

Ghauri, Saghir Pervaiz; Ahmed, Rizwan Raheem; Vveinhardt, Jolita; Streimikiene, Dalia

Article

Estimation of Relationship between Inflation and Relative Price Variability: Granger Causality and ARDL Modelling Approach

Amfiteatru Economic Journal

Provided in Cooperation with:

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Suggested Citation: Ghauri, Saghir Pervaiz; Ahmed, Rizwan Raheem; Vveinhardt, Jolita; Streimikiene, Dalia (2017) : Estimation of Relationship between Inflation and Relative Price Variability: Granger Causality and ARDL Modelling Approach, Amfiteatru Economic Journal, ISSN 2247-9104, The Bucharest University of Economic Studies, Bucharest, Vol. 19, Iss. 44, pp. 249-274

This Version is available at:

<https://hdl.handle.net/10419/169068>

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ESTIMATION OF RELATIONSHIP BETWEEN INFLATION
AND RELATIVE PRICE VARIABILITY: GRANGER CAUSALITY
AND ARDL MODELING APPROACH

**Saghir Pervaiz Ghauri¹, Rizwan Raheem Ahmed², Jolita Vveinhardt³
and Dalia Streimikiene^{4*}**

^{1) 2)} *Indus University, Karachi, Pakistan*

^{3) 4)} *Lithuanian Sports University, Kaunas, Lithuania*

Please cite this article as:

Ghauri, S. P., Ahmed, R. R., Vveinhardt, J. and Streimikiene, D., 2017. Estimation of Relationship between Inflation and Relative Price Variability: Granger Causality and ARDL Modelling Approach. *Amfiteatru Economic*, 19(44), pp. 249-274

Article History

Received: 25 September 2016

Revised: 12 November 2016

Accepted: 12 December 2016

Abstract

The objective of this research paper is to examine the relationship between relative price variability and inflation by using consumer price index (CPI) of Pakistan. The outcomes of the research further divided into food and non-food groups too. The monthly data of CPI was taken from the Pakistan Bureau of Statistics, from August 2001 to July 2011 (with 2000-01 base) for 92 composite commodities with 12 sub-groups. We employed the Granger causality testing approach for the evaluation of any possible influence of one indicator to another. In this scenario, it is viable to state that there is a presence of causality and bidirectional feedback between the variables or the two variables are independent. The major issue is to identify a suitable statistical method that enables us to analyze the association among the variables. The findings of this study demonstrated that there is a probable relationship between inflation (DP_t) and both un-weighted measures of price variability (VP_t and SP_t) for the whole items that have been considered for the analysis. Apart from that, this association also exists between food and non-food categories of CPI basket.

Keywords: CPI basket, consumer price index, food & non-food group, inflation, Granger-causality, relative price variability

JEL Classification: B23, E30, E31, E52

Introduction

The relationship of relative price variability with inflation, monetary, and income development have attracted noteworthy consideration in terms of investigation of the

* Corresponding author, **Dalia Streimikiene** – dalia.streimikiene@lsu.lt

economy on theoretical and empirical basis (Chronis, 2016; Gu et al., 2016; Lis and Zwierchlewski, 2016; Skare and Benazic, 2015; Krajewski, 2005). Though empirical and theoretical models have usually forecasted an affirmative relationship, however, the direction of this association has not been substantiated through these empirical investigations. Although, number of studies has been proposed in the support of positive association between the variables, several researches have also reported an adverse association between variation in prices and inflation. In the view of Reinsdorf (1994) the relationship between these variables is adverse during the decade of 1980s with respect to the United States of America. On the other hand, Fielding and Mizen (2000) and, Silver and Ioannidis (2001) reported similar results for different European countries as well. On the contrary, theoretical similarities such as cost of menu and asymmetric proof predict an affirmative association between relative price variability and inflation. The empirical studies have outlined variety of outcomes in this respect, which is related to trivial and significant relationship between the two variables (Baglan et al., 2016; Blejer, 1983).

Beginning with the research of Parks (1978), which indicated that relative price variations witness an increasing trend more during the periods of decrease in price as compared to the situation in which prices increase. The different directions of the study have raised questions regarding the functional type of association and offered proof of a quadratic association. The proof of the relationship related to threshold changes somewhat from one country to another and depends upon the type of inflation RPV nexus. Cukierman (1982; 1983) has provided a relevant survey regarding the undertaken subject matter. However, the classic elaboration supports the association between relative price variability and level of inflation. Although, different sectors might react differently to the nominal shocks that they suffer in the market. As the fixed cost is associated with the changes in the level of prices; therefore, the prices of goods change only at separated and isolated intervals, which develops deviations in relative prices.

Baglan et al. (2016) attempted to understand the power of relative price variations (RPV) in explaining inflation in Turkey by using monthly micro-pricing data of 128 Turkish goods and services in 13 different cities/regions of the country. Semi-parametric regression revealed a hump shaped relationship between the two measures with RPV at it's the highest when inflation was registered at 20%. The result was consistent with tariff rate models that features Calvo (1983) pricing with an endogenous bond erection and zero-state rise in prices.

The association between rise in the prices of goods and services, and variations in the prices across different countries have made substantial interests for the researchers and financial economists (Parks, 1978; Vining and Elwertowski, 1976). The leading argument vis-à-vis causality direction has always been in discussion. The causal link between one way or the other has been ascertained by the models and theories, and it is further suggested that certain distinct factors may also cause RPV and inflation concurrently.

Dabús and Cerioni (2000) have studied the causality in the association between inflation and RPV with respect to 6 Latin American countries those have a history of suffering from inflation. This study focuses on four inflationary regimes. According to the findings the affirmative association has been seen in most of the cases along with efficient rise in RPV at greater inflation. The results of the Granger causality test illustrated a rapid causality, and Granger causality from inflation to RPV. They further concluded the significant affect of relative price variability and inflation in all the cases.

In the context of Pakistan, the association between inflation and relative variation in prices was evaluated in different researches. One research was undertaken by Mohsin and Gilbert (2008), which was concerned with the estimation of the prices conjunction of city in overall CPI for the time period of July 2001 to June 2008. Another study in this respect was undertaken by Akmal (2012), which explored the association between the inflation and variations in the relative prices in Pakistan by employing groups of products. Both of these researches ignored the causal association between these variables while modelling the relationship between the independent and the dependent variable. Nevertheless, the evaluation of the literature revealed that some researchers have applied Granger's causality test to establish the cause and effect importance between these variables and the direction in which the relationship is flowing.

The aim of this study is to use consumer price index (CPI) inflation to explain variations in the relative prices of varied consumer goods and services. It is suggested that relative variations in prices move in tandem with the variations in national inflation with some anomalies. Changes in the national CPI from one period to the next in a time-series are analyzed using stable distributions to understand and document their unique characteristics in order to extrapolate and superimpose those characteristics into explaining variations in relative prices amongst consumer goods.

The current paper is one of the few researches, which has reflected on the association between RPV and inflation on consumer price index data of Pakistan on monthly basis for the period of ten years for overall and also for twelve sub groups. The remainder of paper consists on previous literature, estimation techniques, findings and results, and conclusions.

1. Theoretical approach

The research of Parks (1978), which is concerned with the transformations in the relative prices and inflation fundamentally motivated various researchers to examine the association between these two variables. The research of Glejser (1965) identified an important factor related to changes in relative prices for the period 1953-1959 for 15 countries, and those were part of OECD. Similarly, a research was conducted by Okun (1971), which took into consideration 17 countries of OECD from the period of 1951-68 and concluded the significant association between mean inflation and standard deviation of the GDP deflator.

According to Chronis (2016) stable distribution is a useful statistical tool that has found its way into plotting and explaining unique phenomena in several social science disciplines including economics. Repeat sampling allows us to capture the nature, trend and characteristics of our series to explain the variable under study. Since inflations generally are stable in nature and several indicators give prior warnings of impending inflations, they have a stable trend, thus our choice of the "stable distributions" model to study its characteristics.

