Empirical Modelling and Model Selection: An Application of Encompassing Principle on Consumption Function of Pakistan

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“Oh Allah, honor me by the light of understanding and take me out from the darkness of doubt and open upon us the doors of your knowledge and open upon us the treasure of your recognition, oh the best of the Merciful ones. Oh Allah, and give me Tawfeeq to study and solving all the difficult problems by your mercy, oh the best of the merciful ones.”

DEDICATION

This humble effort is dedicated to

"My Family for Their Loving Wishes, Support Patience, Understanding and Guidance and All Those Who Seek Knowledge to Reach At Truth"

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Empirical Modeling and model Selection; An application of Encompassing Principle on Consumption function of Pakistan"** submitted by Mr. Shah Abbas is accepted in its present form by the Department of Econometrics and Statistics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in **Master of Philosophy in Econometrics**.

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Abstract

The area of model specification and selection of variables is quite vast in its nature and scope. Several estimation techniques and approaches are designed to select the appropriate model. Its involve comparing competing model by defined goodness of fit or selection criteria. The most commonly used information criteria are Akaike (1973, 1974) information criteria (AIC) and Bayesian Schwarz (1978) information criteria (BIC). The model best-fit criteria are R^2, adjusted R^2 and student t-statistic. Another important development is the use of encompassing principle in testing non-nested models assuming that one of them is correctly specified. The estimation procedures and approaches are simple to general, general to simple, stepwise regression, forward and backward procedure.

The main objective of this study is to select an appropriate consumption model for Pakistan from the set of candidate models. Quarterly time series data is used to estimate different consumption models for the period 1972-2015. Absolute income hypothesis, permanent income hypothesis, and random walk model is estimated by using the traditional econometric methodology. The results are found to be the misleading and improper choice of the specification as several models miss-specifications problems such as autocorrelation, conditional Heteroskedasticity in residuals and omitted variable problem. In order to improve empirical results, Hendry's general to specific modelling strategy is adopted to select the appropriate model. To develop a general model of consumption several variables are identified from the literature and provide theoretical explanations how private consumption is affected by the change in GDP, remittance inflow, government consumption expenditure, indirect taxes, interest rate, financial wealth, prices and inflation rate. The general model is simplified gradually step down and arrived at a parsimonious model by testing sensible economic

restrictions. Each simplification steps are checked by diagnostic testing. The several consumption models are estimated and choose general model which encompass pervious estimated consumption models. The empirical results shows that GDP, remittances, price and inflation are positively related with private consumption in short run and long run. The current interest rate is positive and pervious interest rate is negatively related with private consumption. The government consumption expenditure and indirect taxes are negatively associated with private consumption. The empirical results suggest that private consumption is affect through different channels such as interest rate affect private consumption by saving channel and government expenditure effect the private investment through taxes. This study provide some policy insights to policy makers, Pakistan relies mostly on the foreign and domestic loans, it has adversely affect the private consumption as well as overall economic activities and this will lead to increase against the debt services. Therefore reliance on foreign financing should be avoid and generate the domestic resources. The political instability, law and order condition and transparency should be improve which can attract the foreign investors. The state bank of Pakistan should conduct monetary policy efficiently and effectively with regard to its basic object of stabilizing prices under the fiscal control.

Key Words: General to Specific Model, Error Correction Model, Encompassing

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

AIC	Akaike Information Criteria
AIH	Absolute Income Hypothesis
APC	Average Propensity to Consume
AR	Autoregressive
ARCH	Autoregressive Conditional Heteroskedasticity
ARMA	Autoregressive Moving Average
BS	Backward Selection Procedure
CV	Cross Validation
DGP	Data Generating Process
ECM	Error Correction Model
FPE	Final Predication Error
FS	Forward Selection Procedure
G2S	General to Specific
GUM	General Unrestricted Model
LCH	Life Cycle Income Hypothesis
LCPH	Life Cycle Permanent Income Hypothesis
LDGP	Local Data Generating Process
LSE	Landon School of Economics
MPC	Marginal Propensity to Consume
OLS	Ordinary Least Square
PIH	Permanent Income Hypothesis
REH	Rational Expectation Hypothesis
RESET	Regression Specification Error Test
RSS	Residual Sum of Square
RW	Random Walk
S2G	Specific to General
SC	Schwarz Bayesian Information Criteria
SW	Stepwise Procedure

CHAPTER -1

INTRODUCTION

1.1 Motivation of Study

Model selection refers to the problem of choosing between alternative models, it has been always under discussion due to the uncertainty of functional form of the model, lag length and break points. Although these issues have been discussed frequently but still no conclusion about the best method of selection of variables and model. However, the area of model selection is quite vast in its nature and scope because of its importance in multiple disciplines. The economic theories provide evidences as to functional form to the economic relationship and guidance regarding the model specification. For example, Keynes (1936) argued that consumption depends on income. According to the life cycle hypothesis (1954) income change systematically over the phases of household life and household achieved smooth consumption through saving, and therefore consumption depend on current income and wealth of household. Similarly, Friedman (1957) argued that household consumption depends on the permanent income rather than on transitory income. When statistical tests are applied to different economic models by using the same data set, tests carried out the unclear specification about the model and variable selection. However, these issues are still under discussion.

The selection of an appropriate model depends on the functional form of the model, sample size, statistical inferences, size and power of statistical tests. One of the key issues in the model specification is a lot of explanatory variables are correlated with the dependent variable. It is not possible to include all the explanatory variables in a single model. Another key issue in the model selection process is searching cost and inferences, Leamer (1978) talk's six different types of specification searches that are undertaken in the model selection process. First, Hypothesis testing search for the

choosing a true model, second interpretive search, this step involve interpreting the simple evidence that may be correlated with the variable of interest. Third, simplification search, it includes the construction of the model, fourth proxy variable search, this step involves the choosing of the different variable set for the same hypothesis testing. Fifth data selection search, this step include the choice of appropriate data set for the estimation and prediction. Finally, in sixth step post data model construction, implement and improve an existing model.

Many authors proposed variety of methods and estimation techniques over the time in order to select the appropriate model. The majority of the procedures involved minimizing the loss information based on the least square and maximum likelihood. The most frequent used model selection criteria are Akaike information criterion (AIC), Bayesian information Criterion (BIC), cross-validation methods (CV) etc. These criteria are not sufficient to ensure the congruence of the model and it is also possible to select the miss-specified models (Bontemps and Mizon 2008). These criteria's are not enough to select the appropriate model because model should not be selected on the basis of model fit criteria (Hendry and Krolzig 2005).

The other statistical methods are shrinkage methods, stepwise regression, forward and backward selection method and extreme bound analysis used to select the model and popular in the statistical literature. These methods are not progressive in the sense of the knowledge accumulating about the model selection. The decision rules do not eliminate the insignificant variables (Tibshirani, 1996). Brek (1978) criticized on stepwise regression, forward and backward method, he argued that it does not have guaranteed to find the correct model and which represents the data generating process. On the other hand, there is a huge literature documented on the Bayesian model selection method. The Bayesian model selection method required the assumption of

prior probabilities for the individual models and the posterior probabilities are derived from the model and their parameters. It is evident that the Bayesian method select a mixture of models and it can create uncertainty (see for detailed Raftery and Volinsky 1999). Another aspect of Bayesian method is the extreme bound analysis developed by Leamer (1978, 1983 and 1985). He argued that inference is only robust if the specification assumption is enough to nest the data generating process. This approach has criticized by the Hendry and Mizon (1990) and Breush (1990). Hendry and Mizon (1990) argued that conventional criteria do not address the issues of model selection as a results most of the economic models are miss-specified in empirical studies.

However, the area of model specification and selection of variable got a great attention after the oil price shock in the early seventies. Most of the macroeconomic model are failed due to the specification errors and highly criticized. That provide new impute to the construction of model selection procedures and many different techniques and model selection criteria were revised and developed. Among these were the general to specific approach (1978), Akaike information criteria (1973), Schwarz information criteria (1978) and vector autoregressive approach (1983). The method that got more attention and progress in the recent year is general to specific modelling procedure. It is also known by the Hendry Methodology, Landon school of Economics methodology and PcGet. This approach is one of the emerging and powerful approach to model time series data. This methodology handles a variety of econometric problems and provides a systematic procedure to select parsimonious model.

According to the Hendry and Richard (1984) development of any econometric model required to understand economic mechanism where data is generated. The origin of empirical model is started from a data generating process. Statistically data generating process (DGP) is defined as a joint distribution of all sample data which may be

exogenous or endogenous (Gilbert, 1986). Formally, theory related to the DGP presented by Hendry and Richard (1982) is called the theory of reduction. The theory of reduction provides an explanation of the origin of econometric models by describing all steps involved with the actual data process in the economy (Hendry 2000b). The theory of reduction consists of several steps to obtain the econometric model from the data generating process. Every step involves econometric concepts, but not reduction, for example, data transformation and aggregation, functional form, the parameter of interest, lags truncation and parameter constancy. Furthermore, the theory of reduction contains two major ingredients, first is to construct model guarantee to no loss of information from the observed data and second is the theory of reduction shows the origin of the empirical model. The general to specific approach is an example of deriving a final econometric model from the general unrestricted model (GUM), which contain all available information, including present sample data, previous theoretical and empirical research (Hendry 1995a).

Hoover and Pervez (1999) introduced algorithm under the general to specific modelling framework that contained the idea of multiple search path which gave a new direction to general to specific modelling approach. Hendry and Krolzig (2001) developed the computerized version PcGets. They further refine the search algorithm to include pre-search simplification, multiple reduction paths based on deletion of blocks of variables as well as single variables, implementation of encompassing tests to distinguish between competing candidate congruent models that emerge from different search paths, and the use of an information criterion to make a final selection. This algorithm includes the different diagnostic tests, a measure of fit and searching paths. This algorithm includes the several diagnostic tests such as normality test of residuals and autocorrelated conditional Heteroskedasticity test and parameter stability test.

The main focus of this research is to follow general to the specific model selection procedure, which has a strong theoretical foundation in the theory of reduction. The automatic selections algorithms (PcGets) is used to the specification of the model and encompassing principle for the rival models. The PcGets testing strategy started from the general model by capturing the basic properties of data and testing downward by specifying reduction at each stage. Our empirical analysis is based on several data sets which are obtained from several recently published articles. The analysis will be processed in seven steps (i) choice of data series, (ii) method of seasonal adjustment, (iii) data transformation (iv) functional form, (v) lag structure, (vi) diagnostic tests and (vii) encompassing test on the rival model.

1.2 Objectives of Study

The main objective of this study is to select an appropriate consumption model for Pakistan from the set of candidate models. Quarterly time series data is used to estimate different consumption models for the period 1972-2015. The specific objectives are as follows.

- To investigate the determinates of consumption expenditures
- To investigate the behavior of consumption expenditure in Pakistan

1.3 Contribution/ Significance of Study

The main task of empirical modelling is to select the appropriate model for the policy formulation. The main contribution of this study is to provide a systematic procedure to select the appropriate model from the set of candidate models. In the case of Pakistan, several studies used the macroeconomic time series data and micro data to analyzing the consumption expenditure behavior. Most of the studies investigate determinates of consumption expenditure. Our study is different from the previous studies and this study has a significant contribution to literature in the following context.

- Several important variables are included in the model, such as remittance inflow, indirect taxes, financial wealth and interest rate.
- Several consumption models are estimated and encompass with other rival models.

1.4 Outline of Study

Chapter -2 is the survey of model selection methods, procedure, and criteria. We have briefly reviewed different approaches for example data mining approach, simple to general and general to the simple model selection procedure.

Chapter- 3 contains a survey of theoretical and empirical literature on consumption function. We have briefly reviewed both theoretical and empirical literature and divided into five different categories. The aims of empirical review are to highlight issues that required attention in the analysis of consumption function and summarize the main results found in worldwide studies and especially in Pakistan.

Chapter -4 contains data and methodology. This chapter includes the description of variables, model specification, and econometrics methodology. The methodology developed in this chapter followed to obtain the empirical results in chapter five.

Chapter- 5 is about modeling quarterly consumption function of Pakistan. In this chapter, we have analyzed the data and try to address the issues of model selection.

Finally, **chapter -6** summarize central points of study with some policy recommendations.

CHAPTER- 2

MODEL SELECTION METHODS AND ENCOMPASSING PRINCIPLE

2.1 Overview of Chapter

This chapter contains three sections, the first section is about the survey of literature on different model selection methods. In the second section discuss different conventional econometrics criteria, which are most frequently used to select the best fit model. The third section is about encompassing principle and its types and tests. Finally concluded chapter in section four. The main objective of this chapter is to understand theoretical insights of different approaches and criteria. This chapter can help to identify the issues of model selection, size and power of conventional econometric criteria.

2.2 Model Specification Methods

2.2.1 Data Mining

Data mining is a process that used a variety of data analysis tools for a discover pattern and relationship in data to make a valid prediction. The availability of computing power and algorithms to analyze data have been increasing use of data mining approach to model selection in empirical studies. The main reason to over increasing data mining is due to inefficient results of models, which are based on economic theory alone, which lead to developing inefficient policy and forecasting.

However, the data mining approach to model selection is much controversy in the literature of economics and evident that data mining distorted economic theory and statistical inferences resulting underestimation of coefficients and standard errors (see for detailed, Compos, Ericssion and Hendry 1999). The problem of data mining is also discussed by the Haavelmo (1944) and Leamer (1978). Lovell (1983) investigated certain consequences of data mining and paradigm of research, he argued that data

mining distorted conventional statistical tests and low success rate of selecting small model within the large data set. Furthermore, he demonstrated that standard errors of coefficients are an underestimate when using significance tests. Similarly, Gilbert (1986), Sargan (2001), Hendry (1995) argued that data mining procedure to model selection is not insurmountable.

Hoover and Perez (1999) extended the Lovell (1983) by using the US macroeconomic quarterly data. They generate a dependent variable for the several model specification and applied the general to specific modelling approach. The empirical results of the Hoover and Perez (1999) are a surprise and controversial because the t- statistic behaved well in a repeated sampling. However, data mining used in both positive and constructive sense, in which the empirical models are built to satisfy the economic and statistical criterion (Hendry 1995). The main reasons for the increasing attractiveness of the data mining approach are as follows:

- It overcomes the shortcomings of traditional methods that operate under the assumption that data are distributed normally (as is the case in linear regression) or according to another distribution in the exponential family, such as binomial, Poisson or Gamma (as is required for a generalized linear model). Classical linear methods are based on such assumptions, which can be incorrect and may be difficult to test.
- Less time consuming and more flexible in terms of selection of predictors than those carried out by classical methods. Classical methods applied to large data sets can take longer to develop models and have particular trouble selecting important interactions between predictors.

2.2.2 Simple to General

The simple to general modelling (S2G) method is another important model selection procedure used in applied econometrics to select the appropriate model, in which simple model is specified and subsequently tested against the data. Hendry and Krolzig (2001) identified the following drawbacks of simple to general model selection approach.

- S2G model strategy no clear stopping point to how many test will be conducted for the model specification.
- Multiple rejection tests may be possible if the model is assumed to the outside of the sample. If one or more tests reject it is unclear which has cause to reject, should both or one or other factor cause to reject the test.
- Alternative path search problem, it may possible to select the different path and it cannot postulate what path to be select.
- Miss specification problem, if the final model becomes miss specifying then there is no point to impose restrictions on the model.

The simple to general model is conventional modelling procedure, starting from the theoretical model with a wide range of auxiliary assumptions. In simple to general modelling when a model is poorly fit to data than relax auxiliary assumption by using the statistical tests for a more general model and patching the original theoretical model (Gilbert 1986).

2.2.3 General to Specific

The general to specific method is known by the different names such as Hendry methodology, London schools of economics (LSE) methodology and PcGets. The LSE School of econometrics proposed the empirical modelling methodology in order to be consistent with their view of econometrics. At the theoretical level, the theory of reduction explains how econometric models are intrinsically a kind of empirical model,

derived from the DGP. The theory of reduction provides the origin of the empirical model. The main objective of the theory of reduction is to study probability concept that is used in a simplification process of the empirical model (Hendry, 1995). In general to specific modelling data generating process (DGP) is replaced by the concept of local data generating process (LDGP). The LDGP is the joint distribution of the subset of variables under analysis (Hendry, 2000b).

At the practical level, the general-to-specific approach, which intends to mimic the theory of reduction, in which researchers obtain the final econometric model from a general unrestricted model. The paper Davison et al (1978) is considered as the pillar of general to specific modelling. The general to specific approach is a practical example of the theory of reduction which is related to the data generating process Hendry (1983). Initially general unrestricted model (GUM) is formulated on the basis of the theoretical and previous empirical background. The GUM is simplified gradually step down by testing the sensible economic restrictions for the parsimonious and congruent representation. Each simplification steps are checked by diagnostic testing. Different ways have been used for the simplification of the model in general to specific approach such as Hoover and Perez (1999) offer important evidence in a major Monte Carlo simulation by reconsidering the Lovell (1983) experiment. They simplify automatic model selection algorithm for G2S (PcGets) and their algorithm simplify that GUM is still congruent results. They checked different paths by testing the miss-specification tests. Furthermore, Hendry and Krolzig (1999b) improve the algorithm in several respects, including the pre-search reduction and additional path. In the pre-search method, firstly variables are tested whether significant or insignificant by the pre-assigned selection criteria such as p-values and t- values. The significant level is used, and insignificant variables are deleted permanently from the model. The automatic

model selection algorithm consist of different diagnostic tests. For example residuals Autoregressive test (AR 1-4), Autoregressive Conditional Heteroskedasticity (ARCH 1-5), Normality test, Chi-square test on the constancy of parameters and chow test on break point.

The general to a specific model is vulnerable in many contexts, suppose one can start to model and looking it to narrow down for the simplification that is acceptable on a data. One on the most influential and powerful example is Davidson et *al.*, (DHSY, 1978) model. Davidson et *al.*, (1978) studied the three existing models namely, Hendry (1974), Ball *et al*., (1975) and Wall *et al*., (1975) and constructed general model by combining all three existing models. The DHSY model provides an example of a process of building empirical models, and a clear distinction between theoretical models and empirical models. The general model is first built to encompass previous models, then reductions are processed to reach a parsimonious encompassing model. It also shows the essence of the progressive research strategy that does not regard previous theories the DHSY is successful, for its properties can be found in both the permanent income hypothesis and life-cycle income hypothesis. Furthermore, Hendry and Richard (1982) suggested that the satisfactory econometric model should contain the following criteria.

Data admissible: This is logical criteria, both model, and observed data must have interpretable.

Theory consistent: Economic literature contain huge alternative economic theories, therefore satisfactory model should be within the explicit theoretical framework and must be consistent with properties of observed data. The model should provide some additional explanation that previous model did not.

Weakly exogenous: Technically, regressor of the satisfactory model at least weakly exogenous. Suppose the following model

$$y_t = a + \beta x_t + u_t \dots\dots\dots\dots\dots (a) \qquad u_t \backsim NID(0, \sigma^2)$$

$$x_t = \delta + \gamma y_{t-1} + v_t \dots\dots\dots\dots (b) \qquad v_t \backsim NID(0, \sigma^2)$$

Where, $E(u_t, v_t) = 0$, this implies that x_t is weakly exogenous with β

Parameter constancy: The satisfactory model parameters must be variant with respect to time. This required that the parameter value applies inside and outside of the sample at the end of the sample period for the testing constancy of parameter. Hendry proposed Forecast Chi-square and Chow test to compare the performance of model between inside and outside of sample.

$$Forescat\ Chi^2 = \frac{\sum_{t=T+1}^{T^*} e_{ft}^2}{\sigma^2}$$

Where, σ^2 is error variance, $\Sigma {e^2}_{ft} = MSE_f.(T^* - T)$ and shows the forecast error. The null hypothesis of test is all the parameter values are unchanged between the sample and post sample period. The statistic is asymptotically distrusted as χ^2 with $T^* - T$ is degree of freedom.

$$Forescat\ Chi^2 = \frac{MSE_f.(T^* - T)}{\sigma^2}$$

A model specification test on the constancy of model parameters over the entire sample and post sample is formally calculated as following.

$$Chow\ Test = \frac{(RSS^* - RRS)/\ (T^* - T)}{RSS/(T - K)}$$

Where RSS^* shows residual sum of square from the estimated model using both sample and post sample data. The null hypothesis of test is same above the $Forescat\ Chi^2$ test. The chow test asymptotically follow the F -distribution with $(T^* - T)$ and $(T - K)$ degree of freedom.

Data Coherent: The model error should not predictable, no serial correlation between the residuals, they should not predictable from their past history.

