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Effects of Community Based Forest Management on Livelihoods under Terai Arc Landscape Program, Nepal

[1]Ram Prasad Lamsal, [1]Bikash Adhikari, [1]Sanjay Nath Khanal,
[2]Keshav Raj Kanel
[1]Department of Environmental Science and Environment Engineering, Kathmandu University, Nepal
[2]Resource Economist and Forestry Expert, Nepal

Abstract: *Appreciation of the multiple benefits of conservation is always incomplete without a good understanding of their impact on local peoples' livelihoods.This study investigates the impact of Terai Arc Landscape (TAL) program on households' livelihood in Nepal by examining how the various types of livelihood options contribute to community and household assets and income. A survey of 400 household was conducted to obtain information before and after community based forest management (CBM) interventions within TAL. Sustainable livelihood framework was utilized along with principal component analysis (PCA) and regression model to analyze the factors that contribute to household livelihood and income. The study found that communities in CBM areas have improved their access to different assets.The regression results show that the contribution of the selected components are significant to livelihood index and household income.Future poverty alleviation policy options need to give priority to investments in sustainable livelihood assets.*

Keywords: *Terai Arc Landscape, Principal component analysis and Multiple linear regression*

I. Introduction

The current conservation approaches in Nepal have been to work with communities to develop complementary linkage with livelihood that provide frameworks for: a) recognition of communities' role in conserving natural resources (Acharyaet al. 2010); b) recognition that local livelihood systems are compatible with environmental conservation; and c) strengthening of understanding, commitment and capacity of communities and stakeholders to conservation (Consultative Group on International Agricultural Research, CGIAR, 2011)

The Terai Arc Landscape (TAL) program, Nepal is founded on the recognition that developing sustainable, effective and equitable approaches to biodiversity conservation requires a thorough understanding of the interlinkages between socio-economic and biophysical status, influences and threats (World Wildlife Fund, WWF, 2004). This, in turn, requires that the methodologies used to assess local resources and to inform management responses are integrated and deal with biodiversity and livelihood aspects (Roe et al, 2009; Allenet al, 2008; Springate-Baginski,et al, 2009).

The improvement of livelihoods of local communities is high on the agenda at conservation sector (Siloriet al, 2009), and it is therefore important to develop tools and techniques that can measure this multi-dimensional concept. The need therefore exists for a composite index of livelihoods with the ability to both track the quality of life of people over time and compare it across different conservation parameters. Such a measure could identify those critical factors associated with livelihood and also highlight dimensions that need to be prioritized for improvement.

II. Objectives

This study aimed to assess the status and trend on livelihood of the local communities of TAL.The primary objective was to construct a composite index taking into account of objective, subjective, economic and non-economic dimensions and objectively weighted.Furthermore, the livelihood differences before CBM and after CBM was then compared using this newly constructed composite index with the regressed factors and gross income. The second objective was to compare the components that explain the most variance in the data set of the different sub-sets.

III. Field Sites And Sample

TAL is a transboundary landscape area between Nepal and India consisting of a total area of 23,199 Km^2 and forest area of 14000 Km^2 in Nepal. Four corridors (Mohana-Laljhadi, Basanta, Khata and Barandavar) and three bottleneck areas (Mahadevpuri, Lamahi and Dovan) of TAL were selected for study.A set of survey questions was developed and possible participants were identified with a sample strategy of 400 household respondents based on Cochran's sample size formula for categorical data collection with the sampling error of 5

percent.The TAL program intervention consists of 341 community based institutions and 66642 householdsas per data of 2012.

IV. Methods

The survey was carried out in 2009 and repeated in 2012 to compare before and after scenario of CBM on livelihoods. The interview explored matters on perception, current status and changes of livelihood of communities. The interviews elicited an array of perspectives and a large amount of unstructured information. Analysis of both qualitative and quantitative data involved interpretation and categorization of responses using SPSS 20. In the first step, seven different sub-indices with 72 variables of sustainable livelihood model were developed. The data setsof year 2009 and 2012 were used to conduct PCA for each asset separately and aggregated for all assets. Household income was analyzed using both descriptive statistics and multiple linear regression. The participatory approach has been adopted to collect the data.