Gu et al. (2016) tried to understand the marginal impact of inflation in explaining variations in prices of goods in several Chinese provinces. Regression analysis showed that the relationship was significant with high variations in inflation explaining the relative differences in prices in the Chinese market. Low variations in inflation did poorly explaining the relative price variations. This result substantiates the economic policy objective of setting low inflation targets in China, as high inflation causes severe distortions in prices.

According to Wolman (2016), US relative prices registered varying trends which need to be captured and controlled by adjusting the cost prices of goods and services. Adjusting for the cost prices would take care of severe price spikes and variability of certain goods thereby helping to predict inflation with somewhat accuracy. The US service industry has experienced dramatic increases in prices relative to the durable goods industry. Since a CPI index is a conglomeration of several goods and services, price adjustments work to reduce distortions in cost prices and help to ascertain the real inflation (adjusted for cost prices).

According to Ahmed et al. (2016) the low income developing countries' monetary policy is to stabilize their business cycles to achieve economic stability. The researchers have found out that several developing economies aspiring for a middle income status have added an additional objective of setting inflation targets to influence relative prices of goods and services. The study further reveals that variations in relative prices of most of the goods and services do not accurately explain the distortions in inflation and discrediting previous studies, those showing a positive and stable relationships between relative price variability (RPV) and inflation.

Baglan et al. (2016) examined the relationship between relative price variability and inflation with the help of employing micro price data on a monthly basis for 128 commodities in 13 different regions of Turkey for the time period from 1994 to 2010. There is a unique characteristic of the taken data time series including annual inflation in the range of 0% to 90%. Projections in this respect highlighted a significant and an affirmative relationship between level of inflation and RPV. It was also evaluated that the highest amount of price variability is gained when inflation on the yearly basis is around 20%. Therefore, it can be concluded that these results are in lined with metropolitan alike menu cost (price) model that comprises on Calvo (1983) pricing through internal assembly bond.

Hajzler and Fielding (2014) have theorized that substantial empirical literature exists that establishes an association between inflation and relative price variations (RPV), and relative inflation variability (RIV) across goods and situations. While early empirical theory on relative inflation variability has its bases on the signal-extraction models, contemporary relative price variability has produced results inconsistent with signal-extraction theory. In particular, while RIV is rising in the utter prices of inflation shocks, RPV is a negative monotonic function of inflation shocks. They show that consumer search theory offers a potential explanation for these apparently contradictory observations.

Ghauri et al. (2014) analyzed the role of pricing mediators as emphasized in relative price transformations in reaction to the features of supply and demand. They have also analyzed the model of Parks (1978) on the basis of monthly data, which is related to CPI of Pakistan. The results have highlighted that variations in the relative prices was decided generally through the factors of supply as it has been highlighted in unforeseen inflation. The factors of demand such as changes in the real income of a country were explored as insignificant for the determination of the level of RPV.

Akmal (2011) examined the relationship between inflation and relative price variability with the help of non-aggregated CPI data for Pakistan. The application of statistical techniques indicated the ambiguous association between relative variations of prices and inflation. On the other hand, the systematic regression method indicated that association is not significant throughout all the rolling samples. Apart from that, it may not be appropriate to adopt anti-inflationary policies if the relationship between inflation and RPV is

insignificant. The studies of Parsley (1996), and Lastrapes (2006) have the opinion that the increase in the level of inflation lead towards increase in RPV only in the condition if it leads towards increase in the threshold value. In one of the researches undertaken by Head and Kumar (2005) investigated the monetary examination by applying Calvo (1983) type model, and results have been stipulated the inverse connection between inflation and relative price variability in Japan and China.

Tommasi (1992), Caglayan et al. (2008), Debelle and Lamont (1997) established a V-shaped association between inflation and relative price variability. The studies also reported the U shaped outlined that the inverse association is identified among the countries that have low inflation irrespective of information technology adoption. It has been observed among targets of high inflation only after the process of adopting the information technology. Nevertheless, no shift has been observed among the targets of high inflation.

Choi (2010) through his research applied judgment regarding the association between RPV and inflation on the basis of non-aggregated data for consumer price index for the US and Japan. They explored a negative association between rise in prices and changes in relative prices. On the contrary, the association was not stable over a period of time and it changed in a significant manner with the transformations in the inflationary practices. As a result of that, the results of the general price setting between inflation and relative changes in prices are in contradiction with the prevailing theoretical models which predict a positive relationship regarding menu prices.

Balderas and Rogelio (2009) examined the remittances and relative piece variability that affect the inflation of 32 Latin American countries for the two years. They have used panel data of 224 observations with different modelling techniques. The Findings suggest that there is an affirmative association between overall level of prices and transfer of funds. On the other hand, when they non-aggregated the overall level of prices with respect to the type of expenditure into 7 different categories of activities of the industry, they concluded a significant positive association only in education and house hold sectors, but it is inconclusive to establish the overall association between RPV and remittances. Rather, the five important sectors demonstrated a negative association.

It has been evaluated that in both short and long run, Ukoha (2007) explored significant affect of overall inflation on the price variability of agricultural products through 1970-2003 in Nigeria. The fluctuations in the level of prices of agricultural commodities estimated the significance of this association in in the long-term in Nigeria. In another interesting research by Nath (2004), in which modern correlations techniques were employed to compare the long-term and short-term relationships between RPV and Inflation. In both instances the relationships were found to be positive and the research emphasized the need, to incorporate special features in the models to bring the short and long term results into harmony and coherence.

Another study conducted by Chang and Cheng (2000) that examined the discrete data set of the prices of the United States after the period of war and highlighted the association between variability levels in the prices inflation. As a first step they utilized a model to evaluate the variations in the level of prices, which are subject to unforeseen inflation and the changes in inflation. Afterwards, they explored the proof that RPV has a noteworthy association with inflation as well as the fluctuations in the level of relative prices.

Furthermore, they emphasized upon the fact that prices of oil continue to be the strong shudder in the development of this association.

Silver and Ioannidis (2001), and Fielding and Mizen (2000) came up with the similar outcomes for different European countries. This original course of study has raised objections regarding the prevailing functional mode of the association, and demonstrated the quadratic relationship. The robust threshold effects changes from one country to another. Balk (1985) attempts to determine the direction of causality between relative inflation and relative prices fell flat on its facade when evidence he collected pointed to an inconclusive direction of the above mentioned relationship.

The research of Jaramillo (1999) suggested that the affects of inflation on relative price variability (RPV) is always significant when it is lower than 0. In the same way, Carabello et al. (2006) reported that the situation of positive relationship differs in Argentina and Spain where the positive relationship is stronger when the rate of inflation is high and reached at an alarming rate in Argentina. According to Caglayan and Filiztekin (2003) the association is significantly dissimilar in higher and lower inflationary periods in the case of Turkey. However, during the higher inflation period, the relationship is weak between RPV and inflation. According to Bick and Nautz (2008) an adverse implications of inflation have been indicated on relative price variability only in the situation if it enhances the value of threshold in the United States.

The Outcomes that were derived from the region of Europe by Nautz and Scharff (2012) evaluated that inflation leads towards reduction of RPV just in the case of extremely low or high inflation. The affects of RPV and inflation have been examined by Choi and Kim (2010) in case of the United States, Japan, and Canada. Becker (2011) studied the European countries' data, and Fielding and Mizen (2008) undertook research in the context of the US. In addition to that, in one of the researches related to the impact of inflation aiming on the association of inflation and its linkage with RPV. Choi et al. (2011) evaluate a set of data consisting of 20 emerging countries that comprised of 12 targeters and 8 non-targeters which also involve Turkey during the period of moderation They indicated that the causative association between RPV and inflation is inverse, and in majority of the cases, these results are consistent with previous researcher such as, Fielding and Mizen (2008), and Choi and Kim (2010).