2.3 Main Features of Hendry Methodology

1. Data Generating Process

The central aspects of the Hendry methodology is a theory of reduction which is related to the data generating process. The data generating process is unknown because the economic mechanism is complicated where rules, laws, the situation changed over the time and data are generated from an unknown high dimensional probability distribution, which indexed by the set of parameters Hendry (1983)**.**

2. Data Transformation and Specification of Parameter of Interest

The general unrestricted model itself can be tested using the different diagnostic tests in order to see whether the general model is enough to capture the silent feature of data or not. If the basic properties of time series data are not meet then we can transform data. Two data transformation methods are useful in previous literature, differences, and differential method and both are the appealings economically and it generates cointegration relationship.

3. Sequential Reduction and Diagnostic Tests

The insignificant variables are removed from the model and reduced sequentially by imposing sensible economic restrictions on the model. The diagnostic test are used to test the validity of model as well as restrictions. The diagnostic tests including, residuals autocorrelation (AR 1-4), autoregressive conditional Heteroskedasticity (1-5), functional form miss-specification test (RESET), and kurtosis and skewness (Normality test).

4. Model Replication and Evolution

Model replication and evolution of existing empirical model are the central aspects of Hendry methodology. First new empirical model encompass existing previous one. Second, extend miss-specification in existing model and suggests how to improve the results of existing previous model.

2.4 Application of Encompassing

There are a lot of explanatory variables which are correlated with the dependent variable, it is not possible to include all the related variables in a single model. Therefore need to build a small alternative model and make choice one from the alternative. The economic theory cannot guide us in this case. The alternative model is a choice on the basis of the statistical ground. In the previous literature, the concept of encompassing was used to select the alternative models. The encompassing principle is used to develop a testing framework which unifies the literature on non-nested testing, allowing analysis of the relationship between alternative models. The literature and testing of non-nested hypothesis started from the pioneering work of Cox (1961, 1962). The different test has been proposed for the non-nested linear regression model, non-linear regression models, and multivariate regression models. These models are estimated by the instrumental variables (Pesaran, (1974), Pesaran and Deaton (1978), Ericsson (1983) and Godfery (1983)). In addition, there has been a number of Monte Carlo studies of the small sample properties of alternative tests which have usually analyzed the power of the tests against local alternatives (Ericsson, (1983), Davidson and MacKinnon (198), and Pesaran (1982)). Partly to reduce the computational burden in using non-nested tests, Davidson and MacKinnon (1981) proposed alternative tests to those which had exploited directly Cox's generalized likelihood ratio test, which could be computed using standard regression packages.

Hence though the econometrics literature on testing non-nested hypotheses is vast, and is still growing (Sawyer, (1982) and Dastoor and Mc Aleer (1978)). In fact encompassing has already been applied in econometrics (Davidson et al. (1978), Davidson and Hendry (1981), Davis (1982), and Gregory and McAleer (1983)).

The role of encompassing principle extends beyond the computation of nested or non-nested test statistics Hendry and Richard (1982) discuss its critical role in the evaluation of a model as an adequate representation of the data. The encompassing principle emphasized on the choice of best model and it also explains the failure and success of rival models for the same data (Mizon and Richard, 1986). For example, model $\mathcal{M}_1$ encompass another model $\mathcal{M}_2$ if the $\mathcal{M}_1$ explain empirical results of $\mathcal{M}_2$. This implies that parameter of $\mathcal{M}_2$ are the function of $\mathcal{M}_1$.

Let's suppose we have following two non-nested linear models $\mathcal{M}_1$ and $\mathcal{M}_2$

$$\mathcal{M}_1: y_t = \alpha_1 z_{t-1} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (A)$$

$$\mathcal{M}_2: y_t = \alpha_1 x_t + \alpha_2 x_{t-1} + \epsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (B)$$

$$\epsilon \backsim IID(0, \sigma^2)$$

It is assumed that above models are correct which provide the complete description of the economy. If the model (A) explain results of the model (B) then it is called model (A) encompass model (B). The selected model satisfied all above criteria's than it is called congruent model. The goodness of fit criteria are not under consideration which are frequently used in applied econometric research including high R-square and Durbin-Watson statistic near to two. However, Hendry (1984) argued that goodness of fit are not explicit criteria for the selecting the good model as a representation of DGP. He emphasized that the criteria are implicitly embodied in the encompassing principle. More generally one model can encompass another model if the model has lower error variance.

2.4.1 Encompassing Test

The encompassing test can be done by using the various diagnostic tests as following.

- Cox Non-Nested Hypothesis Test
- Ericsson Instrumental Variable Test
- Sargan Restricted and Unrestricted Reduce form Test
- Joint Model F-test (*J- test*)

2.5 Model Selection Criteria

In conventional econometrics several criteria are used for the model selection, huge literature contained on model selection criteria, it is not possible to review all criteria, but important to highlight some important criteria which are frequently used in empirical studies. This section aims to discuss and highlight pros and cons of model selection criteria.

2.5.1 R^2, Adjusted R^2 and Residual Sum of Square (RSS)

The coefficient of determination (R^2) shows the overall goodness of fit of estimated regression model and is frequently used to select the best fit model. The high value shows good fit model and low value of R^2 shows the worse fit model.

$$R^2 = 1 - \frac{\sum \hat{\mu}_i^2}{\sum (y_i - \bar{y})^2}$$

The main drawback of R^2 is, due to inclusion of irrelevant independent variable increase R^2 value and also increase by decreasing the number of observations. To overcome this problem the adjusted R^2 is used which is written as following.

$$R_a^2 = \frac{1 - (n-1)\sum \hat{\mu}_i^2}{(n-q)\sum (y_i - \bar{y})^2}$$

Where n is the number of observations and q is number of variables, the value of R_a^2 is increased or decrease monotonically as q increase.

$$(R_a^2) \leq (R^2)$$

But

$$Var(R_a^2) \geq Var(R^2)^1$$

Furthermore, the residual sum of square is also used as a model selection criteria which is written as following

$$RSS = \sum (\hat{\mu}_i)^2$$

The low value of the residual sum of the square are considered to be a model is best, but it is not sufficient criteria to select the best fit model (see for detailed Srivastava A.K *et al.,* .1995). However, the use of either $R^2$and R_a^2 and RSS decision to choice best fit model is dangerous procedure, because if add new irrelevant variable to model than R^2 value become high (see for detailed Dhrymes 1970b, Theil, 1971, and Johnston, 1984). Therefore, R^2, R_a^2 and RSS criteria are not sufficient and satisfactory criteria for the selection of best fit model.

2.5.2 Student t-Statistic Criteria

The second most frequently used statistical criteria in empirical modelling is student t-criteria. The t-values are used to test the null hypothesis that the parameter is insignificant. According to this criteria, the model that contains most of the significant variables are as consider to be the best model.

$$t = \frac{\hat{\beta}}{se(\widehat{\beta})} \ldots\ldots\ldots\ldots\ldots\ldots (2.3)$$

The ratio of the estimated parameters values to its estimated standard errors to be test the null hypothesis that the parameter is equal to zero.

2.5.3 Akaike Information Criteria (AIC)

One of the most commonly use criteria in empirical studies to select the model is AIC. The idea behind AIC (Akaike 1973) is to select the model which has the minimum loss

[1] *See for the detailed explanation Srivastava A.K et al (1995)*

of information that is the smallest AIC. The aims of AIC is to find the best approximating model to the unknown true data generating process.

$$AIC = (-2.\ln L(\cdot) + 2\,k)/T \ldots . (2.4)$$

Where L shows the value of log likelihood function of the estimated model. k denote the number of parameters in the model.

2.5.4 Schwarz Bayesian Information Criteria (SC)

Schwarz Bayesian information criteria is also most frequently used criteria in empirical studies. BIC is derived within a Bayesian framework on the basis of Bayes factor for two competing models (Schwarz 1978). The BIC is different from the AIC, it also depends on the sample size.

$$SC = ln\hat{\sigma}^2 + \frac{k.lnT}{T} \ldots\ldots\ldots\ldots\ldots . . (2.5)$$

Where $\hat{\sigma}^2$ shows the unbiased estimate of the residuals variance.

2.5.5 Final Prediction Error (FPE)

The FPE test is based on actual values rather than estimated values of explanatory variables. FPE is lead to a select model with the smallest ex-post prediction errors for the entire samples, inclusive of the forecasting period.

$$FPE = \frac{T+k}{T-k}.\hat{\sigma}^2 \ldots\ldots\ldots\ldots\ldots . . (2.6)$$

2.6 Conclusion

Model specification and selection of variables is contention issues. Econometric and economic literature contain several methods and statistical criteria to select appropriate model. Data mining approach, simple to general approach and general to simple approach is the frequently used to select the appropriate model. The conventional econometric criteria such as R^2 and adjusted R^2 are also most frequently used in the empirical modeling. In the first part of this chapter, we discussed the different approach

of model selection. In the second section discussed statistical criteria with their advantage ad drawbacks. In the third section, we discussed the application of encompassing principle and tests of encompassing and conventional information criterion. The main objective of these criteria's are to minimize the uncertainty about the model and best fit model. Forging literature suggested that conventional econometrics criteria are not sufficient to select the best model. The alternative methods are also discussed in above chapter such as Hendry's general to specific approach. The basic concern of the Hendry methodology is the model specification and its validation in time series context. The Hendry methodology is most influential and powerful methodology to handle the variety of econometrics problems. The main advantages of Hendry methodology is, provide a systematic procedure to select the satisfactory model which represent the actual data. It provides the extension and improvement of existing practices in empirical economics.

CHAPTER -3

CONSUMPTION FUNCTION: THEORETICAL AND EMPIRICAL OVERVIEW

3.1 Overview of Chapter

Literature related consumption consist of huge and varied studies, it is not possible to review all the relevant literature, but it is important to shed most recent relevant literature for two reasons. First is to sort out the silent features of literature and second is to understand the empirical relationship between different variables to the consumption expenditure. The main objective of this chapter is to survey both theoretical and empirical literature worldwide as well as on Pakistan. This chapter contains three sections. The first section consists of theoretical and empirical literature around the world. The second section contains literature on DHSY approach to study consumption expenditure and finally in the third section, discussed recent studies on consumption expenditure in Pakistan.

3.2 Brief Overview of Most Relevant Literature

Consumption functions are studied by many authors and measuring of consumption is dividing into five alternative approaches, Keynes (1936) consumption approach, life cycle income hypothesis approach, permanent income hypothesis approach and Hall random walk approach. Empirical studies have used above models or combination of variables suggested by these approaches and also introduced some more variables in empirical studies. The theoretical and empirical literature is divided into following sections.

3.2.1 Keynes Absolute Income Hypothesis

Absolute income hypothesis (AIH) is one of the well documented and widely known estimating consumption function, presented by the Keynes in 1936. Keynes stated that

it is a human nature, when income increase, consumption of individuals also increase over the time but not as much by as income increase. In other words marginal propensity to consume is less than unity. The simple formulation of the model is as the following, which can be capture at least these ideas from the time series data.

$$C_t = \alpha_0 + \beta_1 Y_t \dots\dots\dots\dots\dots\dots\dots\dots (3.1)$$

Where α_0 intercept, β_1 shows the marginal propensity to consume (MPC), C_t shows consumption and Y_t is real per capita income. It is assume that intercept is positive and MPC is greater than zero and less than one. In long run the average propensity to consume is equal to the marginal propensity to consume but in the short run marginal propensity to consume is less than the average propensity to consume.

$$APC = \frac{C_t}{Y_t}$$

$$\frac{C_t}{Y_t} = \frac{\alpha_0}{Y_T} + \beta_1$$

According to Keynes (1936), the current consumption is mainly explained by the current income. Keynes consumption theory gave a static explanation of household income and consumption. The theory does not explain tradeoff between current and future consumption as well as income. However, Keynes consumption function creates a new opportunity for the econometric analysis of macroeconomic time series data. Initially, the short time data were available for the empirical analysis and most of the empirical results support to the validity of Keynes consumption function, but over the time development in macroeconomic research and availability of long data series, empirical results appeared inconsistent with Keynes consumption function[2].

The first objection came from the Simon Kuznets (1952) that the relationship between income and consumption does not decline over the time. According to the Kuznets in

[2] *For detail see pp. 24 chapter one New Direction in Econometric Practice second edition*

the short run marginal propensity to consume is less than average propensity to consume due to fluctuation in income. He argued that in the short run Keynesian consumption function gave accurate results but for the long run it gave inappropriate results.

3.2.2 Life Cycle Income Hypothesis

The second alternative explanation of consumption proposed by Modigliani and Brumberg (1954) and it is known as life cycle income hypothesis (LCH). The life cycle income hypothesis (LCH) explain income change systematically over the phases of household life. The household achieved smooth consumption through saving, and therefore consumption depend on current income and wealth of household. In the LCH model household consumption expenditure decision does not depend on the current income, but it depends on the expected lifetime income.

$$c_t = \alpha_1 y_t + \alpha_2 y_t^e + \alpha_3 A_{t-1} \dots\dots\dots\dots (3.2)$$

Where C_t and y_t represent aggregate consumption and non-property income respectively, y_t^e represent expected annual non-property income and A_t represent net wealth over the time.

3.2.3 Permanent Income Hypothesis

The permanent income hypothesis was developed by the Friedman (1957), he argued that income is a most important determinant of consumption. Furthermore, current income and consumption are divided into two components, transitory and permanent component. However, PIH explains household consumption decision depends on their permanent income rather than on transitory income.

$$C_t^P = a + \beta Y_t^T \dots\dots\dots (3.3)$$

$$C_t = C_t^P + C_t^T \dots\dots\dots\dots (3.3a)$$

$$Y = Y_t^P + Y_t^T \dots\dots\dots\dots (3.3b)$$

Empirically, Friedman tests this implication by using the household data from the various budget studies conducted in 1940 and 1950 and found supports to permanent income hypothesis. Life-cycle hypothesis and permanent income hypothesis are closely related, the basic theme of both theories are the plan of consumer expenditure does not depend on current level of income received by the individuals but it depend on the life time income expectation of consumer. This implies that plan of consumer expenditure depends on the particular time period. It is assumed that linear multiple relationships between permanent income and permanent consumption. In the both cases, the major components that determine linear multiple relationships are non-human wealth ratio to the total wealth, age, taste, and interest rate.

Friedman and Modigliani (1957) defined the consumption in term of consumption on goods and services. Friedman more emphasis on estimation of wealth on the basis of flow of current income and past income and on the other hand Modigliani emphasis on estimating wealth is current income plus non-human wealth. The empirical relationship between income and consumption is positive, an increase in real income may raise the ratio of saving and this can increase the permanent consumption level in the long run. In the case of life cycle income hypothesis, the relationship between consumption and real income is vary with the age of household, positive relationship for a younger and negative relationship for the older and retired households. Testing the validity of both hypothesis have raise empirical problem, because of difficulty to decompose permanent component and transitory component from income and consumption (Hadijmatheou 1987).

3.2.4 Hall Random Walk Model

The permanent income hypothesis and life cycle hypothesis are closely related with each other and in literature both theories are combined into life-cycle permanent income

hypothesis (LCPI). Robert Hall (1979) developed a theory of life-cycle permanent income hypothesis and it is also known as rational expectation hypothesis (REH). According to Hall consumer choice current consumption after considering his available resources over the entire life, consumption follow the first autoregressive process, this is called random walk model. Hall opened the way of econometric approach to study REH. He considered a representative household operating in an uncertainty environment and solved for its optimal consumption plan a period by period budget constraint.

$$E_t \sum_s \left(\frac{1}{1+\delta}\right)^s u(C_{t+s}) \dots\dots\dots\dots\dots (3.4)$$

Subject to

$$E_t \sum_s \left(\frac{1}{1+\gamma}\right)^s (C_{t+s} - y_{t+s}) = A_t$$

Where E_t shoes the expectation operator, conditional on the all information at time t. δ and γ represent discount and interest rate both are assumed constant. In equation (4) u shows the instantaneous utility function. C_t and y_t represent consumption and income respectively. A_t shows the physical assets. R. Hall derived following Euler equation from above specification.

$$E_t \acute{u}(C_{t+1}) = \left(\frac{1+\delta}{1+\gamma}\right) \acute{u}(C_t)$$

Where $E_t \acute{u}(C_{t+1})$ shows the household expectation of period $t+1$ marginal utility of consumption. Finally Hall derived the following model.

$$C_t = \gamma C_{t-1} + \epsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (3.5)$$

Where γ is constant and ϵ_t is error term, where discount rate and interest rate consider $\gamma = 1$ and consumption follow the random walk. The equation shows current consumption is predicted by the only last period consumption, no other variables in model.

However, several studies used the Hall random walk model to test the empirical relationship between consumption and income. Bilson (1980) tested the rational expectation life-cycle permanent income by using the aggregate consumption data of Germany and UK. He found the ambiguous result, lagged of income influenced aggregate consumption in both countries and he concluded that anticipated change in income has significant predicting aggregate consumption.

Flavin (1981) estimated a structural econometric model based on the life-cycle permanent income hypothesis and found consumption was more sensitive as compared to income change. Similarly, Blinder and Deaton (1985) replicate Flavin (1981) finding that change in consumption is predicted from the past income. This study great deal with the outstanding issues in aggregate consumption, including difference of consumption can be predictable. Moreover, Blinder and Deaton decomposed all the components including wealth, income, and inflation into anticipated and unanticipated. They found lagged income and forecasting of current income are significant it is contrary to the implication of Hall random walk model. The relationship between interest rate and inflation and consumption is negative. Blinder and Deaton (1985) also gave attention to another important issue of temporary tax effect on consumption, they are unable to explain the effect on a temporary tax cut on consumption as predicted by rational expectation theory. They found that in the long run temporary tax has negative effect on consumption which is inconsistent with any theory. Blinder and Deaton also test the impact of the budget deficit on consumption. Both income and wealth subtracting from the budget deficit and found that budget deficit reduced consumption. Mankiw (1982) estimated the consumer expenditures on durable goods and extended the Hall (1979) hypothesis using the US post-war data. He argued that consumer expenditures on durable goods follow the ARMA (1, 1) but not AR (1, 1) process.

Furthermore, he rejected the rational expectation model. However, several studies highlighted the reasons for rejection of Hall (1978) rational expectation model. Zeldes (1989), Muellbauer and Lattimore (1995) showed the empirical rejection of REH is due to the existence of liquidity constraints and Haug (1991) proposed that rejection of REH is due to time aggregation bias. Similarly, Deaton (1989) also emphasized on issues related to the aggregate time series behavior of consumption, furthermore highlighted that consumption is more smoothness than the income.

3.3 Hendry Approach to Study Consumption Expenditure

David Hendry methodology is one of the powerful and influential method to modelling consumption expenditure. Davidson, Hendy, Sarba and Yao (1978) presented a data-based methodology to modelling the consumer expenditures, later it is known as DHSY modelling. Davison *et al.,* (1978) used the quarterly data of UK consumption from 1958 to 1970 to estimate the consumption expenditure. First, they estimated three existing consumption model, Hendry (1974), Ball *et al*., (1975) and Wall *et al*., (1975), which are as following.

$$C_t = \beta_0 + \beta_1 C_t + \beta_2 C_{t-1} + \sum_{j=1}^{4} b_j\, Q_{jt} + \sum_{j=1}^{4} d_j\, Q_{jt} t + \varepsilon_t \dots\dots (3.6)$$

$$t = 1, \dots\dots\dots\dots . T$$

Where C denote consumption, Y denote income and Q_{jt} shows dummy variable for the j[th] quarter. Hendry imposed several restriction on parameters and finally Hendry (1974) got the following estimated model.

$$C_t = \beta_0 + \beta_1 C_t + \beta_2 C_{t-1} + S_t + \sum_{j=1}^{4} d_j\, Q_{jt} t + \varepsilon_t \dots\dots\dots\dots\dots\dots . (3.7)$$

Secondly, they estimate the Ball *et al.*, (1975) consumption model as following.

$$(C - G)_t^{\beta} = \beta_0 + \beta_1 (Y - G)_t^{\beta} + \beta_2 (C - G)_{t-1}^{\beta} + (\omega_1 D_t + \omega_1 D_{t-1}) \dots\dots . . (3.8)$$

Where G shows direct transfer payments to individuals and D_t is dummy variable for 1968.

