PARAMETRIC AND NON PARAMETRIC DESIGN BASED TESTS ANALYSIS OF THE LEVEL AND DIFFERENTIALS OF HOUSEHOLD CONSUMPTION EXPENDITURE IN RWANDA 2010-2011

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A research project report submitted to the Department of Statistics and Actuarial Sciences in the School of Mathematical Sciences in partial fulfillment of the requirements for the award of the degree of Master of Science in Applied Statistics of Jomo Kenyatta University of Agriculture and Technology.

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DECLARATION

This project report is my original work and has not been presented for a degree in any other University.

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REG N$^{O:}$ SC384-CO10-3992/2013

This project report has been submitted for examination with our approval as University

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DEDICATION

This work is dedicated to our dear parents for encouragement throughout our study.

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We give our utmost thanks to our almighty God for He has provided us with the means to this end. We would like to sincerely thank Dr. Joseph K. Mung'atu, Dr. Marcel Ndengo our supervisors for their relentless assistance in perusing through our work and suggesting some of the very critical changes which have seen us get through with the study.

Warm thanks go to my work mates without their support especially EICV4 team, it would not be easy to finish my studies and well conducting this research.

We are grateful to our colleagues and for their positive criticism of our work. We believe their criticisms have added some value in this work. We acknowledge with thanks the role-played by National Institute of statistics of Rwanda (NISR) in making this study a reality, and anybody else who directly or indirectly supported during our research study period.

We wish them God's blessings.

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LIST OF ABBREVIATIONS

EICV:	Integrated Household Living condition Survey, EICV (Enquête Intégrale sur les condutions de vie des Ménages)
CPI:	Consumer Price Index
DDG:	Deputy Director General
DG:	Director general
HC:	Household Composition
HCE:	Household Consumption Expenditure
HH:	Household Head
LSMS:	Living Standards Measurement Study
NISR:	National Institute of Statistics of Rwanda
SE:	Standard Error
Std.Dev:	Standard deviation
U/R:	Urban and Rural

ABSTRACT

The purpose of this project was to analyze the household consumption expenditure especially in food, non food, education, health, alcohol and housing consumption expenditures in Rwanda. The government wants to know where people spend much money for some item for them to be able to budget for food security, non food and housing consumption expenditure. This information is not always available and people keep changing their spending.

The project studied the distribution of the household consumption expenditure data and the mean differences between household consumption expenditure by component, by urban and rural areas, by sex of head of household and by household size and household adult equivalent size.

The research found out that the distribution of household consumption expenditure data was not approximately normally distributed, and Kigali city was the province with higher household consumption expenditure mean and the last was southern province. The research also revealed that, in Rwanda households spent much money in food consumption, followed by non food and the last was alcohol. The parametric and non parametric statistical hypothesis test (Kruskal-wallis test and ANOVA test) found out that the Household consumption expenditure mean differences between components were statistically significant at significance level of $\alpha = 0.05$.

Mann-Whitney test and Student t-test showed that, the mean differences household consumption expenditure between urban and rural areas were statistically different at confidence level of 95%, the annual mean household consumption expenditure for urban was higher than annual mean household consumption expenditure for rural. Mann-Whitney test and Student t-test demonstrated that, the mean differences of household consumption expenditure between household headed by male and female were statistically different at confidence level of 95%. The annual mean of household consumption expenditure for household headed by male was higher than household headed by female. The project report had again showed that, the mean adult equivalent household size was lower than mean household composition size and the Wilcoxon signed rank test and Student t test for paired sample showed that the two means differences were statistically significant at significance level of 0.05.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The most direct indicator of economic life being is consumption, and it is of substantial scientific and policy interest to understand how consumption varies. It is in this context many countries in the word design the survey on household consumption expenditure to monitor poverty and living conditions. The Living standards Measurement Study (LSMS) was established by the World Bank in 1980 to improve the availability of high quality household survey data collected by statistical offices in developing countries. One of the main purposes of these surveys is to provide data on a number of different dimensions of household welfare to better understand household behavior, and to evaluate the impact of various government policies and programs on living conditions. To date living standards Measurement surveys have been conducted in many countries throughout the world, and in a number of countries these surveys are now carried out at regular intervals by the Statistical offices as part of their routine data collection activities. For a more comprehensive introduction to the World Bank's LSMS surveys, see Grosh and Glewwe (1998).

The results of the 1999 European Union Household Budget Survey **(**EU-HBS. 2003) show that most European households in the EU Member States spent an average between 20 000 and 30 000 PPS[1] on goods and services in 1999 (See table1).The percentage change of average household expenditures since the previous survey, which was conducted in 1994, can vary substantially from one country to another. In United Kingdom and Greece average household expenditures rose more than 30% over the 5-year period, whereas in Spain an increase of only 2% could be observed. The average household size decreased or stabilized from 1994 to 1999. EU-HBS. 1999

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[1] In 1000 PPS. Source: Household Budget Surveys 1994 and 1999 (Eurostat). A PPS converts every national monetary unit into a common reference unit, the 'Purchasing Power Standard', of which every unit can buy the same amount of products across the countries in a specific year

Table1.1 **Average consumption Expenditure per household in PPS and average household size, 1994, 1999**

Average consumption expenditure per household in PPS, 1994, 1999			Average household size, 1994, 1999 2[2]	
Countries	1999	1994	1999	1994
Belgium	27.4	22.7	2.5	2.5
Denmark	23.4	19.2	2.1	2.1
Germany:	23.5	20.7	2.2	2.3
Greece	23.4	17.7	2.8	2.9
Spain:	20	19.6	3.2	3.3
France	24.6	22.3	2.4	2.5
Ireland	24,6	22.2	3.1	3
Italy	27.2	22.8	2.6	2.8
Luxembourg	45.2	38.6	2.7	2.6
Netherlands	25.7	20.3	2.3	2.3
Austria	26.5	24.3	2.5	2.7
Portugal	18,2	16.3	2.8	3
Finland	18.2	16	2.2	2
Sweden	21.7	18	2.2	2.2
United Kingdom	27.6	20.5	2.3	2.4

In 1999, the largest broad categories of household consumption expenditure were on ‘housing’, ‘transport’ and ‘food and non-alcoholic beverages’ for most of the 15 Member States, and in that order. ‘Housing’ was first on the list for all the 14 EU countries. In almost all countries

[2] Source: EU-HBS

‘transport’ and ‘food’ ‘were in either second or third place. In Belgium, Spain, Greece, Italy and Sweden food was in second place. In Germany and the United Kingdom ‘recreation’ came third. In Graph below, the spending pattern by goods/services categories is presented. Per product category, the Member State with the highest and the lowest expenditure is shown.

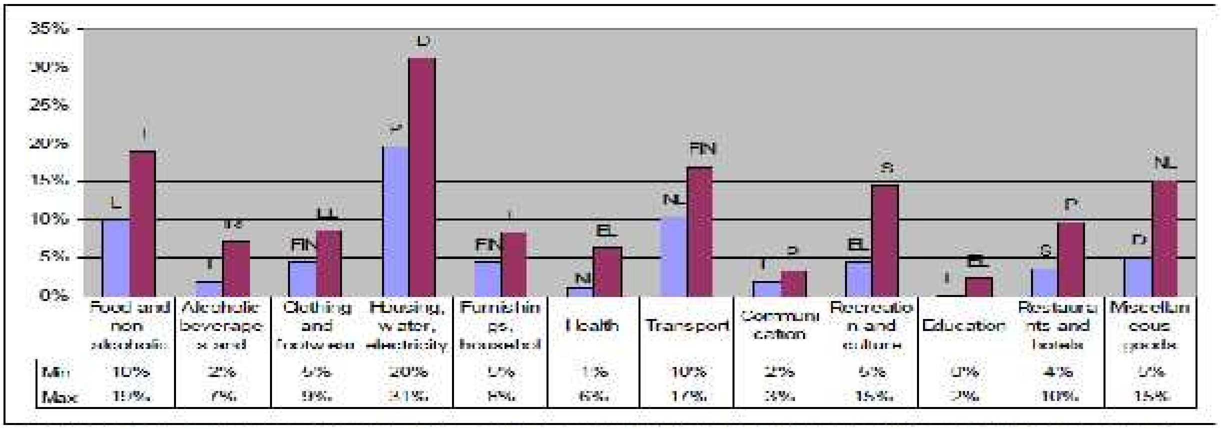

Figure1.1 Distribution of household expenditures by goods and services categories (%), 1999

Source: Household Budget Surveys, 1999.

It is in that context in RWANDA the main data source for living standards measurement survey has been the Integrated Household Living condition Survey, EICV(Enquête Intégrale sur les conditions de vie des Ménages) conducted by National Institute of Statistics of Rwanda (NISR) which collect data in the whole country and was undertaken every five years . Given to the importance and the needs of this survey, NISR reduced the periodicity of the survey and will be undertaken every three years. It has started in 2000/01; 2005/06 and 2010/11 with the main objectives to provide information on poverty and living conditions in Rwanda and measure changes over time as part of the ongoing monitoring of the poverty Reduction Strategy and other Government policies. The survey data are also very important for national accounts and updating the consumer price index (CPI).This study is going to construct the household consumption aggregate for the main components of consumption such are: Food (purchases[3] and home production[4]); Non-food item (Education, Health and other non-food); Housing (Rent and Utilities) and to analyze the household consumption expenditure component using the recent NISR EICV3 data set available at NISR Website.

[3] Includes meals taken away from Home

[4] Includes also food received from other household members, friends, and in the form of kind payments.

1.2 Statement of the problem

Household consumption expenditure is a big challenge in Rwanda. The variables related to Rwanda to be used in household consumption expenditure aggregate are not specific and some information is not available to be included in constructing the household consumption expenditure aggregate. The government also wants to know where people spend much money for some items for them to be able to budget for food security, non food, education, health and etc. This information is not always available and people keep changing their spending.

1.3 Objectives

1.3.1 General Objective

The main objective of this study was to measure the level of household consumption in Rwanda and to show the contribution of each household consumption expenditure component in the total household consumption expenditure.

1.3.2 Specific Objectives

This study had the following Specific Objectives:

1. To analyze the distribution of the household consumption expenditure data
2. To determine the level of households consumption expenditure in Rwanda
3. To analyze the mean households consumption expenditure by component in Rwanda
4. To determine the mean households consumption expenditure by Urban and Rural area
5. To analyze the households consumption between households headed by Males and household headed by females.
6. To determine the mean of household size with the mean of adult equivalent household size

1.4 Research Questions

1. Is household consumption expenditure data normally distributed?
2. What is the level of household consumption expenditure in Rwanda?
3. Is the mean of household consumption expenditure component equal in Rwanda?
4. Does household consumption expenditure in urban area equal to mean household consumption expenditure in rural area?
5. Do households headed by Male spend much more than those household headed by female?
6. Does the mean of household composition size is different from the mean of household adult equivalent size?

1.5 Justification

This study first of all was design in the purpose of obtaining a Degree in Master Science in Applied Statistics and it will be used by different people such are:

It can help the government to know, where to allocate resources in mostly used consumption expenditure component.

It can help many investors to know where they can invest according to the classification of the most household consumption expenditure component in Rwanda.

It can help other researchers to understand the methodology used in Rwanda to compute the household consumption expenditure.

1.6 Scope

This research project used the secondary data from the Third Integrated Household Living Conditions Survey (EICV3) to investigate the level and differentials of household consumption expenditure in Rwanda. The EICV3 is the third in the series of surveys which started in 2000/01 and is designed to monitor poverty and living conditions. It comprised a sample size of 14,308 households which was sufficient to provide estimates which are reliable not only at National level but also at the district level. The data collection commenced in November 2010 and continued for one full year, ensuring that seasonal variations in consumption and income were accounted for in the survey. The data were gathered by visiting households on several occasions over each cycle in order to aid household's recall of all their consumption items.

1.7 Limitation

EICV surveys collects large and diverse information on household consumption, however despite the effective and efficient implementation of both the data collection and the data processing some outliers and missing data remain untracked.

Although definitions vary, an outlier is generally considered to be a data point that is far outside the norm for a variable or population (Paul Newbold, William Carlson, Betty Thorne: Books, 6th Edition). An Outlier is described as an observation that "deviates so much from other observations as to arouse suspicions that it was generated by a different mechanism" Outliers can have potential deleterious effects on statistical analyses. First, they can increase error variance and reduce the power of statistical tests. Second, if non-randomly distributed they can decrease normality. Third, they can seriously bias or influence estimates that may be of substantive interest and make them unreliable.

On the other hand according to (Paul Newbold, William Carlson, Betty Thorne: Books, 6th Edition) missing data, or missing values, occur when no data value is stored for the variable in an observation. Missing data are a common occurrence and can have a significant effect on the conclusions that can be drawn from the data.

To address the aforementioned issues, outliers and missing data were first tracked and identified in the dataset and then various imputations methods were applied to improve the data quality and ensure a sound analysis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Following the discussion of the basic theoretical framework implicitly in using consumption as a measure of welfare, this chapter provides guidelines to construct a nominal consumption aggregate from a typical in Household Living standards measurement surveys (Deaton, A and S. Zaidi 2002). For the purpose of this study, the procedures followed in constructing the consumption aggregate from the recent integrated household Living Conditions survey (EICV3) in Rwanda will be reviewed in detail.