Lach and Tsiddon (1992) discussed about the influence of inflation, which has on the food costs that vary for the tenure of 6 years in Israel. This impact was found much unexpected as compared to other studies. Loy and Weaver (1998) got the similar outcomes in Russia, the result depicted that a predictable inflation actually persuaded disturbance in prices, not an unpredictable inflation.

Cukierman and Wachtel (1982) researched about the outline which was based on Parks' study excluding the allowed inflation anticipations that had variations across marketplaces. According to the different markets, the balance prices have variance and predictions of inflation may also vary as well. There was a direction shown the favourable relationship between cost that varies and predictable inflation. According to their study, either the collective demand or supply shocks are the reason behind this variation which resulted in variability of price.

Fischer (1982) discussed about the economies of Germany and the United States and their inflation and price relation to get the knowledge about inflation and its cost. According to

him, these two factors are the pillar for both the economies. The VAR model assessments ended that due to policy reactions to supply shocks, the inflation and inconsistently decreased.

Venning and Elwertowski (1976) discussed that there was a connection between changes in prices and inflation instability in the USA. The results demonstrated that there was a link between wholesale and consumer price index and it showed the inconsistency of difference in price through integration of each sub-index of the main sequence and at every stage the variance was estimated. Due to some pitfalls of calculations, this research was criticized. However, Granger causality test was used by Ashley (1981), and concluded that variations in price difference because of variations in the inflation.

2. Data and Methodology

Through the Pakistan Bureau of Statistic, the CPI was derived from the month of August 2001 to July 2011. There were 92 goods with 12 subgroups. This study requires both, the prices of goods and their weights. That is why 92 indices for food and non-food groups have been taken.

Unit Root Test. In this test, the order of combination of the individual series is included, various measures for this test have been established. Augmented Dickey-Fuller (ADF) test (1979; 1981) was the effective one. It depends on refusing a null hypothesis of this test which shows that it favors the alternative hypothesis. This test is generally calculated by following regression:

$$\Delta y_t = \alpha_0 + \alpha_1 y_{t-1} + \sum_{i=1}^n \alpha_i \Delta y_t + e_t \quad (1)$$

where y represents time series, t shows time period, the first difference operator is Δ , a constant is α_0 , and n shows the finest no of lags in the dependent variable, and e represents the random error terms.

Data construction and variables. To create the data of the variables, the data set is used, which is required for this research. Following variables must be defined first. Let P_t becomes the Consumer price index of every good in month t . After that the inflation in month t is described as:

$$DP_t = \ln(P_t) - \ln(P_{t-1}), \quad (2)$$

Variance (VP_t) which is one of the relative price variability (RPV) in month t is described as:

$$VP_t = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (DP_{it} - \overline{DP}_t)^2} \quad (3)$$

Where $\overline{DP}_t = \frac{1}{n} \sum_{i=1}^n DP_{it}$, the average change in prices (averaged through 92 composite stuffs) in time period t . This should be also considered that i is an indexes consumption goods, and then n is denoted the number of goods.

This shows that the variable is actually the standard deviation change in price¹. And the other one is the skewness of changes in prices for all goods in month time period t is expressed as follows:

$$SP_t = \frac{1}{(n-1)(n-2)} \sum_{i=1}^n \left(\frac{DP_{it} - \overline{DP}_t}{VP_{it}} \right)^3 \tag{4}$$

When the construction of the series is made, the pair wise Granger Causality test is verified for entire CPI, non food, and food groups.

Vector autoregressive (VAR) models. The way of causality is tested in this model. This is actually different from the concept which is common nowadays. It shows the ability of one variable to forecast the other one. Assume two variables, y_t and x_t , which are affecting themselves with spreader lags. This model can notice the link which these variables have between them. So it can be stated that as:

- X_t is caused by y_t
- Y_t is caused by x_t
- Two way comments which shows the causality between the variables
- These two variables are independent in nature

Now the cause and effect relationship which the variables have between each other must be tested and statistically detected by any relevant technique.

Granger Casualty Analysis. This analysis is to test the causality of the time series data, and this model was established by Granger (1969). A variable x_t is caused by y_t , incase if it can forecast the x_t with greater number of accuracy with the usage of y_t past value.

The first step of this test is the calculation by the VAR model and given as follows:

$$y_t = \alpha_1 + \sum_{i=1}^n \beta_i x_{t-i} + \sum_{j=1}^m \gamma_j y_{t-j} + e_{1t} \tag{5}$$

¹ All these estimates are un-weighted, in this research we also build these as weighted estimates. The weighted measures are estimated as provided the basis by Parks (1978). Therefore, the weighted mean inflation in time period t is described as weighted variance is defined as and weighted skewness is defined as where w_i is known as the relative weight of the items i in time period t , and, $\sum_{i=1}^n w_{it} = 1$.

$$x_t = \alpha_2 + \sum_{i=1}^n \theta_i x_{t-i} + \sum_{j=1}^m \delta_j y_{t-j} + e_{2t} \quad (6)$$

Where e_{1t} and e_{2t} are known as the uncorrelated white noise error expressions. In our taken model following four different cases to be happened:

Case 1: y_t is caused by x_t because there is a difference between lagged x terms in equation (5) and zero, and there is not a difference between lagged y terms in equation (6) not and zero.

Case 2: x_t is caused by y_t , as there is a variance amongst the lagged y expressions in mathematical equation (6) and zero, and there is not a difference between lagged x terms in equation (5) not and zero.

Case 3: two-way causality is there. because there is a difference between sets of x and y terms and zero in equation (5) and (6).

Case 4: y_t is dependent of x_t because there is a difference between both sets of x and y and zero in equation (5) and (6).

Then the following steps are included in this test also;

Measuring the model of VAR with the help of Eview's utility test. Applying the test of Granger causality. Here null hypothesis shows that x_t is not caused by y_t . If there is a situation that value of F computed > F critical value, thenceforth, the null hypothesis rejected, and it is finalized that x_t is caused by y_t .

An Autoregressive Distributed Lag (ARDL) Modeling Approach. Illustration for the association for ARDL testing approach has developed as specified below:

$$\Delta Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \sum_{i=1}^k \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^k \beta_{2i} \Delta X_{t-i} + \epsilon_t, \quad (7)$$

Wald coefficient restriction estimation used to test the presence of valid long run association by taking the null hypothesis of $\beta_1 = \beta_2 = 0$. In this test we equated the F computed value with the group of critical values from 4.93 to 5.73 for the lag 1 (at 5% critical level), as formulated and proposed by Pesaran et al. (2001). A computed value of F is greater than the higher level, which shows that there is a relation between the variables.

3. Results and discussion

The quick view on the data exhibits the positive association between the variables, and can be observed from the scatter plot diagrams for the pairs of the variables. Since we have used two measures of relative price variability i.e. Vp_t , & Sp_t , for overall and sub-groups of CPI data so we draw 12 pairs with Dp_t for all series (see Figure no. 1 and Figure no. 2). By viewing both figures 1 and 2, we can say that there is positive and strong relationship between almost all pairs of Dp_t vs. Vp_t and Dp_t vs. Sp_t for overall and subgroups of CPI data.