Thirdly, they estimate the Wall *et al.*, (1975) model which is as following.

$$\dot{C_t^*} = \beta_0 + \beta_1 \dot{Y_t^{\beta}} + \beta_2 \dot{Y_{t-1}^{\beta}} \ldots\ldots\ldots\ldots\ldots (3.9)$$

Where C^* shows the aggregate consumption expenditures and superscript β shows the seasonal adjusted data. They used the raw data rather than seasonally adjusted data and used the following seasonally adjusted procedure

Suppose X_t is a vector of variables, $\Delta_4 X_t = X_t - X_{t-4}$, by using this procedure raw data is converted into seasonal adjusted data. The data is transformed into log $\Delta ln X_t = \Delta \frac{X_t}{X_{t-1}}$. Than finally Davidson *et al.*, (1978) construct the functional form of the model by filtering trends, specify the autocorrelation properties of error term. However, combining all these approximations they obtain the following model in implication of the three models.

$$C_t = \psi_0 + \psi_1 C_{t-1} + \psi_2 C_{t-4} + \psi_3 Y_t + \psi_4 Y_{t-4} + \psi_5 \Delta Y_t + \psi_6 \Delta Y_{t-4} + \sum_{j=1}^{3} \psi_{7=j}\, Q_{jt}$$

$$+\ \psi_8 DO_t + \ \psi_9 T + \psi_{10} DO_{t-4} + \ \varepsilon_t \ldots\ldots\ldots\ldots (3.10)$$

The above model is called general unrestricted model and need to check the important feature of the model such as multi - collinearity and orthogonal transformation for the parameter of interest related to the theory. However, after the diagnostic tests of the model some variables are ruled out due to the orthogonal test and finally Davidson *et al.*, (1978) got the following specific model.

$$\Delta_4 C_t = \psi_1 \Delta_4 Y_t + \psi_2 \Delta\Delta_4 Y_t + \psi_3 \Delta_4 DO_t + \ \varepsilon_t \ldots\ldots (3.11)$$

Where C_t and Y_t is natural logarithms of the consumption and income and DO_t is special effect, which shows the tax policy changes in 1968 in UK. Δ is difference operator, $\Delta C_t = C_t - C_{t-1}$ and $\Delta_4 C_t = C_t - C_{t-4}$. Similarly in equation (3.11) $\Delta\Delta_4 Y_t =$

$(Y_t - Y_{t-1}) - (Y_{t-1} - Y_{t-5})$. This model need to check whether econometric model is relate with economic theory or not. The model ((3.11) implies that current quarter consumption is the same as in the corresponding quarter one year before. However, under the permanent income hypothesis ψ_1 is positive, this implies that increase in income is treated as increase in permanent income. The $\Delta\Delta_4 Y_t$ term is annual growth of additional income and expected sign of $\Delta\Delta_4 Y_t$ is negative, it shows long run relationship. The economic theory impose long run relationship between consumption and income as $C_t = KY_t$. Where C is a aggregate consumption and Y is income. K shows the constant term.

$$C_t = K + Y_t$$

In a difference from it can be written as $\Delta C_t = \Delta Y_t$. On the bases of above equation the, error term is added to the model to postulate the stochastic disequilibrium relationship between C and Y. However, theory of the dynamic adjustment of C and Y seem to assume a general rational lag model from as

$$\alpha(L)C_t = k + \beta(L)Y_t + \varepsilon_t$$

Where $\alpha(L)$ and $\beta(L)$ are the lag operator and ε_t is white nice. For the simplicity it is, assume that both polynomials are first order

$$C_t = k + \alpha_1 Y_t + \alpha_2 Y_{t-1} + \alpha_3 C_{t-1} + \varepsilon_t$$

In order to ensure the steady state solution of model needs to imposed the following restrictions on coefficients of parameter $\alpha_1 = -\alpha_2 + \delta$ and $\alpha_3 = 1 - \delta$

$$\Delta_1 C_t = k + \alpha_1 \Delta Y_t + \alpha_2 (Y_{t-1} + C_{t-1}) + \varepsilon_t$$

This specification shows the long run relation without loss of any long run information in the data. Davidson *et al.*, (1978) borrow the idea of error correction mechanism from the Sargan (1964) wage price model and make it consistent with long-run economic theory. Unfortunately, the derived model initially did not predict well but Deaton

(1977) work provide a solution (see Hendry, 2000a). Initially inflation effect was not incorporated in the model, the Deaton (1977) suggesting that unanticipated inflation is important in consumption function, therefore inflation effect is added in the model as finally known as the DHSY model that represent the local data generating process.

$$\Delta_4 C_t = k + \psi_1 \Delta_4 Y_t + \psi_2 (C - Y)_{t-4} + \Delta\Delta_4 Y_t + \psi_3 \Delta_4 DO_t + \psi_4 \Delta p_t + \psi_5 \Delta_1 \Delta_4 p_t + \varepsilon_t \dots\dots (3.12)$$

Where C_t is the consumption of goods and services, Y_t is personal disposable income, $\Delta\Delta_4 Y_t$ is the first difference of the annual change if income, $(C + Y)_{t-4}$ is error correction term, D_t is a dummy variable, $\Delta_4 P_t$ is level of inflation, $\Delta\Delta_4 P_t$ is the rate of growth of inflation and μ_t is disturbance term. All the variable in the model are expressed in the natural logarithm. This model has successfully describing the short run as well as long run dynamic between the cointegrated macroeconomic variables. The main advantages of the DHSY model is that avoid running into the problem of spurious correlation.

Moreover, the DHSY model has gained wide world support on both empirical and methodological ground. Several empirical studies follow the Hendry general to specific approach in which general model is reduced through sensible economic restrictions. Early empirical evidence on DHSY was favorable such as Davis (1984) test the number of alternative consumption model but he concluded that the DHSY model is the best specification. Similarly, Molana (1991) applied the Error Correction Model (ECM) approach and concluded that the ECM is appropriate and best method for specifying the relationship between consumption and wealth. Chamber (1991) also produced good results by using the ECM approach in the UK.

However, some earlier studies have shown that the DHSY model has poor perform outside of the sample. The outside sample is effected by the change in seasonality

(Harvey and Scott, 1994). The nondurable consumption exhibits seasonality over time. Therefore Harvey and Scott suggested estimating the structural model rather than DHSY model for UK consumption expenditures. Similarly, Darnell and Evans (1990) criticized on the Hendy methodology. He argued that the Hendry methodology is verification that is not used to test the theories, but theories are used for the empirical results. He argued that theories explain the world best, and Hendry approach cannot rigorously explain. Many other studies also criticism on the Hendry approach including Carruth and Henley (1990) and Gausden and Brice (1995). Carruth and Henley checked the existing consumption model such as DHSY model explain the quarterly UK consumption behavior. They concluded that most of the models in the UK have poor forecasting performance in UK consumption. Similarly, Gausden and Brice (1995) used the seasonal adjusted and seasonal unadjusted data for the estimation of consumption of durable and non-durable goods. They concluded that effect of income growth that changes the pattern of consumption over time, for this purpose they used time varying parameter which improves the goodness of fit of the model within sample period. Hendy *et al.,* (1990) argued that five important facts potentially impact on the consumer behavior, such as income, credit constraints, uncertainty, demographic change, liquidity and dynamic adjustment. However, all these factors play an important role in determining the consumption.

3.4 Recent Studies on Consumption Expenditure in Pakistan

Consumption expenditure is one of the major component of GDP and it has a great importance in determining the economic performance of a country. Generally, the consumption is disaggregated into private sector consumption and public sector consumption. Pakistan is a domestic consumption driven economy, and GDP is about

80 percent consumption and it heavily depends on the public and private spending[3]. Historically Pakistan economic growth is characterized by a consumption orientated growth, consumption, investment and exports are the main symbolical drives which force to economic growth in the country. By the end of 2012-13 consumption estimated at 87.67 percent and it was 88 percent in 2011-12 (Economic Survey 2012-13). The rapid growth of consumer expenditure has attached to the economist and academic researcher to study the consumer behavior individually as well as aggregate consumption. In this connection, the studies on consumption and its determinants have a great importance in the empirical studies. Several empirical studies were conducted at the micro and macro level in Pakistan. Most of the micro level studies used the Household income and expenditure survey data (HIES), and Pakistan Social and Living Standards Measurement (PSLM) Survey data. The macro level studies used time series data and they investigate the consumption pattern over time in Pakistan.

Khan and Memon (2011) tested Hall Permanent income hypothesis for Pakistan using annual time series data. In order to check the validity of the LPIH, they used Campbell and Mankiw (1990) consumption model, which suggest that the proportion of forward-looking consumer and backward looking consumer in the total population. They found that 32% of consumers are forward looking and remaing are backward looking. Furthermore, He argued that in the case of Pakistan large fluctuation in the per capita income and small opportunity for the consumption smoothing. The empirical results are consistent with the AIH and consumer rely on their current income rather than expected income. The study concluded that in the case of Pakistan current income play an important role in the determination of the individual's consumption and consumption does not follow the random walk hypothesis. Similarly, Khan and Khalid (2011)

[3] See for detailed Economic Survey of Pakistan (2012-13)

investigated permanent income hypothesis for Pakistan. Hall (1978) random walk and Campbell and Mankiw (1990) model are used to test the validity of PIH. Empirical results support the absolute income hypothesis rather than permanent income hypothesis. In addition, the reasons for the rejection of the permanent income hypothesis Shea (1995) model is used and found that asymmetric relationship between income and consumption and provide little evidence of liquidity constraint.

Khan *et al.,* (2014) analyzing the consumption behavior for Pakistan by using the annual time series data. They explored the long-term effect of current income and previous consumption on consumption level. The method of the least square method is used for the estimation of the linear regression model. They found that the consumption is significant and positively related to income and previous consumption. Based on the empirical finding they gave policy recommendations, long-term planning is important to determine the level of consumption if government give priority to enhancing the productivity level and employment rate. All these are effective running of both fiscal and monetary policy which stabilize and stimulate the economy to achieve the expected economic growth. Moreover, aggregate consumption is an important part of the national account and has been extensively researched in macroeconomics. On the other hand, the aggregate saving is also a powerful influence on the economy, in the long run, this can attention to both policy makers and academic researchers. Khan and Jamil (2015) investigated the aggregate consumption behavior by using seasonal unadjusted quarterly data. They used Hall Random Walk Model and DHSY error correction methodology in estimating the aggregate consumption function for Pakistan. They found that Hall Martingale hypothesis hold in the case of Pakistan and current consumption is a good predictor of future consumption, in the case of Pakistan 86% of income is consumed and 14% is saving and 49% of consumers followed backward

looking and remaining 51% consumer follows the permanent income hypothesis and forward looking. They concluded that Random walk model and DHSY model has shown the stable relationship between consumption and income but DHSY model has a slight edge in term of forecast analysis.

3.5 Conclusion

This chapter summarized the several developments in the consumption literature. The wide variety of the studies has been discussed both theoretically and empirically. The main purpose of this chapter was to highlight the current knowledge in the field of interest as well as understand theoretical concepts and the empirical relation between the variables. The different modelling techniques, methods and theories are discussed, for example, absolute income hypothesis, permanent income hypothesis, life cycle income hypothesis, random walk model and Hendy modelling methodology to modelling the consumer expenditures. The overall conclusion drawn from these studies is that most of the empirical studies follow the Hall random walk model (1978) and the Hendry methodology to model the consumer expenditure. The Hall random walk model is a strongly theoretical foundation but empirically it has lacked sufficient representations without the modification. On the other hand, the Hendry approach has a strong empirical foundation but the lack of theoretical foundation. Furthermore, in the case of Pakistan several studies investigate the consumption pattern by using the micro and macroeconomic time series data. The most recent studies shows that 49 % individuals follow the rule of thumb and 51% follow the permanent income hypothesis. The majority of household consumption decision depend on permanent income. Hence, temporary change in income has little impact on their consumption decision. On the other hand, a small number of household consumption decision depend on the current income and temporary change in income is associated with the business cycle.

CHAPTER- 4

DATA AND METHODOLOGY

4.1 Overview of Chapter

In this chapter, we construct the methodological framework to obtain empirical results in next chapter. This chapter contains four sections. The first section describes model specification, it examine the different models and their theoretical and empirical properties. The second section discussed the sources of data and definition of variables. The third section is about method of analysis, it include the model selection procedure and model specification test. The fourth section is about the encompassing principle. The aims of this chapter is to build methodological framework for the empirical analysis, which will be further used in next chapter.

4.2 Model Specification

The studies on consumption is divided into five alternative approaches as already discussed in chapter 3. In this study we will estimate several consumption models and finally applying the encompassing test and select the appropriate model. The first step is to estimate the three well known consumption functions, absolute income hypothesis, permanent income hypothesis and random walk model by using the traditional econometric methodology. In the second step we will estimate the several consumption models by general to specific approach.

4.2.1 Absolute Income Hypothesis

The model based on the absolute income hypothesis is written as following.

$$PC_t = \beta_o + \beta_1 Y_t + \varepsilon_t \ldots\ldots (\mathbf{4.1})$$

Where PC_t is private consumption and Y_t is GDP. According to the absolute income hypothesis the marginal propensity to consume is greater than zero but less than one.

In the long run average propensity to consume equal to marginal propensity to consume but in the short run MPC less than APC.

4.2.2 Permanent income hypothesis

$$PC_t = \beta_o + \gamma_1 PC_{t-1} + \beta_1 Y_t + \varepsilon_t \ldots\ldots (\mathbf{4.2})$$

4.2.3 Random walk model

Hall (1978) combine life cycle income hypothesis and permanent income hypothesis with rational expectation. He concluded that change in consumption follow the random walk process and is unpredictable.

$$PC_t = \gamma_1 PC_{t-1} + \varepsilon_t \ldots\ldots (\mathbf{4.3})$$

Where γ is constant and ϵ_t is error term, where discount rate and interest rate consider $\gamma = 1$ and consumption follow the random walk. The model (4.3) shows current consumption is predicted by the only last period consumption. Model (4.1), (4.2) and (4.3) are estimate on the bases of traditional econometric methodology. Next move to general to specific approach, which is most frequently used to model the consumption expenditures in modern research in the form of error correction model.

4.3 General to Specific Models

4.3.1 DHSY Model

Davidson *et al.,* (1978) estimate the consumption model for UK, which is also known as DHSY error correction model.

$$PC_t = \beta_0 + \sum_{j=1}^{5} \beta_j \, C_{t-j-1} + \sum_{j=0}^{5} \beta_j \, Y_{t-j} + \sum_{j=0}^{5} \partial_j \, P_{t-j} + \sum_{j=0}^{5} \gamma_j \, Inf_{t-j} + \sum_{j=i}^{3} d_j \, S_{jit} + \sum_{j=i}^{3} \gamma_j \, ST_{jit} + \omega Trnd_t + \sum_{j=j}^{5} \varphi_j \, D_{jit} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{4.4})$$

Where, P_t is price and Inf_t is inflation rate.

4.3.2 Deaton Hypothesis

Deaton Hypothesis is another most frequently used consumption model in empirical studies, which is based on the life cycle permanent income hypothesis. Blinder and Deaton (1985) developed the consumption model by including five potential variables, income, wealth, interest rate, price and inflation.

$$C = f(Y, FW, R, Infl, Pr)$$

The Deaton consumption function gave answer to variety of questions[4], which was arise after the Lucas Critiques (1976). They estimate consumption function by adding several variables. We will estimate the following general model.

$$PC_t = \beta_0 + \sum_{j=1}^{5} \beta_j \, C_{t-j-1} + \sum_{j=0}^{5} \beta_j \, Y_{t-j} + \sum_{j=0}^{5} \partial_j \, FW_{t-j} + \sum_{j=0}^{5} \gamma_j \, Infl_{t-j} + \sum_{j=0}^{5} \gamma_j \, P_{t-j} + \sum_{j=i}^{3} d_j \, S_{jit} + \sum_{j=i}^{3} \gamma_j \, ST_{jit} + \omega Trnd_t + \sum_{j=}^{5} \varphi_j \, D_{jit} + \varepsilon_t \ldots\ldots\ldots (\mathbf{4.5})$$

Where PC_t denote consumption, Y_t denote GDP, FW_t is financial wealth, $Infl_t$ is inflation rate and P_t price.

4.3.3 Remittance and Private Consumption

Ball *et al.,* (1975) estimate the following model for the UK consumption.

$$(C - G)_t^{\beta} = \beta_0 + \beta_1 (Y - G)_t^{\beta} + \beta_2 (C - G)_{t-1}^{\beta} + \beta_3 D_t + \beta_4 D_{t-1} + \varepsilon_t \ldots . (\mathbf{4.6})$$

Where G denote direct transfers to individuals, D_t denote special effects, 1 for the 1968 and zero for otherwise. In this study we modify model (4.6) due to the unavailability of quarterly data on direct transfers. We used remittances inflow in model, the modify version of model (4.6) is write as following

[4] *See for detailed (Blinder and Deaton 1985)*

$$PC_t = \beta_0 + \sum_{j=1}^{5} \beta_j\, PC_{t-j} + \sum_{j=0}^{5} \beta_j\, Y_{t-j} + \sum_{j=0}^{5} \partial_j\, Rem_{t-j} + \sum_{j=0}^{3} d_j\, S_{jit} + \sum_{j=i}^{3} \gamma_j\, ST_{jit} + \omega Trnd_t + \sum_{j=}^{5} \varphi_j\, D_{jit} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{4.7})$$

Where, Rem_t is remittance inflow

4.3.4 Stock Market and Private Consumption

In order to check the impact of stock market on private consumption estimate the Church *et al*., (1994) model. He argued that five potentially important variables influence the consumer behavior. The variables are including income uncertainty, credit constraints, demographic change, liquidity and dynamic adjustment. In this study we modify the model by adding the time trend Trd_t instead of demographic change. These variables are incorporate in the framework and model is written in the following form.

$$PC_t = \beta_0 + \sum_{j=1}^{5} \beta_j\, C_{t-j} + \sum_{j=0}^{5} \beta_j\, Y_{t-j} + \sum_{j=0}^{5} \partial_j\, FW_{t-j} + \sum_{j=0}^{5} \gamma_j\, R_{t-j} + \sum_{j=0}^{5} \gamma_j\, SMR_{t-j} + \sum_{j=i}^{3} d_j\, S_{jit} + \sum_{j=i}^{3} \gamma_j\, ST_{jit} + \omega Trnd_t + \sum_{j=}^{5} \varphi_j\, D_{jit} + \varepsilon_t \ldots\ldots\ldots (\mathbf{4.8})$$

Where PC_t denote real consumption, Y_t denote real disposable income, FW_t denote net financial wealth, R_t is interest rate and SMR_t is stock market returns. On the bases of all above information and constructed models, finally we construct the following general unrestricted model

4.3.5 General Unrestricted Model for Pakistan

$$C_t = \xi_0 + \sum_{j=1}^{5} \beta_j\, C_{t-j} + \sum_{j=0}^{5} \beta_j\, Y_{t-j} + \sum_{j=0}^{5} \beta_j\, P_{t-j} + \sum_{j=0}^{5} \beta_j\, infl_{t-j} + \sum_{j=0}^{5} \beta_j\, FW_{t-j} + \sum_{j=0}^{5} \beta_j\, Intr_{t-j} + \sum_{j=0}^{5} \beta_j\, Tax_{t-j} + \sum_{j=0}^{5} \beta_j\, SMR_{t-j} + \sum_{j=0}^{5} \beta_j\, GE_{t-j} + \sum_{j=0}^{5} \beta_j\, Rem_{t-j} + \omega z_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (\mathbf{4.9})$$

Where, PC_t is Consumption, Y_t is real GDP, P_t is prices, $Infl_t$ is inflation rate, FW_t is financial wealth, $Intr_t$ is interest rate, Tax_t is indirect taxes, SMV_t is stock returns variable, GC_t is government expenditures, z_t is vector of seasonal dummies and time trend, Rem_t is remittance inflow, and Special effect variables are also include in model as discussed already.

4.4 Source of Data and Definition of Variables

In order to achieve the objective of study data are taken form the monthly working papers of state bank of Pakistan (Quarterization of National Accounts of Pakistan) and International Financial Statistics (2015) for the period 1972(i) to 2015(iv) in million Pakistani rupees. The main variables include private consumption as percentage of GDP, government consumption, real GDP, indirect taxes, remittance inflow, Interest rate, financial wealth, consumer price index, inflation rate and stock market returns. For further analysis, initial five observations are left, the variable $\Delta_4 PC_t = PC_t - PC_{t-4}$ created by using the data 1972(i). The variables are convert into real form and same base year (2010).

$$Real\ Variable = \frac{Nominal\ Varible}{CPI_{2010=100}} \times 100$$

4.4.1 Private Consumption

The dependent variable of this study is private consumption at constant price 2010=100. The data on private consumption is collected from the monthly working paper published by the state bank of Pakistan.