One important preliminary issue should be emphasized; tough it is one where it is hard to give any very precise guidelines. This is the issue of data cleaning. In most cases, analysts who are constructing consumption aggregates will be using a “clean” set of data that has already been subjected to the usual consistency checks and elimination of gross outliers and coding errors. Aggregates and sub-aggregates should similarly be checked. Such checks often reveal, not only isolated, but groups of outliers, for example if the units have been misinterpreted for all observations in a cluster. Sometimes, outliers can clearly be attributed to coding errors, as when the units have been miss interpreted, or where zeros have been added, and in such cases it is routine to impute an average(or better median) value for other households in the same cluster or region. In other cases, it is unclear whether the “outlier” is genuine or not, and the analyst must make a judgment that balances the desirability of keeping any reasonable number against the risk of contaminating the aggregate (Deaton, A and S. Zaidi 2002).

The components of consumption are aggregated into four main classes: (i) food items, (ii) non-food items, (iii) consumer durables, and (iv) housing (Deaton, A and S. Zaidi 2002). The relative importance of each of these classes in the overall consumption aggregate depends on many factors, including the average level of income in the country, prevalent tastes and norms, as well as the types of data collected in the survey. In this regards, it should be noted that there was considerable variation in the design of questionnaires across the various countries, so that the aggregates do not always include the same items. In general, as we would expect from Engel’s law, the share of food items in the total tends to be relatively more important the lower the level of income in the country. The share of home-production in the food consumption aggregate tends to be higher in countries where relatively transactions take place through the market place compared to those countries where agricultural markets are relatively well developed.

The share of consumption attributable to education and health also depends on the level of income of the country, as well as the extent to which these services are purchased through the market, or else are provided instead by the state at subsidized rates.

2.3 Theoretical review

Households have personal needs and wants that are directly satisfied through consumption of goods and services resulting from activities that are reproductive in an economic (SNA, 1993). These goods and services are referred to as consumer goods and services and their individual value is defined as the consumption expenditure on these goods or services. Household consumption expenditure (HCE) is the value of consumer goods and services that were acquired (used or paid for) by a household for the direct satisfaction of the needs and wants of its members through direct monetary purchases in the market; through the market-place but without using any money as means of payment (barter, income in kind) and from production within the household (own-account production). Households also acquire (or use) consumer goods and services that satisfy the needs and wants of its members through social transfers in kind from government and non-profit institutions or through transfers from other households. The sum of HCE and the value of these transfers are referred to as actual final consumption (AFC) of the household. This is the total value of consumer goods and services available to the household for satisfying the needs and wants of the household members. The non-consumption expenditures of households include current transfers of cash, goods and services to other households such as gifts donated, remittances, alimony, child supported. Other items included are irregular contributions to non-profit institutions; compulsory transfers to governments such as income and other direct taxes (e.g. wealth taxes), compulsory fees and fines; and pension and social security contributions. Expenditures on goods and services for use in the operation of unincorporated enterprise as well as the occupational expenses of employees are excluded from the measurement of household expenditure. In addition, capital expenditures such as savings, reduction of liabilities, amounts loaned, purchases of financial assets, life insurance premiums are excluded.

Expenditure on valuables (Works of art, jewellery, gemstones, etc.) is also excluded from household expenditure (ICLS-2003-06-0049-1-EN.Doc/v1).

2.4 Food consumption

In practice, however, households consume food obtained from a variety of different sources, and so in computing a measure of total consumption to include as part of the aggregate welfare measure, it is important to include food consumed by the household from all possible sources (Deaton, A and S. Zaidi 2002). In particular, this measure should include not just (i) food purchased in the market place, including meals purchased away from home for consumption at or away from home, but also (ii) food that is home-produced, (iii) food items received as gifts or remittances from other households as well as (iv) food received from employer as payment in-kind for services rendered. In cases where food can be and is stored over long periods of time, and where the questionnaire permits it, "food consumed" can be distinguished from "food purchased". In principle, it is the value of the former that should go into the consumption aggregate. A household that stocks up on cereals up on once every month, and whose purchase is caught by the survey, should not be there by counted as well-off, nor should someone who did not stock up in the survey period be counted as poor.

The food purchases module in LSMS questionnaires typically contains questions on purchases of a fairly comprehensive list of food items during a relatively short reference period and during a typical month in which purchases were made. Data are often collected on the total amount spend on purchasing each food item, and sometimes also on the quantities purchased, during the specific reference period. Calculating the food purchases sub-aggregate involves converting all reported expenditures on food items to a uniform reference period-say one year- and then aggregating these expenditures across all food items purchased by the household.

The total value of meals consumed outside the household (restaurants, prepared foods purchased from the market place) should also be included in the food consumption aggregate, as should the value of meals taken household members at school, work, during vocations, etc. The total value of meals taken outside the home by all household members; this amount should also be included in the food consumption aggregate (Aguiar & Hurst, 2005).

The home production food items must be also included in food consumption. Here it is more common to find questions only on the amount of home-produced food items consumed in a typical month as well as the number of months each food item is typically consumed in a hear. Data are often collected on both the total value and quantity of consumption of each home-produced food item. The home-product food items consumed by the household may not be comparable in quantity to items traded in the market place. Households' own valuation of the amount they would except to receive (pay) if they had sold (bought) the home-produced food items that they consume are therefore likely to be much better approximation to their true" farm-gate" value, rather than estimates derived using prevailing market prices.

2.5 Non-food items Consumption

Living standard measurement survey questionnaires typically collect information on consumption of a wide range of non-food items (Deaton, A and S. Zaidi 2002). For example, data collected on consumption on daily-use items such as soap and cleaning supplies, kerosene and petrol, newspapers, tobacco, stationary and supplies, recreational expenses and miscellaneous personal care items, as well as other less frequently purchased items such as clothing, footwear, kitchen equipment, household textiles such as sheets, curtains, bedcovers, etc., and other household use items. Data are also collected on education, health expenditure for all household members and household utilities.

Finally, these questionnaires typically also solicit information on other infrequent expenses such as legal fees and expenses, home repair and improvements, taxes and levies, as well as expenditure on social ceremonies, marriages, births, and funerals, etc.

Data on purchases of non food items are often collected for different recall periods, for example over the past 30 days, the past 3 months, or the past 12 months, depending on how frequently the items concerned are typically purchased. Constructing the non-food aggregate thus entails converting all these reported amounts to a uniform reference period say one year, and then aggregating across the various items (Attanasio, Hurst &Pistaferri ,2012).

As far as singling out which non-food "expenditures" should be excluded from the consumption aggregates, some choices are straightforward. Expenditures on taxes and levies are not part of consumption, but a deduction from income, and should not be included in the consumption total. An apparent exception can sometimes be argued for some local taxes, such as property taxes, that are used to provide local services, such as schools, policing, or garbage collection. In some locations, these taxes bear no relation to services provided and so should not be included in the consumption aggregate. Commodity taxes are included in the prices of goods, and so (correctly) find their way into the consumption aggregate through the prices though it is also possible to imagine using reference prices for money metric utility that excludes commodity taxes. In any case, no special treatment is required for commodity taxes.

Expenditure on "regrettable necessities", such as travel to work or work-related clothing, are best included, though business expenses associated with the operation of own-account business must be excluded. These distinctions are much more easily enunciated than implemented; the welfare analyst faces much the same difficulties as does a tax inspector. Some surveys list as "expenditures" items that are clearly capital account transactions, such as expenditures for a "saving club". All purchases of financial assets, as well as repayments of debt, and interest payments should be excluded from the consumption aggregate (Lise &Seitz, 2011)

More complex is the case of "lumpy" and relatively infrequent expenditures such as marriages and dowries, births, and funerals. While almost all households incur relatively large expenditures on these at some stage, only a relatively small proportion of households are likely to make such expenditures during the reference period typically covered by the survey. Those expenditures are excluded in the consumption aggregate. Note the analogy with measurement error. Although transitory expenditures are real enough, consumption aggregates that include them can be thought of as "noisy" measures of the longer-run averaged totals that we would really like to measure. Expenditure on health is an often lumpy expenditure where a decision almost always has to be made. One argument for exclusion is that such expenditure reflects a regrettable necessity that does nothing to increase welfare.

By including health expenditures for someone who has fallen sick, we register an increase in welfare when, in fact, the opposite has occurred. The fundamental problem here is our inability to measure the loss of welfare associated with being sick, and which is (presumably) ameliorated to some extent by health expenditures. Including the latter without allowing for the former is clearly incorrect, though excluding health expenditures altogether means that we miss the difference between two people, both of whom are sick, but only one of which pays for treatment. It is also true that some health expenditures for example cosmetic expenditures are discretionary and welfare enhancing, and that it is difficult to separate "necessary" from "unnecessary" expenditures, even if we could agree on which is which. Some people have insurance, so that expenditures are only "out of pocket" expenditures which may be only a small fraction of the total, while others have none, and may bear the whole cost. Simply adding up expenditures will not give the right answer. Yet another approach is a pragmatic one that recognizes that measured health expenditures are a noisy approximation to what we would ideally like to have. The decision about whether to include them in the total depends, not only on the extent of the measurement error, but also on elasticity of health expenditures with respect to total expenditure, the higher the elasticity, the stronger the case for inclusion health consumption aggregate ABS. 2009-10. Although educational expenses are not as irregular as health expenditures, they are located at a particular point in the lifecycle, so that, even if all households paid the same for education and had the same number of children, some would appear better-off than others simply by virtue of their age. In this sense, educational expenditures, like health expenditures, would ideally be smoothed over life (ABS. 2009-10). There is also the argument that education is an investment, not consumption, and should be included in saving, not in the consumption aggregate. But we follow standard national income accounting practice and recommend that it be included in the consumption aggregate.

Another important group of items to consider are items such as consumer durables and housing whose useful life typically spans a time-period greater than the interval for which the consumption aggregate is being constructed. The relevant component of the total is not the expenditure on such items but a measure of the flow of services that they yield. How to calculate this measure of "user-cost" for consumer durables and for housing is taken up in more detail in Sections **2.6** and **2.7** respectively. Another group of expenditures are gifts, charitable contributions, and remittances to other households. A case can be made for including gifts to others based on the fact that they must yield as much welfare to the transmitting household as do other consumption expenditures that could have been made with the funds. However, their inclusion in the consumption aggregate would involve double-counting if, as one would expect, the transfers show up in the consumption of other households. Average living standards could be increased without limit if each household were simply encouraged to donate its income to another household, and so on; nothing would have changed except our measure of welfare. The recommendation is excluding gifts and transfers, counting them as they are spent by their recipients. Some households own small enterprises which produce goods for own-consumption; such items should be treated analogously to home-produced food, priced as well as is possible in the circumstances, and added to the total. There are also a number of non-foods received as payment in kind; housing subsidies, transport to work, and education are probably the most important examples. In principle, all such items should be valued and included though, as always, thought should be given to the tradeoff between comprehensiveness on the one hand, and measurement error on the other hand.

2.6 Consumer Durables

From the point of view of household welfare, rather than using expenditure on purchase of durable goods during the recall period, the appropriate measure of consumption of durable goods is the value of services that the household receives from all the durable goods in its possession over the relevant time period (Deaton, A and S. Zaidi 2002).

The "user cost" or "rental equivalent" for durable goods is approximately:

$$S_t p_t \left(r_t - p_t + d \right) \quad \textbf{(1)}$$

Where:

$S_t p_t$ is the current value of the durable goods**,** $r_t - p_t$ the real rate of interest, and **d** the rate of depreciation for the durable goods. Although in theory, r_t is the general nominal rate at time t, and p_t is the specific rate of inflation for each durable goods at time t, in practice it is best to collapse the two into a single real rate of interest, taken as an average over several years, and to use that real rate for all durable goods.

Almost all LSMS surveys collect data on the stock of durable goods currently owned by the household. However, the amount of detailed information collected about each durable goods varies quite considerably across surveys. Therefore, depending on the type of data available, the analyst must choose between numbers of different strategies when using **(1)** to estimate the durable goods consumption sub-aggregate. The "Inventory of Durable Goods" module of the questionnaire collects information on (i) the current value of each durable goods ($S_t p_t$), (ii) the age of the item T in years, as well as (iii) the value of the item when purchased $(S_t p_t - T)$**.**

Using **(1),** consumption of durable goods is then calculated as follows:

First the depreciation rate ¢ for each type of durable goods was calculated using:

$$\delta - \pi = 1 - \left(\frac{p_t}{p_t - T} \right)^{1/T} \text{ (e.g. Meyer and Sullivan, 2011)} \qquad (2)$$

The estimates of $\delta - \pi$ are calculated from the survey data.

These estimates are used, in conjunction with data on the real rate of interest $r_t - \pi_t$ and the current value of durable goods owned by each household $S_t p_t$, to calculate the durable goods consumption sub-aggregate. In order to minimize the influence of any outliers in the data, the median value of depreciation rates are used for each of the items for which data are collected (i.e. rather than using household-specific values of ¢ calculated from the data).

When the value of the **(1)** item when new is not available in the data sets **(2)** could not be used to calculate the ¢ ; instead, an estimate of consumption of durable goods is calculated as follows:

First, the average age for each durable goods, T, is calculated from the data on the purchase dates of the goods recorded in the survey. We then estimate the average lifetime of each durable goods as $2T$ under the assumption that purchases are uniformly distributed through time. (In some cases, for example where a good has only recently been introduced, some other guess would have to be made.) The remaining life of each good is then calculated as $2T - T$; in this case, and somewhat arbitrarily, this estimate is "rounded up" to 2 years when the estimate was less. A rough estimate of the flow of services is then derived by dividing the current replacement value $S_t p_t$ by its expected remaining life. For the countries, the interest component in the flow of services was ignored.