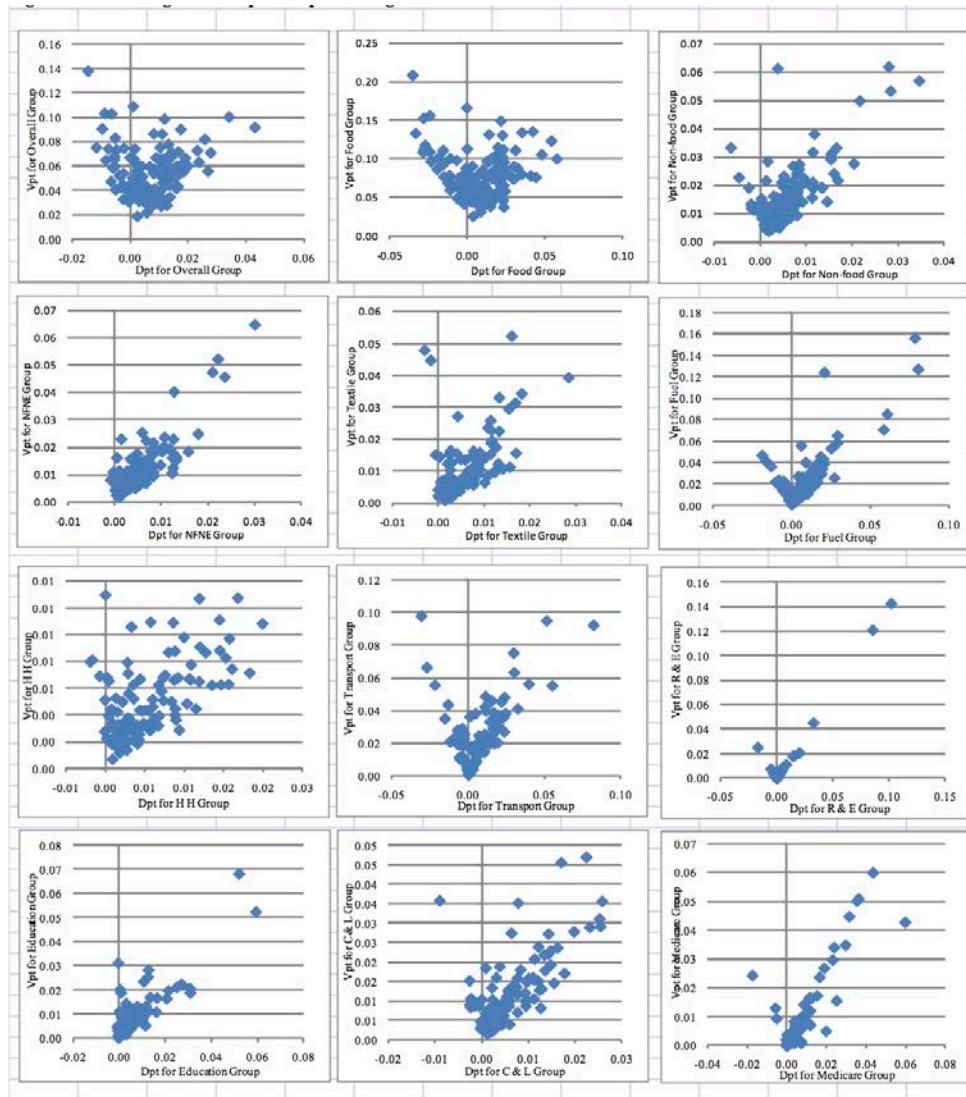


Figure no. 1: Scatter Diagram for *Dpt* and *Vpt* of sub-groups- Unweighted

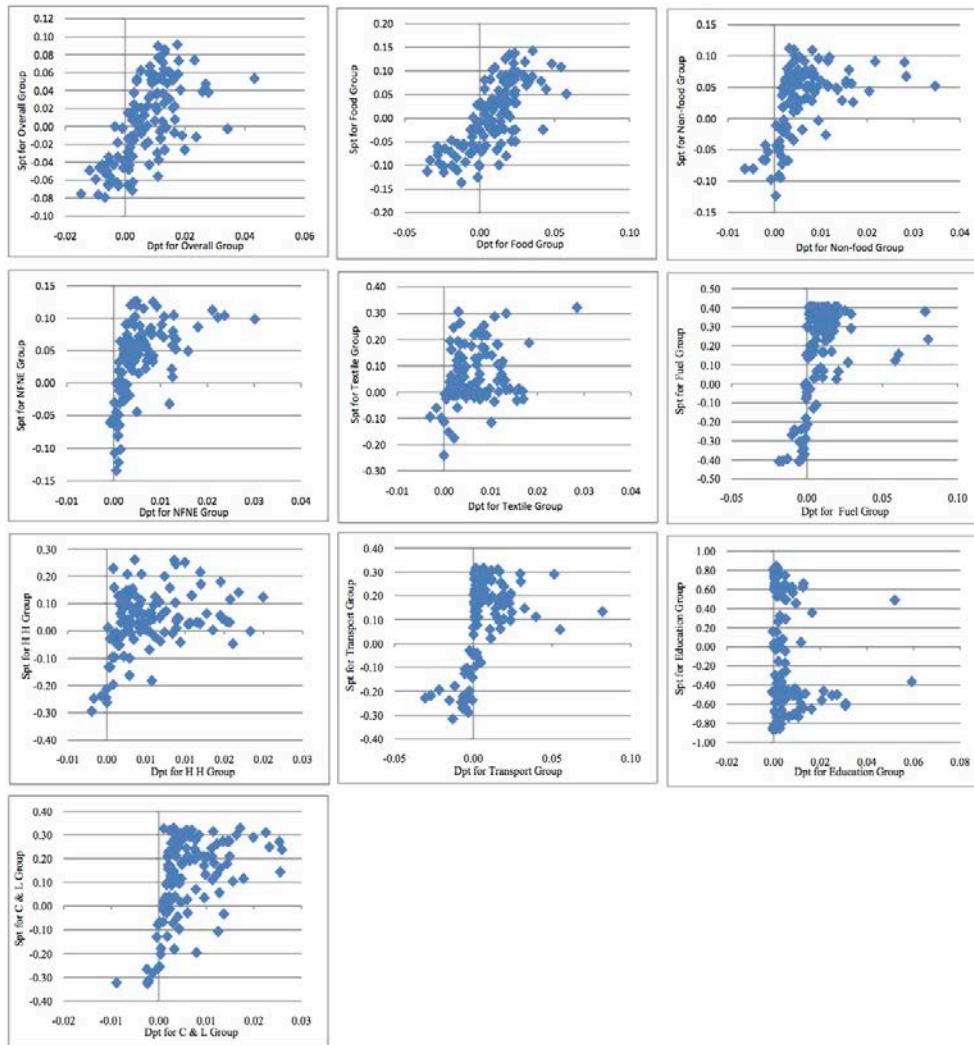


Figure no. 2: Scatter Diagram for Dpt and Spt of sub-groups – Unweighted

Augmented Dickey-Fuller testing approach. The important step to way forward is to check the Stationarity of the data time series. Since, Granger causality approach requires that all the data series have to be stationary. Therefore, for this purpose we used unit root test, and ADF is the most widely used test, thus, ADF test has employed in order to check the Stationarity of all the data series (Dp_t , Vp_t , & Sp_t for overall and sub-groups of CPI data). All series used in this study, the results of ADF show that null hypothesis has rejected for non-stationarity at 5% level of significance. The non-stationary at level (became stationary at 1st difference) includes two sub groups of Dpt , non-food and cleaning laundry and personal appearance (g_9) and the other rest are stationary at level. So Granger causality is not applied to those pairs associated with these (Dp_t vs. Vp_t & Dp_t vs. Sp_t) series.

Akaike Information Criteria (AIC). Since the Granger causality test is multifaceted to the no of lags that is incorporated in the regression. Therefore, the Akaike information criteria (AIC) is applied to identify the appropriate no of lags (see Figures no. 3, 4 and 5). Since we have used two measures of relative price variability i.e. Vp_t , and Sp_t , for overall and sub-groups of CPI data, therefore, we draw 12 pairs with Dp_t for all series (see Figures no. 3, 4 and 5). The figures no. 3 and no. 4, depict that there is positive and strong relationship between almost all pairs of Dp_t vs. Vp_t and Dp_t vs. Sp_t for overall and subgroups of CPI data.