For construction of composite index, the steps were followed in line with Sharpe& Smith, 2005 and McGranahan,et al. 1972. The dimensions were selected based on a theoretical framework using both top-down approach (Sirgy, 2011) and bottom-up approach (Dluhy& Swartz, 2006); focused on acquiring structured and good quality data(McGranahan, et al.1972) and avoided the anticipated problem of missing data (Organization for Economic Co-operation and Development, OECD, 2008). The data was explored using PCA to identify the underlying structure and constructs followed by weighting and aggregation of the index (McGranahan, et al., 1972).

V. Sustainable Livelihood (SL) Components

Broadly, the SL parameters were grouped into seven categories: (i) human, (ii) physical, (iii) financial, (iv) natural and (v) social capitals; (vi) vulnerability context and (vii) Policy, intuitions and process.This clearly indicated that there was a need to develop sub-indices based on these categories and then an integrated livelihood index at landscape level. The seven components each of them have 5 to 15 subcomponents and each subcomponents had different score system containing information on the variables included in the development of different sub-indices (Table 1).

VI. Data Analysis

The correlation between variables and component indicated by factor loading followed by subsequent analysis was used as a basic for classifying the dominant variables in each component. If the factor loading value wasmore than 0.7, the attribute could be considered as dominant role in the component (Hairet al., 2009) because it would account for more than 50% of the variance.

6.1 Human capital

Five variables loaded highly on a single common factor in 2009 (Table 2). The scores of variables were aggregated to form the human capital index. The most dominating factors in social capital in 2009 were labor availability (0.876), human health, skilled manpower (0.833) and training (0.920) and education (0.880).Similarly, in 2012 the factor loading with dominating factor were found changed. Training, education and human resource showed a vital role. The receiving training (0.961) has been an important factor. The factor for education was 0.947. The labor and human health factors (0.921 and 0.839 respectively) were important in human capital variables.

6.2 Physical capital

The selection consisted of 6 variables for 2009 and 5 variables for 2012 covered the broad themes of the assessment. However, the nature of the loading of variables between 2009 and 2012 has been changed. With factor loading of 0.995 each on communication, market access, community house, school, road and house made much higher contribution as regressors to the factor structure of 2009. On the other hand, house (0.942), road (0. 942), school (0.867), health services (-0.852) and communication (0.852) made greater contribution to the factor structure in 2012.

6.3 Natural capital

Among natural capitals, four variables were found significant in reiterated loading in the first component of PCA method with loading value of 0.70 in both 2009 and 2012, however, the nature and loading differed. Fodder and fuelwood (0.968), farming system (0.948), forest management (0.948) and access to natural resources (NR) (0.824) were of great importance in the settlement of factors on non-CBM in 2009. However, access to NR (0.999), forest management (0.999), fuelwood (-0.999) and Non timber forest product (NTFP) management (0.936) outstandingly contributed to the formation of factors on CBM in 2012 (Table 4).

6.4 Social capital index

The factor scores were weighed according to factor loadings. Four key variables, with loadings above 0.7, were identified for the social capital index.The most important variables for the social capital factor in 2009 were: community size (0.963), landlessness (-0.963), community organization (0.926) and Trust (0.926). On the other hand in 2012, the five contributing factors weretrust (1.0), participation (-0.986), population (0.915), community organizations (0.915) and village size (-0.9150) as shown in Table 5.

6.5 Financial capital index

Among the financial capitals three variables with high loadings above 0.7 on the first component were then aggregated to form the financial capital index. As shown in Table 6, in 2009, the most dominant factors found wereentrepreneurships of households (0.855) followed by income (0.742) and employment (0.701). However, in 2012, the changes have occurred with three dominant factors contributing significantly were income generation (0.973), mobilization of community funds (0.970) and prospect for ecotourism (0.904).

6.6 Index on Vulnerability

Indicators of vulnerability which were significant with single component analysis in 2009 were natural shocks (0.857) and human health (0.823), however, in 2012 natural shock (-0.852), biodiversity threats (0.844), and human wildlife conflicts (0.766) scored higher (Table 7).

6.7 Index on policy, institutions and process

In constructing the Index on policy and institutions using the PCA, the significant variable was community based forestry operational plan in 2009 (0.740) in 2009 and changes occurred in 2012 to coordination (0.962) and policy anomalies (0.891) in the single factor of PCA (Table 8).