Taking logs and rearranging the terms somewhat, **(2)** can be rewritten as:

$$\ln(p_t) = \ln(p_t - T)\ln(1 - \delta + \pi) \qquad \mathbf{(3)}$$

Thus, in cases where data are available on the current value and age of the durable goods only, using **(3)** $\delta - \pi$ can be estimated by regressing the current value of the durable goods on a constant and T (i.e. by assuming that the current value of the durable good when new is a constant).

2.7 Housing

Of all components of the household consumption aggregate, the housing sub-aggregate is often one of the most problematic. The underlying principle is the same as for other consumer durables; what is required is a measure in monetary terms of the flow of services that the household receives from occupying its dwelling. (Deaton, A & S. Zaidi, 2002).

Because house purchase is such a large and relatively rare expenditure, under no circumstances should expenditures for purchase be included in the consumption aggregate. In the hypothetical case where rental markets function perfectly and all households rent their dwellings, the rent paid is the obvious choice to include in the consumption aggregate. Whenever such rental data are available, and provided the rents are a reasonable reflection of fair market value, they should be used for constructing the housing sub-aggregate and the consumption total.

In many cases, however, households own the dwelling in which they reside and do not pay rent as such. Others are provided with housing free of charge (or at subsidized rates) by their employer, a friend, a relative, government, or other such entities. In many LSMS surveys, non-renter households are asked how much it would cost them if they had to rent the dwelling in which they reside, and this "implicit rental value" can be used in place of actual rent. Such measures must be treated with caution and carefully inspected prior to use. Implicit rent is a hypothetical concept, perhaps to the interviewer as well as to the respondent, and the numbers reported may not always be credible or usable. Even when people are apparently confident about their estimates, they may do a very poor job of reporting market rents. Rents known to them may be subsidized, out of date, or in some way unrepresentative of the general run of property in their area.

The hardest cases arise when there are data on neither actual nor imputed rent. In addition to information on rents, data were collected on the total property value (i.e. current sale value) of the dwelling. For households who reported property values but neither actual nor imputed rents, the local median of the ratio of rental to property value was used to calculate an imputed rental. In cases where the property value of the dwelling was also missing, a median property value per room was used in each locality to assign a property value to the dwelling based on the total number of rooms, and the estimated property value used to estimate its rental value.

In the LSMS data sets, hedonic housing regressions are used to impute a value of housing consumption wherever information on rents was missing. The idea behind this approach is to estimate an econometric model in which rents reported by a subset of the population (either actual or reported, as the case may be) are regressed on a set of housing characteristics including, for instance, the number of rooms and measures of quality of the dwelling such as type of roof, floors, construction material of walls, type of sanitation, etc. as well as regional dummies. The parameter estimates obtained from this model are then used to calculate rents for that segment of the population for which data on rents are missing.

In cases where data on imputed rental value for non-renting households are not available, or where such estimates are deemed to be unreliable or difficult to estimate because rental markets are thin (as is the case, for instance, in rural areas in some countries), the hedonic regression approach can also be used to impute rents for such households. The regression model is first estimated using rent paid by renter-households as the dependent variable; the results of the model are then used to impute rents for the rest of the population. Because there may be systematic differences in characteristics between renters and non-renter households, the (Heckman,1976) two stage estimation method is also sometimes used when estimating such hedonic models, see for example (Lee & Trost ,1978) and (Malpezzi & Mayo, 1985).

Finally, in cases where data on rental value are not available for both renters as well as non-renters, or where the percentage of the population renting their dwelling unit is so small as to make estimation of a hedonic housing model unfeasible, data on property values can be used to estimate the value of housing consumption. Following an approach similar to that used for consumer durables**,** the value of the flow of services received by the household from housing can be calculated by using an appropriate guesstimate of the user cost per unit to derive a measure of housing consumption from the total property or “stock value of the dwelling.

Once again, it is necessary to warn against the mechanical application of these (and other related) procedures. In some countries, housing and rental markets are not well enough developed to permit any serious estimate of rental value, and attempts to repair the deficiency using data from a small number of households are unlikely to be effective, however sophisticated the econometric technique. Even if there is information on rents in some parts of the country, it is obviously hazardous to apply it to other areas, and econometric fixes sometimes do no more than disguise the problem. In extreme cases, the best available solution may simply be to exclude the housing component for all households.

Note finally that data related to expenditures on water, electricity, garbage collection, and other such utilities and amenities are usually collected in the housing module of LSMS questionnaires. They should also be included in the housing sub-aggregate, and in the measure of total expenditure.

2.8 Adjusting for differences in the size and composition of households

The literatures have shown on how to use LSMS data to construct a nominal measure of total household consumption and of how to adjust it to take into account cost-of-living differences, see for example (Lee & Trost ,1978) and (Malpezzi & Mayo ,1985).However, we are ultimately interested in individual welfare, not the welfare of a household, something that is hard to define in any very useful way. If it were possible to gather data on consumption by individual family members, we could move directly from the data to individual welfare, but except for a few goods, such data are not available, even conceptually think of public goods that are shared by all household members. As it is, the best that can be done is to adjust total household expenditure by some measure of the number of people in the household, and to assign the resulting welfare measure to each household member as an individual.

Equivalence scales are the deflators that are used to convert household real expenditures into money metric utility measures of individual welfare. If a household consists entirely of adults, and if they share nothing, each consuming individually, then the obvious equivalence scale would be household size, which is the number of people over which household expenditures are spread. Even when households consist of adults and children, welfare is often assessed by dividing expenditures by household size, as a rough-and-ready concession to differences in family size. However, such a correction does not allow for the fact that children typically consume less than adults, so that deflating by household size will understate the welfare of people who live in households with a high fraction of children. Moreover, simply deflating household expenditures by total household size also means implicitly ignoring any economies of scale in consumption within the household. Some goods and services consumed by the household have a “public goods” aspect to them, where by consumption by any one member of the household does not necessarily reduce the amount available for consumption by another

person within the same household. Housing is important household public goods, at least up to some limit, as are durable items like televisions, or even bicycles or cars, which can be shared by several household members at different times. Because people can share some goods and services, the cost of being equally well-off does not rise in proportion to the number of the people in the household. Per capita measures of expenditure thus understate the welfare of big households relative to the living standards of small households; see, (Malpezzi & Mayo, 1985).
In this Section we discuss equivalence scales in general and outline some of the main approaches to their calculation. But before doing so, it is worth emphasizing that we do not recommend abandoning the use of per capita expenditure. Twenty years ago, per capita expenditure was itself something of an innovation, and many studies worked with total household expenditure or income without correction for household size. In the years since, deflation to a per capita basis has become the standard procedure, and although its deficiencies are widely understood, none of the alternatives discussed have been able to command universal assent. As a result, no calculation of welfare or poverty profile should ever be done without the calculation of per capita expenditure as at least one of the alternatives. In part, this recommendation reflects the burden of the past; results are almost always compared with previous analyses for the same country, or with similar analyses for other countries which use per capita expenditure. But it is also true that 20 years of experience with per capita expenditure has given analysts a good working understanding of its strengths and weaknesses, when it is sound (in most cases), and when it is likely to be misleading (for example, in comparisons of the average living standards of children and the elderly.)

2.8.1 Adult Equivalences scales

To make welfare comparisons across households with different size and demographic composition, we need some way of adjusting aggregate consumption measures to make them comparable across households. In this regard, just as a price index is used in order to make comparable consumption levels of households with different cost-of-living, equivalence scales is a way to make comparable consumption aggregates of households with different demographic composition. While many different methods have been proposed in the literature to calculate the exact conversion factors used in each particular set of equivalence scales, the underlying principle is often the same: the basic idea is that various members of a household have “differing needs" based on their age, sex, and other such demographic characteristics, and that these differing needs should be taken into account when making welfare comparisons across households. The costs of children relative to adults and the extent of economies of scale are of the first-order of importance for poverty and welfare calculations. Indeed, the direction of policy can sometimes depend on exactly how equivalence scales are defined. Larger households typically have lower per capita expenditure levels than small households but until we know the extent of economies of scale, we do not know which group is better off, or whether anti-poverty programs should be targeted to one or the other. Rural households are often larger than urban households, and we are sometimes unable to compare rural with urban poverty without an accurate estimate of the extent of economies of scale. Another frequent comparison is between children and the elderly, and both groups have claims for public attention on grounds of poverty. Children tend to live in larger households than do the elderly, and (obviously) live in households with a higher fraction of children. As a result, comparisons of welfare levels between the two groups are often sensitive to what is assumed about both child costs and about economies of scale. Unfortunately, there are no generally accepted methods for calculating equivalence scales, either for the relative costs of children, or for economies of scale. There are three main approaches to deriving equivalence scales: (i) one relying on behavioral analysis to estimate equivalence scales, (ii) one using direct questions to obtain subjective estimates, and (iii) one that simply sets scales in some reasonable, but essentially arbitrary, way. Each of these is discussed in turn in the sections that follow. The recommendation, apart from the continuing use of per capita expenditure, is the arbitrary method.

2.8.2 Arbitrary Approach

Given the current unreliability of either the behavioral or the subjective approach, there is much to be said for making relatively ad hoc corrections that are likely to do better than deflating by household size. One useful approach, detailed in National Research Council (1995), is to define the number of adult equivalents by the formula:

$$AE = \left(A + \alpha K\right)^{\vartheta} \quad \textbf{(4)}$$

Where A the number of adults in the household, and K is the number of children, the parameter ~ is the cost of a child relative to that of an adult, and lies somewhere between 0 and 1. The other parameter g , which also lies between 0 and 1, controls the extent of economies of scale; since the elasticity of adult equivalents with respect to effective size, $A+\alpha K$ is ϑ , $(1-\vartheta)$ is a measure of economies of scale. When both ~ and g are unity the most extreme case with no discount for children or for size the number of adult equivalents is simply household size, and deflation by household size is equivalent to deflating to a per capita basis.

A case can be made for the proposition that current best practice is to use **(4)** for the number of adult equivalents, simply setting ~ and g at sensible values. Most of the literature as well as common sense suggests that children are relatively more expensive in industrialized countries (school fees, entertainment, clothes, etc.) and relatively cheap in poorer agricultural economies. Following this, a could be set near to unity for the US and western Europe, and perhaps as low as 0.3 for the poorest economies, numbers that are consistent with estimates based on Rothbarth's procedure for measuring child costs, ((Deaton & Muellbauer ,1986) and (Deaton,1997)).

If we think of economies of scale us coming from the existence of shared public goods in the household, then g will be high when most goods are private and low when a substantial fraction of household expenditure is on shared goods. Since households in the poorest economies spend as much as three quarters of their budget on food, and since food is an essentially private good, economies of scale must be very limited, and g should be set at or close to 1. In richer economies, g would be lower, perhaps in the region of 0.75. We argue that it is important to assess the robustness of poverty comparisons using stochastic dominance techniques, and we sketch out a simple methodology for doing so. When the results are not robust, for example when the comparison of poverty rates between children and the elderly is sensitive to the choice of ~ and g within the sensible range for that country, there is probably not much alternative to facing failure squarely. Certainly the behavioral approach is unlikely to provide estimates that would be sufficiently precise and sufficiently credible to support such fine distinctions. In such situations, it might be better to turn to other indications of well-being, such as mortality or morbidity. When the analyst is not concerned with situations in which everything depends on the choice of ~ and g for example in comparing the poverty of children and the elderly. The recommendations are straightforward. At the first round, calculate per capita expenditure for each household by deflating the expenditure aggregate by household size. As an alternative and likely more accurate supplement, use the arbitrary method, with values of ~ and g set according to the level of development. In poor economies, we recommend setting ~ low, perhaps 0.25 or 0.33, and setting g high, perhaps 0.9. Children are not very costly in poor, agricultural economies, and when the budget share of food is high, there is not much scope for economies of scale. As we move to richer economies, children are relatively more expensive, and economies of scale larger. NRC (1995) recommended setting both parameters to 0.75 for the US, and others have noted that the official US poverty lines are quite well approximated by setting ~ to be 0.5 and g to be unity. To some extent, these parameters are substitutes for one another; ~ low a goes with a high g , and vice versa.

Eurostat uses different equivalence scales where the most common is the OECD scale where each member is assigned a weight which is 1 for the first adult, 0,7 for other persons of more than 13 years of age and 0,5 for children of 13 years and less. The OECD modified scale will be used for the presentation of 1994 results. This attributes the same coefficient to the first adult (1) but the coefficient for the other members is less (0,5 for each person of more than 13 years and 0,3 for 13 years of age and less). Some countries using the adult equivalent scale reproducing as follows (Deaton, A and S. Zaidi, 2002).

Table 2.1 Adult equivalent scale by age group and Gender

Age range	**Gender**	
	Male	**Female**
Less than 1 year	0.41	0.41
1 to 3 years	0.56	0.56
4 to 6 years	0.76	0.76
7 to 9 years	0.91	0.91
10 to 12 years	0.97	1.08
13 to 15 years	0.97	1.13
16 to 19 years	1.02	1.05
20 to 39 years	1	1
40 to 49 years	0.95	0.95
50 to 59 years	0.9	0.9

60 to 69 years	0.9	0.8
More than 70 years	0.7	0.7

Source: (Deaton, A and S. Zaidi 2002)

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter sets out the methodology that was used to achieve the objectives of the study. According to the Petit Larousse dictionary (1982), methodology is ‘’the systematic study by observation of the scientific practice, the basic principles and methods of research that it uses’’. The methodology includes the general approach of the study (research design), the population of interest, the sample, data collection instruments and the data analysis technique that were used.