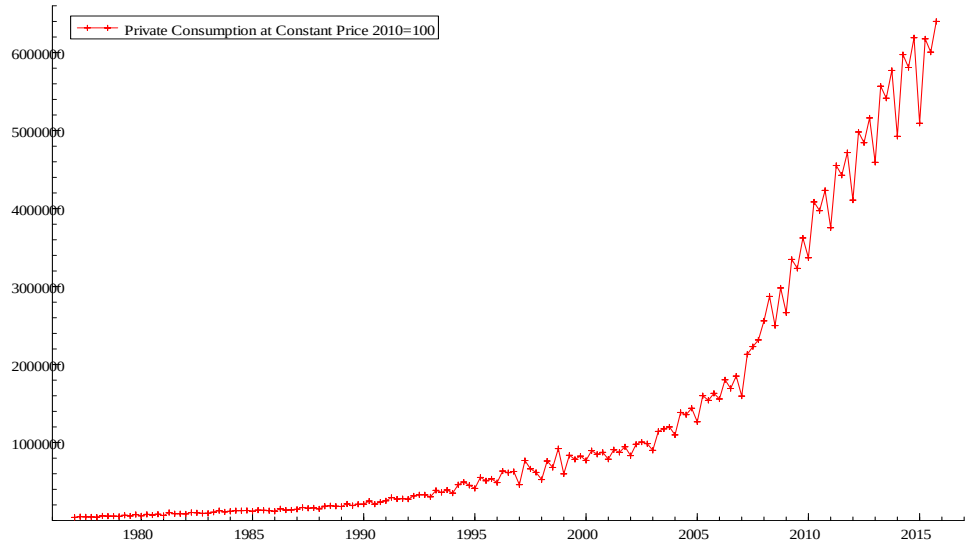

Figure 4. 1: Time Series Plot of Private Consumption

The figure 4.1 report time series plot of quarterly consumption form 1972(ii) -2015(iv). The figure shows that pattern of private consumption changed over the time. The series have strong time trend and seasonal pattern and although seasonal pattern has been trend increasingly.

4.4.2 GDP

GDP is most important factor which determine the consumption decision of consumer. In this study GDP at constant price 2010=100 is used as independent variable, and expected sign of GDP is positive with private consumption. The figure 4.2 exhibited that GDP is changed over the time and have strong seasonal pattern and time trend.

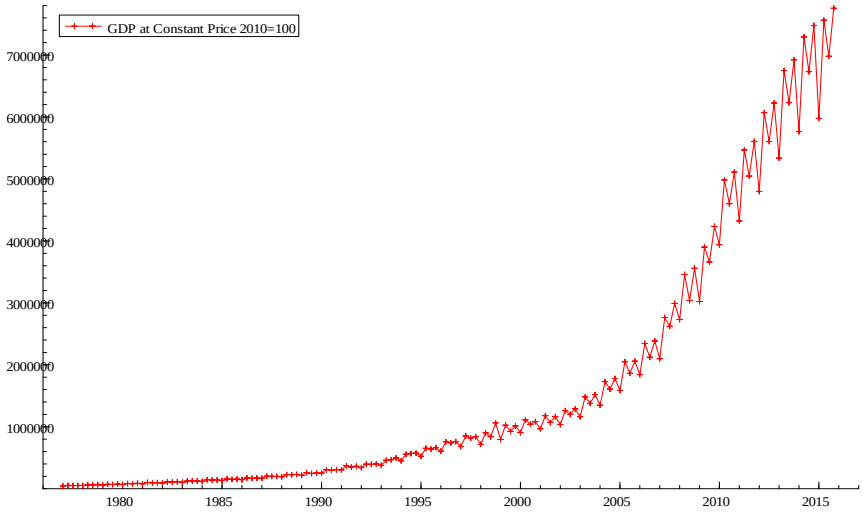

Figure 4. 2: Time Series Plot of GDP

The figure 4.2 shows initially GDP has no strong seasonal pattern and after 2000 increase both pattern and time trend. The GDP is clearly departure from mean and its variance.

4.4.3 Price

Consumer price index (CPI) is used for the measurement of price. The data was taken from the international financial statistics (IFS) 2015.

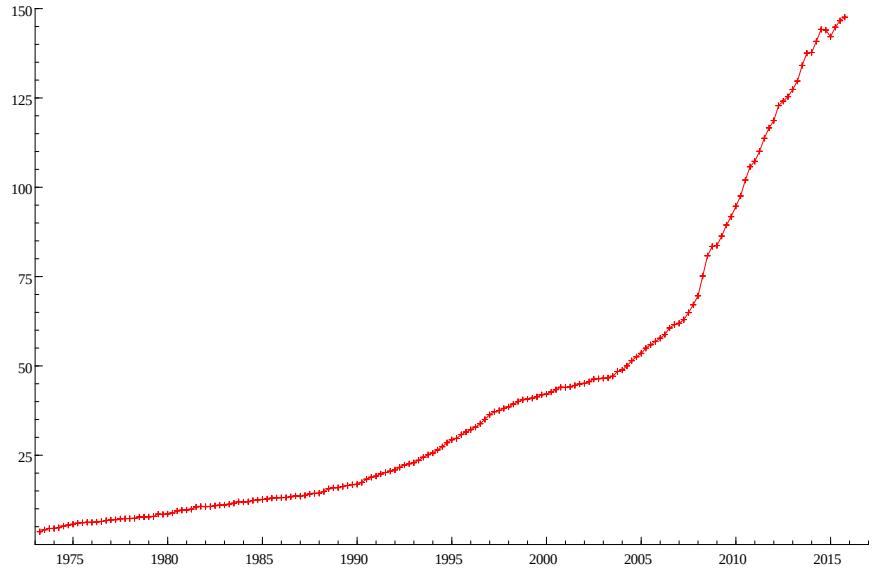

Figure 4. 3: Time Series Plot Consumer Price Index

The figure 4.3 shows time series plot of consumer price index. The price is strong time trend and have no seasonal pattern.

4.4.4 Inflation Rate

Consumer price index is used to measure the inflation rate. The inflation rate is also an independent variable which negatively affect the level of consumption. According to the Deaton (1977), economic agent have not sufficient information to distinguish between the general price movement and relative price. However, under this condition unanticipated inflation is misinterpreted as a raise in relative price. The inflation capture effect of inflation uncertainty. Under the Deaton hypothesis if the inflation is unanticipated than inflation has negatively related to consumption. The rate of inflation is approximated by $inf_t = \Delta_4 p_t$

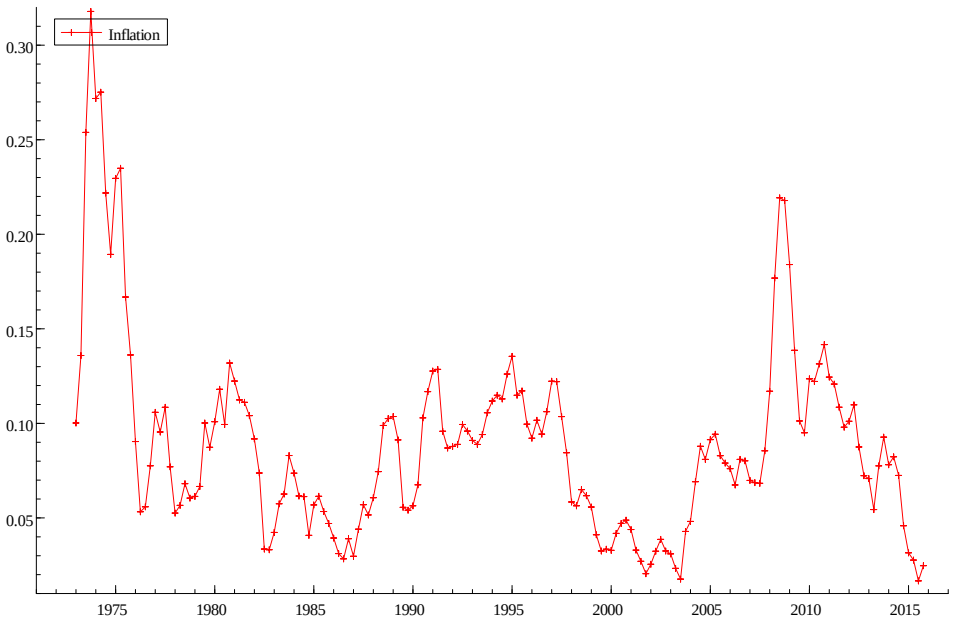

Figure 4. 4: Time Series Plot of Inflation

The figure 4.4 shows the inflation series has irregular cycles which indicate positive time dependency and clear departure from the independent assumption.

4.4.5 Financial Wealth

The wealth is another important variable which effect the private consumption. The wealth variable is a part of original Keynesian consumption function. However, in this study M2 aggregate is used as proxy for the financial wealth. The data on financial wealth is collected form the monthly bulletin of state bank of Pakistan

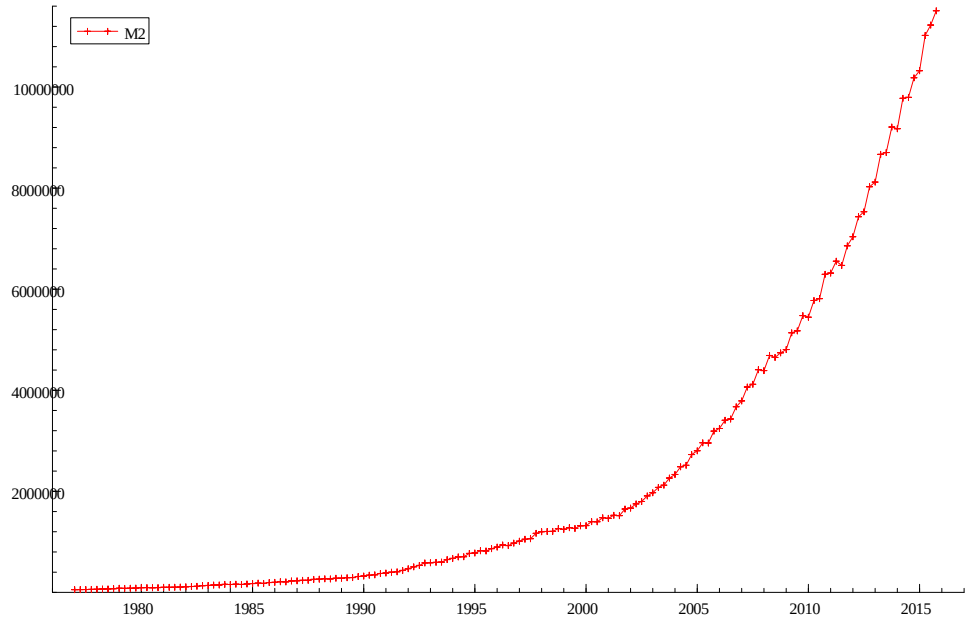

Figure 4. 5: Time Series Plot of Financial Wealth

The figure indicating that financial wealth has strong time trend and seasonal pattern.

4.4.6 Interest Rate

Real interest rate is potential explanatory variable which effecting both long run and short run consumption level. The effect of an increase in interest rate have both substitution and income effect. The substitution effect is negative and income effect is positive. In substitution effect consumption is more costly and there is substitution toward tomorrow consumption. However, in this study we used call money rate as proxy for the interest rate. The data is taken from the International Financial Statistics.

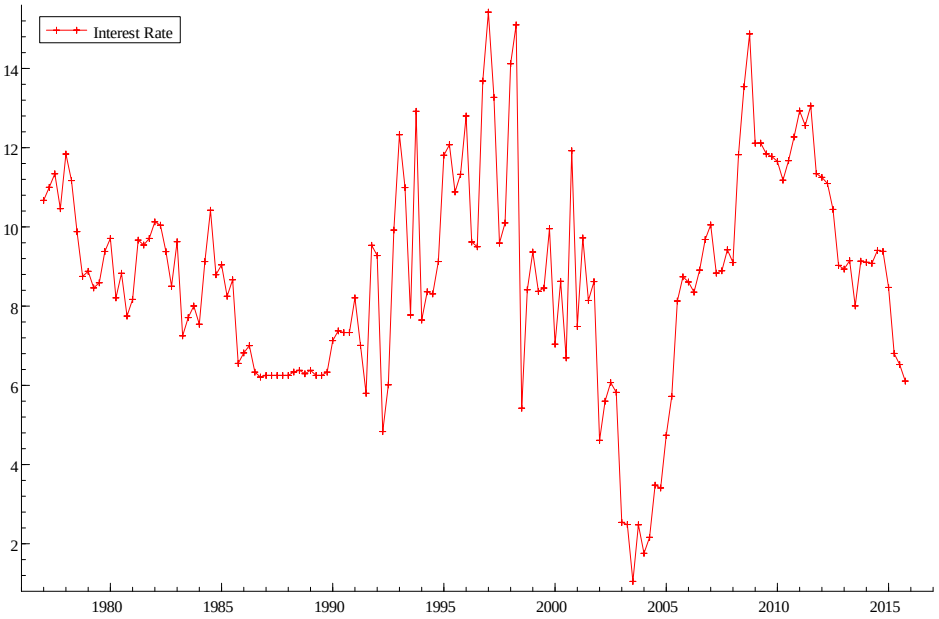

Figure 4. 6: Time Series Plot of Interest Rate

The figure 4.6 shows the inflation series has irregular cycles which indicate positive time dependency and clear departure from the independent assumption.

4.4.7 Indirect Tax

Indirect taxes include sales taxes, custom, excise duties value added tax (VAT) goods and services tax general sales tax (GST). The data on indirect taxes are collected for the various quarterly report published by the State Bank of Pakistan. The figure 4.7 report time series plot of indirect taxes at constant price 2010=100 over the period 1973(ii) to 2015(iv). The figure suggests series have strong trend and seasonal pattern and although seasonal pattern has been trend increasingly. This implies that the behavior of indirect taxes has changed over the time.

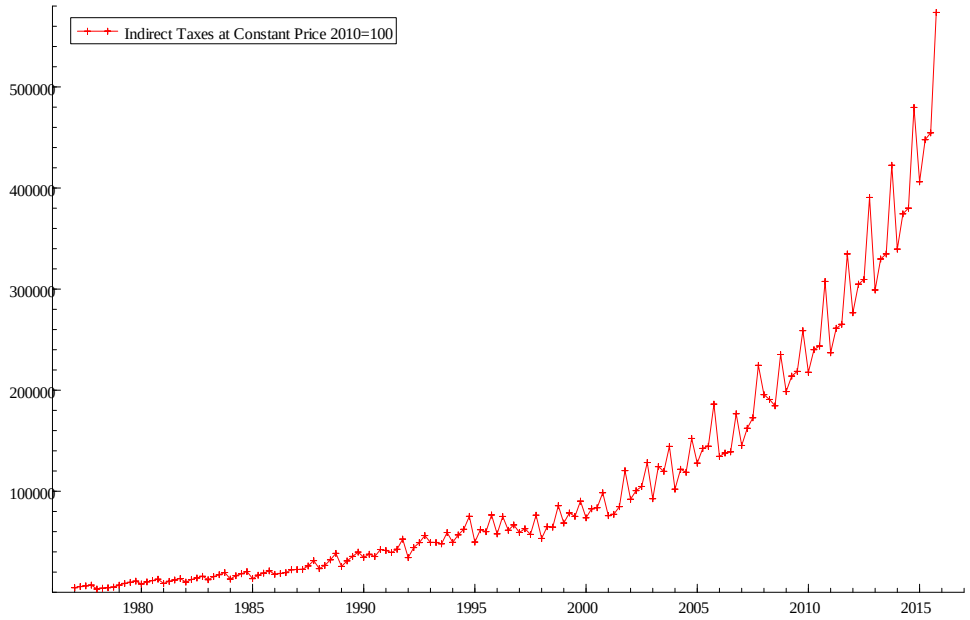

Figure 4. 7: Time Series Plot of Indirect Taxes

4.4.8 Stock Market Returns

The stock market returns variable is generated by using the share prices. This variable is used to check impact of stock market on private consumption. The data on share prices are taken from the International Financial Statistics (IFS) 2015. $SMR_t = Sp_t - Sp_{t-1})$

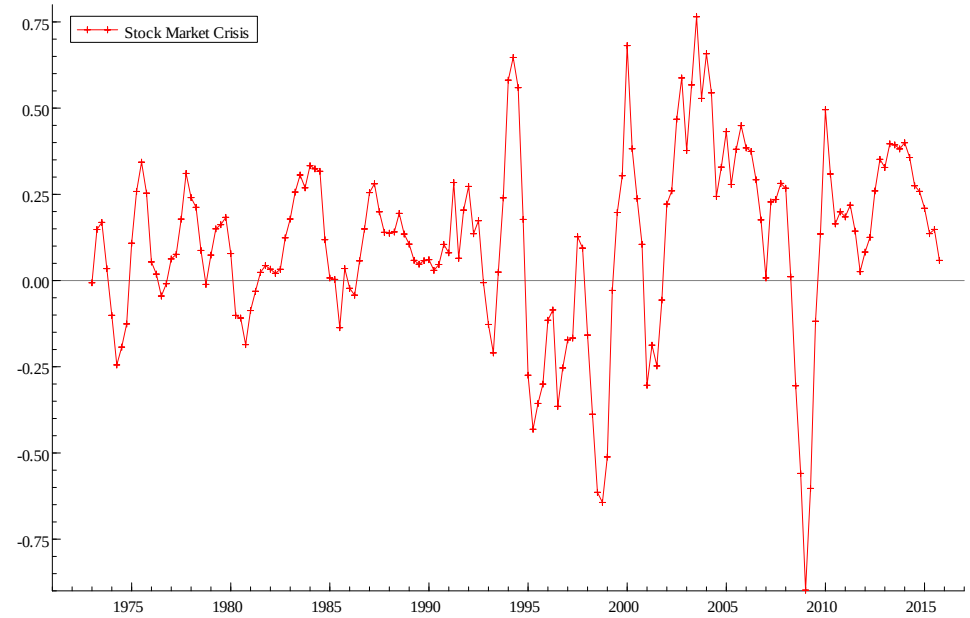

Figure 4. 8: Time Series Plot of Stock Market Returns

The figure 4.8 shows the stock market returns has irregular cycles which indicate positive time dependency and clear departure from the independent assumption.

4.4.9 Government Expenditures

Government expenditures are refers to the spending of central government and local government to satisfy the social wants of peoples. The government expenditures include defense expenditures, social welfare expenditures, public health and education expenditures, revenue expenditures etc. in this study the government consumption on goods and services at constant price 2010=100 are used as a policy variable, to check impact of government policy change on private consumption.

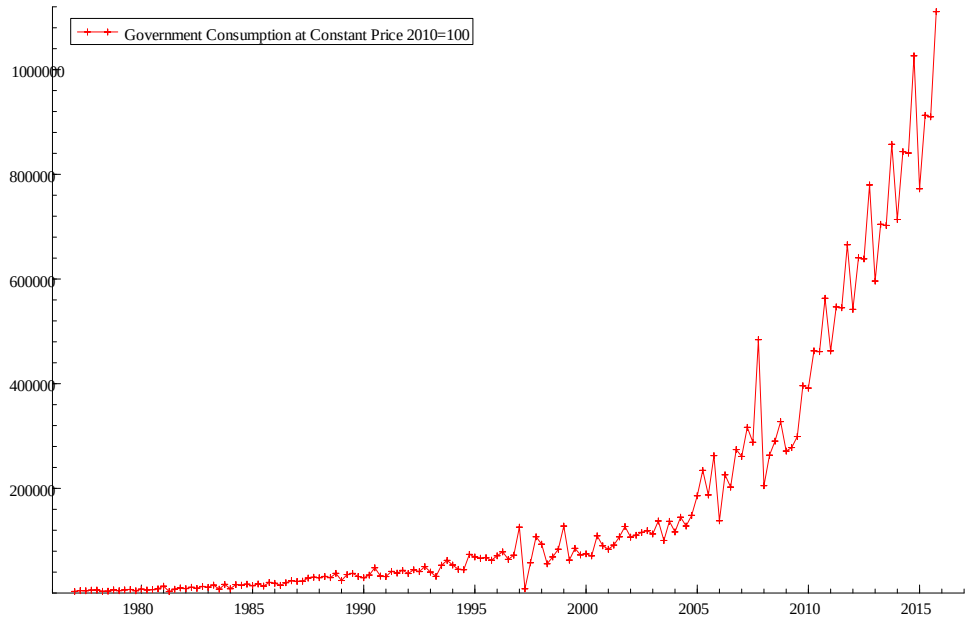

Figure 4. 9: Time Series Plot of Government Consumption

The figure 9.4 shows the government expenditures has strong time trend and seasonal pattern. The series has clearly departure from the independent assumption.

4.4.10 Remittance Inflow

The current transfers by the migrants from host country to home country in which they are consider residents. The data on inflow of quarterly remittances taken from the State Bank monthly bulletins.