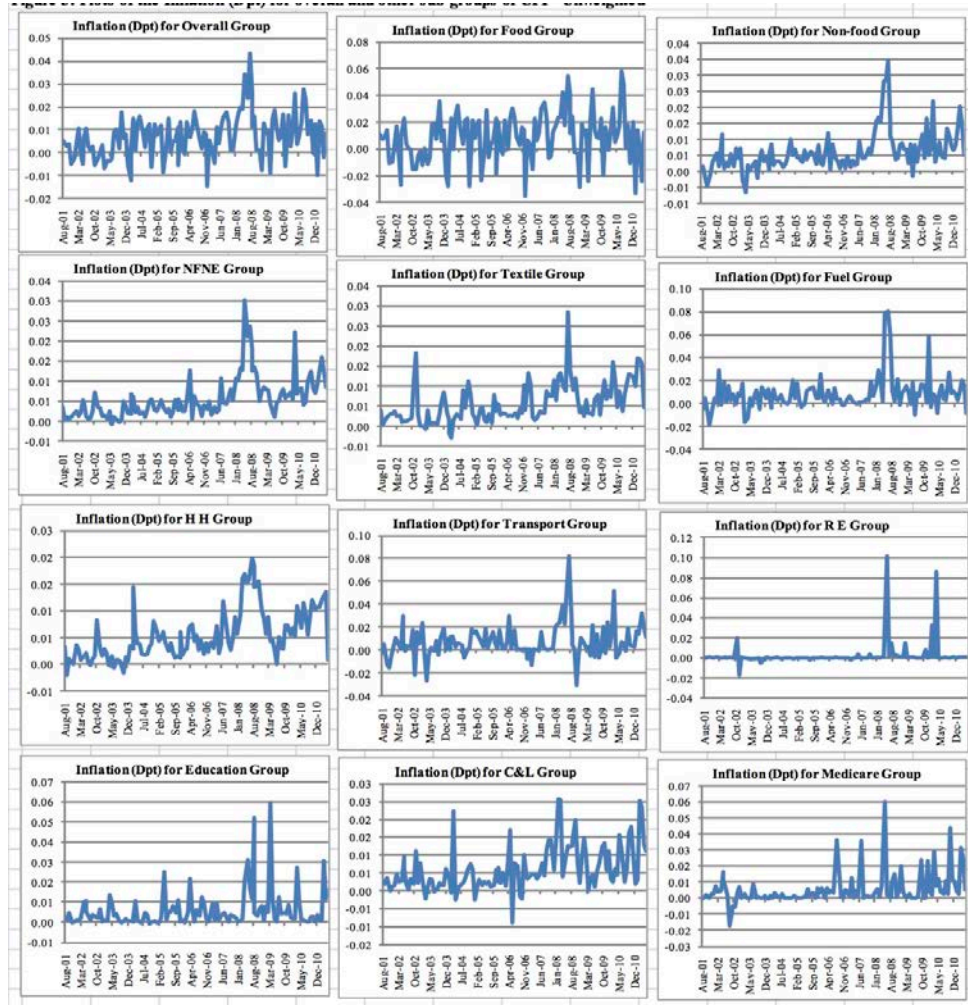


Figure no. 3: Plots of the Inflation (Dp_t) for overall and other sub-groups of CPI – Unweighted

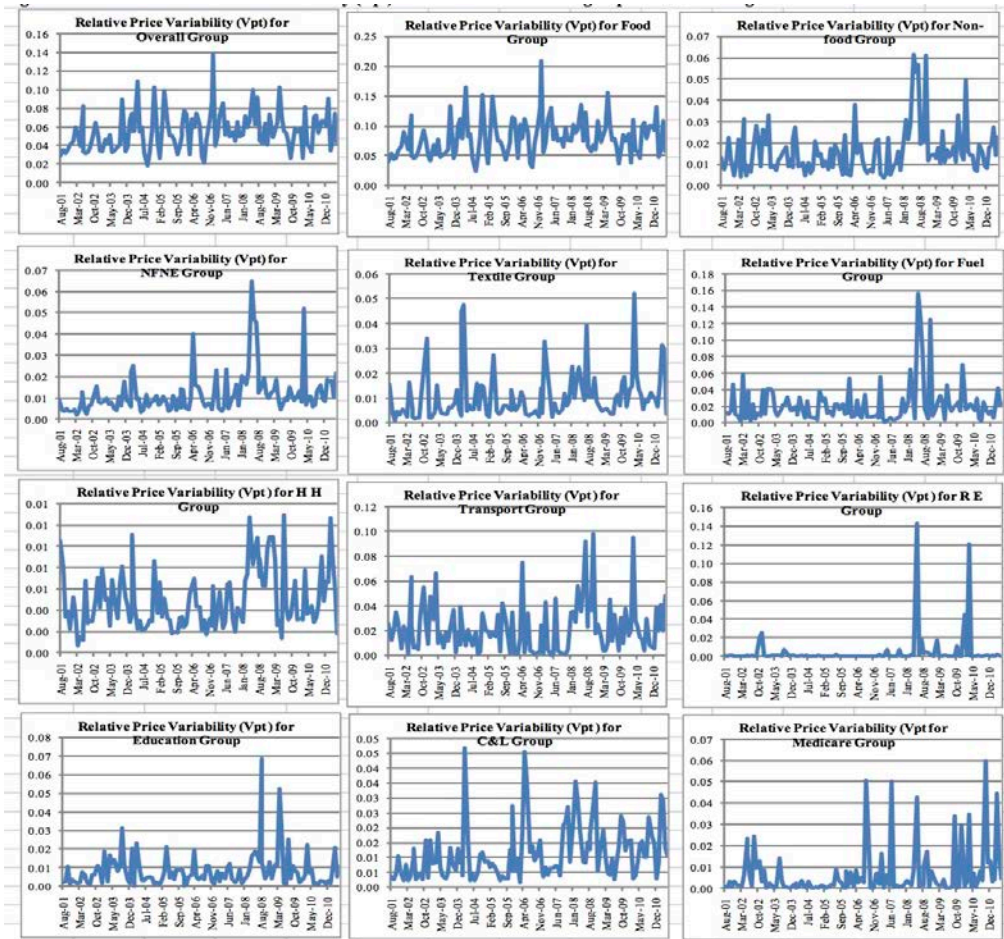


Figure no. 4: Plots of the Relative Price Variability (V_{pt}) for overall and other sub-groups of CPI – Unweighted

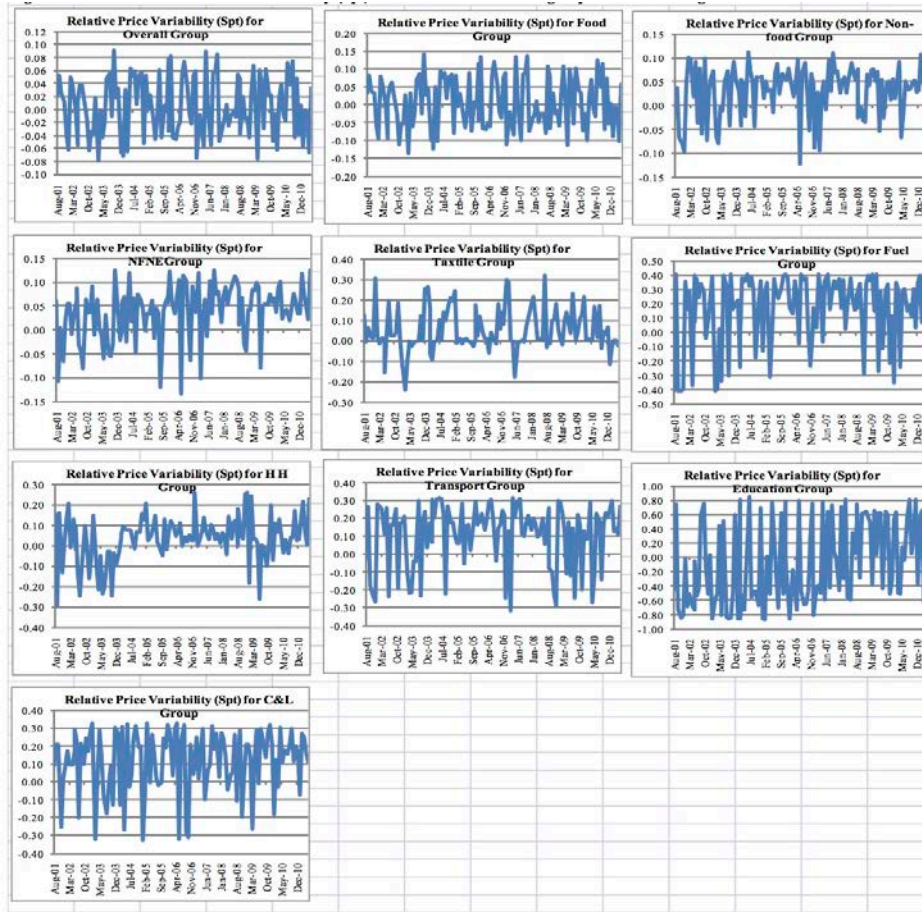


Figure no. 5: Plots of the Relative Price Variability (*Spt*) for overall and other sub-groups of CPI – Unweighted

