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Willingness to Pay for Efficient Waste Management: The Case of Bolgatanga Municipality

Ferdinand Ahiakpor[1]
Samuel Erasmus Alnaa[1]
Peter B. Aglobitse[1]

Department of Economics, University of Cape Coast, Ghana

Abstract

This study sought to determine how much individual households are willing to pay for efficient solid waste management in the Bolgatanga municipality as well as what factors influence people's demand for the services at a particular price. In pursuance of this, the contingent valuation method which employed the biding game was used. Using cross tabulation and Analysis of Covariance (ANCOVA) the calculated mean willingness to pay (WTP) was ¢16,750. The income variable was found to have a significant effect on the individuals' WTP. Through the interaction dummy variables model, the income elasticity was 0.37. It was also found that occupation (OCC), level of education (EDU), the interaction between sex and occupation (SOC) and the interaction between sex and education (SED), as well as income (lnY) which is the covariate were all significant. Thus the antilog of the differential effects of OCC, EDU, SOC and SED were found to be; 0.64194, 1.65571, 1.69476 and 0.44884, respectfully. Thus the mean WTP of SOC was higher by ¢2.3367, while the mean WTP of SED was also higher by ¢2.10455. It is recommended that differential pricing as well as door-to-door refuse collection in selected areas among other services be put in place to ensure efficient refuse management in the municipality.

Key words: Contingent Valuation, Willingness to Pay, ANCOVA

Introduction

Solid waste management has always been a herculean task especially in large towns and cities all over the world. Huge sums of money are spent on collecting volumes of waste, especially refuse generated by human activities, in order to avert possible disasters that this refuse could cause if not well managed. Solid waste management has attracted much public attention. The regional capitals of Ghana are currently facing serious crisis in terms of collecting and managing refuse to keep the cities clean. For instance, the Kumasi Metropolis is reported to generate about 1,000 tonnes of waste daily which it plans to use to generate electric power (Daily Graphic, Monday, may 7, 2007 No. 150041 page 1.).The Bolgatanga Municipality is not new to this refuse collection problem. It collects about 340m3 of refuse per week. This does not include areas like Zaare, Sunbrungu, Zuarungu, etc which are not covered by the refuse collection services of the municipality.

Unlike other public good, the price refuse collections cannot be determined by market forces. It is therefore difficult to determine how much people must pay for the collection of refuse. Thus the Willingness to Pay (WTP) using Contingent Valuation (CV) method is more suitable in determining how much the people in the municipality are willing to contribute to the collection of refuse to make it more sustainable and as such keep the environment clean.

The CV method is not only suitable for determining how much people are willing to pay for a particular non- market service / goods but also the factors influencing how much they are willing to pay. According to the World Bank Water Demand Research Team, in World Bank Research Observer (1993), three sets of characteristics jointly influence a household's willingness to use or pay for improved water supply:

- The socio-economic and demographic characteristics of the household, including education of family members; occupation; size and composition of family; and measures of income, expenditures, and assets

- The characteristics of the existing or traditional sources of water versus those of the improve water supply, including the cost (both financial and in time required to collect water), the quality, and the reliability of the supply.
- Households' attitudes toward government in the water supply sector and their sense of entitlement to government services.

The team noted surprisingly that, family size and composition rarely showed any significant effect on household willingness to pay for or use improved water services, thus collaborating with the findings of Lockwood et al (1993) in their study.

In related studies by Bhati and Fox-Rushby (2002) on the WTP for treated mosquito nets in Surat, India and also by Cho-Min-Nang et al (2000), on the WTP for the ICT malaria *pf/pv* test kit in Myanmar, both using regression analysis found out that education, income, beliefs and the ideological acceptance of health care was positively associated with the WTP.

Writing on the WTP by Victorians' to preserve unprotected East Gippsland national estate forests in national parks, Lockwood et al (1993) noted that attitudinal questions included in the survey revealed that Victorians consider the non-market values associated with these forests to be more important than market values. The median WTP per respondent household for preserving the forest was $52. However, a sub-sample of Gippsland residents showed that people living in or adjacent to East Gippsland placed relatively more emphasis on market values and had significantly lower WTP for preserving the forest. This suggests that while a majority of the Victorians would prefer non-market values be placed on non-market goods and services, a sub-sample would rather market values be placed on all goods and services be they market or non-market goods or services. Also it was found out that the ratio of females to males, age, and number of people per household did not have a statically significant effect on the magnitude of WTP as the t-values were less than one, however, income and number of years of education both had a significant influence on WTP (Lockwood et al, ibid).