3.2 Population

A population is a group of objects, items or persons from which samples are taken for measurement. DEPELTEAU (2000) defines the population as being "a set of all individuals who have precise characteristics in relationship with the objectives". According to ODERA and OKENYI (2006), "the population means a group of people living in a geographic place well determined".

For our case, the population of interest was all households in Rwanda which defined as a group of persons normally living together and taking food from a common kitchen.

3.3 Sampling frame

The sampling frame for the EICV3 was based on a database of villages (umudugudu) that cover all of the households in Rwanda. This database includes information on all the geographic codes and the approximate number of households in each village. The geographic hierarchy of the villages in the sampling frame was based on the new administrative divisions of Rwanda: 5 provinces, 30 districts, 416 sectors, 2148 cellules and 14837 villages. The average number of households per village was 132 (168 for urban villages, 129 for rural villages). The urban and rural classification was based on the 2002 Rwanda Census of Population.

In each sample village all the households were listed. This provided an updated sampling frame for the second stage of selection.

3.4 Sample

A sample is a finite part of a statistical population whose properties are studied to gain information about the whole. It is a set of respondents selected from larger population for purposes of survey. According to DE LANDSHEERE (1982), sampling is the fact of choosing a limited number of individuals, objects, events which the observation allows to draw conclusions applicable to the whole population from which the choice has been made. The EICV3 was used a sample size of 1320 villages and 14310 households

3.5 Sampling technique

3.5.1 Stratification

A stratified random sample is one obtained by separating the population elements into no overlapping groups, called strata, and then selecting a simple random sample from each stratum. See Richard L. Scheaffer, William Mendenhall III, R. Lyman Ott and Kenneth Gerow (1996).

Regarding to the design of the study we found that the stratification sampling technique is the best sampling technique compare to other methods because the estimates for the survey were estimated up to district level considered as strata. "According to Richard L. Scheaffer, William Mendenhall III, R. Lyman Ott and Kenneth Gerow (1996)" they mentioned three reason for using stratification sampling technique and the nature of the study satisfy those conditions.

Those three reasons are:

1. Stratification may produce a smaller bound on the error of estimation than would be produced by a simple random sample of the same size. This result is particularly true if measurements within strata are homogeneous.
2. The cost per observation in the survey may be reduced by stratification of the population elements into convenient groupings.
3. Estimates of population parameters may be desired for subgroups of the population.

These subgroups should then be identifiable strata.

The sampling frame of villages was stratified by district. Within each district the villages were ordered by urban and rural classification, then by geographic codes to provide an implicit stratification by urban and rural classification, and geographic location. This resulted in a proportional distribution of the sample villages by urban and rural classification.

3.5.2 Sample Size and Allocation

The sample size was designed for measuring the poverty reduction in Rwanda.

Let define:

p : Prevalence of population below poverty line in 2005 (was the key indicator, 56%)

q : Prevalence of population above poverty line (46%)

n : Sample size

RR : Response Rate (96%)

h : Expected household size (5 members)

E : Margin error (2%)

Z : Confidence level at 95% (1.96)

Deff: Design Effect (1.5)

The sample size was computed as follows:

$$n = \frac{Z^2 * p * (1-p) * Deff}{E^2 * RR * h}$$, see DE LANDSHEERE (1982), **(5)**

This gives the minimum sample size of 442 households of which was increased up to 480 households in rural stratum and 450 households in urban stratum and total strata was 30 (3 urban and 27 rural).

In the entire country, 1230 PSUs (Villages) were selected in the 30 strata with probability proportionally to size of PSUs in each of the 30 strata (District) and for each selected PSU, one second Stage sampling (SSU) unit or in this case households were randomly selected using a simple systematic sampling.

This was result in a sample of size 40 villages per district for the full year (10 cycles). In the case of the three districts in Kigali Province there has been 50 sample villages each; since 9 households have been selected in each sample village, the sample size for these districts were 450 households each. Although the sample size per district was slightly smaller for Kigali Province than for the other provinces, the 50 sample villages in each of these urban districts will ensure a more disperse sample, and the smaller number of sample households per village were reduced the design effects for the urban estimates.

3.5.3 Sample Selection Procedures

Let define:

PPS : Probability proportional to size

MOS_{α} : Measure of Size (Number of households in a specific village)

P_{α} : Probability of selecting a specific village

n : Number of village to be selected in a specific stratum

The first stage sample of villages in each district was selected systematically with PPS, where the measure of size was based on the number of households in the frame for each village. According to PPS, the probability of selecting a certain village (p_{α}) is:

$$P_{\alpha} = \frac{nMOS_{\alpha}}{\sum MOS_{\alpha}} \quad \textbf{(6)}$$

At the second sampling stage the households within each sample village were selected with equal probability using systematic random sampling.

According to the simple random sampling (SRS), the probability of selecting household in primary sampling unit ($p_{\sim}$) is:

$$P_{\beta} = \frac{\gamma}{MOS_{\alpha}} \quad \textbf{(7)}$$

Where 'γ' is the sample size (households) to be selected from the district, and MOS_{α} is the census number of households in the $\sim^{th}$ primary sampling unity (PSU).

3.5.4 Design Weight

The Design weight of the sample denoted by W is merely the inverse of the selection probability. It was computed as follows:

$$W = \frac{1}{P_{\alpha} * P_{\beta}} \quad \textbf{(8)}$$

This weight was based on census household in PSU (Village) and for updating the number of households in PSU a listing operation was done and the number for households in PSU after listing was used to adjust the weight. The adjusted weight denoted by W_{adj} was computed as follows:

Let define:

MOS_1 : Number of households listed in the PSU

MOS_2 : Number of household in PSU from census

$$W_{Adj} = W * \frac{MOS_1}{MOS_2} \qquad \textbf{(9)}$$

3.6 Listing operation

A listing form was given to enumerators to collect information of total number of households in each village sampled with the purpose of updating the sampling frame for second stage and to select households in the village. This was used to design a final probability for selection household in a village and the final weights which used to estimate the population parameters.

3.7 Questionnaire

A questionnaire was designed and covered the collection of data on ten sections to be asked in each household sampled such are: Households identification, Immigration, Education, Health, Housing, Employment, Agriculture, Consumption Expenditure, Transfer and Income, Durables and Saving.

3.8 Data collection

Data collection of EICV3 took 12 months which is divided in ten cycles. Each cycle covered 33 days in Kigali city province where enumerators visited a household after two days and 16 days in other provinces and enumerators visited the household after one day. In Kigali city province in each cycle the enumerators covered 5 clusters and in other provinces they covered 2 clusters. During the period of data collection a calendar was drafted and in each day of visit the enumerator has the section to be asked. All section was asked one time except the consumption expenditure and auto consumption expenditure which were asked in each visit. Here the enumerators asked the amount purchased for consumption item and for auto consumption they measured with scale the quantity consumed by the household for each visit and the unit price for the item was asked at the last visit.

3.9 Data processing

Data entry of the completed and checked questionnaires was undertaken at National Institute of statistics of Rwanda (NISR) offices by trained staff members using CSPro software.

Thereafter, data was entered in computers, exported in SPSS software and edited.

This dataset are available at NISR website where people can access it for different analysis.

The Data Analysis a Statistical Software IBM SPSS 21 version software and STATA were used in data analysis and interpretation was done through the use of test of normality , non parametric test, parametric test and statistical descriptive.

3.10 Data Analysis

3.10.1 Estimation Methodology

As the stratified random sampling techniques have been adopted for the survey, below are the formula used to estimate various statistical parameters. Some notation is required for stratified random sampling. The suffix h denotes the stratum and i the unit within the stratum. The following symbols all refer to stratum h .

Let define:

N_h : Total number of units

n_h : Number of units in sample

y_{hi} : Value obtained for the i^{th} unit

$W_h = \frac{N_h}{N}$: Stratum weight (10)

$$f_h = \frac{n_h}{N_h} : \text{ Sampling fraction in the stratum} \quad (11)$$

$$\overline{Y}_h = \frac{\sum_{i=1}^{N_h} y_{hi}}{N_h} : \text{ True mean} \quad (12)$$

$$\overline{y}_h = \frac{\sum_{i=1}^{n_h} y_{hi}}{n_h} : \text{ Sample mean} \quad (13)$$

$$S_h^2 = \frac{\sum_{i=1}^{N_h} (y_{hi} - \overline{Y}_h)^2}{N_h - 1} : \text{ True variance} \quad (14)$$

3.10.2 Estimation of a Population Mean and Total

Let $\overline{y}_{st}$ denote the sample mean for the simple random sample selected from

Stratum h, n_h the sample size for stratum h, μ_h the population mean for stratum h, and τ_h the population total for stratum i. Then the population total τ is equal to $\tau_1 + \tau_2 + ... + \tau_L$ We have a simple random sample within each stratum. Therefore, we know that $\overline{y}_{st}$ is an unbiased estimator of μ_h and $N_h \overline{y}_{st}$ is an unbiased estimator of the stratum total $\tau_h = N_h \mu_h$.

It seems reasonable to form an estimator of τ , which is the sum of the τ_h values, by summing the estimators of the τ_h . Similarly, because the population mean μ equals the population total τ divided by N, an unbiased estimator of μ is obtained by summing the estimators of the τ_h overall strata and then dividing by N. Cochran, Willam Gemmell (1909).

We denote this estimator by $\overline{y}_{st}$, where the subscript st indicates that stratified random sampling is used.

a. Estimator of the population mean μ:

$$\overline{y}_{st} = \frac{1}{N}[N_1\overline{y}_1 + N_2\overline{y}_2 + ... + N_L\overline{y}_L] = \frac{1}{N}\sum_{h=1}^{L} N_h \overline{y}_h = \sum_{h=1}^{L} w_h \overline{y}_h \quad \textbf{(15)}$$

The estimate $\bar{y}_{st}$ is not in general the same as the sample mean. The sample mean, $\bar{y}$, can be written as $\bar{y} = \frac{\sum_{h=1}^{L} n_h \bar{y}_h}{n}$. The difference is that in $\bar{y}_{st}$ the estimates from the individual strata receive their correct weights $\frac{N_h}{N}$. It is evident that $\bar{y}$ coincides with $\bar{y}_{st}$ provided that in every stratum. $\frac{n_h}{n} = \frac{N_h}{N}$ or $\frac{n_h}{N_h} = \frac{n}{N}$ or $f_n = f$. This means that the sampling fraction is the same in all strata. If in every stratum the sample estimate $\bar{y}_h$ is unbiased, then $\bar{y}_{st}$ is unbiased estimate of the population mean $\bar{y}$. $E(\bar{y}_{st}) = E\left(\sum_{h=1}^{L} w_h \bar{y}_h\right) = \sum_{h=1}^{L} w_h \bar{Y}_h$, Cochran, Willam Gemmell (1909).

b. Estimator of the population total τ

Procedures for the estimation of a population total τ follow directly from the procedures presented for estimating μ. Because τ is equal to $N\mu$, an unbiased estimator of τ is given by $N\bar{y}_{st}$.

$$N\bar{y}_{st} = [N_1\bar{y}_1 + N_2\bar{y}_2 + \ldots + N_L\bar{y}_L] = \sum_{h=1}^{L} N_h \bar{y}_h \qquad \textbf{(16)}$$

c. Estimated variance of $N\bar{y}_{st}$

If a simple random sample is taken within each stratum, an unbiased estimate of S_h^2 from theorem 2.4, is given by

$$s_h^2 = \frac{1}{n_h - 1} \sum_{i=1}^{n_h} (y_{ni} - \bar{y}_h)^2 \qquad \textbf{(17)}$$

Proof can be found in Cochran, Willam Gemmell (1909)

With stratified random sampling, an unbiased estimate of the variance of $\bar{y}_{st}$ is given by

$$V(\bar{y}_{st}) = S^2(\bar{y}_{st}) = \frac{1}{N^2} \sum_{h=1}^{L} N_h(N_h - n_h)\frac{s_h^2}{n_h} \quad \textbf{(18)}$$

An alternative form for computing purposes is

$$S^2(\bar{y}) = \sum_{h=1}^{L} \frac{w_h^2 S_h^2}{n} - \sum_{h=1}^{L} \frac{w_h S_h^2}{N} \quad \textbf{(19)}$$

The second term on the right represents the reduction due to the fpc. In order to compute this estimate, there must be at least two units drawn from every stratum. Willam Gemmell, Cochran (1909)

e. Estimate confidence limits

The formulas for confidence limits are as follows

Population mean: $\bar{y}_{st} \pm ts(\bar{y}_{st})$ (20)

Population total: $N\bar{y}_{st} \pm tNs(\bar{y}_{st})$ (21)

These formulas assume that $\bar{y}_{st}$ is normally distributed and that $s(\bar{y}_{st})$ is well determined, so that the multiplier t can be read from tables of the normal distribution. If only a few degrees of freedom are provided by each stratum, the usually procedure for taking account of the sampling error attached to a quantity like $s(\bar{y}_{st})$ is to read the t-value from the tables of student's t instead of from the normal table. Cochran ,Willam Gemmell(1909)

3.11 Statistical test

A statistical test provides a mechanism for making qualitative decisions about a process or processes. The intent is to determine whether there is enough evidence to “reject” a conjecture or hypothesis about the process. The conjecture is called the null hypothesis. Not rejecting may be a good result if we want to continue to act as if we “believe” the null hypothesis is true. Or it may be a disappointing result, possibly indicating we may not yet enough data to “prove” something by rejecting the null hypothesis.

