

Case Report

Multiple Local Polynomial Regression Modelling: Case of Life Insurance Uptake in Kenya, Uasin Gishu County

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Abstract: In Kenya life insurance has contributed widely and still remains a vital aspect of the social-economic development of the society. It focuses on safe-guarding the future as well as ensuring that there is some savings that can be used later in life. Despite its importance, the penetration of life insurance is currently only at one point three percent in Kenya. This is a small percentage in comparison to the developed countries where life insurance penetration is quite high. In this research, local regression (LOESS) method was used. LOESS specifically denotes a method that is also known as locally weighted polynomial regression. At each point in the data set a low-degree polynomial is fitted to a subset of the data, with explanatory variable values near the point whose response is being estimated. In local polynomial regression, a low-order weighted least squares (WLS) regression is fit at each point of interest using data from some neighbourhood around x . The value of the regression function for the point is then obtained by evaluating the local polynomial using the explanatory variable values for that data point. In this research income, education, age and marital status were found as the major factors associated with low insurance intake in Uasin Gishu County. The research highly recommends the insurance companies to apply the knowledge of LOESS to determine the major factors associated with low life insurance uptake in the country. Insurance companies should strive to provide educative seminars to the public to increase life insurance uptake. In this research we had uptake of life insurance as dependent variable and level of income, education level, age and marital status being independent variables

Keywords: Locally Weighted Regression, LOESS, Multivariate Loess Surface, Multiple Local Polynomial Regression

1. Introduction

Background information

The business entities and individuals are mostly exposed to substantial risk that is associated with losses to property, income, and wealth due to the damage to assets, legal liability, disability, retirement, and death. Insurance uptake is a measure of the amount of premium sales compared to the total theoretical market for those premiums to cover such losses. According to Association of Kenya Insurers (2012), Kenya has been ranked among the top three African markets in terms of profitability for insurance companies seeking expansion opportunities. Most of the Kenyan Insurance Companies deliver insurance products to participants at the bases of the pyramid; Micro Insurance. It is offered to shield clients

against specific risks in consideration for premiums matching the possibility of occurrence of the risk Campbell (2012). Conceptual differences exist between micro-Insurance and other forms of insurance since micro-insurance has lesser assets and lower volatile premiums. Although low income earners face risks and economic shocks that might be the same as conventional insurance clients, the low end market is more susceptible due to limitation of resources and knowledge Akotey (2011), are not able to mitigate risks compared to their higher income participants; and in case of economic loss from perils, they are less equipped to cope with the aftermaths. Micro-insurance therefore serves as their best bet in building financial confidence and wealth restoration in the event that risks materialize Butt (2010). The poor face two types of risks namely; idiosyncratic (specific to the household) and covariate

(common to all). To combat these risks, they have traditionally used risk pooling (for instance funeral and burial in societies), income support (for instance credit arrangements and transfers) and informal insurance or risk-sharing schemes such as grain storage, savings, asset accumulation and loans from friends and relatives Campbell (2012). However, the prevalent forms of risk management (savings, self-insurance and mutual insurance) which were appropriate earlier are no longer adequate and feasible Pierro (2007) as they are limited in outreach and the benefits typically cover a small portion of the loss Campbell (2012), and offer limited protection, low returns for households, and are prone to breakdown during emergencies Beck (2012). Formal insurance instruments can offer superior risk management alternatives, provided poor households can access these services Maleika (2008).

2. Methodology

Designing a multiple local polynomial regression

Consider a set of scatterplot data $\{(X_1, Y_1), \dots, (X_m, Y_m)\}$ from the model. We treat the m -dimension estimation problem where the measured data Y at the position $X = [x_1, x_2, \dots, x_m]^T$ is given by

$$Y = f(X_i) + \varepsilon \quad (1)$$

Where $f(\cdot)$ is the regression function to be estimated and $E(\varepsilon) = 0$ and $Var(\varepsilon) = I_n$ (I_n denoting the identity matrix of order n), and X and ε are independent. We will denote the conditional variance of Y given $X = X_T$ by $\sigma(X_T)$ and the marginal density of X , that is, the design density, by $f(\cdot)$ while the specific form of $f(\cdot)$ may remain unspecific, if we assume that the $(p+1)^{th}$ derivative of $f(X)$ at the point X_T exists, then in order to estimate the value at this point, we can rely on a generic local expansion of the function about this point. Specifically, for X in a neighbourhood of X_T , a P^{th} term expansion gives,

$$f(x) = \sum_{0 \leq k \leq p} \frac{1}{k!} D^{(k)} M(Z)_{z=x} (X - X_T)^k \quad (2)$$