Loomis and Larson (1994) tested for the consistency of an individual's WTP responses for increases in the quantity of an environmental public good (whole populations) along three lines. First, they test whether WTP for 50 percent and 100 percent increases in whole populations are statistically different from zero. Second, they ask whether the incremental WTP from a 50 percent increase to a 100 percent increase is statistically significant. Finally, they test whether there is diminishing marginal valuation of the second 50 percent increment in gray whale populations. The paired t-tests on open-ended WTP responses supported all three sets of hypotheses. Both visitors and households provided WTP responses that were statistically different from zero and increased (but in a diminishing fashion) for the second increment in WTP. In this survey, both visitors and households provided estimates of total economic value (including non-use or existence values) for large changes in wildlife/fishery resources that were consistent with consumer theory.

Willingness to pay for an improvement of environmental quality by Cho-Min-Nang et al (2000), simulation results indicate that the precision of welfare estimates increases with individuals income levels and decreases with the price of the quality-related good. The dependence of the consumption of the quality-related good on the environmental quality also affects the reliability of welfare estimates.

In a telephone survey, 1000 adults were confronted with pairs of life saving programs that differed in number of lives saved and asked which program in each pair they would choose to implement. Respondents were also asked to rate qualitative program characteristics on 10 point scales. For most respondents, lives saved are significant in explaining program choices, as are psychological risk characteristics. The rate of technical substitution between these characteristics and lives saved is, however, inelastic. It is noteworthy that for about 20 percent of respondents, choices among programs appear to be insensitive to lives saved (Subramanian and Cropper, 2000).

In Boyle and Bishop (1988), three commonly used techniques for asking contingent valuation questions are compared: iterative bidding, payment cards, and dichotomous choice. The results revealed that no single contingent valuation technique was neutral in the elicitation of hicksian surplus and each technique has its strengths and weaknesses. The iterative bidding estimates contain a starting point bias, while the payment card and dichotomous choice estimates were influenced by the interviewers soliciting the contingent values. Finally, the analysis of dichotomous choice responses involves unresolved issues that warrant further investigation. On the other hand, dichotomous choice is the easiest technique to administer in a survey setting. Though the biding game contains a starting point bias, it gives the respondents the opportunity to finally decide whether to pay a value higher or lower than the starting point consistent with their marginal utility of consuming the good under valuation.

In the light of the above, we wish to value solid waste management in the Bolgatanga Municipality. The Municipal Assembly has been saddled with logistic constraints and has been unable to effectively provide for the management of waste in the municipality. It is thus, common sight to find heaps of refuse left uncollected for days. These heaps of refuse that litter the Municipality are potential breeding grounds for mosquitoes and other pathogens which can easily lead to an epidemic. Interestingly, the people who generate the waste do little if not nothing at all to help in its management and continue to depend on the efforts of the Municipal Assembly to keep the municipality clean.

Desirably, if individuals and households are sensitised and willingly accept to pay for solid waste management, it will go a long way to augment the efforts of the authorities to effectively and efficiently manage waste in the municipality to avert disasters such as those that have hit especially Accra and Kumasi in recent times.

Following from the above therefore, pertinent questions that come to mind are: how much is an individual household willing to pay in ord

to enjoy an efficient and effective waste (refuse) management system in the municipality? And what factors influence the amount households are willing to pay for the solid waste management?

Objectives

The main objective of the research was to determine through Contingent Valuation, how much individual households are willing to pay for refuse management in the municipality and to also find out what factors inform an individual's willingness to pay for refuse management.

Methodology

In pursuance of the objectives of the study, Contingent Valuation (CV) was used in order to determine how much individuals and households are willing to pay for efficient solid waste management in the municipality. The CV method involves directly asking people, in a survey, how much they would be willing to pay for specific goods and services that are not traded in the marketplace (environmental services). In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service (Carson, 2000)