6.8 PCA on aggregate data

The raw data were used for the multi-collinearity diagnostics, and the problem had existed with high values of variance inflation factor (VIF>10.0). Moreover, out of 72 variables, 45 variables were excluded from multi-collinearity test consideration as the computed value was less than the amount specified. The VIF test included variables were used for PCA analysis and constantly refined, and variables, which did not affect the model, were excluded. Successive changes were made to improve the robustness. In the initial analysis, the first principal component accounted for 51.5% for 2009 and 53.1% for 2012 of the variation in the original variables with loading 0.70 and had high loadings for many of the variables. In the second and subsequent analysis variables of low loading were removed.

Finally, 11 variables for year 2009 and 12 variables for year 2012 were identified with the highest loadings (Table 9). For year 2009, the variables of factor loading of value 0.999 were participation, road, house, income entrepreneurships, community organization and access and use of NR. Other contributing variables were forest management plans (0.869), labor availability (0.724), proportion of land owner/landless (0.724) and natural shocks (0.710).

On the other hands, for year 2012, ownership and use rights (0.954), road (0.954), access to market and infrastructures (0.954), income (0.923), remittances (0.923), population and migration (0.823), forest management (0.823), education (0.711), farming system (0.711), natural shocks (0.711), human wildlife conflicts (0.711) and policy harmonization (0.711) were found major loaded variables.

The final selection for the model consisted of 11 and 12 variables out of original 72 variables which covered the all themes of the assessment. The factor scores showed the relative weights given to each variable in the index.To calculate the index these coefficients are multiplied by the standardised values of the respective variables. The index accounts for 31.1% of the variation in the original variables used in the analysis in year 2009 and 68.5% in 2012

6.9 Analysis of household income

An analysis of household income by income group shows thatthe mean annual income from farm and forests has been estimated as Nepalese Rupees (NRs). 56,288 ±1699.72 in 2009 and NRs. 115,748±2809.01 in 2012. Similarly, the figure was quite large when remittance was included as shown in Table 9 with mean NRs. 99,985 ± 1854.71 in 2009 and NRs. 136460.70 ± 2170.89 in 2012. (Table 9).The incomes, both without or with remittances have been increased significant between 2009 and 2012 with p =0 as revealed by independent sample t test in Table 10.

CBM under TAL as an integrated package has been an important income source to the households compared to those without such management. The communities have access to protect, manage and use the resources. The communities in the program area have increased the income level compare to the previous

period. As shown in Table 12 and 14, the percent of income range of communities has been upscaled between year 2009 and 2012.

During the period of five years income from remittances has been increased sharply. Active community members were less reliant on local income and they have migrated either to abroad or within countries for seasonal farm employment, road and building construction, rickshaw pulling and other wage laboring activities. Therefore, the remittance has played a significant role in increasing the income level of communities (Table 11 and 13).

The level of remittance income was positively correlated with household income, reflecting that some remittances received as cash are used to purchase inputs for assets. During the period of 2009 to 2012, the proportion of remittance to total income has been increased from 30.5 percent to 44.9 percent. As evidenced by the correlation tests between total household income and remittance in Table 13, there was no significant correlation in 2009 ($p>0.05$) but highly significant in 2012 at $p=0.000$.

It is important to note that communities also depend upon farm, livestock, wage laboring, salary, collection and sale of forest products, handicrafts, skilled non-farm jobs, salaried jobs and self-employment having effects on income distribution and often subject to debate on attributions. However, the multiple resources of CBM provide several opportunities to poor and disadvantaged communities as an important source of income under the TAL program interventions.The impact of conservation conducted by TAL helped the organized communities in gaining different capitals. The process has encouraged local communities to participate actively in decision making on livelihood issues. There is also evident that they have capability to influence their access to livelihood assets.

6.10 Regression Analysis

The factors that contribute to household income were analyzed using a regression model. The explanatory variables included in the model consist of those measuring various priority assets. The dependent variable was the annual household income from different sources by using equations estimated separately using the survey data from households sampled before CFM in 2009, equation 1, and after CBM in 2012, equation 2.