Where

$$k = (k_1, k_2, \dots, k_m),$$

$$k! = (k_1!, k_2!, \dots, k_m!),$$

$$W = \begin{pmatrix} K_M(X_1 - X_T) & K_M(X_1 - X_T) & \dots & K_M(X_1 - X_T) \\ K_M(X_2 - X_T) & K_M(X_2 - X_T) & \dots & K_M(X_2 - X_T) \\ \vdots & \vdots & \ddots & \vdots \\ K_M(X_6 - X_T) & K_M(X_6 - X_T) & \dots & K_M(X_n - X_T) \end{pmatrix} \quad (6)$$

And

$$X_x = \begin{pmatrix} 1 (X_1 - X_T)^T \{ (X_1 - X_T)(X_1 - X_T)^T \} & \dots & (X_n - X_T)^T \\ 1 (X_2 - X_T)^T \{ (X_2 - X_T)(X_2 - X_T)^T \} & \dots & (X_2 - X_T)^T \\ \vdots & \vdots & \ddots & \vdots \\ 1 (X_n - X_T)^T \{ (X_n - X_T)(X_n - X_T)^T \} & \dots & (X_n - X_T)^T \end{pmatrix} \quad (7)$$

$$|k| = \sum_{i=1}^m k_i,$$

$$\sum_{0 \leq |k| \leq p} k = \sum_{j=0}^p \left(\sum_{k_1=0}^j k_1, \dots, \sum_{k_m=0}^j k_m \right)$$

$$j = (k_1 + k_2 + \dots, k_m)$$

$$X^k = x_1^{k_1}, x_2^{k_2}, \dots, x_m^{k_m}$$

$$D^{(k)} M(Z) = \frac{\partial^k M(Z)}{\partial z_1^{k_1} \dots \partial z_m^{k_m}}$$

Given the series, this polynomial is fitted locally by a weighted least squares regression: minimize

$$\sum_{i=1}^n \{ \sum_{0 \leq |k| \leq p} \theta_k(X_T) (X_i - X_T)^k \}^2 K_M(X_i - X_T) \quad (3)$$

Where M is a bandwidth matrix controlling the size of the local neighborhood and $K(\cdot)$ is the kernel function which penalizes both geometric and radiometric distances, where $K_M(\cdot)$ is defined as

$$K_M(X_i - X_T) = \frac{1}{|M|} K_M[M^{-1}(X_i - X_T)]$$

denoted by $\hat{\theta}_k(X)$ the solution to the least squares problem (2.3). It is clear from the

Taylor expansion in equation (2.2) that $D^{(k)} M(X_T) = K! \theta_k(\hat{X}_T)$ is an estimator for $D^{(k)} M(X_T)$. For the weighted least squared problem, a matrix form can be depicted by

$$W^{1/2} Y = W^{1/2} X \theta + \sigma(X) \varepsilon \quad (4)$$

Where

$$Y = \begin{pmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{pmatrix}, \theta(X_T) = \begin{pmatrix} \theta_0(X_T) \\ \theta_1(X_T) \\ \vdots \\ \theta_p(X_T) \end{pmatrix} \quad (5)$$

We then have a least squared solution with multiple local polynomial fitting.

$$\hat{\theta}(X_T) = (W^{-\frac{1}{2}}X_x)^T Y \quad (8)$$

Where $(^T)$ denotes inverse, or when $X_x^T W X_x$ is inverse, the estimation can be written as

$$\hat{\theta}(X_T) = (X_x^T W X_x)^{-1} X_x^T W Y \quad (9)$$

Then we can get the estimation $\hat{f}(X_T)$,

$$\hat{f}(X_T) = E_1 (X_x^T W X_x)^{-1} X_x^T W Y \quad (10)$$

Where E_1 is a column vector with the first element equal to 1, and the rest equal to zero, that is

$$E_1 = (1, 0, 0, \dots, 0)_{1 \times (p+1)}$$

3. Results and Discussion

3.1. Introduction

The study made use of primary data collected from Uasin Gishu County by use of questionnaires. The questionnaires were both open ended and close ended. Interviewing method was employed to gather any necessary information from the participants of the research. Where we had incomplete questionnaires; we had call backs to get the missing information.