The theory underpinning this study is grounded on Compensating variation in consumer theory. Compensating variation can be used to find the effect of a price change on an agent's net welfare. CV reflects new prices and the old utility level. Compensating variation can be elicited by asking a person to report a willingness to pay an amount. For instance, the person may be asked to report his WTP to obtain the good. Formally, **compensating variation** is defined as the amount that must be taken away from the person's income while keeping his utility constant, which is represented as:

$$V(y - WTP, p, q_1; \mathbf{Z}) = V(y, p, q_0; \mathbf{Z}) \quad (1)$$

Where V denotes the indirect utility function, y is income, p is a vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved environmental quality). **Z** is a vector of individual characteristics (Markandya, 2005). Compensating variation is the appropriate measure when the person must purchase the good, such as an improvement in environmental quality. From (1) the indirect/inverse demand for efficient solid waste management can be estimated by regressing WTP on y, p,q:Z

In pursuance of the above, data was collected from all the localities in Bolgatanga and involved 50 students as well as the researcher who conducted the survey. In all 216 people were interviewed. This sample size was chosen using systematic sampling technique. However, 16 of the returned questionnaires were rejected from inclusion in the analysis because they were either incomplete or wrongly completed. The close-ended questionnaires were administered using the in-person interview.

As regards the WTP, the biding game method was used. This was done by first choosing an arbitrary starting point and respondents were asked if they will accept to pay that amount. If yes then the amount was increased, this continued to a point where respondents were no longer WTP. On the other hand, if the initial amount was not accepted then the amount was reduced to a point where respondents will accept to pay. This approach is more advantageous because it affords the respondents the opportunity to state a price which will be consistent with their utility maximisation.

Data collected from the field were analysed using cross tabulations and Analysis of Covariance (ANCOVA) regression model with the aid of PcGive, Doornik and Hendry (2001). This model enabled us to isolate the income effect on WTP, on one hand, and combined effect of qualitative variables on WTP, on the other once the regressors were a mixture of both quantitative and qualitative variables.

ANCOVA Model Specification

$$lnWTP = \beta_1 + \beta_2 D_{2i} + \beta_3 D_{3i} + \beta_4 D_{4i} + a lnY_i + \varepsilon_i \quad (2)$$

Where:

$lnWTP$ = The natural log of willingness to pay

$lnYi$ = natural log of Income of the respondents

D_{2i} = dummy variable, 1 if the respondent is in formal employment and 0 if informal

D_{3i} = dummy variable, 1 if male respondent and 0 if female

D_{4i} = dummy variable, 1 if respondent has had high level of education and 0 if low level of education

ε_i = error term

β_2 = differential effect of being in formal employment

β_3 = differential effect of being a male

β_4 = differential effect of having high level of education

a = *income elasticity or percentage change in income*

Equation 2 assumes that the differential effect of each of the dummies is constant across the two categories of the other remaining dummies. This is to say that if the mean WTP of males is higher than their female counterparts, this is so whether they have low or high education, or, they are in formal or informal employment. Thus the dummies and the income variables are additive.

However, the effect of each dummy variable may not be constant across all the other dummy variables as there could be an interaction among the dummy variables. In this case the variables multiply each other (Gujarati, 2003). In this wise a model was specified to find the effect of the interaction among the variables on the WTP of respondents.

Interaction Model

$$lnWTP = \beta_1 + \beta_2 D_{2i} + \beta_3 D_{3i} + \beta_4 D_{4i} + \beta_5 D_{2i} D_{3i} + \beta_6 D_{2i} D_{4i} + \beta_7 D_{3i} D_{4i} + \alpha lnY_i + \varepsilon_i \quad (3)$$

Where:

D_i = being dummy variables as explained in (1.0)

B_5 = differential effect of being in formal employment and a male

B_6 = differential effect of being in formal employment and with a high level of education

B_7 = differential effect of being a male with high level of education

Data Analysis and Discussions

Table1: Frequency Distribution of WTP

WTP Interval	DATA (FREQ.)	FREQ. DISTRIB. (%)
1 – 10,000	89	44.5
11,000 – 20,000	39	19.5
21,000 – 30,000	30	15
31,000+	42	21
TOTAL	200	100

Source: Field survey (2010)

From the above table, 89 respondents representing 45% of the total respondents are willing to pay within the lowest range. Also, 42 respondents representing 21% are willing to pay within the highest range of 30,000 Cedis and above. Thus, about 64% of the total respondents are willing to pay between 0 – 20,000 Cedis per week.