3.11.1 Shapiro-wilk test

The Shapiro-will test utilizes the null hypothesis principle to check whether a sample $x_1 \ldots\ x_n$ came from a normally distributed population. The test statistic is:

$$w = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2} \qquad \textbf{(22)}$$

where;

x_i is the i^th order statistic;

$\bar{x}$ is the sample mean;

The constants a_i are given by:

$$\left(a_1, \ldots, a_n\right) = \frac{\overset{T}{m} V^{-1}}{\left(\overset{T}{m} V^{-1} V^{-1} m\right)^{1/2}}$$

Where;

$m = (m_1, \ldots, m_n)^T$ and $m_1, \ldots, m_n$ are the expected values of the order statistics of independent and identically distributed random variables sampled from the standard normal distribution, and V is the covariance matrix of those order statistics. We reject the null hypothesis if W is below a predetermined threshold.

The null hypothesis is this test is that the population is normally distributed. Thus if the p-value is less than the chosen alpha level, then the null hypothesis is rejected and there is evidence that the data tested are not from a normal distributed population. In other words, the data are not normal. On the contrary, if the p-value is greater than the chosen alpha level, the null hypothesis that data came from a normal distributed population cannot be rejected, since the test is biased by sample size the test may be statistically significant from a normal distribution in any large samples. Thus a Q-Q plot is required for verification in addition to the test. Pearson, A. V., and Hartley, H. O. (1972).

3.11.2 Parametric test

a. Student's t-test

In order to test whether there is a difference between population means, we are going to make three assumptions:

1. The two populations have the same variance. This assumption is called the assumption of homogeneity of variance
2. The populations are normally distributed.
3. Each value is sampled independently from each other value. This assumption requires that each subject provide only one value.

$$t = \frac{\text{statistic} - \text{hypothesized value}}{\text{Estimated standard error of the statistic}}$$

In this case, our statistic is the difference between sample means and our hypothesized value is zero. The hypothesized value is the null hypothesis that the difference between population means is 0. For the calculation, we will make the three assumptions specified above.

The first step is to compute the statistic, which is simply the difference between means.

$m_1 - m_2$ Where m1 is the mean for group 1 and m_2 is the mean for group 2

The next step is to compute the estimate of the standard error of the statistic. In this case, the statistic is the difference between means, so the estimated standard error of the statistic is

$(s_{m_1 - m_2})$

In order to estimate this quantity, we estimate $\pm^2$ and use that estimate in place of $\pm^2$. Since we are assuming the two population variances are the same, we estimate this variance by averaging our two sample variances.

Thus, our estimate of variance is computed using the following formula:

$$MSE = \frac{S_1^2 + S_2^2}{2}$$

Where:

MSE is our estimate of $\pm^2$

$$S_{m_1-m_2} = \sqrt{\frac{2MSE}{n}}$$ for equal sample size and $$S_{m_1-m_2} = \sqrt{\frac{2SSE/df}{n_h}}$$ for unequal sample size

Where:

$$n_h = \frac{2}{\frac{1}{n_1}+\frac{1}{n_2}}$$ and $$SSE = \sum(X-m_1)^2 + \sum(x-m_2)^2$$

The next step is to compute t

$$t = \frac{m_1 - m_2}{S_{m_1-m_2}}$$ (Gopal K. Kanji 2006). **(23)**

b. One way ANOVA Test

A one-Way Analysis of Variance is a way to test the equality of three or more means at one time by using variances.

Assumptions

- **i.** The populations from which the samples were obtained assumed to be normally or approximately normally distributed.
- ii. The samples must be independent.
- iii. The variances of the populations are assumed to be equal.

Hypotheses

The null hypothesis will be that all population means are equal; the alternative hypothesis is that at least one means is different.

In the following, lower case letters apply to the individual samples and capital letters apply to the entire set collectively. That is, n is one of many sample sizes, but N is the total sample size. (Anderson, R.L. (1942)

Let define:

$$\bar{X}_{GM} = \frac{\sum x}{N} = \frac{\sum n\bar{x}}{\sum n}$$: Grand mean

$$SS(T) = \sum\left(x - \bar{X}_{GM} \right)^2 : \text{Total variation}$$

$$SS(B) = \sum n\left(\bar{x} - \bar{X}_{GM} \right)^2$$: Interaction between the samples (There are k-1 degrees of freedom)

$$MS(B) = S_b^2 = \frac{SS(B)}{K-1} : \text{Mean square between groups}$$

$$SS(W) = \sum df * s^2 = \sum (N-K) * s^2 : \text{Sum squares within groups}$$

F-test statistic

Recall that the F statistic is the ratio of two independent chi-square variables divided by their respective degrees of freedom. Also recall that the F-test statistic is the ratio of two sample variances, well, it turns out that's exactly what we have here. The F-test statistic is found by dividing the between group variance by the within group variance. The degrees of freedom for the numerator are the degrees of freedom for the between group $(k-1)$ and the degrees of freedom for the denominator are the degrees of freedom for the within group $(N-K)$.

$$F = \frac{S_b^2}{S_w^2} \qquad \textbf{(24)}$$

Decision Rule

The decision will be to reject the null hypothesis if the test statistic from the table is greater than the F critical value with $K-1$ numerator and $N-K$ denominator degrees of freedom. see Gopal K. Kanji (2006)

3.11.3 Non parametric test

a. Kruskal–Wallis test

The Kruskal-Wallis H test is a non-parametric test which is used in place of a one-way ANOVA. Essentially it is an extension of the wilcoxon rank-sum test to more than two independent samples.

This test is appropriate for use under the following circumstances:

1. You have three or more conditions that you want to compare;
2. Each condition is performed by a different group of participants; i.e. you have an independent-measures design with three or more conditions
3. The data do not meet the requirements for a parametric test. (i.e. use it if the data are not normally distributed; if the variances for the different conditions are markedly different; or if the data are measurements on an ordinal scale).

The K samples are combined and arranged in order of increasing size and given a rank number. Where ties occur the mean of the available rank numbers is used. The rank sum for each of the K samples is calculated. Let Rj be the rank sum of the j^{th} sample, n_j be the size of the j^{th} sample, and N be the size of the combined sample. The test statistic is

$$H = \left\{ \frac{12}{N(N+1} \sum_{j=1}^{K} \frac{R_i^2}{n_j} \right\} - 3(N+1) \quad \text{Gopal K. Kanji (2006)} \qquad \textbf{(25)}$$

This follows a χ^2-distribution with K-1 degrees of freedom. The null hypothesis of equal means is rejected when H exceeds the critical value. Critical values of H for small sample sizes and K = 3, 4, 5 are given in Table 22 (Gopal K. Kanji 2006). Each sample size should be at least 5 in order for χ^2 to be used, though sample sizes need not be equal.

The K frequency distributions should be continuous.

Decision rule:

If $\chi^2_{calculated} > \chi^2_{table}$ reject the null hypothesis

b. Mann-Whitney Test

The Mann-Whitney U test is essentially an alternative form of the Wilcoxon Rank-Sum test for independent samples and is completely equivalent.

Define the following test statistics for samples 1 and 2 where n_1 is the size of sample 1 and n_2 is the size of sample 2, and R_1 is the adjusted rank sum for sample 1 and R_2 is the adjusted rank sum of sample 2. It doesn't matter which sample is bigger.

$$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1, \qquad U_2 = n_1 n_2 + \frac{n_2(n_2+1)}{2} - R_2 \quad \text{and } U = \min(U_1, U_2) \qquad \textbf{(26)}$$

Hypothesis test:

H_0 : The samples are taken from identical populations

Decision rule:

If the observed value of U is < $U_{Critical}$ then the test is significant (at the α level), i.e. we reject the null hypothesis. Neave, H.R. (1976b)

c. The wilcoxon Signed ranks test.

The Wilcoxon signed-rank test is a non-parametric statistical hypothesis test used when comparing two related samples, matched samples, or repeated measurements on a single sample to assess whether their population mean ranks differ (i.e. it is a paired difference test). It can be used as an alternative to the paired Student's t-test, t-test for matched pairs, or the t-test for dependent samples when the population cannot be assumed to be normally distributed.

Test procedure:

Let N be the sample size, the number of pairs. Thus, there are a lot a total of $2N$ points.

For $i = 1, ..., N,$ let $x_{1,i}$ and $x_{2,i}$ denote the measurements.

H_0 : median difference between the pairs is zero

H_1 : Median difference is not zero.

For $i = 1, ..., N,$, calculate $|x_{2,i} - x_{1,i}|$ and $Sgn(x_{2,i} - x_{1,i})$ where Sgn is the sign function.

Exclude pairs with $\left|x_{2,i} - x_{1,i}\right|$ =0. Let N_T be the reduced sample size. Order the remaining N_T pairs from smallest absolute difference to largest absolute difference, $\left|x_{2,i} - x_{1,i}\right|$. Rank the pairs, starting with the smallest as 1. Ties receive a rank equal to the average of the ranks they span. Let R_i denote the rank.

Calculate the test statistic W: $W = \left|\sum_{i=1}^{N_r}\left[Sgn(x_{2,i} - X_{1,i}) * R_i\right]\right|$, **(27)**

the absolute value of the sum of the signed ranks as N_T increases, the sampling distribution of W converges to a normal distribution. Thus, for $N_r \geq 10$, a z-score can be calculated as follows:

$$Z = \frac{W - 0.5}{\partial_W}, \partial_W = \sqrt{\frac{N_r(N_r+1)(2N_r+1)}{6}}$$ Neave, H.R. (1976b)

Decision rule:

If $Z > Z_{critical,}$ then reject H_0. For $N_r < 10, W$ is compared to a critical value from table

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Distribution of household consumption expenditure data

4.1.1 Skewness and kurtosis of the HCE data

Table1 shows that the HCE data are highly skewed as well and their skewness is not falling in the range of -1/2 and +1/2. This means that the data are not normally distributed and the shape of the distribution is leptokurtic as well since the value of the kurtosis is greater than 3.Additional to this the household has a big difference between household consumption expenditure.

Table 4.1 Skewness and kurtosis of the HCE data

Variable	skewness	kurtosis
HCE	15.15514	501.9635

Figure1 show that the distribution of HCE data is highly positively skewed and the shape of the distribution is leptokurtic. The figure shows that the data are somehow far from the mean or median which mean that there is not symmetric of the household consumption expenditure from the mean.

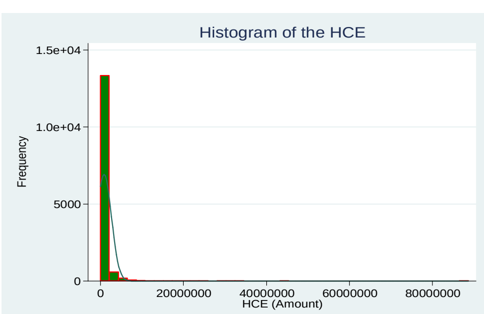

Figure 4.1 Histogram of Household Consumption Expenditure data

4.2.3 Test of normality of HCE

Table 4.2 represents the output of the test of normality of HCE data. The test shows that the data are not normally distributed as well as the p value (Sig) is less than 0.05.

Table 4. 2 Test of normality of Household Consumption Expenditure data

Tests of Normality			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
HCE	.301	2252844	.000
a. Lilliefors Significance Correction			

Regarding the Q-Q plot, normally when the data are normally distributed the dots are along the line but figure 4.2 shows that the dots are not following the line which mean that the data are not approximately normally distributed.

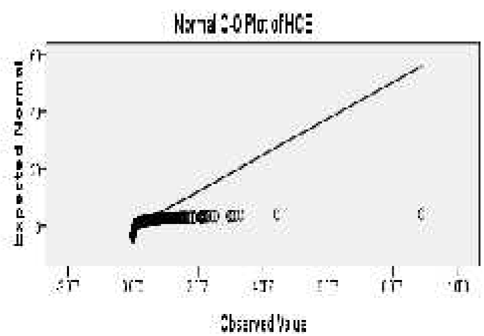

Figure 4. 2 Q-Q plot of Household Consumption Expenditure data

The box plot of HCE should be as symmetric as possible. Figure 4.3 shows that the box plots are not symmetric. Therefore we conclude that the data are not approximately normally distributed

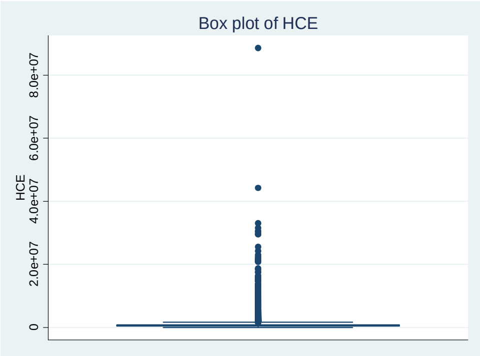

Figure4. 3 Box plot of Household Consumption Expenditure data

Conclusion: The test of normality, kurtosis, skewness, Q-Q plots and Box plots shows that the household consumption expenditure are not normally distributed and the non parametric test must be used to test the differences mean of HCE.

4.2 Normalization of Household Consumption Expenditure data

The HCE data is not normally distributed as shown by the result of the test of normality. The parametric test is not allowed to use in testing the differences means of HCE by domain or components. To use the parametric test we need first of all to normalize the HCE data by using the transformation function recommended in statistics. The log transformation was used to transform the HCE data and histogram Q-Q plots, Box plot and were plotted to verify if the log HCE data are approximately normally distributed.

Figure 4.4 has a shape as normal distribution curve; this allows us to say that the logarithm household consumption expenditure data are approximately normally distributed.