Granger Casualty results for CPI overall and Groups (V_{pt} vs. D_{pt} & D_{pt} vs. V_{pt}) – Unweighted Measured. After that these requirements have been satisfied, Granger-causality is used, and calculated results are reported in Table no. 1. Elaborating the Table no. 1, overall and transport & communication group shows one-way causation from V_{pt} to D_{pt} , which means V_{pt} has power to predict D_{pt} . Whereas Non-food groups has two-way causation, i.e. both variables have predicting power both ways. The Granger causality of D_{pt} to V_{pt} showed improved result because out of 12 groups including overall 5 groups rejecting the null hypothesis of non-food groups by the Granger causality test, but important group i.e. overall accepting the null hypothesis.

**Table no. 1: Granger Casualty results for CPI overall and Groups
(Vpt vs. Dpt & Dpt vs. Vpt) – Unweighted Measured**

Description of Series	No of Lags	Vpt # does not Granger Cause Dpt #		Dpt # does not Granger Cause Vpt #	
Overall	2	0.0395	***	0.2076	
Food Group	1	0.5755		0.1791	
Non-Food Group	6	0.0951	**	0.0003	***
NFNE	2	0.2161		0.0125	***
Apparel, Textile & Footwear	2	0.1634		0.0385	
Fuel and Lighting House Hold Furniture & Equipment	1	0.2851		0.0000	***
Transport & Communication	1	0.8655		0.0028	***
Recreation & Entertainment	1	0.0712	**	0.1221	
Education	1	0.7568		0.5937	
Cleaning Laundry & Personal Appearance	1	0.6800		0.4619	
Medicare	1	0.2174		0.0128	***
	1	0.9534		0.4181	

Notes: *Rejecting the Ho at 95% confidence level; ** Rejecting the Ho at 90% confidence level; *** Rejecting the Ho at 99% confidence level; # Both Dpt and Vpt are unweighted measured.

Granger Casualty results for CPI overall and Group (Spt vs. Dpt & Dpt vs. Spt) – Unweighted Measured. Table no. 2 shows the analysis, with the help of the other estimate of relative price variability which is Sp_t , the result is overall recovered in food group of CPI Data. In both groups' data shows two-way causation for Dp_t and Sp_t variables. The result is promising and shows that both variables have power to predict each other.

**Table no. 2: Granger Casualty results for CPI overall and Group
(*Spt* vs. *Dpt* & *Dpt* vs. *Spt*) – Unweighted Measured**

Description of Series	No of Lags	Spt# does not Granger Cause Dpt#		Dpt# does not Granger Cause Spt#	
Overall	3	0.0002	***	0.0273	***
Food Group	3	0.0015	***	0.0095	***
Non-Food Group	3	0.3726		0.6507	
NFNE	2	0.2843		0.0626	**
Apparel, Textile & Footwear	1	0.0195	*	0.7547	
Fuel and Lighting	1	0.2270		0.3262	
House Hold Furniture & Equipment	3	0.4681		0.0515	*
Transport & Communication	1	0.1813		0.7914	
Recreation & Entertainment					
Education	1	0.1445		0.1327	
Cleaning Laundry & Personal Appearance	5	0.6462		0.7916	
Medicare					

Notes: * Rejecting the Ho at 95% confidence level; *** Rejecting the Ho at 99% confidence level; **: Rejecting the Ho at 90% confidence level; # Both Dpt and Vpt are unweighted measured

In this study we also used weighted measures of Dp_t , Vp_t and Sp_t as used by Parks (1978). In order to view relationship between the variables calculating by using the weighted measures, can be seen by drawing the scatter diagrams (See Figures no. 6 and 7) for the pairs of the variables.