Code list for open-ended questions was developed to facilitate coding of the open ended questions, the questionnaires were then coded. The data was analysed by use of R software.

3.2. Penetration of Insurance Among People

The penetration of insurance in Uasin Gishu County is at 26%. However, 74% of the people who filled the questionnaires are not insured; this presents an opportunity to grow insurance uptake in the county.

3.3. Multivariate Loess Surface Summarizing the Function Dependence of LIFE Insurance Uptake on Education and Age in Uasin Gishu County

Figure 1. shows a wireframe plot, using insurance uptake as a function of education and individual's age.

The relationship between education and insurance uptake is relatively strong. The wireframe plot shows that the education level relationship between age and insurance uptake remains nonlinear, even after the level of education is taken into account. However, the nature of the curve varies somewhat: it 'flexes' in opposite directions while moving from the front-right facet of the plotting cube to the left-rear facet. For people with high education level, insurance uptake increases with increase on age, until the latter reach a value of about 75%. When age reach 35% or so, the slope of the surface turns sharply upward. Thus, for individuals who are old there is strongly relationship to insurance uptake.

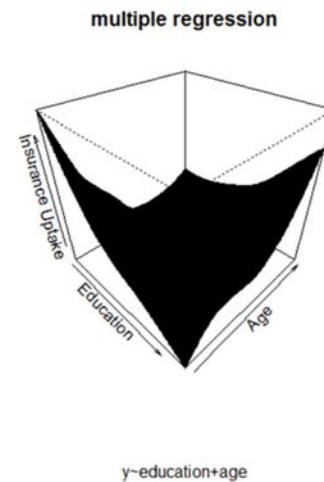


Figure 1. Multivariate loess surface summarizing the functional dependence of Life insurance uptake on education and Age.

3.4. Multivariate Loess Surface Summarizing the Function Dependence of Life- Insurance Uptake on Income and Education in Uasin Gishu County

Figure 2. shows a wireframe plot, using insurance uptake as a function of education level and income level.

The relationship between income and insurance uptake is relatively weak. At the lowest and highest levels of education, insurance uptake seems to be highest among individuals with high level of education, while it is somehow lower among individuals with low level of education.

Uptake declines with increasing level of income. This is attributed to the fact that, insurance is for the poor. It is seen that, the predominant slope of the loess curve in Figure 2: shows that education level has a much more pronounced effect on insurance uptake than does the level of income. This plot shows that the income level relationship between age and insurance uptake still remains nonlinear

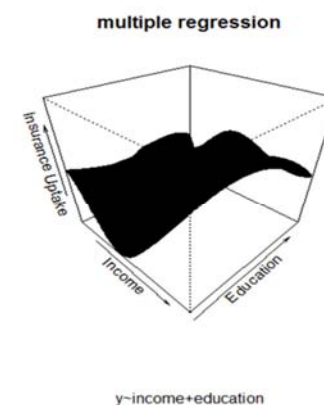


Figure 2. Multivariate loess surface summarizing the functional dependence of Life insurance uptake on education and Income.

3.5. Multivariate Loess Surface Summarizing the Function Dependence of Life Insurance Uptake on Income and Age in Uasin Gishu County

Figure 3: shows a wireframe plot, using insurance uptake as a

function of income level and Age. It is evidence that the relationship on income, age and insurance uptake is nonlinear. It can be seen that at the lowest and highest levels of income, insurance uptake is highest among individuals with low level of income, while it is lower among individuals with high level of income. Insurance uptake declines with increasing level of income as seen on the figure. This is attributed to the fact that, insurance is for the individual who have not invested elsewhere. In overall it is seen that, the predominant slope of the loess curve in Figure 3. Shows that income level has a much more pronounced effect on insurance uptake than does the age.