Table 2: Income distribution by WTP

INCOME(¢)/WTP(¢)	1-10,000	11,000 – 20,000	21,000 – 30,000	31,000+	TOTAL	FREQ. DISTRIB (%)
100,000 – 500,000	37	12	7	5	61	30.5
600,000 – 1,000,000	24	11	9	3	47	23.5
1,100,000 – 1,500,000	13	9	4	10	36	18
1,600,000 – 2,000,000	6	7	5	12	30	15
2,000,000+	10	0	5	11	26	13
TOTAL	90	39	30	41	200	100

Source: Field Survey (2010)

Table 2 shows that 61 respondents, that is 30.5% of the respondents, fall within the lowest income range. As income increases, the number of people who fall within the various income range decreases. The region is the poorest in the country with about 90% of the total population being poor (Ghana Poverty Reduction Strategy 2003 – 2005). This may partly explain why about 45% of the respondents are willing to pay the lowest amount, thus collaborating with the findings of Bhati and Fox-Rushby (2002), Cho-Min-Nang et al (2000) and the World Bank Water Demand research Team (1993) that income, among other factors, was positively associated with WTP.

[6]WTP amounts are quoted in old currency

Table.3: WTP Distribution by Education

WTP/EDUCATION	LOW	HIGH	TOTAL
1 – 1,000	48	41	89
11,000 – 20,000	25	14	39
21,000 – 30,000	12	18	27
31,000+	11	31	42
TOTAL	96	104	200
%	48	52	100

Source: Field survey (2010)

Note: Low – below secondary school level, High – secondary school level and above.

From table 3 above, 104 respondents (52%) have had high education as against 96 (48%) with low education. Though illiteracy is very high in the municipality, the results obtained from the survey may be due to the fact that a great majority of the respondents reside in the Bolgatanga Township who may have an appreciable high level of education. At low WTP more respondents with low education are willing to pay, while more respondents with high education are also WTP at high education levels. Therefore, education could be found to be positively related to the WTP as asserted by Cho-Min-Nang et al (2000) and Bhati et al (2002).

Table 4: WTP Distribution by Sex

WTP(¢) /SEX	MALE	FEMALE	TOTAL
1 – 10,000	60	29	89
11,000 – 20,000	21	18	39
21,000 – 3,000	17	13	30
31,000+	28	14	42
TOTAL	126	74	200
%	63	37	100

Source: Field survey (2010)

Table 4 above shows that 126 respondents representing 63% of the total respondents were males and 37% were females. It was found out that males were more disposed to pay higher at all the intervals of WTP. This could be due to the fact that males as family heads have the task of meeting most of the financial commitment of the family. A more plausible explanation could be due to the fact that more males (126) constituted the sample size than their female counterparts.

Table 5: WTP Distribution by Occupation

WTP/OCC.	FORMAL	INFORMAL	TOTAL
1 – 10,000	40	49	92
11,000 – 20,000	17	22	39
21,000 – 30,000	17	13	27
31,000+	30	12	42
TOTAL	104	96	200
%	52	48	100

Source: Field survey (2010)

From Table 5, 49 respondents in informal employment have the WTP at the lowest interval of 0 – 14,000 Cedis per week; where as 40 respondents in formal employment are WTP at the said interval. However, the situation is different at the highest WTP interval of 30,000 Cedis and above per week, as 30 respondents are in formal employment and 12 are in informal employment. This suggests that at higher levels of payments, may be those in formal employment will be able to afford. This situation could be so because those in formal employment are sure of regular income flows that will enable them meet their expenditures including paying for refuse collection services. This confirms the economic theory that future expectations can determine peoples' demand for a particular commodity or service. In the informal sector, income flows are very volatile and as such too irregular to let people make any future financial commitments.

Table 6: WTP Distribution by Mode of Payment

WTP/ PAY MODE	MONTHLY	TWO WEEKLY	WEEKLY	ON COLLECT DAYS	TOTAL
1- 10,000	60	15	10	4	89
11,000 - 20,000	19	9	7	4	39
21,000 - 30,000	16	4	7	3	30
31,000+	26	8	6	2	42
TOTAL	121	36	30	13	200
%	60.5	18	15	6.5	100

Source: Field Survey (2010)

From the table above, 121 respondents representing 60.5% of the total respondents will want to pay monthly. Possible reason could be that more people are salary workers or are in formal employment and would naturally want to wait till the end of the month to get their salaries to enable them pay for the services.

