household size (X1) and Income level (X2).

Capital expenditure (Y_1) – is the amount spent to acquire or improve long term assets such as equipment or building.
Revenue expenditure (Y_2) – is an amount that is expended on immediate needs.
Household size (X_1) – is the number of individuals per household.
Income level (X_2) – is the total amount earned per month.

The variables are compared against each other to find the relationship. The descriptive factor considered is the correlation matrix involving the levels of expenditure and the levels of poverty. Canonical correlation analysis is a way of making sense of cross-covariance matrices. Suppose there are two vectors $X = (X_1, \cdots, X_n)$ and $Y = (Y_1, \cdots, Y_m)$ of random variables, and there is correlation among the variables, then CCA will find linear combinations of the X_i and Y_j which have a maximum correlation with each other. The correlation matrix of all the variables is divided into four parts namely:

a. The correlations among the X variables. R_{XX}
b. The correlations among the Y variables. R_{YY}
c. The correlations between the X and Y variables. R_{XY}
d. The correlations between the Y and X variables. R_{YX}

ISSN : 2579-5724
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Canonical correlation analysis may be defined using the singular value decomposition of a matrix R which is the product of four correlation matrices and is given by:

$$R = R_{YY}^{-1} R_{YX} R_{XX}^{-1} R_{XY} \quad (1)$$

Where the relations of R are represented by Table 1,
Table 1: Relation of the variables

$\mathbf{R_{XX}}$	$\mathbf{R_{XY}}$
$\mathbf{R_{YX}}$	$\mathbf{R_{YY}}$

To get the canonical correlations, the eigenvalues of R are given by,

$$R_i^2 = \lambda_i \quad (2)$$

Taking the square root on Equation 2 yields the following equation,

$$R_i = \sqrt{\lambda_i} \quad (3)$$

And the eigenvector corresponding to each eigenvalue is transformed into the coefficient that specified the linear combination that made up a canonical variate.

The study further employed regression analysis to establish the effect of poverty variable that is, household size and monthly income on the expenditure variables and also education. A descriptive design method is a scientific design that involves observing and describing the behaviour of a subject without influencing it in any way. In this study simple random sampling involved, selecting households randomly. The household was selected only once from a population of size N. The sample size used in this study was n = 450 people living in informal settlements.

RESULTS AND DISCUSSION

A statistical software R was the preferred analytical tool because it is able to demonstrate clearly whether or not significant correlations exist between the two sets of measures. The analysis was done at two levels. First correlation coefficients between variables were computed and secondly analysis of canonical correlations was done.

a) Correlation coefficients between variables

Analysis of correlation coefficients between the variables is shown in Table 2.

Table 2: Correlation coefficients between variables

	H. Size	M. Income	C. Expenditure	M. R. Expenditure	Educated
H. Size	1.00				
M. Income	0.52	1.00			
C. Expenditure	-0.04	0.49	1.00		
M.R. Expenditure	0.64	0.91	-0.02	1.00	
Educated	-0.49	0.03	0.35	0.23	1.00

Results from the correlation matrix in Table 2 show that the monthly income (M. Income) and monthly revenue expenditure (M. R. Expenditure) had a very

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

strong positive correlation (0.91). This means that people in informal settlement spend as much as they earn. Saving habits were not much reflected among this class of people because monthly income and capital expenditure (C. Expenditure) had a low positive correlation (0.49). One other possible reason for poor saving habits apart from very low income was large household sizes (H. Size) which were reflected among most of them. Capital expenditure and household size has a very weak negative correlation (-0.04) which implies that when there are many members in the household, the family is not likely to invest in long term projects.

Similarly, the correlation between household size and educated is -0.49 which indicates that as the number of household increases majority of members are not able to be educated due to unavailability of resources. Monthly income and educated individuals in a household has a positive relationship (0.03) implying that when there are members who are not educated in the family, there will be little generation of income. It is important to educate members because in a family of educated members, the monthly income will increase thus creating opportunities for other members.

b) Canonical correlations

This was used to determine the degree to which the expenditure or education variables were related to the poverty variables. Canonical correlation analyses provide indices of both statistical significance and practical significance. The analysis revealed that both canonical correlation loadings were statistically significant basing on the hypothesis which stated that:

H_0: The canonical correlations in the current row and all that follows are zero.

Vs

H_1: The canonical correlations in the current row and all that follows are not zero.

For the above hypothesis test, the p-value is used as the critical value and for Fishers probability it states; If $p - value \geq 0.05$ the null hypothesis is not rejected and also if $p - value < 0.05$ the null hypothesis is rejected.