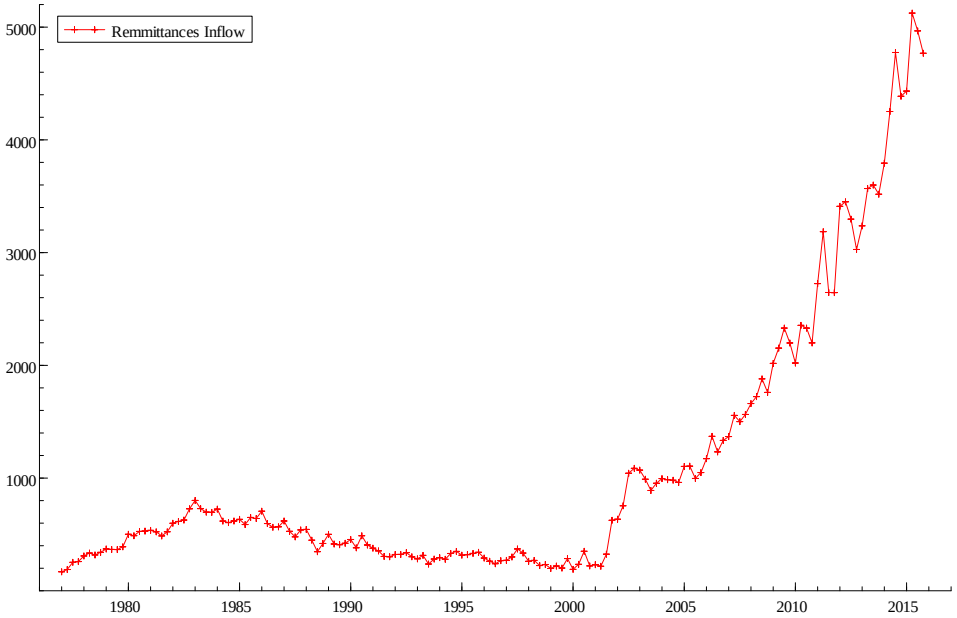

Figure 4. 10: Time Series Plot of Remittance Inflow

4.4.11 Seasonal Dummies

In order to model the seasonal and time trend introduced seasonal dummies in the model.

$$S1_t = \begin{vmatrix} 1\ for\ first\ quater \\ 0\ therwise \end{vmatrix}, S2_t = \begin{vmatrix} 1\ for\ second\ quater \\ 0\ therwise \end{vmatrix},$$

$$S3_t = \begin{vmatrix} 1\ for\ third\ quater \\ 0\ therwise \end{vmatrix}, T = Trend$$

4.4.12 Special Event Dummies

The Pakistan economy has mix orthodox, several economic, socioeconomic, political and constitutional crisis effect the economy. The economic policies, political condition changed over the time in Pakistan. In order to study impact of policy change and other events introduced the following special event variables in our model. In 1979

government received financial support from the West. The generous financial support increase private consumption and other macroeconomic indicators[5]. In 1984 acceleration in the inflow of remittances form the Middle East. These remittances benefiting the middle class working population as a result boost up the economic indicators. In 1990 the democratically elected regime attempting to practice authoritarian form of power with in democratic order. As a results law and order had significant impact on private investment and overall economy[6]. In May 1998 Pakistan blast the atomic bomb, this can also cut off the private consumption and other macroeconomic indicators. Global financial crisis during the January 2008 significantly increase the prices as a results negative impact on the other macroeconomic indicators.

$D_{79t} = \begin{bmatrix} 1\ for\ 1979(4) \\ 0\ otherwise \end{bmatrix}$, $D_{84t} = \begin{bmatrix} 1\ for\ 1984(1) \\ 0\ otherwise \end{bmatrix}$, $D_{90t} = \begin{bmatrix} 1\ for\ 1990(3) \\ 0\ otherwise \end{bmatrix}$

$D_{98t} = \begin{bmatrix} 1\ for\ 1998(1) \\ 0\ otherwise \end{bmatrix}$, $D_{08t} = \begin{bmatrix} 1\ for\ 2008(1) \\ 0\ otherwise \end{bmatrix}$.

4.5 Method of Analysis

The methodology of this study is based on the encompassing principle proposed by the Hendry Mizon (1983). The method of analysis is starting from the general model. The general to specific approach is used to reach a robust prefer model. The general model capture characteristics of underlying data set. The standard testing procedure are adopted to reduce the complexity of model by eliminating statistically insignificant variables. In order to ensure the congruence of the model and validity of reduction process at every stage, use the different diagnostic test including serial correlation, Heteroskedasticity test and normality test etc. Moreover, for the encompassing the rival

[5] *See for detailed Akmal Hussain (2004) Institutions, Economic Structure and Poverty in Pakistan*

[6] *see for detailed Shahid Javed Burki (1999) Pakistan Fifty Years of Nationhood*

models are compared statistically using the diagnostics tests which one model explain the characteristics of another rival model. The following steps are used to select the model.

4.5.1 Data Transformation

In order to specify model, first checked data whether data is linear or non-linear, data contain timer trend or not, data have seasonal effect or not. The data mining procedure is adopt, which is sequential procedure to arrive at the final specification of model. The data mining procedure include time series properties of data including time trend and seasonality, seasonal effects.

4.5.2 Testing order of integration/ Mapping to Stationary I (0)

Most of the macroeconomic variables are non-stationary, the joint and conditional distribution process of variables are changed over time (Spanos 1990). However, the timer series variables have both deterministic trend and stochastic trends. The deterministic trend are taken care of by seasonal dummies. On the other hand the stochastic trend are care of by differencing. For instance the Box Jenkins (1970) methodology is used, first difference to eliminate trend for the yearly data and fourth difference to eliminate seasonality in quarterly data and twelfth difference to eliminate seasonality in monthly data.

However, in this study we used quarterly data on different variables which are specified in pervious section. The Hylleberg, Engle, Granger and Yaoo (1990) HEGY seasonal unit root test is popular to check the property of stationary, therefore in this study we used HEGY seasonal unit root test. There are two possibilities, one is that all the variable are stationary at first difference and second is that the order of integration may be different. One variable may be stationary at level or first difference, one variable

may be stationary at first difference or second difference. The HEGY test is written as following

$$\Delta_4 y_t = \sum_{s=1}^{4} a_s D_{st} + \gamma T_t + \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1}$$

$$+ \sum_{i=1}^{k} \emptyset_i \Delta_4 y_{t-i} + \varepsilon_t$$

Where D_{st} are seasonal dummies, T_t is timer trend and

$$y_{1t} = (1 + L + L^2 + L^3) y_t$$

$$y_{2t} = -(1 - L + L^2 - L^3) y_t$$

$$y_{3t} = -(1 - L^2) y_t$$

If $\pi_1 = 0$ series contain unit root at zero frequency, this implies that the series contain no seasonal stochastic trend. If $\pi_2 = 0$ this implies that two cycle per year. If $\pi_3 = 0$ and If $\pi_4 = 0$ implies that the series contain unit root at annual frequencies. The appropriate filter to use are $(1 - L)$ is $\pi_1 = 0$, $(1 + L)$ is $\pi_2 = 0$ and $(1 + L^2)$ is $\pi_3 = 0$. The t-test are used to checked the significance level of each variables and F- test are used to checked for the joint significance of π_1, π_2 and π_3 are tabulated in Hylleberg *et al*., (1990).

4.5.3 Parameters of interest and Functional Form of Model

In the first and second step, after data transformation and order of integration, construct the functional form of model by incorporating parameters in the model. This step also involved the construction of general unrestricted model.

4.5.4 Model Selection through PcGets Process

Finally, the general unrestricted model is estimate and final model is selected through PcGets process. The PcGets process is called automatic model selection process, which is built in ox matrix package and designed for the general to specific modelling. The

PcGets focusing on the reduction approach for the selection of regression model (Dornik 1998, Hendry and Krolzig 1999a). The PcGets has been developed by the Hoover and Perez (1999) and sought to evaluate performance of PcGets. They introduced advance particle modelling, including reduction paths, strategies, different terminal specifications and diagnostics tests. PcGets involved the following steps.

First, Pre Search Simplification, in this step the PcGets start to exclude irrelevant variables from the general unrestricted model. If the variables are statistically insignificant than PcGets delete all the insignificant variables by using the F-test. After that the GUM model is reformulate. In second step large number of possible multiple as well as single paths are investigated, this step involve the simplification criteria. F-statistics and t-statistics are used as a simplification process. The third step is concerned with the encompassing process. In this step all the reduction process and restriction are collected and then encompassing between the specifications. Finally, the diagnostics test are choice to ensure the silent future of model and characteristics of model congruency in fourth step.

4.6 Model Specification and Diagnostic Tests

- AR 1-5 Test
- ARCH 1-4 Test
- Heteroscedasticity Test
- Normality Test
- Chi^2 Test on Constancy of Parameter
- Chow Test for Break Point
- Encompassing Test

4.7 Tools of Analysis

The overall analysis is done using the OxMetrics 5. Most of the statistical test are bulletin software.

4.8 Concluding Remarks

The various models are constructed in this chapter, their estimation procedure including method of analysis, definition of variables and sources of data are present. Several variables are discussed with their theoretical and empirical properties. The general to specific approach in which automatic selection procedures algorithm (PcGets) is used to select the final model. On the other hand encompassing test is used to compare rival model where the rival model explain all the characteristics of competing model or not. In addition the time series econometric model for the Pakistan is built on the based on life cycle hypothesis.

CHAPTER -5

MODELLING QUARTERLY CONSUMPTION OF PAKISTAN

5.1 Overview of Chapter

In this chapter we estimate different models as discussed in pervios chapter. The main objective of this chapter is to apply the pervios constructed methodology and select the best fit model.

5.2 Transformation of Data and testing for order of Integration

In chapter four we discussed about the silent feature of data, all the variables have both time trend and seasonal pattern. Formally, investigate the stationary status of all variables by using the HEGY seasonal unit root test as shown in table 5.1 at level.

Table 5. 1: HEGY Seasonal Unit Root Test at Level

	$Cont$	$Se.dum$	$Trnd$	lags	π_1^t	π_2^t	$\pi_3 = \pi_4 = 0^F$
PC_t	yes	yes	yes	3	-2.78**	-3.64**	37.258
GC_t	yes	yes	yes	0	-3.72**	-5.37	35.360
GDP_t	yes	yes	yes	1	-2.44**	-2.70**	31.930
Tax_t	yes	yes	yes	0	-2.81**	-7.68	46.975
Rem_t	yes	no	no	0	-1.48**	-8.75	80.668
$M2_t$	yes	yes	yes	1	-2.97**	-4.83	53.007
$Intr_t$	yes	yes	no	0	-2.79**	-6.27	72.562
P_t	yes	yes	yes	0	-2.61**	-5.10	42.029
$Infl_t$	yes	no	no	1,3	-2.88**	-10.2	90.168
SMR_t	yes	no	no	1,4,5	-2.80**	-11.5	67.479

Critical values at 5% (c,d,t) $[\pi_1^t = -3.39]$, $[\pi_2^t = -2.82]$, $[\pi_3^f = \pi_4^f = 7.54]$
Critical values at 5% (c,nd,nt) $[\pi_1^t = -2.85]$, $[\pi_2^t = -1.93]$, $[\pi_3^f = \pi_4^f = 3.82]$
Critical values at 5% (c,d,nt) $[\pi_1^t = -2.84]$, $[\pi_2^t = -2.83]$, $[\pi_3^f = \pi_4^f = 7.57]$
*** indicate significance level at 5%

Table 5.1 indicate that null hypothesis of seasonal unit root is rejected at zero frequency for all variables. This implies that data contains seasonal pattern and time trend. In order to model seasonality and time trend in literature two methods are proposed. The first

is to de-trend seasonality and time trend by using the seasonal differencing. This method is not valuable because if the series have been seasonally adjusted by the differencing method then the economic relation between series may be distorted.

The second method is to introduced seasonal dummies with combination of time trend and seasonal in the model. This methodology is proposed by the Hendy (1974). We use combination of trend and seasonal dummy variable to model. The use of such dummies corresponding to the assumption that model is subject to the deterministic trend and deterministic seasonality. In order to model time trend and seasonality following seasonal dummies are introduced.

$$S1_t = \begin{vmatrix} 1\ for\ first\ quater \\ 0\ therwise \end{vmatrix}, S2_t = \begin{vmatrix} 1\ for\ second\ quater \\ 0\ therwise \end{vmatrix},$$

$$S3_t = \begin{vmatrix} 1\ for\ third\ quater \\ 0\ therwise \end{vmatrix}$$

$$T = Time\ Trend$$

$$DT1_t = S1_t * T, DT2_t = S2_t * T, DT3_t = S3_t * T$$

The value of $DT1$, $DT2_t$ and $DT3_t$ allow for multiplicative seasonality and seasonal effect changed over the time.

5.3 Testing for the Structural Breaks

Structural breaks are occurred within the data sample due to policy changes or special events, which may also effect the variable outcomes or stability of parameters within and out of model. In order to capture effect of special events introduced dummies in the model. The chow break test is used to detect the breaks in data. The figure 5.1 shows the testing of multiple breaks points at 1979Q1, 1984Q4, 1990Q3, 1998Q1 and 2008Q1.

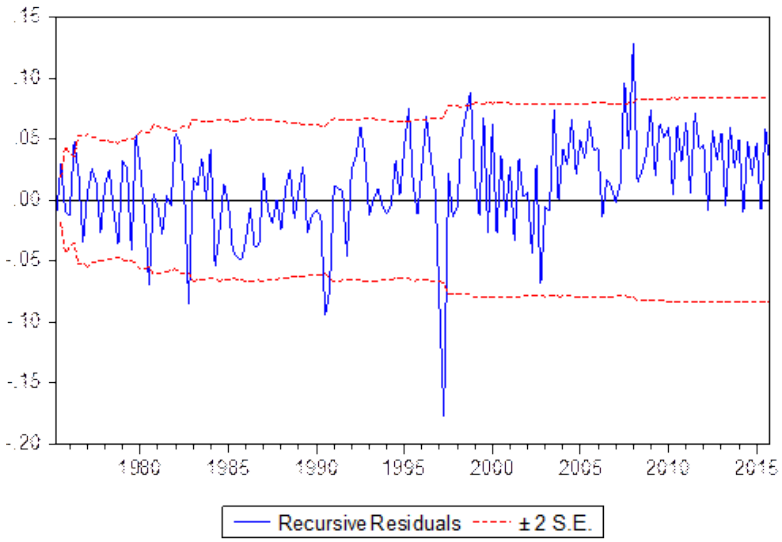

Figure 5. 1: One step residuals test for Structural breaks

Figure 5.1 shows the plot of the one step residuals. In our data we have five structural breaks in the first quarter of 1979, 1998 and 2008, fourth and third quarter of 1984 and 1990. The recursive one step residuals are lies outside the error band. This indicate that the breaks have significant impact on the outcome of variables.

Table 5. 2: Chow Breakpoint Test

F-statistic	3.900175	Prob.	0.0000*
Log likelihood ratio	156.7298	Prob.	0.0000*
Wald Statistic	175.5079	Prob.	0.0000*

* indicate significance level at 1%

Table 5.2 reports chow breakpoint test for the multiple breaks. The null hypothesis of no structural break is reject jointly. This implies that there is a five structural breaks which have significant impact on dependent variable.

5.4 Model Specification and Estimation

This section contain two parts first we estimate the three well known consumption functions, absolute income hypothesis, permanent income hypothesis and random walk model by including seasonal dummies and special event dummies. Furthermore, discussed model specification and selection issues. In addition, we also check the

theoretical properties and different econometric criteria whether properties are full fill or not.

5.4.1 Absolute income hypothesis

$$PC_t = \beta_o + \beta_1 Y_t + \varepsilon_t \ldots\ldots (\mathbf{5.1})$$

Where PC_t is private consumption and Y_t is GDP. The estimated coefficients of absolute income hypothesis are reported in table 5.3.

Table 5. 3: Estimated Coefficients of Absolut Income Hypothesis

	Coefficients	**Std. Error**	**t-values**	**Prob**
β_0	0.112277	0.04506	2.49	0.0138
Y_t	0.977325	0.003503	279	0.0000
R^2	0.99809		DW	1.55
RSS	0.568880377		Sigma	0.0617899
AIC	-2.71700		SC	-2.67703
HQ	-2.70076		FPE	0.0660729
AR 1-5 test:	10.678 [0.0000]**		ARCH 1-4:	0.91208 [0.4588]
Normality test:	5.7313 [0.0569]		Hetero test:	0.12089 [0.8862]
Hetero-X test:	0.12089 [0.8862]		RESET test:	17.290 [0.0001]**
Parameter Constancy Forecast And Diagnostic Tests				
Forecast Chi^2 Test	30.352[0.0643]		Chow Test	0.96969[0.5019]

*** indicate significance level at 5%
[ ] shows the p-values

Table 5.3 repots estimated coefficients of absolute income hypothesis. The intercept and GDP is highly significant. According to the absolute income hypothesis the marginal propensity to consume is greater than zero but less than one. This property is full fill because the MPC is less than one. In the long run average propensity to consume equal to marginal propensity to consume but in the short run MPC< APC.

The model has many drawbacks, first there is exist the problem of autocorrelation and model misspecification problem. This indicate that some important variables are

omitted from the model. In addition the Durbin Watson value is also very low and model forecasting is also failed. The results indicate that parameters are not stable over the time. In the next step we estimate the

5.4.2 Permanent Income Hypothesis

$$PC_t = \beta_o + \gamma_1 PC_{t-1} + \beta_1 Y_t + \varepsilon_t \ldots\ldots (\mathbf{5.2})$$

Table 5. 4: Estimated Coefficients of Permanent Income Hypothesis

	Coefficients	**Std. Error**	**t-values**	**Prob**
β_0	0.111750	0.04545	2.46	0.0151
PC_{t-1}	0.00403590	0.03617	0.112	0.9113
Y_t	0.973397	0.03537	27.5	0.0000

R^2	0.99809	DW	1.56
RSS	0.568832518	Sigma	0.0619957
AIC	-2.70384	BIC	-2.64389
HQ	-2.67948	FPE	0.0669485
AR 1-5 test:	11.004 [0.0000]**	ARCH 1-4:	0.90821 [0.4611]
Normality test:	5.9145 [0.0520]	Hetero test:	1.2070 [0.3105]
Hetero Test	1.1717 [0.3261]	RESET test:	17.229 [0.0001]**

Parameter Constancy Forecast And Diagnostic Tests

Forecast Chi^2 Test	29.745 [0.0741]	Chow Test:	0.87811 [0.6148]

*,*** indicate significance level at 5% and 1% and 10%
[ ] shows the p-values

The model 5.4 shows the estimated coefficients of permanent income hypothesis. The intercept is statistically significant and positive sign of lagged of consumption is consistent with the permanent income hypothesis but it is insignificant statistically. The log run marginal propensity consume is 0.97. Most of the conventional model fit criteria (R square and t-values) are full fill. In this model same problem emerged as in absolute income hypothesis.

5.4.3 Random Walk Model

$$PC_t = \gamma_1 PC_{t-1} + \varepsilon_t \ldots\ldots (\mathbf{5.3})$$

Table 5. 5: Estimated Coefficients of Random Walk Model

	Coefficients	**Std. Error**	**t-values**	**Prob**
PC_{t-1}	1.00269	0.0009828 00	1020	0.0000
R^2	0.9999	DW	3.33	
RSS	3.50014609	Sigma	0.152756	
AIC	-3.75123	SC	-3.73125	
HQ	-3.74311	FPE	0.0234888	
AR 1-5 test:	71.890 [0.0000]**	ARCH 1-4	11.699 [0.0000]**	
Normality test:	4.8498 [0.0885]	Hetero test:	0.25648 [0.7741]	
Hetero-X test:	0.25648 [0.7741]	RESET test:	0.74363 [0.3899]	
Parameter Constancy Forecast and Diagnostic Tests				
Forecast Chi^2 Test	13.761 [0.8424]	Chow Test	0.68483 [0.8366]	

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

Test for linear restrictions $\gamma_1 = 1$

F (1,150) =1.0408006 [0.0000] **

The estimated coefficients of the random walk model is reported in table 5.5. The results indicate that the validity of random walk model, where the estimated coefficient of lagged value of consumption is positive and statistically significant. The model is not pure random walk model because the null hypothesis of $\gamma_1 = 1$ is reject. On the other hand statistical criteria shows that model is miss-specified and exist the problem of autocorrelation and autoregressive conditional heteroscedasticity and residuals are not normally distributed. The forecasting results shows parameter are not stable with in and out of sample. Furthermore, results indicate that models are need to be modify by adding some variable.