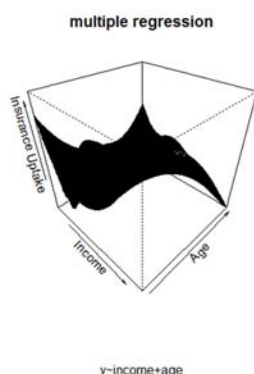


Figure 3. Multivariate loess surface summarizing the functional dependence of Life insurance uptake on Income and Age.

3.6. Multivariate Loess Surface Summarizing the Function Dependence of Life Insurance Uptake on Income and Marital Status in Uasin Gishu County

Figure 4: shows a wireframe plot, using insurance uptake as a function of income level and marital status. The relationship on income, marital status and insurance uptake is still nonlinear. Life insurance uptake seems to be highest among married individuals, while it is somewhat lower among individuals who are not married. It can also be seen that uptake declines with increasing level of income. Marital status has a much more pronounced effect on insurance uptake than does the level of income. This is attributed to the fact that those individuals who are not married don't have any responsibilities of bringing up the children. The uptake is high on married people as most of them are not certain of the future events.

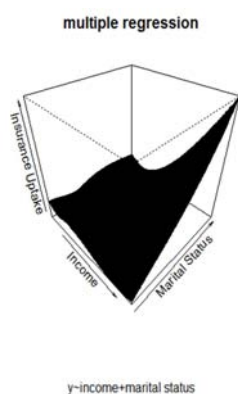


Figure 4. Multivariate loess surface summarizing the functional dependence of Life insurance uptake on Income and marital status.

3.7. Barriers to Insurance Uptake by Public from Uasin Gishu County

Negative talk about insurance (35%) from other people is the main barrier to insurance uptake among the public. Poor understanding of insurance (24%) and complications related to compensation (20%) are also considerable contributors to none purchase of insurance by the public.

Table 1. summarizes the barriers to insurance uptake by the public across Gender.

	Total	Male	Female
Have heard people talk negatively about insurance	35%	36%	35%
I don't have good understanding of insurance	24%	21%	31%
Compensation is complicated	20%	21%	15%
Insurance companies don't give compensation	6%	5%	12%
I don't know the insurance products available	5%	6%	4%
Insurance is expensive	5%	5%	4%
Have never heard about insurance	3%	4%	0%
There are no insurance policies that meet my needs	2%	2%	0%

4. Conclusions and Recommendations

4.1. Conclusion

From the study, it was found that majority of people with insurance policy have low level of education. Most of them do not understand the kind of products or the contracts they have with the insurance companies. It was found that the sales agents take advantage of them and end up selling to them products they don't have enough information. Majority of those with high level of education do not possess any life insurance products. It was found that this group of people could read and understand the insurance contracts with ease and selling any insurance product to them was not easy. Those with insurance policy were found to have products that met their needs and had no problems on paying the premiums. It was also found that those with low income opted to buy insurance products compared to people with more income who preferred investing elsewhere.

Young people with no families preferred not to have any insurance product as opposed to married people who have responsibilities. Male preferred education and motor policies as opposed to female who preferred medical policy. It was evident that education, income, age, gender and marital status affected life insurance uptake in Uasin Gishu County. It was established that 74% of the public from Uasin Gishu County are not insured. The main factors contributing to non-purchase of insurance are: negative talk about insurance from other people (35%); lack of good understanding of insurance (24%); perceived complications in compensation (20%). The public also face a number of challenges in accessing insurance, the main ones being dishonesty of insurance agents, delay in compensation and complexity of information of insurance products. Some of the key suggested ways to address the challenges are: conducting more education seminars (70%), and empowering the agents with knowledge and promoting honesty (12%).

4.2. Recommendations

In order to enhance insurance penetration among the public, it is recommended that

Consumer Education programs be intensified. However, people in different age groups have different insurance needs. It could be useful if the Authority could partner with insurance companies to train on the different insurance products available in the market. Effort should also be made to simplify insurance language. The insurance companies should also push and market policies that provide for both risk coverage and savings component because that is what the customers prefer. The insurance companies should also lower the cost of premiums, have efficient claims settlement, improve on agents integrity, improve on customer service, have variety of products and have country wide presence to improve the penetration of insurance in Kenya.

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