Equation 1:

$Y=\alpha + 1\ \beta\ PAR + 2\ \beta\ ROD + 3\ \beta\ HOS + 4\ \beta\ ENT + 5\ \beta\ CMO + \beta\ 6\ ANR + \beta\ 7\ LSS + \beta\ 8\ FMP + \beta\ 9\ LAB + \beta\ 10\ NSH + Error$

Where; Y= household annual income (NRs); α = constant; β 1 to β 10= coefficient of variables for household assets; PAR = Participation (index); ROD = Road (index); HOS = House(percent); ENT = Entrepreneurships (percent); CMO = Community organization (likert scale) ; ANR = Access to NR (Continuous); LSS = Inverse proportion of landlessness (number); FMP = Effectiveness of forest management plan (Continuous); LAB= Labor availability (percent); NSH= Natural Shock (likert scale) and Error.

Equation 2:

$Y=\alpha + \beta_1\ OWN + \beta_2\ ROD + \beta_3\ ACE + \beta_4\ ENT + \beta_5\ RMT + \beta_6\ POP + \beta_7\ MGT + \beta_8\ EDU + \beta_9\ FMS + \beta_{10}\ NSH + \beta_{11}\ HWC + Error,\ (2)$

Where; Y = household annual income (NRs); α = constant; β 1 to β 11= coefficient of variables for household assets;OWN = Ownership and use rights (index); ROD = Road (index); ACE = Access to market and infrastructure (Continuous); RMT= Remittances (NRs), POP= Population and migration (proportion) MGT= Forest management (Binary), EDU= Education (Continuous), FMS= Farming system, (likert scale) NSH= Natural shocks (likert Scale) and HWC= Human wildlife conflicts (Percent), PHM=Policy harmonization (likert Scale) and Error.

Multiple regression analysis is used to examine the link between the household income and various independent variables. With removing multicollinearity problem, the complex relationship between household income and the measured characteristics was assessed by priority variables for non-CBM in 2009 and CBM in 2012. Income was predicted by multiple linear regression method. R2, R2, adjusted R2, and RMSE values for income prediction were estimated as 0.42, 0.18, 0.163 and 0.358 for non-CBM (Table 15), and 0.696, 0.485, 0.475 and 0.463 for CBM (Table 16).

In case of non-CBM, the coefficient for the variables of three factors were significant. The regression modelin Table 15 reports significant p for landlessness, forest management and access to natural resources and their associated t-statistic was significant at the 5% level. These were important predictors of household income in year 2009 before formation of CBM. However, the model eliminated ROD and CMO variables.

The communities have got easier access to financial institutions due to their institutional identity. Access to financial capital has been provided to them. The greater access to financial support has created both

impact and spillover effects to each other on social, human and financial capitals. The coefficient of RMT was positively linked but is a moderately significant (at 5% level). The implication of negative relationship of PHM, NSC, HWC with positive significance value of p=0.000(Table 16) is that community rights has been restricted by policies and government circulars in the recent past. The variables excluded from the model were ROD, EDU and FMS.

VII. Discussion And Conclusion

This paper contributed on the measurement on livelihood by constructing an objectively weighted composite index and applying the index to compare livelihood across the diverse population of TAL. It also determined which components explained the most variance in the data set of the different groupings. The constructed index included the relevant dimensions of livelihood and included both objective and subjective indicator variables as well as economic and non-economic variables. This is the first measure of this type constructed for TAL and Nepal.

Data from years 2009 and 2012 were used and the initial selection of the index measures were based on the SL approach. Through PCA and MLRA a set of smaller number of variables was identified from the initially selected 72 indicator variables and composite indices of the extracted components were constructed. In addition, the impact of TAL on household's livelihood is examined by investigating how the various types of assets contribute to household income. Comparisons were made between the period before and after CBM interventions.

The results showed not only that a single asset provide a significant role in livelihood or income in TAL area, but also that in some cases one particular capital cannot even encapsulate a complete description of a livelihood component. We also found that the nature and the number of independent asset component slightly varied from one model to another.On the basis of the study we reach the following conclusions: a) livelihood on the sites is improved due CBM attributable to the rights on access to resources b) the use of several assets proved useful to quantify livelihood and this study did not show that any of the capital or assets used was superior to the others.