5.5 Estimation of General Models

In order to improve the results of model in deriving the consumption function we follow the Hendry general to specific approach. This methodology help to solve many issues like autocorrelation, conditional heteroscedasticity, normality and omitted variable problem. We start with general model, reducing it by sequence of test of economically sensible restrictions. In estimating model we used ordinary least square method (OLS) and checked all the basic assumptions of OLS such as best linear unbiased estimate (BLUE). At the first stage of general to specific approach checking significance level of all variables and their lags, and drop out insignificant variables from the model. Furthermore, at the second stage of G2S modelling approach simplified the specific model and construct the error correction model for short run and long run relationship. The procedure to construct DHSY type error correction model is apply sensible economic restriction on the specific model.

5.5.1 Remittances Inflow and Private Consumption

Ball *et al.,* (1975) estimate the model 4.5 for UK consumption. in this study the model is modified due to the unavailability of quarterly data on government consumption, we used remittances inflow in model, which can strong influence the consumption in case of Pakistan. After the estimation of GUM we got the following specific model.

$$PC_t = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 Rem_t + \beta_9 Rem_{t-1} + \beta_{10} ST_2 + \beta_{11} D_{79t} + \beta_{12} D_{84t} + \beta_{13} D_{90t} + \beta_{14} D_{98t} + \beta_{15} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.4})$$

Table 5. 6: Estimated Coefficients of General Restricted Model (Ball)

	Coefficients	Std. Error	t-values	Prob
PC_{t-2}	0.246998	0.06366	3.88	0.0002*
PC_{t-3}	0.183093	0.03823	4.79	0.0000*
PC_{t-4}	0.170578	0.06586	2.59	0.0106*
Y_t	1.30165	0.06803	19.1	0.0000*
Y_{t-1}	-0.235100	0.05756	-4.08	0.0001*
Y_{t-2}	-0.473370	0.08721	-5.43	0.0000*
Y_{t-4}	-0.201005	0.09788	-2.05	0.0419**
Rem_t	0.046961	0.02483	1.89	0.0607***
Rem_{t-1}	0.043965	0.02407	1.83	0.0700***
ST_{2t}	-0.000442	0.00014	-3.15	0.0020**
D_{t79}	0.163126	0.04273	3.82	0.0002*
D_{t84}	0.124187	0.04323	2.87	0.0047*
D_{t90}	-0.171934	0.04319	-3.98	0.0001*
D_{t98}	-0.177119	0.04282	-4.14	0.0001*
D_{t008}	-0.152079	0.04312	-3.53	0.0006*

R^2	0.9991	DW	1.96
RSS	0.243200	sigma	0.04174
AIC	-6.25897	SC	-5.99920
HQ	-6.15343	FPE	0.00191
AR 1-5 test:	1.2903 [0.2719]	ARCH 1-4 test	0.10604 [0.9802
Normality test:	0.96555[0.6171]	Hetero test:	1.0776 [0.3801]
RESET test:	1.2295 [0.2695]		

Parameter Constancy Forecast and Diagnostic Tests

Forecast Chi^2 Test	13.625 [0.8490]	Chow Test	0.43129 [0.9840]

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

Table 5.4 presents the estimated coefficients of model 5.4. The expected sign of the lagged private consumption and GDP are same as we already discussed. In addition, the coefficient of remittances and it lagged in positive and statistically significant. This indicate that inflow of remittance have positive and significant impact on private

consumption. One percent increase in remittance increase private consumption by 4 percent. Furthermore, special event dummies are statistically significant, which are discussed already. Other model selection criteria including AIC, SC and R^2 are also reliable and discussed already in previous model. The model is passed through several diagnostic tests i.e. serial correlation test, Heteroscedasticity test, normality test etc. which indicate that no problem of serial correlation, no heteroscedasticity, residuals are normal and model is well specified. The stability of parameters within and out of model is checked by using chi^2 test and chow test, which indicate the model parameters are stable.

Furthermore, specific model is simplified and construct error correction model by applying several sensible economic restrictions. We apply following sensible economic restrictions on specific model.

(i) $\beta_2 = -\beta_2$

(ii) $\beta_3 - 1 = -(\beta_0 + \beta_7)$

(iii) $\beta_6 = -\beta_6$

(iv) $\beta_9 = -\beta_9$

$$PC_t - PC_{t-4} = (\beta_1 - \beta_2)(PC_{t-2} - PC_{t-3}) + (\beta_3 - 1)(PC_{t-4}) + (\beta_4 - \beta_0)(Y_t - Y_{t-4}) + (\beta_5 - \beta_6)(Y_{t-1} - Y_{t-2}) + (\beta_3 - 1)Y_{t-4} + (\beta_8 - \beta_9)(Rem_t - Rem_{t-1}) + \varepsilon_t$$

Where $\Delta PC_t = PC_t - PC_{t-1}$, $\Delta PC_{t-1} = PC_{t-1} - PC_{t-2}$, $\Delta PC_{t-2} = PC_{t-2} - PC_{t-3}$ and $\Delta_4 PC_t = PC_t - PC_{t-4}$,

We further simplify

$\beta_1 - \beta_2 = \theta_1, \beta_4 - \beta_0 = \theta_2, \beta_5 - \beta_6 = \theta_3, \beta_8 - \beta_9 = \theta_4, \beta_3 - 1 = \varphi$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi PC_{t-4} + \varphi Y_{t-4} + \varepsilon_t$$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi(PC_{t-4} + Y_{t-4}) + \varepsilon_t$$

This equation contains the error correction mechanism $PC_{t-4} - Y_{t-4} = ECM_{t-4}$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta Rem_t + \varphi ECM_{t-4} + \varepsilon_t \dots\dots\dots (\mathbf{5.5})$$

The error correction model 5.5 is estimated for the entire sample by including special event dummies as shown in table 5.7.

Table 5. 7: Estimated Coefficients of Error Correction Model

	Coefficients	**Std. Error**	**t-value**	**Prob**
ΔPC_{t-1}	-0.0330301	0.05639	-0.58	0.5589
ΔY_{t-1}	0.0358878	0.06285	0.57	0.5688
ΔRem_t	0.0093344	0.03038	0.30	0.7591
$\Delta_4 Y_t$	0.891537	0.06027	14.8	0.0000*
ECM_{t-4}	-0.111216	0.04653	-2.39	0.0180*
D_{t79}	0.148152	0.03956	3.74	0.0003*
D_{t84}	0.106081	0.03936	2.69	0.0078*
D_{t90}	-0.100598	0.03971	-2.53	0.0122*
D_{t98}	-0.113389	0.03982	-2.85	0.0050*
D_{t008}	-0.130669	0.03938	-3.32	0.0011*
$\boldsymbol{R^2}$	0.62268	**DW**	2.18	
RSS	0.496630	**sigma**	0.055316	
AIC	-5.58365	**SC**	-5.36385	
HQ	-5.49435	**FPE**	0.003759	

*,*** indicate significance level at 10%, 5% and 1%

Table 5.7 report the estimated coefficients of error correction model. The results shows first difference of one lag private consumption and income are statistically insignificant in short run. The coefficient on first difference of remittance is positive but statically insignificant, this implies there is no relationship between remittance and private consumption in short run. The coefficient of error correction term is negative and statistically significant. This implies that there in long run relationship between remittance inflow, GDP and private consumption.

5.5.2 DHSY Model

Davidson *et al.,* (1978) consumption model is also known as DHSY model. We simplify DHSY model for Pakistan (already discussed in chapter 4). At the first stage in general to specific model drop out the insignificant variables and estimate the following specific model.

$$PC_t = \beta_0 + \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 P_t + \beta_9 ST_2 + \beta_{10} D_{79t} + \beta_{11} D_{84t} + \beta_{12} D_{90t} + \beta_{13} D_{98t} + \beta_{14} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.6})$$

Table 5. 8: Estimated Coefficients of General Restricted Model Based on DHSY

	Coefficients	**Std. Error**	**t-values**	**Prob**
β_0	1.10696	0.4118	2.69	0.0081*
PC_{t-2}	0.179205	0.06554	2.73	0.0071*
PC_{t-3}	0.159096	0.03972	4.01	0.0001*
PC_{t-4}	0.203853	0.06457	3.16	0.0020*
GDP_t	1.41234	0.08003	17.6	0.0000*
GDP_{t-1}	-0.306825	0.06282	4.88	0.0000*
GDP_{t-2}	-0.413367	0.08790	-4.70	0.0000*
GDP_{t-4}	-0.390030	0.1059	-3.68	0.0003*
P_t	0.252681	0.09163	2.76	0.0066*
$S2_t$	-0.000501	0.00014	-3.37	0.0010*
D_{t79}	0.173752	0.04152	4.18	0.0001*
D_{t84}	0.133515	0.04197	3.18	0.0018*
D_{t90}	-0.153231	0.04147**	-3.70	0.0003 *
D_{t98}	-0.195574	0.04171**	-4.69	0.0000*
D_{t008}	-0.157084	0.04255**	-3.69	0.0003*
R^2	0.9992	DW	2.09	
RSS	0.26122	Sigma	0.04047	
AIC	-3.33634	SC	-3.05659	
HQ	-3.22269	FPE	0.03558	
AR 1-5 test:	2.3862 [0.0417]	ARCH 1-4 test	0.59181 [0.6692]	

Normality test:	3.2833 [0.1937]	Hetero test:	1.2835 [0.1961]
RESET test:	3.3489 [0.0695]		
Parameter Constancy Forecast and Diagnostic Tests			
Forecast Chi^2 Test	8.9594 [0.9834]	Chow Test	0.30404 [0.9983]

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

Table 5.8 report estimated coefficients of DHSY model. The expected sign of lag of dependent variable and GDP are highly significant and theoretically consistent. In addition inflation is drop out from the model due to statistically insignificant. This implies that inflation has no role to determine the private consumption in case of Pakistan. The coefficient of price is highly significant and positive. Under the rational expectation permanent income hypothesis private consumption is not reduced in the presence of higher prices due to wealth effect. This indicate that high capital gain encouraging private consumption. Second quarter dummy is minor negative effect on private consumption because it coefficient is -0.0005. In addition, other dummies are highly significant and correct sign (already discussed). Furthermore, model passed through the several diagnostic tests. The result indicate that there in econometrics assumption violate in model.

Model 5.8 is simplified and construct the DHSY error correction model by applying several sensible economic restrictions (see for detailed appendix A-i).

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.7})$$

Model 5.7 is error correction model which shows the long run and short run relationship between private consumption, GDP and price. The model is further estimated by adding special event dummies for the entire sample as shown in table 5.9.

Table 5. 9: Estimated Coefficients of DHSY Error Correction Model

	Coefficients	**Std. Error**	**t-value**	**Prob**
ΔPC_{t-2}	-0.0327666	0.03688	-0.873	0.3838
ΔY_{t-1}	-0.0223633	0.04115	-0.532	0.5957
$\Delta_4 P_t$	0.0679220	0.1059	0.731	0.4658
$\Delta_4 Y_t$	1.03311	0.08770	11.5	0.0000*
ECM_{t-4}	-0.002246	0.002325	-1.63	0.1044***
D_{t79}	0.163807	0.03963	4.18	0.0000*
D_{t84}	0.115410	0.03970	2.91	0.004*
D_{t90}	-0.108548	0.03964	-2.77	0.0062*
D_{t98}	-0.128404	0.03971	-3.29	0.0012*
D_{t008}	-0.137351	0.04093	-3.26	0.0013*
$\boldsymbol{R^2}$	0.35587	**DW**		2.29
RSS	0.137559	**sigma**		0.055997
AIC	-2.22422	**SC**		-2.02440
HQ	-2.14304	**FPE**		0.108173

*,*** indicate significance level at 10%, 5% and 1%

Table 5.9 report short run estimated coefficients of DHSY error correction model. The results are slightly different as compare to pervious model. The first difference of second lag of dependent variable is negatively related with growth of private consumption. This implies that one percent increase in lag of dependent variable decrease consumption by 3%. The results are consistent with Keynesian absolute income hypothesis which stated that current consumption depend on current income. This implies that there is no wealth effect in absolute income hypothesis. However the results are consistent with AIH but it is statistically insignificant. The first difference of lag of income is also statistically insignificant. Annual growth in income is positive and highly significant. The error correction term ECM_{t-4} shows the long run speed of adjustment. The statistically significant and negative sign of coefficient suggest if private consumption diverge from its equilibrium point due to any economic shock, the

private consumption will adjust toward equilibrium point after the one period. This implies there is long run relationship between private consumption, GDP and price. Other variables like special event dummies are statistically significant and correct sign (already discussed).

5.5.3 Random Walk Model with Liquidity Constraints

We estimate random walk model with liquidity constraints, the variables are including interest rate, GDP and financial wealth as suggested by D.Bredin and C. Keith (2001). The specific form of the random walk model with liquidity constraint is as following.

$$PC_t = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-2} + \beta_6 Y_{t-5} + \beta_7 ST_2 + \beta_8 D_{79t} + \beta_9 D_{84t} + \beta_{10} D_{90t} + \beta_{11} D_{98t} + \beta_{12} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.8})$$

Table 5. 10: Estimated Coefficients of General Restricted Model Based on Random Walk Hypothesis with Liquidity Constraints

	Coefficients	Std. Error	t-values	Prob
PC_{t-2}	0.262731	0.06013	4.37	0.0000*
PC_{t-3}	0.171135	0.03437	4.98	0.0000*
PC_{t-4}	0.158562	0.04563	3.47	0.0007*
GDP_t	1.10868	0.05735	19.3	0.0000*
GDP_{t-2}	-0.500513	0.07744	-6.46	0.0000*
GDP_{t-5}	-0.206725	0.04451	-4.64	0.0000*
$ST2_t$	-0.000393	0.00011	-3.32	0.0011*
D_{t79}	0.170221	0.04352	3.91	0.0001*
D_{t84}	0.134705	0.04440	3.03	0.0029*
D_{t90}	-0.160563	0.0438	-3.67	0.0003*
D_{t98}	-0.182281	0.04379	-4.16	0.0001*
D_{t008}	-0.158103	0.04414	-3.58	0.0005*
R^2	0.998016	DW	2.04	
RSS	0.2564553	Sigma	0.042953	
AIC	-3.38126	SC	-3.14148	
HQ	-3.28385	FPE	0.034015	

AR 1-5 test:	1.2952	ARCH 1-4 test	0.28218 [0.8891]
Normality test:	1.5443 [0.4620	Hetero test:	0.90546 [0.5772]
Hetero-X test:	1.4651 [0.0660]	RESET test:	1.0434 [0.3088]
Parameter Constancy Forecast and Diagnostic Tests			
Forecast	14.729 [0.7917]	Chow	0.45689 [0.9776]

The estimated coefficients of model 5.8 are report in table 5.10. At the first stage insignificant variables are drop out from model i.e. financial wealth and interest rate. This implies that in case of Pakistan model of random walk with liquidity constraint is no applicable. Financial wealth and interest rate have no role to determine private consumption in above model. The other variable including lags of private consumption, current GDP and lags of GDP are highly significant and theoretically consistent with permanent income hypothesis.

Furthermore we simplified model and construct error correction model by applying the sensible economic restrictions (see for more detailed appendix A-ii).

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta\Delta_4 Y_t + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.9})$$

The model 5.9 is error correction model, which shows long run and short run relationship. The model is estimated for the entire sample by including special events as shown in table 5.11.

Table 5. 11: Estimated Coefficients of Error Correction Model

	Coefficients	**Std. Error**	**t-value**	**Prob**
ΔPC_{t-2}	-0.026635	0.03145	-0.847	0.3982
$\Delta\Delta_4 Y_t$	3.29323	0.2612	12.6	0.0000*
ECM_{t-4}	-0.386236	0.03689	-10.5	0.0000*
D_{t79}	0.123321	0.04334	2.85	0.0050*
D_{t84}	0.104012	0.04316	2.41	0.0171*
D_{t90}	-0.0760107	0.04309	-1.76	0.0796***
D_{t98}	-0.0769888	0.04329	-1.78	0.0772***

D_{t008}	-0.108914	0.04324	-2.52	0.0127*
$\boldsymbol{R^2}$	0.45902	**DW**		2.18
RSS	0.603606	**sigma**		0.06085
AIC	-2.41197	**SC**		-2.23213
HQ	-2.33891	**FPE**		0.0896510

*,*** indicate significance level at 10%, 5% and 1%

Table 5.11 shows the short run estimated coefficients of error correction model. First difference of lag of consumption is negatively related with private consumption, but it is statistically insignificant. In addition the coefficient of $\Delta\Delta_4 Y_t$ is positive and highly significant. This indicate that change in income is large than the change in income on annual basis. The extra raise to income private consumption increased. The negative and significant coefficient of error term ECM_{t-4} indicate speed of long run adjustment is 38% toward take place in first period. Other variables like special event dummies are statistically significant and with correct expected sign (as discussed in pervious section).

5.5.4 Deaton Hypothesis

Deaton Hypothesis is another most frequently used consumption model in empirical studies, which is also based on the life cycle permanent income hypothesis. Blinder and Deaton (1985) developed the consumption model by including five potential variables, income, wealth, interest rate, price and inflation. At the first state of GUM, eliminate the insignificant variables from model. Inflation is drop due to statistically insignificant and finally we got the following specific model.

$$PC_t = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 P_t + \beta_9 ST_2 + \beta_{10} D_{79t} + \beta_{11} D_{84t} + \beta_{12} D_{90t} + \beta_{13} D_{98t} + \beta_{14} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.10})$$

Table 5. 12: Estimated Coefficients of General Restricted Based on Deaton Hypothesis

	Coefficients	Std. Error	t-values	Prob
β_0	1.13829	0.4150	2.74	0.0070*
PC_{t-2}	0.172140	0.06620	2.60	0.0104***
PC_{t-3}	0.153719	0.04057	3.79	0.0002**
PC_{t-4}	0.207018	0.06555	3.16	0.0020**
GDP_t	1.43131	0.08590	16.7	0.0000*
GDP_{t-1}	-0.296672	0.06543	-4.53	0.0000*
GDP_{t-2}	-0.409650	0.08836	-4.64	0.0000*
GDP_{t-4}	-0.417907	0.1101	-3.80	0.0002*
P_t	0.258642	0.09230	2.80	0.0059*
$ST2_t$	-0.000481	0.00015	-3.13	0.0022*
D_{t79}	0.174325	0.04173	4.18	0.0001*
D_{t84}	0.134020	0.04214	3.18	0.0018*
D_{t90}	-0.155582	0.04173	-3.73	0.0003*
D_{t98}	-0.195063	0.04190	-4.66	0.0000*
D_{t008}	-0.155230	0.04277	-3.63	0.0004*
R^2	0.9991	DW	2.05	
RSS	0.226082	Sigma	0.0406364	
AIC	-6.30546	SC	-6.00573	
HQ	-6.18369	FPE	0.001827	
AR 1-5 test:	2.5206 [0.0328]	ARCH 1-4 test	0.57081 [0.6843]	
Normality test:	3.1594 [0.2060	Hetero test:	1.4325 [0.1129]	
RESET test:	3.9162 [0.0600]			
Parameter Constancy Forecast and Diagnostic Tests				
Forecast	9.9595 [0.9689]	Chow	0.31448 [0.9979]	

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

The empirical results are same as model of DHSY (results are already discussed in DHSY Model). Furthermore, model 5.10 is simplified and construct the error correction model (see for more detailed appendix A -iii).

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.11})$$

The model 5.11 is error correction model which shows the long run and short run relationship between the private consumption, GDP and prices. Furthermore model is estimated for the entire sample by adding special event dummies as shown in table 5.13.

Table 5. 13: Estimated Coefficients of Error Correction Model

	Coefficients	**Std. Error**	**t-value**	**Prob**
ΔPC_{t-2}	-0.032766	0.03688	-0.965	0.3362
ΔY_{t-1}	-0.022363	0.04115	-0.504	0.6152
$\Delta_4 P_t$	0.067922	0.1059	0.604	0.5466
$\Delta_4 Y_t$	1.03311	0.08770	9.65	0.0000*
ECM_{t-4}	-0.002246	0.00232	-2.40	0.0177*
D_{t79}	0.163807	0.03963	3.77	0.0002*
D_{t84}	0.115410	0.03970	2.83	0.0053*
D_{t90}	-0.108548	0.03964	-2.55	0.0117*
D_{t98}	-0.128404	0.03971	-2.86	0.0048*
D_{t008}	-0.137351	0.04093	-3.47	0.0007*
$\boldsymbol{R^2}$	0.358664	**DW**	2.2	
RSS	0.490293	**sigma**	0.05518	
AIC	-5.14655	**SC**	-4.96283	
HQ	-5.07201	**FPE**	0.005820	

*,*** indicate significance level at 10%, 5% and 1%

Table 5.13 reports the short run and long coefficients of error correction model. The first difference of lag of consumption and GDP is negative and statistically significant. The growth of price variable is positive but it is also insignificant. This indicate that in the short run there is no relationship between growth of private consumption and changed in price. The highly significant and negative sign of error correction term ECM_{t-4}indicate that there is long run relationship between price level, GDP and private consumption.