Table 7: Estimation of Benefits from WTP

WTP INTERVALS	FREQ.	%	WTP MIDPOINTS(¢)	BENEFITS(¢)
1- 10,000	89	46	5,500	489,500
11,000 - 20,000	39	19.5	15,500	604,500
21,000 - 30,000	30	13.5	25,500	765,000
31,000+	42	21	35,500	1,491,000
TOTAL	200	100	82,000	3,350,000

Source: Field Survey (2010)

The total WTP (benefits) as per the respondents is ¢3,350,000 per week. Given the total number of households in the municipality it is possible to determine the total benefits to be derived by multiplying the various percentages by the number of households and multiplying the product by the respective WTP midpoints and then take the sum. That is where price discrimination or differential pricing is used. From the above table, the mean WTP can be calculated: thus, ¢3,350,000 / 200 = ¢16,750. To ensure one price for the services in the municipality, the average or mean WTP could be used as the price to be paid by individual households.

Econometric Analysis – OLS ANCOVA Model

When the OLS ANCOVA was estimated and the various diagnostic tests conducted, there existed the problem of heteroscedasticity which resulted in a very low R^2. These results and the diagnostic test are shown in appendix one. In order to correct the problem of heteroscedasticity, the weighted least squares (WLS) was use and the improved results are shown below.

Results

Table 8: Estimation of ANCOVA model

Variable	coefficient	Std error	t-value	t-prob
Constant	4.72402	1.252	3.77	0.000 ***
lnY	0.354609	0.09630	3.68	0.000***
OCC(D_{2i})	0.0224308	0.1463	0.153	0.878
SEX(D_{3i})	-0.157011	0.1114	-1.41	0.160
EDU(D_{4i})	0.0224308	0.1463	0.153	0.878

Source: Field survey (2010)

*** = significant at 1%, ** = significant at 5%, * = significant at 10%

sigma 0.750375 RSS 109.797145

R^2 0.305879 F(4,195) = 5.773 [0.000]**
log-likelihood -223.819
no. of observations 200 no. of parameters 5
mean(LWTP) 9.43624 var(LWTP) 0.613995

From table 8, only the income (Y) coefficient is significant at 1% given its t-probability ratio of 0.0650. This means that the mean WTP varies by 0.3546% with a 1% variation in income. In other words, the income elasticity of WTP is 0.3546. Thus, the effect of the income changes on the mean WTP is constant irrespective of the sex, occupation and educational status of respondents. However the other dummy variables were found not to be significant. The estimated R^2 is at 31% suggesting that only about 31% of variation in the mean WTP is explained by the explanatory variables.

Table 9: Estimation of ANCOVA Interaction Model

	Coefficient	Std.Error	t-value	t-prob
Constant	4.44558	1.241	3.58	0.000***
OCC(D_2)	-0.443260	0.2643	-1.68	0.095
SEX(D_3)	-0.0331430	0.1642	-0.202	0.840
EDU(D_4)	0.504234	0.2822	1.79	0.076*
SOC(D_2D_3)	0.527543	0.2890	1.83	0.069*
EDOC(D_2D_4)	0.0416443	0.2764	0.151	0.880
SED(D_3D_4)	-0.801082	0.2881	-2.78	0.006***
lnY	0.371389	0.09554	3.89	0.000***

Source: Field survey (2010)

Note: *** = significant at 1%, ** = significant at 5%, * = significant at 10%

sigma 0.740925 RSS 105.402129
R^2 0.141669 F(7,192) = 4.527 [0.000]**

log-likelihood -219.734
number of observations 200 no. of parameters 8
mean (LWTP) 9.43624 var(LWTP) 0.613995

From the results of the estimated interaction model in table 9 above, OCC, EDU and SOC could be accepted to be significant at 10%, while SED and lnY are significant at 1%. This implies that holding income (covariate) constant and taking the antilog of these coefficients, we can find the actual differential effects of formal employment, high education, being a male with formal employment and being a male with high education, on the mean WTP as 0.64194, 1.65571, 1.69476 and 0.44884, respectfully. Therefore, if the coefficients of OCC and SOC are added we obtain: 0.64194 + 1.69476 = 2.3367. This means that the mean WTP of males in formal employment is higher by ¢2.3367. Also if the coefficients of EDU and SED are added we obtain: 1.65571 + 0.44884 = 2.10455. This implies that the mean WTP of males with high education is higher by ¢2.10455. The income elasticity is now 0.371389, a bit higher than what was obtained in the previous model. The estimated R^2 is 0.136878, indicating that only about 14% of variation in the mean WTP is explained by the exogenous variables.