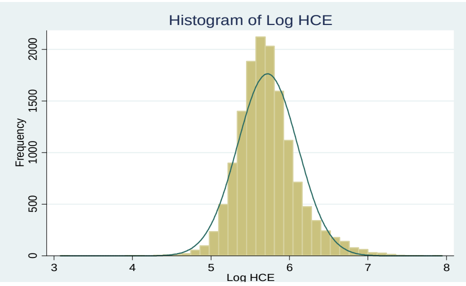

Figure 4.4 Histogram of log Household Consumption Expenditure data

The Q-Q plots should be along the line. Compared to the Q-Q plots of the HCE data, the Q-Q plots of the log HCE indicates that their dots are approximately distributed on the line. These mean that the logarithm household consumption expenditure data are approximately normally distributed.

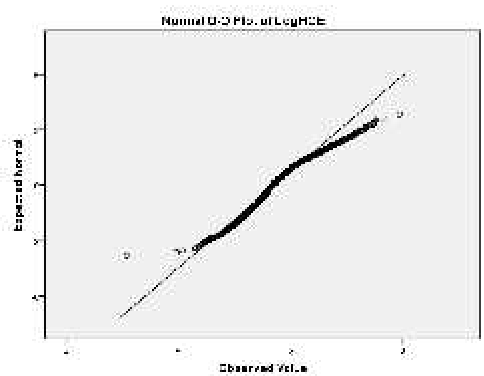

Figure 4. 5 Q-Q plot of log Household Consumption Expenditure

Figure 4.6 shows that the box plots of log HCE are symmetric. It seems that our log HCE data are not perfectly symmetric but are approximately symmetric. The box plot shows that there are outliers and this can affect the normality of the data when the outliers are above 5%. Imputation is not recommended and non parametric test must be used. After checking the percentages of outliers, we found that they are 3% which cannot affect too much the approximation of the normality of the data distribution. Therefore we can conclude based on box plot that the log HCE data are approximately normal distributed as well as the box are approximately symmetric.

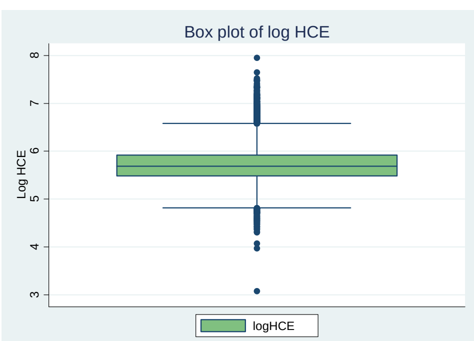

Figure 4. 6 Box plot of log Household Consumption Expenditur

Conclusion: The transformed data are approximately normally distributed after checking the histogram, Q-Q plot and Box plot; this allows us to use the parametric test to test the differences between means. This allow us to use the non parametric test for Household Consumption Expenditure data, and Parametric test for log transformation Household Consumption data to test the mean differences between means.

4.3 Estimated HCE total, Mean and Median by Province and Estimated HCE Mean and percentage by Component

Table 4.3 Shows the estimated total consumption expenditure, mean and median by province and at national level. The survey shows that the HCE was estimated up to 1,952,083,965,204 FRW, with mean of 868,498 FRW and median of 485,603FRW. Kigali city shows the highest estimated total HCE, mean, standard error and median.

Table 4. 3 Level of household consumption expenditure by province in Rwandan

PROVINCE	Total	Mean	SE	CV	Median
Kigali City	553,845,419,933	2,487,489	99,662	1.47	1,238,955
Southern	308,498,106,448	563,144	12,617	1.39	396,293
Western	358,473,906,108	681,032	18,088	1.54	438,672
Northern	303,041,479,962	738,559	23,638	1.57	444,457
Eastern	428,225,052,754	791,820	16,684	1.22	554,900
Rwanda	**1,952,083,965,204**	**868,629**	**13,214**	**1.82**	**485,603**

Figure 4.7 shows the mean of the HCE by component. Food is the component with the highest mean, the second is Non Food, third is the Housing, fourth is the Education, fifth is Health and the last is the alcohol component.

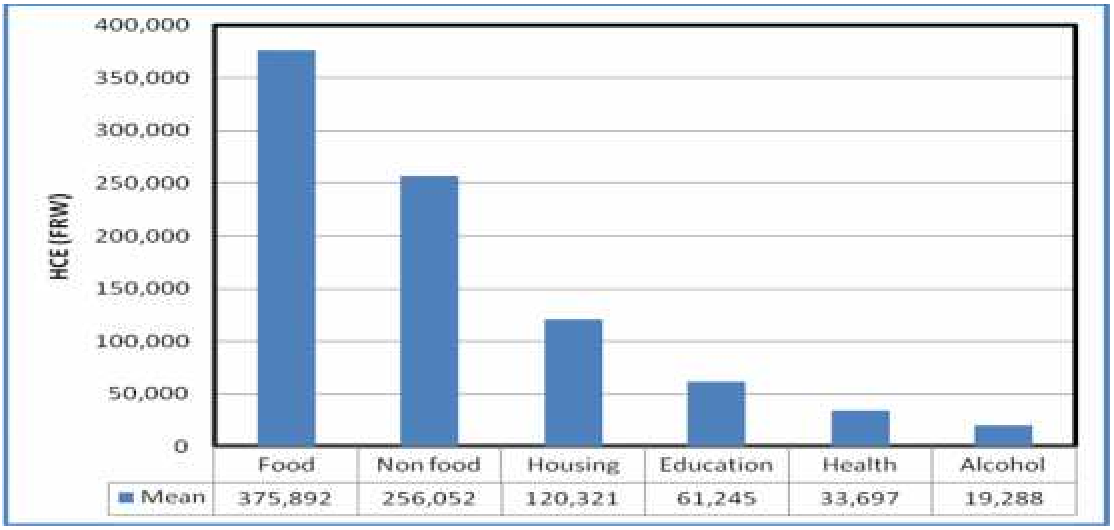

Figure 4.7 Mean Household Consumption Expenditure data by component

Figure 4.8 shows the percentage of household consumption expenditure by component, and it was found that household spent their money at 43% in food, 30% in non food, 14% in housing, 7% in education, 4% health and 2% in alcohol.

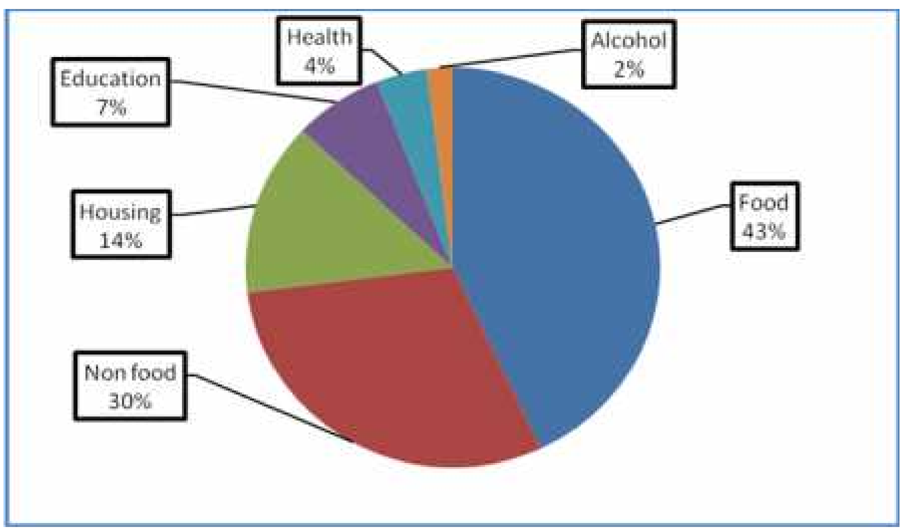

Figure 4.8 Percentage of Household Consumption Expenditure data by component

4.4 Test of the mean differences between HCE components

4.4.1 Kruskal-wallis test

As the household consumption expenditure data is not normally distributed, a non- parametric test called kruskal-wallis test was used to test the mean differences at confidence level of 95%. Running the test using STATA software, we found that the p value for this test is 0.0001. Since the p value is less than 5%, we reject the null hypothesis and we accept the alternative hypothesis. There is a significance difference between means of HCE components. If we divide the Chi-Square by N-1 we found the variation between components with value of 0.6. This shows that there is 60% of variability between means of HCE components. If that ratio is greater than 20%, it means that the variability between means HCE are significant. The chi square calculated is also greater than chi square table with n-1 d.f $\chi^2_{\text{Calculated}}(51616.2) > \chi^2_{\text{table}}(2.01)$ this also allow us to reject the null hypothesis "The difference mean of HCE is not statistically significant" and to accept the alternative hypothesis "The difference mean of HCE is statistically significant at significance level of 0.05.

Table 4.4 Kruskal-wallis test

Kruskal-Wallis equality-of-populations rank test		
component	Obs	Rank Sum
Housing	14308	6.98e+08
Education	14308	3.85e+08
Health	14308	4.11e+08
Food	14308	1.01e+09
Alcohol	14308	2.78e+08
Non Food	14308	9.01e+08
chi-squared = 51616.174 with 5 d.f.		
probability = 0.0001		
chi-squared with ties = 51942.015 with 5 d.f.		
probability = 0.0001		

4.4.2 Analysis of variance test (ANOVA)

The ANOVA is a parametric test used to test if the mean differences between more than two samples are statistically significant. As the researcher clearly showed earlier the household consumption expenditure are not normally distributed and the ANOVA is used only for approximately normally distributed data, that is the reason why the HCE was adjusted using the log transformation to normalize the HCE data.

Figure 4.9 shows that, housing, education and health household consumption expenditure are not approximately normally distributed as well as the box are not approximately symmetric due to the fact that there is no fixed price for renting house, education fees and health expenditure, but other household consumption expenditure like food, alcohol and non-food are approximately normally distributed due to harmonization of price approximately the same in the whole country.

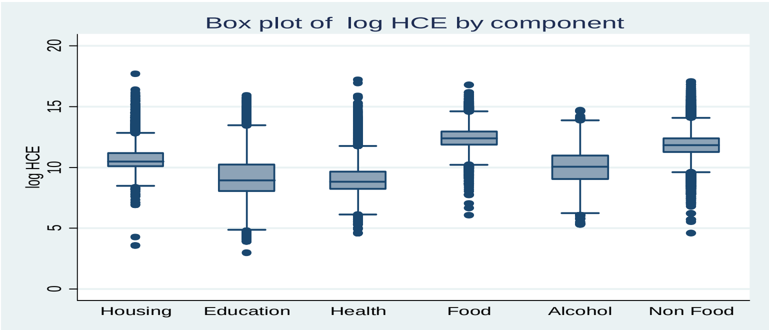

Figure 4.9 Box plot of log Household Consumption Expenditure by Component

Figure 4.10 of histogram indicates again that housing, education and health household consumption expenditure are not normally approximately distributed but on the other side other household consumption expenditure namely food, alcohol and non-food are approximately normally distributed.

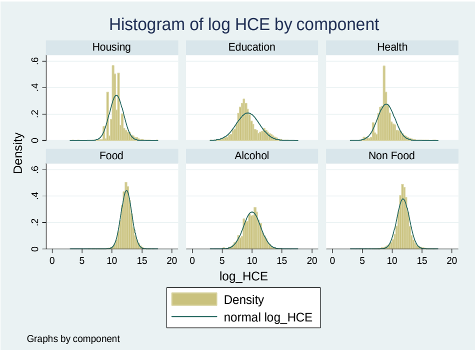

Figure 4.10 Histogram of log Household Consumption Expenditure data by Component

The analysis of ANOVA (Table 4.5) shows that there is a statistical difference between mean of log HCE components since the p-value (prob>F) is less than 0.05 and $F_{Calculated}(13861.18) > F_{Table\ \alpha=0.05}(2.21)$ this means that the mean differences between components are statistical significant at α level of 5% and degree of freedom of 5.

Table 4.5 Analysis of variance for log Household Consumption Expenditure data

Analysis of Variance					
Source	SS	df	MS	F	Prob > F
Between groups	117446.44	5	23489.288	13861.18	0.0000
Within groups	118688.797	70039	1.69461011		
Total	236135.237	70044	3.37124147		
Bartlett's test for equal variances: chi2(5) = 8.6e+03 Prob>chi2 = 0.000					

4.5 Test of differences in HCE mean between U/R households

4.5.1 Mann-Whitney test

The test of normality has shown that the HCE data was not normally distributed that's why we used the non parametric test to test whether the mean HCE between U/R household are the same. The non-parametric test appropriate is Mann-Whitney test

Table4.6 Estimated total, mean and proportion of HCE by component and by urban and rural status

HCE Components	Urban			Rural			Proportion	
	Sum	Mean	SE	Sum	Mean	SE	Urban	Rural
Housing	144,545,523,042	487,322	1,772	126,519,247,909	61,723	100	0.07	0.06
Education	70,290,373,647	238,900	1,093	67,685,270,939	31,853	100	0.04	0.03
Health	31,842,948,945	103,836	872	44,070,691,122	21,893	216	0.02	0.02
Food	240,406,070,922	756,000	1,368	606,419,230,076	310,061	282	0.12	0.31
Alcohol	11,175,340,511	33,954	190	32,276,625,266	16,698	45	0.01	0.02
Non Food	190,795,686,378	630,258	2,209	386,049,646,998	193,935	285	0.10	0.20
Rwanda	689,055,943,444	967,49		1,263,020,712,311	647,76		0.35	0.65

The mann-whitney test is the test used to test the differences mean between two independent samples. This test was used to test whether the mean differences household consumption expenditure between U/R households are statistically significant. The output (table 4.6) of the mann-whitney test shows that the two means of household consumption expenditure are statistical different as well as their p-value is less than 5%. The test shows that the $Z_{Calculated}(36.668) > Z_{table}, \alpha = 0.05(1.645)$ this value also confirm the mean differences HCE between U/R households are statistically significant.