5.5.5 Stock Market and Private Consumption

In order to check the impact of stock market on private consumption estimate the Church *et al*., (1994) model. He argued that five potentially important variables influence the consumer behavior. The variables are including income uncertainty, credit constraints, demographic change, liquidity and dynamic adjustment. Interest rate, financial wealth and stock market crisis variable is insignificant. After the elimination of insignificant variable we got the following specific model.

$$PC_t = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 ST_2 + \beta_9 D_{79t} + \beta_{10} D_{84t} + \beta_{11} D_{90t} + \beta_{12} D_{98t} + \beta_{13} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.12})$$

Table 5. 14: Estimated Coefficients of General Restricted Model

	Coefficients	**Std. Error**	**t-values**	**Prob**
PC_{t-2}	0.221330	0.06428	3.44	0.0008*
PC_{t-3}	0.182758	0.03778	4.84	0.0010*
PC_{t-4}	0.219199	0.06538	3.35	0.0010*
GDP_t	1.36941	0.07531	18.2	0.0000**
GDP_{t-1}	-0.250481	0.05961	-4.20	0.0000**
GDP_{t-2}	-0.428931	0.08887	-4.83	0.0000**
GDP_{t-4}	-0.319188	0.1037	-3.08	0.0025**
$ST2_t$	-0.0004810	0.00014	-3.35	0.0011**
D_{t79}	0.167420	0.04229	3.96	0.0001**
D_{t84}	0.126755	0.04282	2.96	0.0036**
D_{t90}	-0.160902	0.04230	-3.80	0.0002**
D_{t98}	-0.178570	0.04220	-4.23	0.0000**
D_{t008}	-0.151364	0.04282	-3.53	0.0006**
R^2	0.999272	DW	2.04	
RSS	0.321861	sigma	0.0452778	
AIC	-6.11155	SC	-5.85434	
HQ	-6.00719	FPE	0.00221	
AR 1-5 test:	1.1664 [0.3293]	ARCH 1-4 test	0.30430 [0.8746]	
Normality test:	1.0577 [0.5893]	Hetero test:	1.2783 [0.2051]	
Hetero-X test:	1.1928 [0.2363]	RESET test:	0.72720 [0.3953]	

Parameter Constancy Forecast and Diagnostic Tests			
Forecast	19.846 [0.4676]	Chow	0.58611 [0.9169]

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

Table 5.14 presents the impact of stock market crisis on private investment. The results indicate no relationship between stock market crisis and private investment in case of Pakistan. The stock market variable is insignificant and drop from the model. The remaining variables are same as in permanent income hypothesis as discussed in table 5.6. The lagged dependent variable is positive and statically significant which is consistent with permanent income hypothesis. Current GDP is positively related to the private consumption. An increase in income one percent increase private consumption by 12 percent. The lags of GDP are negatively related to private income. This indicate that long run average propensity to consume, both private consumption and income are not increased proportionally over the time. APC is decreased over time as income increased. The special event dummies are highly significant, $D_{t79}$and D_{t84} are positively related with private consumption. The value of R^2 is high and it reflect that our model explain 99% of the variation in private consumption.

Furthermore, model 5.12 is simplified and construct the error correction model (see for more detailed appendix A -iv)

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi ECM_t + \varepsilon_t \ldots\ldots (\mathbf{5.13})$$

The model 5.13 is error correction model, shows long run relationship as well as short run relationship between GDP and private consumption. The model 5.13 is estimated with including special event dummies for the entire sample 1973Q3 to 2015Q4 as shown in table 5.15

Table 5. 15: Estimated Coefficients of Error Correction Model

	Coefficients	**Std. Error**	**t-value**	**Prob**
ΔPC_{t-1}	-0.0339344	0.05615	-0.604	0.5465
ΔY_{t-1}	0.0364794	0.06265	0.582	0.5612
$\Delta_4 Y_t$	0.893034	0.05990	14.9	0.0000*
ECM_{t-4}	-0.111331	0.04640	-2.40	0.0176*
D_{t79}	0.148429	0.03944	3.76	0.0002*
D_{t84}	0.106076	0.03925	2.70	0.0076*
D_{t90}	-0.098764	0.03914	-2.52	0.0126*
D_{t98}	-0.112189	0.03952	-2.84	0.0051*
D_{t008}	-0.130120	0.03923	-3.32	0.0011*
$\boldsymbol{R^2}$	0.640685	**DW**		2.18
RSS	0.495988	**sigma**		0.055332
AIC	-5.73760	**SC**		-5.57225
HQ	-5.67051	**FPE**		0.00322

*,*** indicate significance level at 10%, 5% and 1%

Table 5.15 repot short run estimated coefficients of error correction model. ΔPC_{t-1} shows first difference of lagged of dependent variable indicating within quarterly changed in private consumption. $\Delta_4 Y_t$shows the seasonal difference indicating annually changed in GDP. In short run first difference of lagged of dependent variable and first difference of GDP is statistically insignificant. The fourth difference of GDP is positive and statistically significant. This indicate that one percent changed in GDP increased private consumption by 8 percent in short run. The ECM_{t-4} term indicate the speed of long run adjustment. The coefficient of ECM_{t-4} is statistically significant and negative. This indicate 11 percent of adjustment take toward take place in first period. The result conformed that long run unitary income elasticity of private consumption.

5.5.6 General Unrestricted Model for Pakistan

Furthermore, estimate general model (GUM) combine all variables in a single model. Model 5.4 to model 5.13 are nested in GUM model. The procedure to estimate GUM is already discussed, we got the following specific model.

$$PC_t = \beta_1 PC_{t-1} + \beta_2 PC_{t-5} + \beta_3 Y_t + \beta_4 Y_{t-1} + \beta_5 Y_{t-4} + \beta_6 GC_t + \beta_7 GC_{t-1} + \beta_8 GC_{t-4} + \beta_9 Tax_t + \beta_{10} Tax_{t-1} + \beta_{11} Tax_{t-4} + \beta_{12} Rem_t + \beta_{13} FW_{t-1} + \beta_{14} P_t + \beta_{15} P_{t-2} + \beta_{16} Infl_t + \beta_{17} Intr_t + \beta_{18} Intr_{t-2} + \beta_{19} ST1_t + \beta_{20} ST2_t + \beta_{21} ST3_t + \beta_{22} D_{79t} + \beta_{23} D_{84t} + \beta_{24} D_{90t} + \beta_{25} D_{98t} + \beta_{26} D_{08t} + \varepsilon_t \ldots\ldots (\mathbf{5.14})$$

Table 5. 16: Estimated Coefficients of General Restricted Model

	Coefficients	Std. Error	t-values	Prob
PC_{t-1}	0.261779	0.06969	3.76	0.0003*
PC_{t-5}	0.0907781	0.04194	2.16	0.0324*
GDP_t	1.36298	0.07480	18.2	0.0000**
GDP_{t-1}	-0.427395	0.09492	-4.50	0.0000 **
GDP_{t-4}	-0.139870	0.07215	-1.94	0.0549*
GC_t	-0.107980	0.009298	-11.6	0.0000**
GC_{t-1}	-0.0339260	-0.01196	-2.84	0.0053*
GC_{t-4}	-0.0171924	0.00896	-1.92	0.0576*
Tax_t	-0.104110	0.02334	-4.46	0.0000**
Tax_{t-1}	-0.0517579	0.02333	-2.22	0.0284**
Tax_{t-4}	-0.0534855	0.01967	-2.72	0.0075**
Rem_t	0.0199719	0.00517	3.86	0.0002**
FW_{t-1}	0.106156	0.04679	2.27	0.0251**
P_t	-0.316970	0.1710	-1.85	0.0662***
P_{t-2}	0.370431	0.1709	2.17	0.0322**
$Infl_t$	0.198924	0.1112	1.79	0.0761***
$Intr_t$	0.0277674	0.01068	2.60	0.0105***
$Intr_{t-2}$	-0.0221428	0.01076	-2.06	0.0418**
$ST1_t$	0.0004914	0.00013	3.61	0.0004*
$ST2_t$	-0.0001806	0.00010	-1.68	0.0947**

$ST3_t$	0.000505	0.00001	5.06	0.0000*
D_{t79}	0.080864	0.03288	2.46	0.0153*
D_{t84}	0.115360	0.03079	3.75	0.0003*
D_{t90}	-0.116528	0.03025	-3.85	0.0002*
D_{t98}	-0.127149	0.03091	-4.11	0.0001*
D_{t008}	-0.0818049	0.03187	-2.57	0.0115*

R^2	0.999619	DW	2.18
RSS	0.113413	Sigma	0.03012
AIC	-6.84963	SC	-6.33010
HQ	-6.63857	FPE	0.00106
AR 1-5 test:	1.7677 [0.1251]	ARCH 1-4 test	1.3461 [0.2574]
Normality test:	2.0662 [0.3559]	Hetero test:	0.81359 [0.7729]
RESET test:	0.073461 [0.7868]		

Parameter Constancy Forecast and Diagnostic Tests

Forecast	17.674 [0.6089]	Chow	0.31037 [0.9980]

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values

The estimated coefficient of lag of private consumption and GDP are discussed already in pervious section. In addition reaming variables are as discussed below.

The coefficient of current lags of government consumption expenditure are negative and highly significant. The government consumption expenditure pick up the fiscal multiplier. This variable also explain the Ricardain behavior in the model. The negative coefficient of government consumption expenditure suggests that substitutability between private consumption and government consumption and it consistent back up to fourth period that capture crowding out behavior. These results support to non-Keynesian effect of fiscal policy action.

The coefficient of current indirect taxes are negatively related with private consumption back up to fourth lags and highly significant. This indicate that high indirect taxes discourage private investment. The coefficient of remittance inflow is positive and

statistically significant, this implies that one percent increase in inflow of remittance increased private consumption by 0.19%. The previous period of financial wealth is positive and statistically significant. This implies that one percent increase in financial wealth increased private consumption by 10%. The financial wealth have strong impact on private consumption because value of coefficient is quietly high.

The coefficient of current prices is negative and highly significant, this implies that current prices are faster than income, household increased their saving in order to preserve their wealth as a results reduced the private consumption. On the other hand pervious period prices and inflation rate are negatively related with private consumption and both are highly significant. The results are theoretically consistent with rational expectation permanent income hypothesis. Under the REH-PIH private consumption is not reduced in the presence of higher prices due to the wealth effect. The results suggests that high capital gain encouraging private consumption.

The coefficient of current interest rate is positive and lag of interest rate is negative and both are statistically significant. These variables capture the element of household decision making, it involved the behavior of individuals and time preference. However, in a traditional aggregate consumption models consumption is depend on the income and wealth. In fact interest rate and saving effect the private consumption through the channel of wealth. The overall changes in the private consumption to change in interest can be three main effects, first is income effect, second substitution effect and third is wealth effect. The substitution and income effect is depend on the utility function and initial level of interest rate. On the other hand the wealth effect is depend on the preference of consumer and expected future economic environment.

The positive sign of interest rate suggests an increase in interest rate increase current private consumption. This implies amount of future private consumption is more

expensive as compare to today. Thus peoples are better off in a life time sense, they save less today and consume more. Theoretically our results are consistent and this effect is called income effect.

The negative sign of the lag on interest rate indicate that an increase in interest rate decline private consumption. This indicate that an increased in interest rate decline expected value of feature income and capital income when individuals have accumulated the certain amount of assets. This implies that people worse off in lifetime sense and consume less today and save more for the future. Theoretically, this effect is called substitution effect. The alternative explanation is that in case of Pakistan private consumption is adversely affect through the budget deficit channel. An increase in interest rate is due to rise in budget deficit, this can lead to raise private saving, but it would not raise the overall national wealth because of increase in overall budget deficit. This would increase tax payments to financed debt services. The net effect would be decrease private income and private consumption. The model is passed through several diagnostic test which shows no problem in the model.

Furthermore, model 2.14 is simplified and construct the error correction model (see for more detailed derivation appendix A-v)

$$\Delta_4 PC_t = \theta_1 \Delta_4 PC_{t-4} + \theta_2 \Delta Y_t + \theta_3 \Delta GC_t + \theta_4 \Delta Tax_t + \theta_5 \Delta_4 Rem_t + \theta_6 \Delta_4 Fw_t + \theta_7 \Delta Fw_t + \theta_8 \Delta P_t + \theta_9 \Delta P_{t-1} + \theta_{10} \Delta_4 Infl_t + \theta_{11} \Delta Intr_t + \theta_{12} \Delta Intr_{t-1} + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.15})$$

Model 5.15 is called error correction model. The model is estimated by including special event dummies for the entire sample 1973Q2 to 2015Q4 as shown in table 5.17.

Table 5. 17: Estimated Coefficients of Error Correction Model

	Coefficients	Std. Error	t-value	Prob
ΔPC_{t-4}	-0.0733232	0.07347	-0.998	0.3199
ΔTax_t	-0.0429035	0.04008	-1.07	0.2861
$\Delta_4 Rem_t$	0.00268935	0.02173	0.124	0.9017
$\Delta_4 Fw_t$	0.126655	0.1235	1.03	0.3066
ΔFw_t	0.0161631	0.2344	0.0690	0.9451
$\Delta_4 Infl_t$	0.0728392	0.1342	0.543	0.5880
$\Delta Intr_t$	0.0183456	0.02800	0.655	0.5133
$\Delta Intr_{t-1}$	-0.0313061	0.02867	-1.09	0.2766
ΔY_t	0.107498	0.06152	1.75	0.0826***
ΔGC_t	-0.0370383	0.01472	-2.52	0.0129*
ΔP_t	1.47469	0.41151	3.58	0.0005*
ΔP_{t-1}	1.52061	0.39925	3.81	0.0002*
ECM_{t-4}	-0.001430	0.00045	-3.11	0.0022*
D_{t79}	0.129981	0.05468	2.38	0.0187*
D_{t84}	0.104010	0.05487	1.90	0.0600**
D_{t90}	-0.114173	0.05487	-2.08	0.0391**
D_{t98}	-0.0977153	0.05472	-1.79	0.0761***
D_{t008}	-0.153551	0.05728	-2.68	0.0082*
$\boldsymbol{R^2}$	0.528272	**DW**		1.92
RSS	0.05020	**sigma**		0.05528
AIC	-5.32271	**SC**		-5.32271
HQ	-5.17461	**FPE**		0.004885

*,*** indicate significance level at 10%, 5% and 1%

Table 5.17 report the estimated coefficients of error correction model. The results shows there is no relationship between ΔPC_{t-4}, ΔTax_t,$\Delta_4 Rem_t$, $\Delta_4 Fw_t$, ΔFw_t, $\Delta_4 Infl_t$, $\Delta Intr_t$ and $\Delta Intr_{t-1}$in short run. The coefficient of ΔY_t is positive and highly significant. This indicate that one percent change in income increase private consumption by 10%. ΔGC_t is negative in short run and long run (already discussed).

The changed in prices and lagged of change in price are positive and highly significant. This implies that quarterly changed in prices are positively associated with private consumption in short run and long run. The negative sign and highly significant coefficient of error correction term ECM_{t-4} indicate speed of adjustment toward the equilibrium point in the long run.

We have estimate several consumption models. We finally select the appropriate model from the above estimated models. Hendry proposed encompassing test on the non-nested model for the selection of parsimonious model. In the final step we apply encompassing test on non-nested model in next section.

Table 5. 18: Summary of Selected Model

	Model	R^2	DW	RSS	Sigma	AIC	SC
5.5	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta Rem_t + \varphi ECM_{t-4} + \varepsilon_t$	0.62268	2.18	0.496630	0.05531	-5.58365	-5.36385
5.7	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t$	0.35587	**2.29**	0.137559	0.05599	-2.22422	-2.02440
5.9	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta \Delta_4 Y_t + \varphi ECM_{t-4} + \varepsilon_t$	0.45902	2.18	0.603606	0.06085	-2.41197	-2.23213
5.11	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t$	0.358664	2.2	0.490293	0.05518	-5.14655	-4.96283
5.13	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi ECM_t + \varepsilon_t$	0.640685	2.18	0.495988	0.05533	-5.73760	-5.57225
5.15	$\Delta_4 PC_t = \theta_1 \Delta_4 PC_{t-4} + \theta_2 \Delta Y_t + \theta_3 \Delta GC_t + \theta_4 \Delta Tax_t + \theta_5 \Delta_4 Rem_t + \theta_6 \Delta_4 Fw_t + \theta_7 \Delta Fw_t + \theta_8 \Delta P_t + \theta_9 \Delta P_{t-1} + \theta_{10} \Delta_4 Infl_t + \theta_{11} \Delta Intr_t + \theta_{12} \Delta Intr_{t-1} + \varphi ECM_{t-4} + \varepsilon_t$	0.528272	1.92	0.05020	0.05528	-5.32271	-5.32271

Note:

(i) Model, 5.5, 5.9, and 5.20 $\mathrm{ECM_{t-4}} = (\mathrm{PC_{t-4}} - \mathrm{Y_{t-4}})$, and model 5.12, 5.18 $\mathrm{ECM_{t-4}} = (\mathrm{PC_{t-4}} - \mathrm{P_{t-4}} - \mathrm{Y_{t-4}})$, and model 5.15 $\mathrm{ECM_{t-4}} = (\mathrm{PC_{t-4}} - \mathrm{Y_{t-4}} - \mathrm{GC_{t-4}} - \mathrm{Tax_{t-4}} - \mathrm{Rem_{t-4}} - \mathrm{Fw_{t-4}} - \mathrm{Infl_{t-4}})$

(ii) For nested and non-nested see detailed appendix B table 1)

Final model is selected after the encompassing test on non-nested model as shown in table 5.19.

5.6 Encompassing Test

The concept of encompassing has been developed as a model evaluation criteria to capture the silent feature of data. In general an empirical model ability to explain all the characteristics of rival model and it is associated with non-nested hypothesis. It is important in encompassing that the vector of explanatory variable which is at least one variable is not common with other rival model. The following hypothesis are tested against the alternative hypothesis.

(i) H_a: $Model\ 1\ Encompassing\ Model\ 2\ \rightarrow model\ 1\ is\ better\ model$

(ii) H_b: $Model\ 2\ Encompassing\ Model\ 1\ \rightarrow model\ 2\ is\ better\ model$

(iii) H_c: $Model\ 1\ Encompass\ Model\ 2\ and\ Model\ 2\ Encompass\ Model\ 1\ \rightarrow$

$Both\ models\ are\ equivalent\ Models$

The encompassing test are carried out by using the several diagnostic tests. The diagnostic tests include Cox (1961 and 1962) non-nested hypothesis test, Ericsson (1992) instrumental variable test, Sargan (1964) restricted and unrestricted educe form test and Joint model F-test (*J- test*). The encompassing test shown in table 5.19.

Table 5. 19: Encompassing Test on Non-Nested Models

Model	H_a	H_b	H_c	Conclusion
Model 5.5 Encompass Model 5.7	reject	accept	reject	Model 5.7 is better Model
Model 5.7 Encompass Model 5.9	reject	accept	reject	Model 5.9 is better Model
Model 5.9 Encompass Model 5.11	reject	accept	reject	Model 5.11 is better Model
Model 5.11 Encompass Model 5.13	reject	accept	reject	Model 5.13 is better Model
Model 5.13 Encompass Model 5.15	reject	accept	reject	Model 5.15 is better Model

Table 5.19 indicate encompassing test on non-nested models. The table shows model 5.15 encompass all the competing models. This implies that model 5.15 is parsimonious model and better model, which is best fit model among all rivals model. This model

explained all the characteristics of other models (see detailed for statistical criteria appendix B).