Table 3: Canonical correlation coefficients

	CanR	CanRSQ	Eigen	Percent	cum
1	0.9645	0.9302	13.3257	99.0134	99.01
2	0.3424	0.1172	0.1328	0.9866	100.00

Test of H_0: The canonical correlations in the current row and all that follow are zero

	CanR	WilksL	F	df1	df2	p.value
1	0.96447	0.06162	57.5393	4	76	0.0000
2	0.34237	0.88278	5.1784	1	39	0.0284

As shown in Table 3, the first test of the latent roots tested whether the two latent roots were significant (i.e. F = 57.5393) with *p- value* = 0.0000. Also, the second test which was the last one tested whether the second latent root by itself, was significant (F = 5.1784) with *p-value* = 0.0284. All latent roots were found to be significant because both p-values are less than 0.05.

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

Testing for latent successive roots, the first pair showed a significant relationship and a strong positive degree of canonical correlation (0.9645). The second canonical loading is also significant with a weak positive degree of correlation (0.3423). The canonical correlation I describes the strength of the relationship between the latent variables and the square of this relationship (R^2) described the proportion of variance of one latent variable predictable from the other latent variables in the same set. These results are summarized in Table 4:

Table 4: Summarized data on canonical correlations

	R_i	R_i^2	λ_i	WilksL	F	df1	df2	p.value
1	0.96447	0.9302	0.9302	0.06162	57.5393	4	76	0.0000
2	0.34237	0.1172	0.1172	0.88278	5.1784	1	39	0.0284

The first canonical correlation (r_1 = 0.9645) was strongly significant, contributing 93.02% (i.e.,R_1^2) to the shared variance. The second canonical correlation (r_2 = 0.3423) contributed only 11.72% (i.e.R_2^2) to the shared variance.

c) Regression Analysis

Regression analysis helped to determine the effect of poverty variables on expenditure variable and education. The effect of household size and monthly income on capital expenditure is shown in Table 5.

Table 5: Effect of poverty variables on capital expenditure

Coefficients:	Estimate	Std.Error	t Value	P r(> |t|)
(Intercept)	42318.1063	5308.4608	7.972	$1.32e^{-14}$
H.Size	-3083.0304	717.4024	-4.297	$2.12e^{-05}$
M.Income	0.6324	0.4006	1.578	0.0115

Household size negatively affected capital expenditure with coefficient (-3083.0304) indicating that when household size increases, there was no much spending on long term investment. However, monthly income positively affected the expenditure with coefficient (0.6324). The effect of the variables that is, household size and monthly income on monthly revenue expenditure is shown in Table 6.

Table 6: Effect of poverty variables on monthly revenue expenditure

Coefficients:	Estimate	Std.Error	t Value	P r(> |t|)
(Intercept)	$1.490e^{+03}$	$5.811e^{+02}$	2.565	0.0106
H.Size	$5.820e^{+02}$	$7.853e^{+01}$	7.410	$6.34e^{-13}$
M.Income	$2.945e^{-01}$	$4.386e^{-02}$	6.714	$5.75e^{-11}$

In the table, monthly revenue expenditure depended on both household size and monthly income. Increase in household size and income affected positively expenditure behaviour among the individuals. This implies that as the household size increases, monthly revenue expenditure also increases. With this kind of behaviour in the society of having more than four members in the household without income, it was difficult for individuals to save the little hard-earned cash. Educating members in the society helps in eradicating poverty. The study also

ISSN : 2579-5724
ISSN : 2579-5260 (Online)
http://ejournal.umm.ac.id/index.php/MEJ

focused on the effect of poverty variables (household size and monthly income) on education represented by Table 7.

Table 7: Effect of poverty variables on Education

Coefficients:	Estimate	Std.Error	t Value	P r(> |t|)
(Intercept)	$7.925e^{-01}$	$1.742e^{-01}$	4.550	$6.92e^{-06}$
H.Size	$-4.124e^{-01}$	$2.354e^{-02}$	17.522	$< 2e^{-16}$
M.Income	$1.060e^{-04}$	$1.314e^{-05}$	8.066	$6.72e^{-15}$

Poverty variables were all significant which implied that they have a strong impact on education of family members. A household with many members was likely to have only few members being educated. However, as more individuals in a household received education, the income of that household was likely to increase. Therefore, it is advisable for each household to educate members so that they can help others and the society at large in future.

CONCLUSION

The analysis showed that poverty and expenditure are correlated. The results of the analysis undertaken were statistically significant from the discussions above. The study has shown that in general, if expenditure is minimized then it is a good measure of human development as the saving can be invested in key development projects such as education, hence improving livelihoods. Based on these results, there is need to:

1. Educate families in informal settlements on the importance of cautious spending so that vital functions such as Education can get a share.
2. Sensitize families on the numerous ways of generating income. This will help prevent the hand to mouth habits among most residents and provide them with the ability to take care of their children's education.
3. Initiate community resource centres geared towards encouraging more children to go to school and get education. Parents will also be sensitized on the importance of giving their children education.
4. Initiate STEM campaigns in schools in these settlements in order to encourage more enrolment in STEM related careers since it is a key driver to development.

The implication of this is that the quality of education in such settlements will improve and therefore STEM uptake will also improve

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