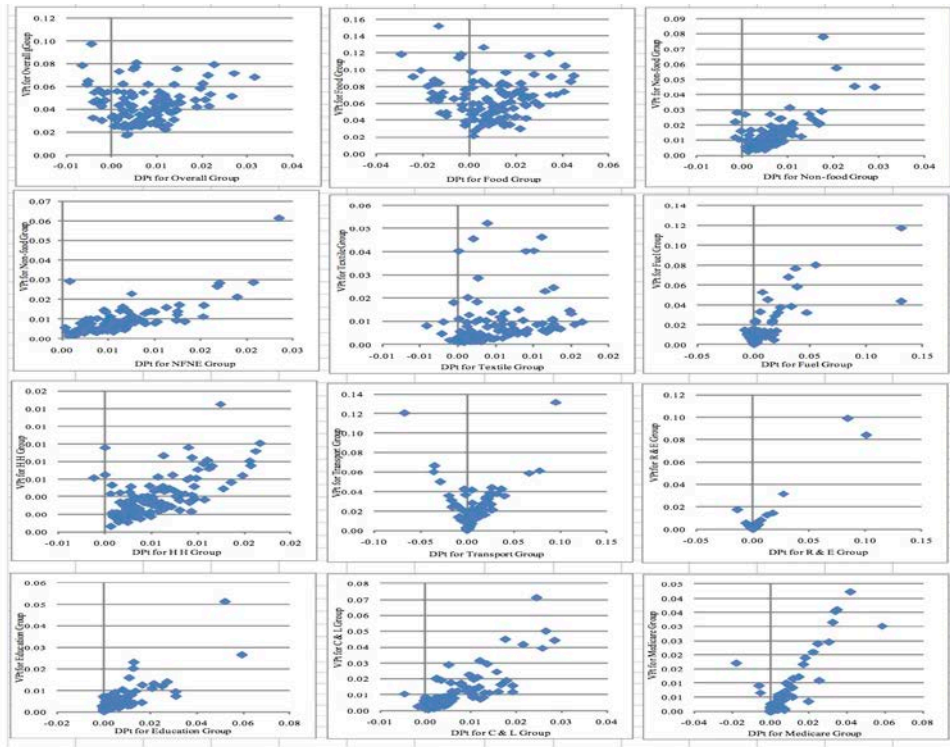


Figure no. 6: Scatter Diagrams for Dpt and Vpt of other sub-groups – Weighted

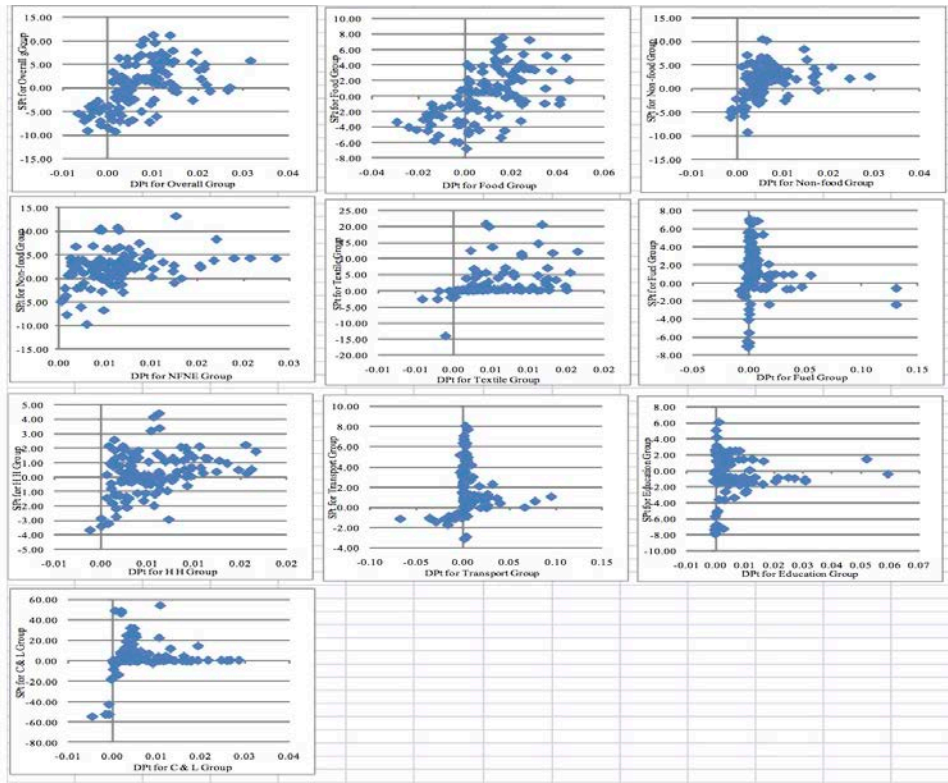


Figure no. 7: Scatter Diagrams for Dp_t and Sp_t of other sub-groups – Weighted

An Autoregressive Distributed Lag (ARDL) Modeling Approach. This method is used to find out the long run relationship which is there in between pairs of series. The result of F-computed for pairs Dp_t vs. Vp_t for non-food group is 9.28, Dp_t vs. Vp_t for g9 sub-group is 9.96, whereas for Dp_t vs. Sp_t for non-food group is 13.78 and for g9 19.99. These F-computed values are much higher than upper bond for lag 1 (at 95% CI) that demonstrated the long-term association between these variables.

The groups which are left, to find out the lag length criteria, Akaike Information Criteria (AIC) is applied, because Granger causality test is complex enough. (see Figures no. 3, 4 and 5).

Granger Casualty results for CPI overall and Groups (Vp_t vs. Dp_t and Dp_t vs. Vp_t) – Weighted Measured. After these requirements have been completed, there is a computation of Granger-causality tests and the outcomes are mentioned in tables no. 3 and 4. The pairs which are of Vp_t vs. Dp_t and of Sp_t vs. Dp_t for overall and other sub-groups of CPI data for weighted measures. From table no. 3, one-way causation can be seen for overall CPI from Vp_t to Dp_t . Other strong one-way causation reported in CPI sub-group of Fuel and lighting from Dp_t to Vp_t . 8 from the 12 sub-groups have shown that there is long-term association, which is very encouraging in the way that each of the variable has predicting power to other variable.

**Table no. 3: Granger Casualty results for CPI overall and Groups
(*Vpt* vs. *Dpt* and *Dpt* vs. *Vpt*) – Weighted Measured**

Description of Series	No of Lags	Vpt# does not Granger Cause Dpt#		Dpt# does not Granger Cause Vpt#	
Overall	3	0.0147	***	0.1026	
Food Group	1	0.2374		0.0302	*
Non-Food Group @	1	9.2800	*		
NFNE	2	0.0282	*	0.0051	***
Apparel, Textile & Footwear	2	0.2043		0.1120	
Fuel and Lighting	0	0.1960		0.0000	***
House Hold Furniture & Equipment	1	0.3482		0.0245	*
Transport & Communication	1	0.1783		0.1196	
Recreation & Entertainment	1	0.7059		0.6650	
Education	1	0.6070		0.0340	*
Cleaning Laundry & Personal Appearance @	1	13.7800	*		
Medicare	1	0.9738		0.4414	

Notes: * Rejecting the Ho at 95% confidence level; *** Rejecting the Ho at 99% confidence level; ** Rejecting the Ho at 90% confidence level; # Both Dpt and Vpt are weighted measured; @: F-computed using ARDL approach compared by Pesaran et al (2001) bond test ratio 4.93 - 5.73 for lag 1 at 5% critical level.

Granger Casualty results for CPI overall and Groups (*Spt* vs. *Dpt* & *Dpt* vs. *Spt*) – Weighted Measured. The result in table no. 4, which is obtained by using other measures of relative price variability i.e. Sp_t , also depict the same result as of using Vp_t . Therefore, for weighted measures there is no significant difference between using the two measures of relative price variability (see also Figures no. 8, 9 and 10).

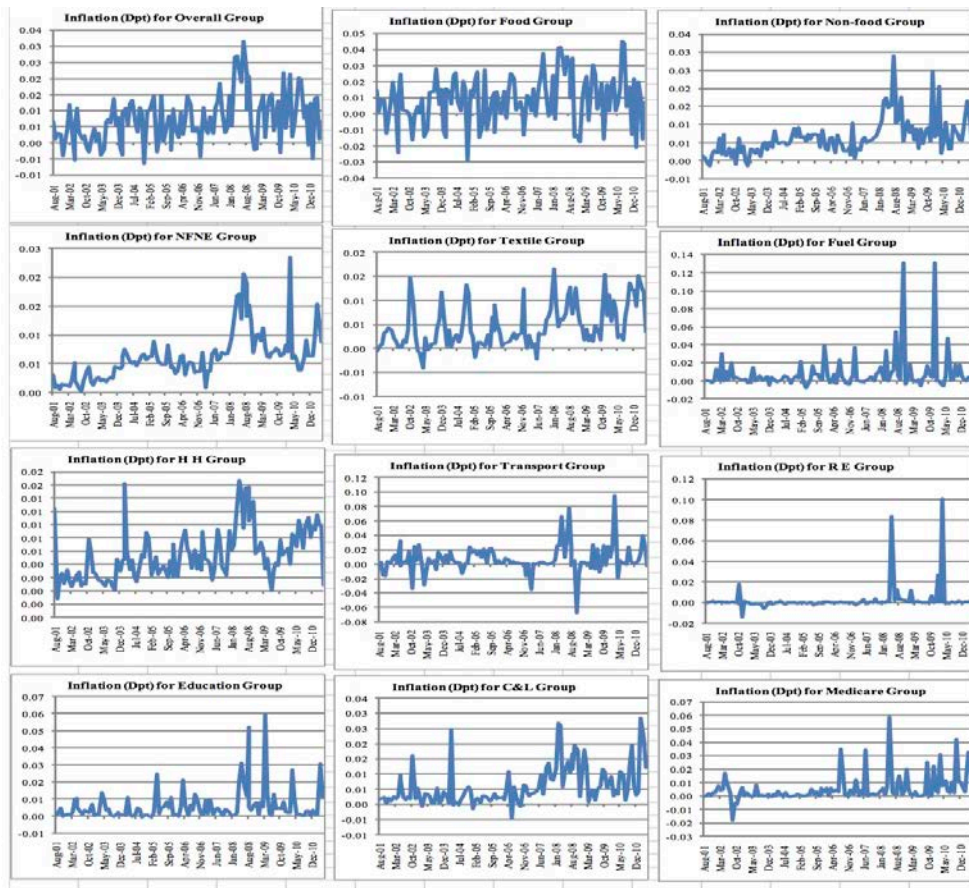


Figure no. 8: Plots of the Inflation (*Dpt*) for overall and other sub-groups of CPI – Weighted