5.7 Concluding Remarks

In this chapter we have estimated eight different consumption models that explain the private consumption. Initially we have estimate three well known consumption functions, absolute income hypothesis, permanent income hypothesis and random walk model by using the traditional econometric methodology. At the initial stage the empirical results are not much reliable and different econometric problems occurred like autocorrelation in residuals, heteroscedasticity, omitted variable problem and model miss specification issues in the model. In order to improve the empirical results as well as solve the econometric problems Hendry general to specific modelling approach is adopt. The general to specific modelling strategy help to improve the empirical results and issues of autocorrelation, conditional heteroscedasticity in residuals, omitted variable problem and model miss specification issues. The restricted model are derived from the general unrestricted model by applying the sequential reduction procedure. Furthermore, specific models are simplified by imposing sensible economic restrictions and constructed different error correction models for the short run and long run relationship. We develop the general consumption model for Pakistan, several variables are identified from literature and provide theoretical explanations of how the private consumption can be effected by change in GDP, remittances inflow, government consumption expenditure, indirect taxes, interest rate, financial wealth, prices and inflation rate. We estimate several consumption models and found that our general model encompass pervious estimated models. The empirical results shows that GDP, remittances, price and inflation are positively related with private consumption in short run and long run. The current interest rate is positive and pervious interest rate

is negatively related with private consumption. The government consumption expenditure and indirect taxes are negatively associated with private consumption. The empirical results suggest that private consumption is affected through different channels such as interest rate affect private consumption through saving channel and government expenditure effect the private investment through taxes.

CHAPTER- 6

CONCLUSION AND RECOMMENDATIONS

Model specification refers to the problem of choosing between candidates of models and it is important task in empirical modelling of economic data. The economic theory provide few evidence to economic relationship between variables. On the other hand when the statistical tests are applied on different economic models by using the same data set, tests carried out the unclear specification about the model and variables selection. However the area of model specification and selection of variable is quite vast and contention issue in literature of econometrics. In this study we have discussed several criteria, methods and procedures. We have identified several problems, it included model miss specification issues, autocorrelation problem, and conditional heteroscedasticity in residuals and omitted variable problem. In order to improve empirical results, we have used the Hendry general to specific modelling approach. This methodology improved the empirical results and resolve issues of autocorrelation, heteroscedasticity, omitted variable problem and model miss specification problem. We have estimated different models which explain the behavior of private consumption. The specific model have derived from the general unrestricted model by applying the sequential reduction procedure. Furthermore, specific model have simplified by applying sensible economic restriction and constructed error correction model for long run and short run relationship. In addition, we have encompass several rival models and found that our general model explain all characteristics of other rival models. The major finding of study as following.

- GDP and remittance are positively related with private consumption
- Financial wealth is positively associated with private consumption

- The current prices are negatively associated with private consumption and pervious period price and inflation rate are positively related with private consumption.
- The current interest rate is positive and pervious interest rate is negatively associated with private consumption.
- Government expenditures and indirect taxes has negative impact on private consumption.
- The fluctuation in stock market have no role to determine private consumption in case of Pakistan.
- The political instability, special events, law and order situation has adversely affect private consumption and vice versa.
- The global financial crisis have negative impact on private consumption in case of Pakistan.

7.1 Recommendations

There are main two economic policies, which are used to stabilized economy, monetary policy and fiscal policy. In our analysis government consumption expenditure and indirect taxes are the instrument of fiscal policy, and interest rate is instrument of monetary policy. The private consumption is affected by both instruments through different channels such as interest rate affect private consumption through saving channel and government expenditure effect the private investment through taxes. We have following recommendations.

- Pakistan relies mostly on the foreign and domestic loans, it has adversely affect the private consumption as well as overall economic activities and this will lead to increase against the debt services. Therefore reliance on foreign financing should be avoid and generate the domestic resources.

- The political instability, law and order condition and transparency should be improve which can attract the foreign investors.
- The state bank of Pakistan should conduct monetary policy efficiently and effectively with regard to its basic object of stabilizing prices under the fiscal control.

7.2 Limitation of Study

In this study we discussed different model selection criteria's, but we are unable to check the power and size of model selection criteria through different simulation methods.

7.3 Future Direction

This study is based on aggregate time series data. The use of micro level household data instead of aggregate can also produce more reliable and robust results. Moreover, it can be produce some interesting insights and contribute to existing literature on consumption. Furthermore, the power and size of model selection criteria's will be evaluate by using the Monte Carlo simulation.

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Appendixes (A)

Error Correction Model

(i) First we subtract the PC_{t-4} on both sides and add and subtract $\beta_0 Y_{t-4}$ and $\gamma_0 P_{t-4}$ to the right side of model.

$$PC_t - PC_{t-4} = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} - PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 P_t + \beta_0 Y_{t-4} - \beta_0 Y_{t-4} + \gamma_0 P_{t-4} - \gamma_0 P_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.11a})$$

The following restrictions are imposed on above equation

(i) $\beta_2 = -\beta_2$ (ii) $\beta_3 - 1 = -(\beta_0 + \beta_7) = (\beta_8 - \gamma_0) = -\gamma_0$ (iii) $\beta_6 = -\beta_6$

(iv) $\beta_9 = -\beta_9$

$$PC_t - PC_{t-4} = (\beta_1 - \beta_2)(PC_{t-2} + PC_{t-3}) + (\beta_3 - 1)PC_{t-4} + (\beta_4 - \beta_0)(Y_t - Y_{t-4}) + (\beta_5 - \beta_6)(Y_{t-1} - Y_{t-2}) + (\beta_3 - 1)Y_{t-4} + (\beta_8 - \gamma_0)(P_t - P_{t-4}) + (\beta_3 - 1)P_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.11b})$$

As we already discussed the difference operator, further model 5.11b is simplify

$\beta_1 - \beta_2 = \theta_1$, $\beta_4 - \beta_0 = \theta_2$, $\beta_5 - \beta_6 = \theta_3$, $\beta_8 - \beta_9 = \theta_4$, $\beta_8 - \gamma_0 = \theta_4$, $\beta_3 - 1 = \varphi$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi Y_{t-4} + \theta_4 \Delta_4 P_t + \varphi PC_{t-4} + \varphi Y_{t-4} + \varphi P_{t-4} + \varepsilon_t$$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi(PC_{t-4} - Y_{t-4} - P_{t-4}) + \varepsilon_t \ldots\ldots (\mathbf{5.11c})$$

This equation contains the error correction mechanism $PC_{t-4} - Y_{t-4} - P_{t-4} = ECM_{t-4}$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.11d})$$

The model 5.11d is error correction model which shows the long run and short run relationship between private consumption, GDP and price.

(ii) First we subtract the PC_{t-4} on both sides and add and subtract $\beta_0 Y_{t-4}$ on right side of equation

$$PC_t - PC_{t-4} = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} - PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-2} + \beta_6 Y_{t-5} + \beta_0 Y_{t-4} - \beta_0 Y_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.15a})$$

We imposed the following restrictions

(i) $\beta_0 = -\beta_0$ (ii) $\beta_2 = -\beta_2$ (iii) $\beta_3 - 1 = -\beta_0$ (iv) $\beta_6 = -\beta_6$ (v) $\beta_4 - \beta_0 = (\beta_5 - \beta_6) = \theta_2$

$$PC_t - PC_{t-4} = (\beta_1 - \beta_2)(PC_{t-2} - PC_{t-3}) + (\beta_3 - 1)PC_{t-4} + (\beta_4 - \beta_0)(Y_t - Y_{t-4}) + (\beta_5 - \beta_6)(Y_{t-2} - Y_{t-5}) - \beta_0 Y_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.15b})$$

We further simplify $\beta_1 - \beta_2 = \theta_1, \beta_4 - \beta_0 = (\beta_5 - \beta_6) = \theta_2, \beta_3 - 1 = -\beta_0 = \varphi$ and $\Delta\Delta_4 Y_t = (Y_t - Y_{t-4})(Y_{t-2} - Y_{t-5})$.

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta\Delta_4 Y_t + \varphi(PC_{t-4} - \beta_0 Y_{t-4}) + \varepsilon_t \ldots\ldots (\mathbf{5.15c})$$

$$\Delta\Delta_4 Y_t = (Y_t - Y_{t-4})(Y_{t-2} - Y_{t-5})$$

This equation contains the error correction mechanism $PC_{t-4} - Y_{t-4} = ECM_{t-4}$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta\Delta_4 Y_t + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.15d})$$

(iii) First we subtract the PC_{t-4} on both sides and add and subtract $\beta_0 Y_{t-4}$ and $\gamma_0 P_{t-4}$ to the right side of model.

$$PC_t - PC_{t-4} = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} - PC_{t-4} + \beta_4 Y_t + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \beta_8 P_t + \beta_0 Y_{t-4} - \beta_0 Y_{t-4} + \gamma_0 P_{t-4} - \gamma_0 P_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.17a})$$

Following restrictions are imposed on above equation

(i) $\beta_2 = -\beta_2$ (ii) $\beta_3 - 1 = -(\beta_0 + \beta_7) = (\beta_8 - \gamma_0) = -\gamma_0$ (iii) $\beta_6 = -\beta_6$

(iv) $\beta_9 = -\beta_9$

$$PC_t - PC_{t-4} = (\beta_1 - \beta_2)(PC_{t-2} + PC_{t-3}) + (\beta_3 - 1)PC_{t-4} + (\beta_4 - \beta_0)(Y_t - Y_{t-4}) + (\beta_5 - \beta_6)(Y_{t-1} - Y_{t-2}) + (\beta_3 - 1)Y_{t-4} + (\beta_8 - \gamma_0)(P_t - P_{t-4}) + (\beta_3 - 1)P_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.17b})$$

As we already discussed the difference operator, furthermore simplify the model

$\beta_1 - \beta_2 = \theta_1, \beta_4 - \beta_0 = \theta_2, \beta_5 - \beta_6 = \theta_3, \beta_8 - \beta_9 = \theta_4, \beta_8 - \gamma_0 = \theta_4, \beta_3 - 1 = \varphi$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi Y_{t-4} + \theta_4 \Delta_4 P_t + \varphi PC_{t-4} + \varphi Y_{t-4} + \varphi P_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.17c})$$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi(PC_{t-4} + Y_{t-4} + P_{t-4})$$

This equation contains the error correction mechanism $PC_{t-4} - Y_{t-4} - P_{t-4} = ECM_{t-4}$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_t + \varepsilon_t \ldots\ldots (\mathbf{5.17d})$$

(iv) First we subtract the PC_{t-4} on both sides and add and subtract $\beta_0 Y_{t-4}$ to the right side of model.

$$PC_t - PC_{t-4} = \beta_1 PC_{t-2} + \beta_2 PC_{t-3} + \beta_3 PC_{t-4} - PC_{t-4} + \beta_4 Y_t - \beta_0 Y_{t-4} + \beta_0 Y_{t-4} + \beta_5 Y_{t-1} + \beta_6 Y_{t-2} + \beta_7 Y_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.19a})$$

The following restrictions are imposed on above equation

(i) $\beta_2 = -\beta_2$ (ii) $\beta_3 - 1 = -(\beta_0 + \beta_7)$ (iii) $\beta_6 = -\beta_6$

$$PC_t - PC_{t-4} = (\beta_1 - \beta_2)(PC_{t-2} - PC_{t-3}) + (\beta_3 - 1)(PC_{t-4}) + (\beta_4 - \beta_0)(Y_t - Y_{t-4}) + (\beta_5 - \beta_6)(Y_{t-1} - Y_{t-2}) + (\beta_3 - 1)Y_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.19b})$$

We know that the equation in difference operator $\Delta PC_t = PC_t - PC_{t-1}$, $\Delta PC_{t-1} = PC_{t-1} - PC_{t-2}$, $\Delta PC_{t-2} = PC_{t-2} - PC_{t-3}$ and $\Delta_4 PC_t = PC_t - PC_{t-4}$,

We further simplify

$\beta_1 - \beta_2 = \theta_1, \beta_4 - \beta_0 = \theta_2, \beta_5 - \beta_6 = \theta_3, \beta_3 - 1 = \varphi$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi PC_{t-4} + \varphi Y_{t-4}$$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi(PC_{t-4} + Y_{t-4}) + \varepsilon_t \ldots\ldots (\mathbf{5.19c})$$

This equation contains the error correction mechanism $PC_{t-4} - Y_{t-4} = ECM_t$

$$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi ECM_t + \varepsilon_t \ldots\ldots (\mathbf{5.19d})$$

(v) First we subtract the PC_{t-4} on both sides and add and subtract $\beta_0 Rem_{t-4}$ $\omega_0 Fw_t$,$\emptyset_0 Fw_{t-4}$,$\gamma_0 P_{t-1}$, $\tau_0 Infl_{t-4}$ and $\theta_0 Intr_{t-1}$to the right side of model.

$$\begin{aligned} PC_t - PC_{t-4} = {} & \beta_1 PC_{t-1} + \beta_2 PC_{t-5} - PC_{t-4} + \beta_3 Y_t + \beta_4 Y_{t-1} + \beta_5 Y_{t-4} + \beta_6 GC_t \\ & + \beta_7 GC_{t-1} + \beta_8 GC_{t-4} + \beta_9 Tax_t + \beta_{10} Tax_{t-1} + \beta_{11} Tax_{t-4} \\ & + \beta_{12} Rem_t + \beta_0 Rem_{t-4} - \beta_0 Rem_{t-4} + \beta_{13} FW_{t-1} + \omega_0 Fw_t \\ & - \omega_0 Fw_t + \emptyset_0 Fw_{t-4} - \emptyset_0 Fw_{t-4} + \beta_{14} P_t + \beta_{15} P_{t-2} + \gamma_0 P_{t-1} \\ & - \gamma_0 P_{t-1} + \beta_{16} Infl_t + \tau_0 Infl_{t-4} - \tau_0 Infl_{t-4} + \beta_{17} Intr_t \\ & + \beta_{18} Intr_{t-2} + \theta_0 Intr_{t-1} - \theta_0 Intr_{t-1} + \varepsilon_t \ldots\ldots (\mathbf{5.21a}) \end{aligned}$$

Apply the following nine restrictions

$\beta_2 = -\beta_2, \beta_4 = -\beta_4, \beta_7 = -\beta_7, \beta_{10} = -\beta_{10}, \beta_{13} = -\beta_{13}, \gamma_0 = -\gamma_0, \beta_{15} = -\beta_{15}$

$\beta_{18} = -\beta_{18}, -1 - \beta_5 - \beta_8 - \beta_{11} - \beta_0 - \emptyset_0 - \tau_0 = \varphi$

$$\begin{aligned} PC_t - PC_{t-4} = {} & (\beta_1 - \beta_2)(PC_{t-1} - PC_{t-5}) + (\beta_3 - \beta_4)(Y_t - Y_{t-1}) \\ & + (\beta_6 - \beta_7)(GC_t - \beta_8 GC_{t-1}) + (\beta_9 - \beta_{10})(Tax_t - Tax_{t-1}) \\ & + (\beta_{12} - \beta_0)(Rem_t - Rem_{t-4}) + (\omega_0 - \emptyset_0)(Fw_t - Fw_{t-4}) \\ & + (\omega_0 - \beta_{13})(Fw_t - Fw_{t-1}) + (\beta_{14} - \gamma_0)(P_t - P_{t-1}) \\ & + (\gamma_0 - \beta_{15})(P_{t-1} - P_{t-2}) + (\beta_{16} - \tau_0)(Infl_t - Infl_{t-4}) \\ & + (\beta_{17} - \theta_0)(Intr_t - Intr_{t-1}) + (\theta_0 - \beta_{18})(Intr_{t-1} - Intr_{t-2}) \\ & + \varphi(PC_{t-4} - Y_{t-4} - GC_{t-4} - Tax_{t-4} - Rem_{t-4} - Fw_{t-4} - Infl_{t-4}) \\ & + \varepsilon_t \ldots\ldots (\mathbf{5.21b}) \end{aligned}$$

We know that the equation in difference operator $\Delta PC_t = PC_t - PC_{t-1}$, $\Delta PC_{t-1} = PC_{t-1} - PC_{t-2}$, $\Delta PC_{t-2} = PC_{t-2} - PC_{t-3}$ and $\Delta_4 PC_t = PC_t - PC_{t-4}$,

Furthermore simplify the above model. This model contain the error correction term

$PC_{t-4} - Y_{t-4} - GC_{t-4} - Tax_{t-4} - Rem_{t-4} - Fw_{t-4} - Infl_{t-4} = ECM_{t-4}$

$\beta_1 - \beta_2 = \theta_1,\ \beta_3 - \beta_4 = \theta_2,\ \beta_6 - \beta_7 = \theta_3,\ \beta_9 - \beta_{10} = \theta_4,\ \beta_{12} - \beta_0 = \theta_5,\ \omega_0 - \emptyset_0 = \theta_6, \omega_0 - \beta_{13} = \theta_7, \beta_{14} - \gamma_0 = \theta_8, \gamma_0 - \beta_{15} = \theta_9, \beta_{16} - \tau_0 = \theta_{10}, \beta_{17} - \theta_0 = \theta_{11}, \theta_0 - \beta_{18} = \theta_{12}$

$$\Delta_4 PC_t = \theta_1 \Delta_4 PC_{t-4} + \theta_2 \Delta Y_t + \theta_3 \Delta GC_t + \theta_4 \Delta Tax_t + \theta_5 \Delta_4 Rem_t + \theta_6 \Delta_4 Fw_t + \theta_7 \Delta Fw_t + \theta_8 \Delta P_t + \theta_9 \Delta P_{t-1} + \theta_{10} \Delta_4 Infl_t + \theta_{11} \Delta Intr_t + \theta_{12} \Delta Intr_{t-1} + \varphi ECM_{t-4} + \varepsilon_t \ldots\ldots (\mathbf{5.21c})$$

Appendixes (B)

Table 1: Nested and Non-Nested Models

	Model	Nested	Non-Nested
5.5	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta Rem_t + \varphi ECM_{t-4} + \varepsilon_t$		5.10 - 5.12
5.7	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t$		5.12 - 5.16
5.9	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta \Delta_4 Y_t + \varphi ECM_{t-4} + \varepsilon_t$		5.16 - 5.12
5.11	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-2} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \theta_4 \Delta_4 P_t + \varphi ECM_{t-4} + \varepsilon_t$		5.16 - 5.18
5.13	$\Delta_4 PC_t = \theta_1 \Delta PC_{t-1} + \theta_2 \Delta_4 Y_t + \theta_3 \Delta Y_{t-1} + \varphi ECM_t + \varepsilon_t$		5.18 - 5.20
5.15	$\Delta_4 PC_t = \theta_1 \Delta_4 PC_{t-4} + \theta_2 \Delta Y_t + \theta_3 \Delta GC_t + \theta_4 \Delta Tax_t + \theta_5 \Delta_4 Rem_t + \theta_6 \Delta_4 Fw_t + \theta_7 \Delta Fw_t + \theta_8 \Delta P_t + \theta_9 \Delta P_{t-1} + \theta_{10} \Delta_4 Infl_t + \theta_{11} \Delta Intr_t + \theta_{12} \Delta Intr_{t-1} + \varphi ECM_{t-4} + \varepsilon_t$		5.20 - 5.22

Table 2: Encompassing Test

	Model 5.5 vs. Model 5.7	Model 5.7 vs. Model 5.5
Cox	1.774 [0.0761]	-10.60 [0.0000]**
Ericsson IV	-1.848 [0.0646]	7.781 [0.0000]**
Sargan	3.4973 [0.1740]	56.852 [0.0000]**
Joint Model	1.7651 [0.1745]	87.340 [0.0000]**
	Model 5.7 vs. Model 5.9	Model 5.9 vs. Model 5.7
Cox	0.2419 [0.8088]	-2.635 [0.0084]**
Ericsson IV	-0.2372 [0.8125]	2.547 [0.0109]*
Sargan	2.371 [0.1705]	29.792 [0.0000]**
Joint Model	1.4216 [0.6733]	36.329 [0.0000]**
	Model 5.9 vs. Model 5.11	Model 5.11 vs. Model 5.9
Cox	-0.4396 [0.6603]	-11.33 [0.0000]**
Ericsson IV	0.4216 [0.6733]	8.603 [0.0000]**
Sargan	1.821 [0.0686]	78.161 [0.0000]**
Joint Model	1.774 [0.1861]	20.758 [0.0000]**

	Model 5.11 vs. Model 5.13	Model 5.13 vs. Model 5.11
Cox	1.391 [0.1642]	-112.2 [0.0000]**
Ericsson IV	-1.328 [0.1842]	60.95 [0.0000]**
Sargan	2.977 [0.1193]	128.39 [0.0000]**
Joint Model	1.906 [0.07937]	57.939 [0.0000]**
	Model 5.13 vs. Model 5.15	Model 5.15 vs. Model 5.13
Cox	-1.445 [0.1485]	-31.52 [0.0000]**
Ericsson IV	1.371 [0.1705]	12.80 [0.0000]**
Sargan	1.942 [0.0521]	137.01 [0.0000]**
Joint Model	1.7651 [0.1745]	166.57 [0.0000]**

*,*** indicate significance level at 10%, 5% and 1%
[ ] shows the p-values