From the diagnostic test, the presence of heteroscedasticity was rejected at the 5% significant level for the various test of heteroscedasticity test. Again, the test for residual autocorrelation was also rejected at the 10% significant level from lag 1 to lag 3. Autocorrelation was, however, present from lags 4 and above.

Conclusions

The conclusion drawn from the study is that 89 (44.5%) of the respondents were willing to pay at the lowest range of 1- ¢10,000 per week, while 42 (21%) of the respondents were willing to pay at the highest range of ¢31,000+ per week for the same service. The calculated mean WTP was ¢16,750 per week. Also from the cross tabulation, it was found out that respondents in formal employment as well as those with high education

were more disposed to pay at higher rates than their counterparts. This fact was established through the ANCOVA interaction model. However the differential effect of being a male with high education (SED) as well as the differential effect of being a male with formal employment (SOC) was found to be positively related to the WTP.

Recommendations

From the findings and the conclusion drawn thereafter, it is recommended that:

- Differential pricing should be used, with those living in well planned (government) residential areas paying higher than the mean WTP since these categories of individuals have high education, are in formal employment and earn appreciable level incomes
- Collection points should be used like the current system where refuse containers are place at vantage points for people to drop refuse, but house-to-house collection of levy should employed, the levy should not be below the mean WTP.
- Refuse collection levies should be paid monthly.

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Appendix A

Table 8a: Estimation of ANCOVA model

Variable	coefficient	Std error	t-value	t-prob
Constant	4.72402	1.252	3.77	0.000 ***
lnY	0.354609	0.09630	3.68	0.000***
OCC(D_{2i})	0.0224308	0.1463	0.153	0.878
SEX(D_{3i})	-0.157011	0.1114	-1.41	0.160
EDU(D_{4i})	0.0224308	0.1463	0.153	0.878

Source: Field survey (2010)

*** = significant at 1%, ** = significant at 5%, * = significant at 10%

sigma 0.750375 RSS 109.797145

R^2 0.115472 F(4,195) = 5.773 [0.000]**

log-likelihood -223.819

no. of observations 200 no. of parameters 5

mean(LWTP) 9.43624 var(LWTP) 0.613995

Table 9: Estimation of ANCOVA Interaction model

	Coefficient	Std.Error	t-value	t-prob
Constant	2.34578	1.241	3.22	0.008***
OCC(D_2)	-0.443260	0.2643	-1.41	0.095
SEX(D_3)	-0.0331430	0.1642	-0.12	0.840
EDU(D_4)	0.504234	0.2822	1.73	0.076*
SOC($D_{2i}D_3$)	0.527543	0.2890	1.22	0.069*
EDOC($D_{2i}D_4$)	0.0416443	0.2764	0.61	0.880
SED($D_{3i}D_{4i}$)	-0.801082	0.2881	-2.99	0.006***
lnY	0.371389	0.09554	3.89	0.000***

Note: *** = significant at 1%, ** = significant at 5%, * = significant at 10%

sigma 0.740925 RSS 105.402129
R^2 0.031561 F(7,192) = 4.527 [0.000]**
log-likelihood -219.734
no. of observations 200 no. of parameters 8
mean(LWTP) 9.43624 var(LWTP) 0.613995

Diagnostic Tests
AR 1-2 test: F(2,190) = 4.5389 [0.0119]*
ARCH 1-1 test: F(1,190) = 6.1351 [0.0141]*
Normality test: Chi^2(2) = 27.859 [0.0000]**
hetero test: F(8,183) = 2.7675 [0.0065]**
hetero-X test: F(15,176)= 2.7146 [0.0009]**

Testing for error autocorrelation from lags 1 to 3
Chi^2(3) = 9.2863 [0.0257]* and F-form F(3,189) = 3.0676 [0.0292]*

Testing for heteroscedasticity using squares
Chi^2(8) = 21.586 [0.0057]** and F-form F(8,183) = 2.7675 [0.0065]**

Testing for heteroscedasticity using squares and cross products
Chi^2(15)= 37.578 [0.0010]** and F-form F(15,176)= 2.7146 [0.0009]**

Where the interaction dummy variables being:
SOC: interaction between sex and occupation
EDOC: interaction between education and occupation
SED: interaction between sex and education