Table 4.7 Mann-Whitney test

Two-sample Wilcoxon rank-sum (Mann-Whitney) test			
Status	obs	rank sum	expected
Urban	2149	21847475	15375021
Rural	12159	80519112	86991566
combined	14308	1.024e+08	1.024e+08
unadjusted variance 3.116e+10			
adjustment for ties -5.9993591			
adjusted variance 3.116e+10			
Ho: HCE(Status==Urban) = HCE(Status==Rural)			
z = 36.668			
Prob > z = 0.0000			

4.5.2 Student t-test

The student t test is the test used to test the differences mean between two independent samples that are approximately normally distributed. To use this test the HCE was first of all adjusted using log transformation to normalize the data and histogram and box plots shows that the log HCE are approximately normal distributed and this allows us to use the student t test for testing the differences mean HCE between Urban and rural households.

The box plot (Figure 4.11) of log HCE by Status reveals the outliers above quintile (Q_{3}) and below quintile (Q_1) for rural status and outliers are above only for urban status. Those outliers are due to the fact that some household spent much money for outliers above Q3 and for outliers below Q1 is due to household spent less; In general the box plot for log HCE by urban and rural are approximately normally distributed.

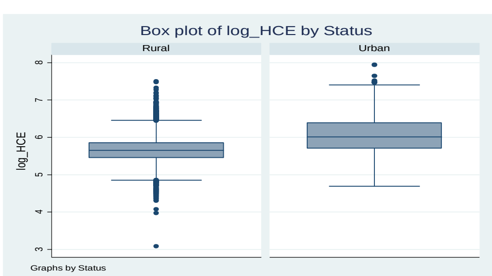

Figure 4.11 Box plot of log Household Consumption Expenditure data by status

Figure 4.12 show that the histogram of log HCE has a shape as a normal curve which means that the log HCE is approximately normally distributed. This allow as to use the parametric test to test whether the differences means between mean urban HCE and mean rural HCE are statistically significant at a given level of significance.

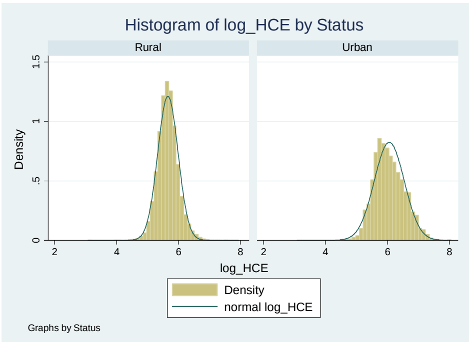

Figure 4.12 Histogram of log Household Consumption Expenditure by status

Table 4.7 show that t calculated is greater than t table; the difference mean between U/R area is statistically significant as well as the absolute $\left|t_{calculated}(-47.6802)\right| > t_{\sim/2, ddf} = 14306(1.645)$.

The p-value also shows that the two mean differences are statistically significant at confidence level of 95% as well since it is less than 5%.

Table 4.8 Two-sample t test with equal variances

Two-sample t test with equal variances						
Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]	
Rural	12159	5.661434	.0029872	.329388	5.655578	5.667289
Urban	2149	6.059769	.0104529	.4845677	6.039271	6.080268
combined	14308	5.721262	.003213	.3843257	5.714964	5.72756
diff		-.3983359	.0083543			-0.7966718
diff = mean(Rural) - mean(Urban)					t = -47.6802	
Ho: diff = 0		degrees of freedom			= 14306	
Ha: diff < 0	Ha: diff != 0				Ha: diff > 0	
Pr(T < t) = 0.0000	Pr(T > t) = 0.0000				Pr(T > t) = 1.0000	

4.7 Test of the mean difference between household headed by male and female

4.7.1 Mann-Whitney test

The tables 4.8 indicate that the mean HCE for household headed by male are 967,496 FRW and for those household headed by female is 647,761 FRW. The table 4.8 also shows that the household headed by male consume 79.5% of the total household consumption expenditure while the household headed by female consume 20.5% of the total household consumption expenditure.

Table 4.9 Estimated total, mean and percentage of HCE by sex of head of household

Sex of HH	Mean HCE	SE of HCE	Percentage of HCE
Male	967,494	16,740	79.5
Female	647,761	18,742	20.5

As shown previously the HCE data are not normally distributed and we have to use the non parametric test to test whether the mean household consumption expenditure between household headed by male and household headed by female are equal. The non parametric test appropriate to this test is Mann-Whitney test. The two-sample wilcoxon rank-sum test is the test used to test the difference mean between two independent samples. This test was used to test whether the difference means household consumption expenditure between households headed by male and households headed by female are statistically different. The output of the two-sample wilcoxon rank-sum test shows that the difference in mean household consumption expenditure between household headed by male and household headed by female are statistically significant as well as their p-value is less than 5%. This means that the households headed by male spend more than households headed by female. The test show that the $Z_{Calculated}(23.248) > Z_{table}\ \alpha = 0.05(1.645)$ this value also confirm the differences in mean HCE between household headed by male and female are statistically significant.

Running the mann-whitney test in STATA Software gives the output in table 4.9

Table 4.10 Two-sample Wilcoxon rank-sum test

Two-sample Wilcoxon rank-sum (Mann-Whitney) test			
Gender	obs	rank sum	expected
Male	10330	79052073	73905985
Female	3978	23314513	28460601
combined	14308	1.024e+08	1.024e+08
unadjusted variance		4.900e+10	
adjustment for ties		-9.4348602	
adjusted variance		4.900e+10	
Ho: HCE(Gender==Male) = HCE(Gender==Female)			
z = 23.248			
Prob > z = 0.0000			

4.7.2 Student t test

The student t test is the test used to test the differences mean between two independent samples approximate normal distributed. To use this test, the HCE was first of all transformed using log transformation to normalize the data and histogram, box plots shows that the log HCE are approximately normally distributed and this allows us to use the student t test for testing the differences mean HCE between household headed by male and household headed by female.

Figure 4.13 show that the box plot of the log HCE by sex of HH shows that the quintile (Q1) and quintile (Q3) are approximately normally distributed, but some outliers are still visible because the HCE is not perfectly normal distributed.

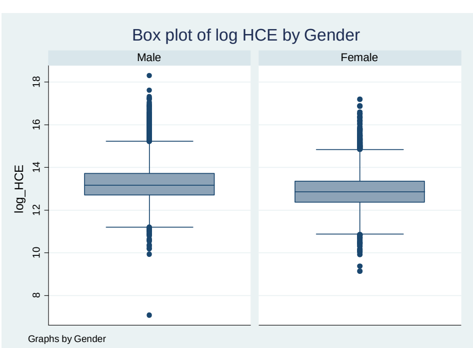

Figure 4.13 Box plot of log Household Consumption Expenditure by household head sex

The shape of histogram for log HCE by sex of HH has approximately a shape of normal curve. This gives us the basis to confirm that the log HCE is approximately normally distributed therefore we are allowed to use the parametric test for testing the equality of two mean between household headed by male and female.

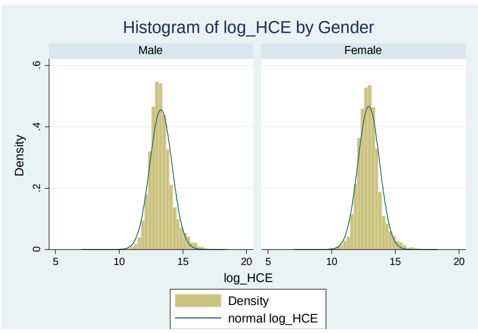

Figure4.14 Box plot of log Household Consumption Expenditure by household head sex

The table 4.10 shows that the mean differences is statistically significant as well as the p value is less than 5% and the $t_{calculated}(22.46) > t_{\alpha = 0.05 \;\; ddf = 14306}(1.96)$ .This means that the household headed by male spent much money than household headed by female.

Table 4.11 Two-sample t test with equal variances

Two-sample t test with equal variances					
Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf. Interval]
Male	10330	13.27511	.0086122	.8753138	13.25822 13.29199
Female	3978	12.91034	.0135582	.855135	12.88376 12.93692
combined	14308	13.17369	.0073982	.8849426	13.15919 13.18819
diff		.3647643	.0162294		.3329526 .396576
diff = mean(Male) - mean(Female)					t = 22.4756
Ho: diff = 0		degrees of freedom			= 14306
Ha: diff < 0		Ha: diff != 0			Ha: diff > 0
Pr(T < t) = 1.0000		Pr(T > t) = 0.0000			Pr(T > t) = 0.0000

4.8 Test of mean differences between AE household size and HC size

Table 4.11 shows that the mean household adult equivalent size is 4.3 and the mean household composition size is 4.8. Statistical test was used to test whether the differences of those two means are statistically significant.

As discussed previously that, there are many methods used for adjusting the adult equivalent, in this research we used the adult equivalent scale related for age group and for gender.

Table 4.12 Mean adult equivalent size and mean household composition size

Variable	Obs	Mean	SE
Adult equivalent HH size	14308	4.309	0.017
HH composition size	14308	4.780	0.018

4.8.1 Distribution of Adult Equivalent household size data

The histogram, Q-Q plot and Box plot shows that the Adult Equivalent household size is approximately normally distributed. The histogram has a normal curve and is positively skewed, the Q-Q plot the dots most of them are on the line and the Box plot are approximately symmetric. We can conclude by saying that the Adult equivalent household size is approximately normally distributed.

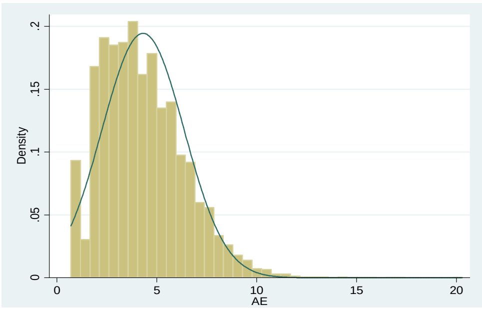

Figure4.15 Histogram of Adult Equivalent household size data

Figure 4.15 show that the adult equivalent household size has a shape as a normal curve. This allows as concluding that the adult equivalent size data are approximately normally distributed. As the data of Adult equivalent household size are approximately normally distributed the parametric test will be used to test if the differences means between adult equivalent household size and household composition size are statistically significant at a given level of significance.

The figure 4.16 show that the dots lie approximately on the line which means that the adult equivalent household size data are approximately normally distributed which allows us to use the parametric test for testing the differences means between AE household size data and household composition size.

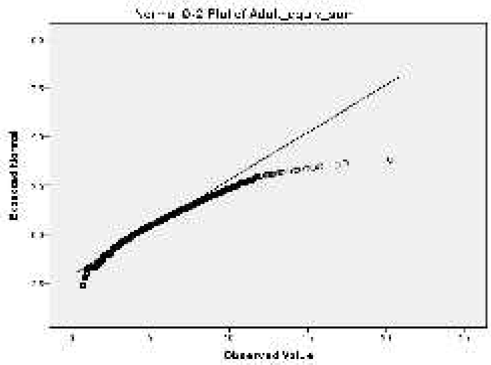

Figure 4.16 Q-Q plots of Equivalent household size data

Figure 4.17 shows that the box plot is approximately symmetric, which means that the adult equivalent size data are approximately normally distributed. This allows us to use the parametric test to test if the differences means between adult equivalent household size and household composition size if are statistically significant at a given level of significance.

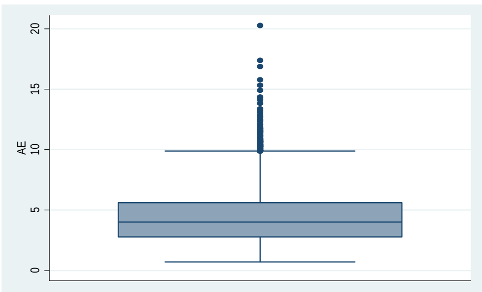

Figure 4.17 Box plots of Equivalent household size data

4.8.2 Distribution of Household composition size data

Figure 4.18 show that the histogram of household composition size has a shape as a normal curve. This allows as concluding that the adult equivalent size data are approximately normally distributed. As the data of Adult equivalent household size are approximately normally distributed the parametric test will be used to test if the differences means between adult equivalent household size and household composition size are statistically significant at a given level of significance.

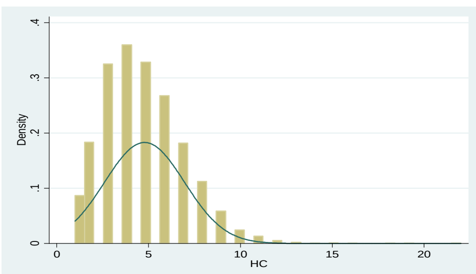

Figure 4.18 Histogram of household composition size data

The figure 4.19 shows that the Q-Q plots of household composition size data the dots lie approximately on the line, which means that household composition size data are approximately normally distributed which allows us to use the parametric test for testing the differences means between AE household size data and household composition size.