Furthermore, the indices are useful tools in policy analysis as they help set policy priorities and benchmark performance (Nardo, et al., 2005; OECD, 2008) and provide a means to compare different measuring units of analysis in which the different indicators are measured. However, the composite indices can communicate misleading information if the index is poorly constructed and the selection and weighting of the indicators is not transparent (Sharpe, 2004). These indices can also contribute to users or policy-makers reaching the wrong conclusions and consequently making incorrect policy decisions.

The study also observed two major problems in analysis. First, it was related to measurement problems on how to measure and quantify the results. The second one was related to the attribution problems on how to determine whether and to what extent the programs caused the results that were observed.

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Table 1: Components and subcomponents

Components	Sub Components	Data types	Data nature	Data sources
1. Human	5	C	QN and QU	Primary
2. Physical	12	C; LS	„	„
3. Natural	13	C; B; LS	„	„
4. Financial	15	C; B; LS	„	„
5. Social	14	C; B; LS	„	„
6. Vulnerability context	8	C; LS	„	„
7. Policy, institutions and process	4	B; LS	QU	Secondary

Source: Survey design, 2009 and 2012; C= Continuous; LS=Likert scale and B= Binary; QU = Qualitative; QN = Quantitative

Table 2: Human capital factor loading and scores

Year 2009			Year 2012		
Performance indicators (PIs)	Factor loading (FL)	Score	PIs	FL	Score
Labor availability	0.954	0.221	Training	0.961	0.226
human health	0.953	0.220	Education	0.947	0.223
Skills	0.941	0.218	Labor	0.940	0.221
Training	0.920	0.213	Human health	0.921	0.216
Education	0.880	0.203	Skills	0.839	0.197
Variance explained (%)	86.502			85.133	

Table 3: Physical capital factor loading and score

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Communication	0.995	0.136	House	0.942	0.201
Market access	0.995	0.136	Road	0.942	0.201
Community house	0.995	0.136	School	0.867	0.185
School	0.995	0.136	Health services	-0.852	-0.177
Road	0.995	0.136	Communication	0.852	0.177
House	0.995	0.136			
Variance explained (%)	60.727			59.446	

Table 4: Natural capital factor loading and score

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Fodder and fuel-wood	0.968	0.345	Access to NR	0.999	0.193
Farming systems	0.948	0.236	Forest management	0.999	0.193
Forest management	0.948	0.236	Fuel-wood	-0.999	-0.193
Access to NR	0.824	0.212	NTFP management	0.936	0.153
Variance explained (%)	50.859			56.689	

Table 5: Social capital factor loading and score

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Community size	0.963	0.249	Trust	1.000	0.136
Landlessness	-0.963	-0.249	Participation	-0.986	-0.128
Community organizations	0.926	0.189	Population and migration	-0.915	-0.108
Trust	0.926	0.189	Community organizations	0.915	0.108
			Village size	-0.915	-0.108
Variance explained (%)	57.069			59.689	

Table 6: Financial capital factor loading and score

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Entrepreneurships	0.855	0.418	Income	0.973	0.228
Income	0.742	0.355	Mobilization of community funds	0.970	0.227
Employment	0.701	0.392	Remittances	0.970	0.227
			Prospects on eco-tourism	0.904	0.236
Variance explained (%)	53.460			59.270	

Table 7: Factor loading and score on vulnerability

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Natural shocks	0.857	0.510	Natural shocks	-0.852	-0.263
Human health	0.823	0.502	Biodiversity threats	0.844	0.291
			Human wildlife Conflicts	0.766	0.243
Variance explained (%)	39.963			40.668	

Table 8: Factor loading and score on policy, institutions and process

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Operational Plan	0.740	0.581	Coordination	0.962	0.498
			Policy anomaly	0.891	0.444
Variance explained (%)	51.846			49.401	

Table 9: Variables of the final model

Year 2009			Year 2012		
PIs	FL	Score	PIs	FL	Score
Participation	0.999	-0.075	Ownership and use rights	0.954	0.078
Road	0.999	0.075	Road	0.954	0.078
House	0.999	0.075	Access to market and infrastructures	0.954	0.078
Income	0.999	0.075	Income	0.923	-0.112
Entrepreneurships	0.999	0.075	Remittances	0.923	0.112