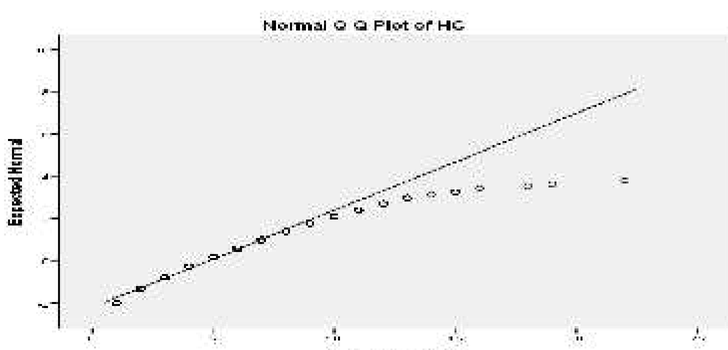

Figure 4.19 Q-Q plots of household composition size data

Figure 4.20 shows that the box plot is approximately symmetric, which means that the household Composition size data are approximately normally distributed. This allows us to use the parametric test to test if the differences means between adult equivalent household size and household composition size if are statistically significant at a given level of significance.

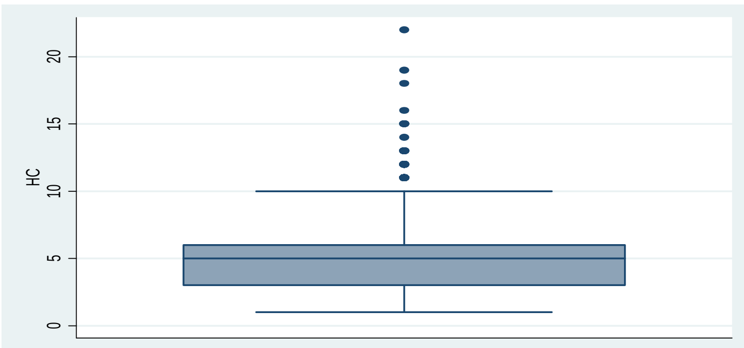

Figure 4.20 Box plots of household Composition size data

4.8.3 Wilcoxon signed rank test

This test is used for testing the mean differences for paired samples for non parametric test. Running the test of wilcoxon signed rank test, it gives the output where the wilcoxon signed rank test show that the differences mean between AE and HC size is statistically significant at significance level of 0.05 as well as Z calculated is greater than z table.

Table 4.13 Wilcoxon signed rank test

Wilcoxon signed-rank test			
sign	Obs	Sum ranks	expected
positive	12786	1.01E+08	51043978
negative	776	1439958.5	51043978
zero	746	278631	278631
all	14308	1.02E+08	1.02E+08
unadjusted variance 2.441e+11			
adjustment for ties -10966730			
adjustment for zeros -34666340			
adjusted variance 2.441e+11			
Ho: HC = AE			
z = 100.405			
Prob > z = 0.0000			

4.8.4 Student t test for paired sample

Running the test of t test paired sample test, it gives the output where the t test paired sample test shows that the mean difference between AE and HC size is statistically significant as well as the zero difference does not lie in the interval of 95%, $t_{calculated}(153.45) > t_{table}$, α=0.05(1.96) and their p value also is less than 5%.

Table 4.14 Student t test for paired sample

Paired t test		
Variable Obs Mean	Std. Err. Std. Dev.	[95% Conf. Interval]
HC 14308 4.780403	.0182171 2.179061	4.744695 4.816111
AE 14308 4.309808	.0171541 2.051908	4.276184 4.343433
diff 14308 .4705941	.0030667 .3668324	.4645828 .4766053
mean(diff) = mean(HC - AE)		t = 153.4505
Ho: mean(diff) = 0	degrees of freedom	14307
Ha: mean(diff) < 0 Ha:	mean(diff) != 0	Ha: mean(diff) > 0
Pr(T < t) = 1.0000 Pr(T > t) = 0.0000	Pr(T > t) = 0.0000	

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The research has shown that, the household consumption expenditure data is not normally distributed and the non parametric analysis is better statistical methods to use for deep analysis of HCE which doesn't take any consideration of the distribution of the data during the analysis.

The research shows that, the annual estimated level of household consumption expenditure in Rwanda for six components (Food, Non Food, Education, Health, Housing and Alcohol) is 1,952,083,965,204FRW and the annual mean household consumption expenditure is 866,498 FRW.

The differences in mean Household annual consumption expenditure between household consumption expenditure components are statistically significant and households spent their money mostly on food with 43%, followed by non-food with 30%, Housing with 14%, Education with 7%, Health with 4% and the last is alcohol with 2%.

The research shows that, 65% of the Annual estimated total household consumption expenditure is consumed by rural households and 35% by urban households. Regarding the annual estimated mean household consumption expenditure, it was found that the urban households consume more than rural households with respectively estimated annual mean of 2,080,416 FRW and 657,261 FRW and it was proven that the two mean difference is statistical significant at confidence level of 95%.

The research found out that, the household headed by males spend much more (79.5%) than household headed by females (20.5%) with respectively annual estimated mean of 967,494 FRW and 647,761 FRW and the two mean difference was found statistically significant at significance level of 0.05. The research found that the mean of Adult Equivalent household size is 4.3 and mean household composition size is 4.8. The test of hypothesis confirmed that the two mean difference is statistically significant at 95% of significance level.

5.2 Recommendations and Suggestions

As it was statistically proven that, the data for household consumption expenditure are not approximately normally distributed any statistical analysis should take into consideration the following points:

1. To check the outliers and missing data carefully before any statistical analysis , and where found the imputation must be done.
2. The mean household consumption expenditure must be used carefully since the data are not normally distributed and therefore instead of using the mean it is imperative to replace it by the median.
3. The mean adult equivalent household size must be used when dealing with the household consumption expenditure and mean household composition size must be used when dealing with counting people in the house.
4. The government of Rwanda must invest in production of food as well as most of household consumption expenditure is food item.
5. As there is no methodology related to Rwanda for household consumption expenditure, we encourage people to continue working on it and to improve the methodology of collecting data for household consumption expenditure.
6. As the dataset is too large, the variable specific to household consumption expenditure must be separate with other variables to facilitate the users to find easily the data related to household consumption expenditure in the datasets.
7. We recommend the inclusion of the depreciation rate of durables goods in the EICV datasets.

REFERENCES

Bailey, A. D. 1981. *Statistical Auditing*. New York: Harcourt Brace Jovanovich.

Bailey, N. T. J. 1951. "On Estimating the Size of Mobile Populations from Recaptive Data."*Biometrika*, 38: 292–306.

Paul Newbold, William l.Carlson and Betty Thorne, *Statistics for Business and Economics*, Books, sixth Edition

Bergsten, J. W. 1979. "Some Methodological Results from Four Statewide Telephone Surveys Using Random Digit Dialing." *American Statistical Association Proceedings of the Section on Survey Research Methods*, pp. 239–243. Alexandria, VA: American Statistical Association.

Agresti, A. and Coull, B. A. (1998). *Approximate is better than "exact" for interval estimation of binomial proportions*", The American Statistician, 52(2), 119-126.

Aguiar Mark and Hurst Erik (2004) *consumption vs. expenditure* , National Bureau of Economic Research

Orazio Attanasio, Erik Hurst & Luigi Pistaferri (2012),*The evolution of Income, Consumption, and Leisure Inequality in the US*, 1980-2010, National Bureau of Economic research

ABS (2009-10), *Household Expenditure Survey and Survey of Income and Housing*, User Guide. Autralia.

Berenson M.L. and Levine D.M. (1996) *Basic Business Statistics,*Prentice-Hall, Englewood Cliffs,New Jersey.

Bhattacharyya, G.K., and R.A. Johnson, (1997). *Statistical Concepts and Methods*, John wiley and Sons, New York

Booth, J. G., Butler, R. W., and Hall, P. 1994. "Bootstrap Methods for Finite Populations."*Journal of the American Statistical Association* 89(428): 1282–1289.

Bradburn, N. N., Rips, L. J., and Shevell, S. K. 1987. "Answering Autobiographical Questions:The Impact of Memory and Inference on Surveys." *Science*, 8 (April 10): 157–161.

Bryson, M. C. 1976. "The Literary Digest Poll: Making of a Statistical Myth." *American Statistician,*30(4): 184–185.

Campbell, C., and Joiner, B. 1973. "How to Get the Answer without Being Sure You Asked the Question." *American Statistician,* 27: 229–231.

Chapman, D. G. 1952. "Inverse, Multiple and Sequential Sample Censuses." *Biometrics,* 8:286–306.

Cochran, W. G. 1950. “Estimation of Bacterial Densities by Means of the ‘Most ProbableNumber.’ ” *Biometrics,* 6: 105.

Cochran, W. G. 1977. *Sampling Techniques,* 3rd ed. New York: Wiley.

Crossen, C. 1994. *Tainted Truth: The Manipulation of Fact in America*. New York: Simon & Schuster.

Deming, W. E. 1960. *Sample Design in Business Research*. New York: Wiley.

Efron, B., and Tibshirani, R. J. 1993. *An Introduction to the Bootstrap*. London: Chapman andHall.

Frankel, L. R. 1976. “Statisticians and People—The Statistician’s Responsibility.” *Journal of the American Statistical Association,* 7: 9–16.

Gallup, George. 1972. *The Sophisticated Poll Watcher’s Guide*. Princeton, NJ: Princeton Opinion Press.

Greenberg, B. G., Kuebler, R. R., Abernathy, J. R., and Horvitz, D. G. 1971. “Application of Randomized Response Technique in Obtaining Quantitative Data.” *Journal of the American Statistical Association, 66: 245–250.*

Richard L. Scheaffer, William Mendenhall III, R. Lyman Ott and Kenneth Gerow .1996. *Elementary survey sampling,*Seven Edition

Pearson, A. V., and Hartley, H. O. (1972). *Biometrica Tables for Statisticians, Vol2*, Cambridge, England, Cambridge University Press.

Neave, H.R. (1976b) ‘Non-parametric testing – why and how’, Bulletin in Applied Statistics, 3(2): 49–58.

ABS. 2000. *Household expenditure survey: User guide 1998-99*. Canberra, Australian Bureau of Statistics.

1995. *A provisional framework for household income, consumption, saving and wealth*. Canberra, Australian Bureau of Statistics.

Astin, J. 1999. “The European Union Harmonized Indices of Consumer Prices (HICP)”,Proceedings of the Ottawa Group Fifth Meeting, Gudnason, R., and Gylfadottir, T.(eds.), held at Statistics Iceland, Reykjavik, Iceland, 25-27 Aug. Text available at http://www.statcan.ca/secure/english/ottawa_group/, also published in *Statistical Journal of the United Nations* ECE 16 (1999), pp. 123-135.

Atkinson, A.B.; Stiglitz, J.E. 1980. *Lectures in public economics* (Singapore, McGraw-Hill, international edition).

BLS. 2001. Consumer expenditure survey home page (http://stats.bls.gov/csxhome.htm).Washington, DC, Bureau of Labor Statistics.

Canberra Group. 2001. *Expert group on household income statistics: Final report and recommendations* (Ottawa).

Demery, L.; Dubois, J.-L.; Grootaert, C.; Marchant, T. 1992. "Annotated questionnaire:Section 9. Household expenditures", in G. Delaine et al. (eds.): *The social dimensions of adjustment integrated survey* (Washington, DC, World Bank, Working Paper No. 4).

Dougherty, A.; Van Order, R. "Inflation, housing costs and the consumer price index", in *American Economic Review*, Vol. 72, No. 1, Mar. 1982, pp. 154-164.

EU-HBS. 1997. *Household budget surveys in the EU: Methodology and recommendations for harmonization* (EUROSTAT, Luxembourg).

EU-SILC. 2002. *Income measurement manual*, Draft Manual (Report, Lot 2), Working Group on Statistics on Income, Poverty and Social Exclusion, http://forum.europa. eu.int/Members/irc/dsis/soipase/home (EUROSTAT, Luxembourg).

ICLS-R-2003-06-0049-1-EN.Doc/v1 77

Franz, A.; Ramprakash, D.; Walton, J. 1998. *Statistics on the distribution of income, consumption and accumulation of households* (DICAH), Report to EUROSTAT.

Garner, T.I.; Short, K.S. 2002. "A new 'official poverty measure' for the United States? Experimental measurement and analysis", paper presented at the 27th General Conference of the International Association for Research in Income and Wealth, Djurhamn, Sweden, 18-24 Aug. http://www.iariw.org .

Gibson, J.; Huang, J.; Rozelle, S. 2003. "Improving estimates of inequality and poverty from urban China's household income and expenditure survey," in *Review of Income and Wealth*, Series 49, No. 1, pp. 53-68.

Gillingham, R. "Measuring the cost of shelter for homeowners: Theoretical and empirical considerations," in *Review of Economics and Statistics*, Vol. 65, No. 2, May 1983, pp. 254-265.

ILO. 2001a. Household income and expenditure statistics, Report I, Meeting of Experts on Labour Statistics, Geneva. 2001b. Report of the Meeting of Experts on Labour Statistics, Geneva. 2000. *Current international recommendations on labour statistics* (second edition, Geneva).

1995. *Household income and expenditure statistics*, No. 4 (Geneva).

78 ICLS-R-2003-06-0049-1-EN.Doc/v1

INSEE. 1999. *La consommation des ménages en 1999* (Paris).

Deaton, A and S. Zaidi (2002), *Guidelines for Constructing Consumption Aggregates for Welfare Analysis*, World Bank: Washington D.C.

Andy , M and Geoffrey G (2007), *Methods Used for Poverty Analysis in Rwanda,* Oxford Policy Management