Community organization	0.999	-0.075	Population and migration	0.823	0.028
Access and use of NR	0.999	0.075	Forest management	0.823	-0.028
Forest management plans	0.869	-0.068	Education	0.711	0.130
Labor availability	0.724	0.062	Farming system	0.711	0.130
Landlessness	0.724	0.062	Natural shocks	0.711	0.130
Natural shocks	0.710	0.077	Human wildlife conflicts	0.711	0.130
			Policy harmonization	0.711	0.130

Extraction Method: Principal Axis Factoring; Rotation Method: Varimax with Kaiser Normalization; Factor Scores Method: Regression

Table 10: Mean incomes

Variables	Period	Mean (NRs)	SE of Mean (NRs)
Income from farm and forests	2012	115748.80	2809.01
	2009	56288.80	1699.72
Income with remittance	2012	136460.70	2170.89
	2009	99885.86	1854.71

(Source: Field survey, 2009 and 2012)

Table 11: Independent t test between year 2009 and 2012.

Variables	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	p	t	df	p
Income without remittances	168.351	0	18.11	798	0
Income with remittances	21.649	0	12.809	798	0

Table 12: Frequency and percentage of annual income from farm and forests

Income range (NRs)	2009		2012	
	Count	Percent	Count	Percent
<40,000	296	74.00%	78	19.50%
40,000-80,000	66	16.50%	103	25.80%
80,000-120,000	20	5.00%	73	18.20%
120,000-160,000	10	2.50%	65	16.20%
>160,000	8	2.00%	81	20.20%
Total	400	100.00%	400	100%

(Source: Field survey, 2009 and 2012)

Table 13: Correlation test between total income and remittances

Data types	Test types	Year 2009		Year 2012	
		Value	p	Value	p
Interval by Interval	Pearson's R	0.015	0.764	-0.371	0
Ordinal by Ordinal	Spearman Correlation	0.015	0.764	-0.374	0

Table 14: Gross income including remittances

Income range (NRs)	Year 2009		Year 2012	
	Count	Percent	Count	Percent
<40,000	26	6.50%	3	0.80%
40,000-80,000	88	22.00%	85	21.20%
80,000-120,000	126	31.50%	140	35.00%
120,000-160,000	71	17.80%	76	19.00%
>160,000	89	22.20%	96	24.00%
Total	400	100.00%	400	100.00%

(Source: Field survey, 2009 and 2012)

Table 15: Mul tiple linear regression on Non-CBM

	B	Std. Error	Beta	t	p	Tolerance	VIF
(Constant)	1.109	0.234		4.739	0		
PAR	-0.034	0.037	-0.048	-0.934	0.351	0.94	1.063
HOS	-0.036	0.037	-0.048	-0.957	0.339	0.986	1.015
ENT	0.007	0.043	0.008	0.163	0.87	0.93	1.075
LAB	0.005	0.056	0.005	0.08	0.936	0.559	1.788
LSS	-0.141	0.116	-0.061	-1.221	0.023	0.983	1.017
FMP	-0.095	0.059	-0.081	-1.613	0.047	0.99	1.01
ANR	0.272	0.106	0.129	2.571	0.011	0.986	1.014

NSH	0.111	0.138	0.04	0.802	0.423	0.982	1.018

(Model summary=R = 0.42; R^2 = 0.18; Adjusted R^2= 0.163 and SE =0.358)

Table 16: Multiple linear regression on CBM

	B	Std. Error	Beta	t	p	Tolerance	VIF
(Constant)	2.93	0.2		14.656	0		
OWN	0.004	0.024	0.005	0.148	0.883	0.983	1.017
ACE	0.014	0.029	0.018	0.482	0.63	0.992	1.008
POP	0.034	0.048	0.026	0.706	0.48	0.956	1.047
MGT	0.012	0.022	0.02	0.526	0.599	0.95	1.052
RMT	0.874	0.368	0.643	2.376	0.018	0.018	4.67
PHM	-0.325	0.051	-0.321	-6.372	0	0.52	1.923
NSH	-0.289	0.019	-0.729	-15.369	0	0.586	1.707
HWC	-1.582	0.371	-1.158	-4.262	0	0.018	3.01

(Model summary=R = 0.69; R^2 = 0.48; Adjusted R^2= 0.475 and SE =0.463)

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