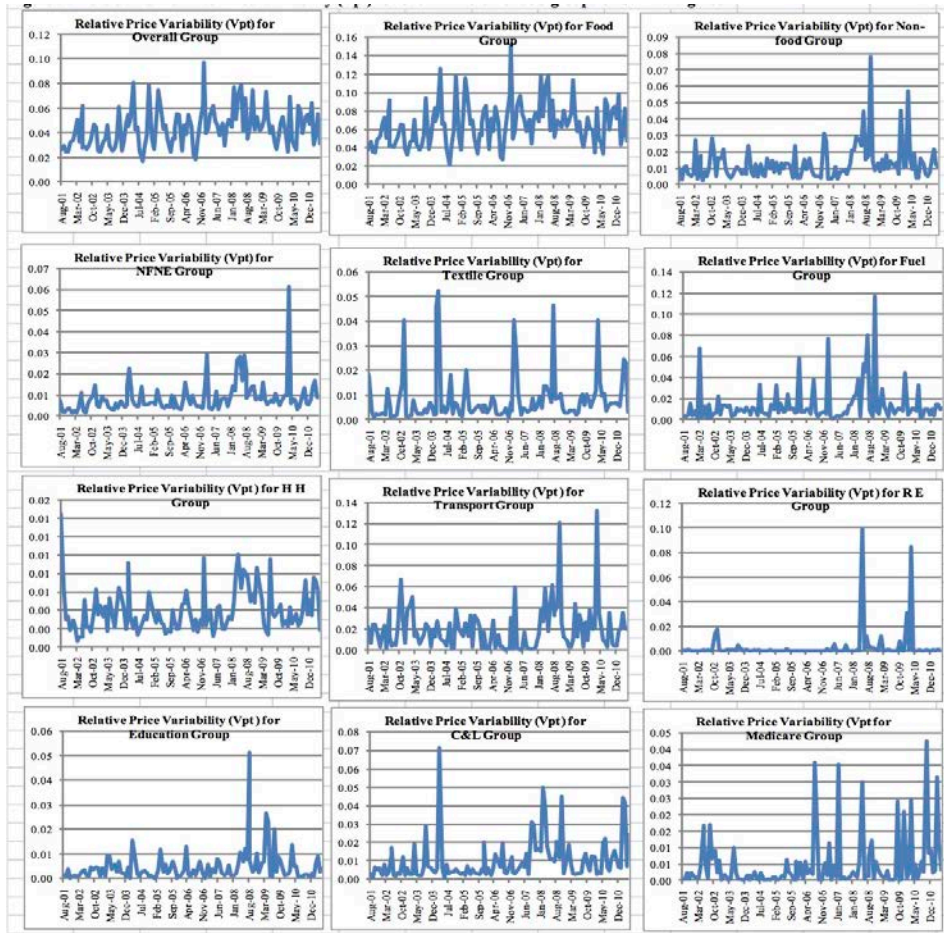


Figure no. 9: Plots of the Relative Price Variability (V_{pt}) for overall and other sub-groups of CPI – Weighted

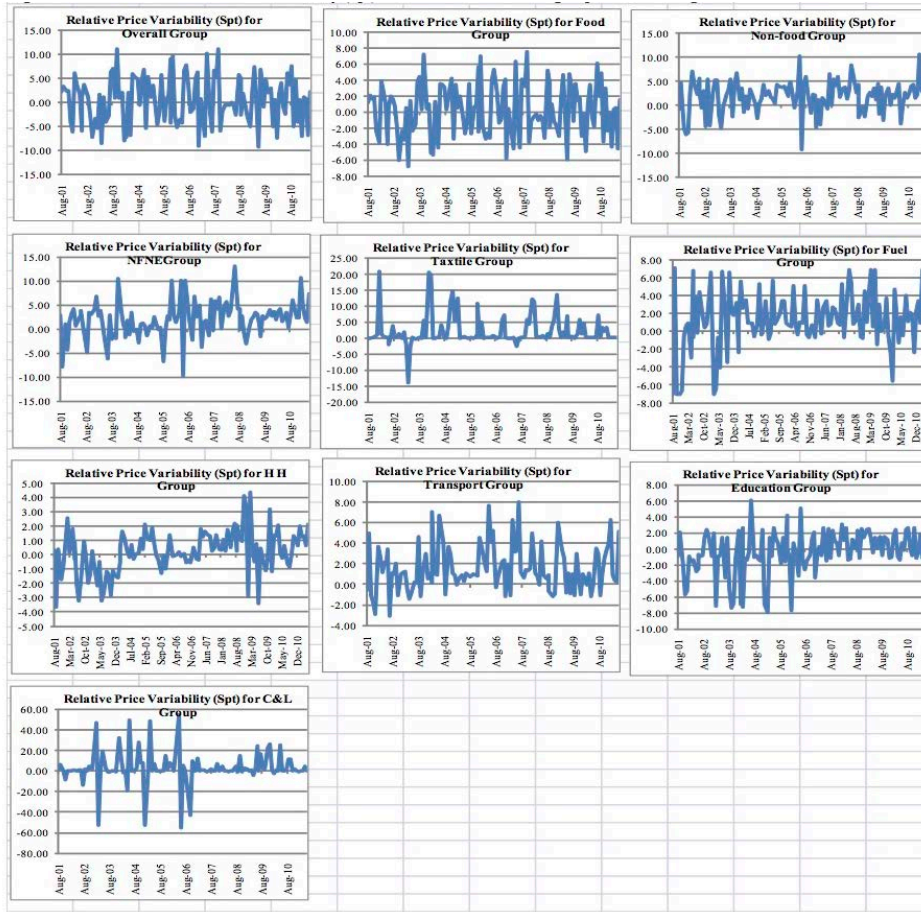


Figure no. 10: Plots of the Relative Price Variability (*Spt*) for overall and other sub-groups of CPI – Weighted

**Table no. 4: Granger Causality result for CPI overall and Groups
(*Spt* vs. *Dpt* & *Dpt* vs. *Spt*) – Weighted Measured**

Description of Series	No of Lags	Spt# does not Granger Cause Dpt#	Dpt# does not Granger Cause Spt#	
Overall	2	0.0087	***	0.6145
Food Group	1	0.2155		0.4870
Non-Food Group @	1	9.9600	*	
NFNE	2	0.4847		0.5155
Apparel, Textile & Footwear	1	0.0423	*	0.0576
Fuel and Lighting	1	0.5985		0.1046
House Hold Furniture & Equipment	3	0.6518		0.0096
Transport & Communication	1	0.4524		0.2919
Recreation & Entertainment				
Education	1	0.1331		0.1411
Cleaning Laundry & Personal Appearance @	1	19.9900	*	
Medicare				

Notes: * Rejecting the Ho at 95% confidence level; *** Rejecting the Ho at 99% confidence level; ** Rejecting the Ho at 90% confidence level; # Both Dpt and Vpt are weighted measured; @ F-computed using ARDL approach compared by Pesaran et al (2001) bond test range 4.93 - 5.73 for lag 1 at 5% critical level.

Conclusions

The purpose of this research is to identify the linkage of inflation with the price variability. Data set used for this study is overall and 12 sub-groups of CPI basket. For relative price variability two measures Vp_t and Sp_t were used and these measures were calculated using weighted and un-weighted methods.

According to the ARDL testing approach, the long-run relationship is existed between these variables. And the outcomes of Granger-causality tests concluded that the one-way causality could be noticed for overall CPI from Vp_t to Dp_t . Other strong one-way causation reported in CPI sub-group of Fuel and lighting from Dp_t to Vp_t . Out of 12 sub-groups 8 groups show the long run relationship between each other, which is very encouraging in a way that each of the variable has predicting power to another variable.

It is further concluded that un-weighted measures have strong predicting power as compared to weighted measures. Between two measures Vp_t having better predicting power as compared to Sp_t . Among the 12 sub-groups almost eight, Dp_t have predicting power with respect to Vp_t . There is two-way causation in overall and food group by using Sp_t un-weighted measure of relative variability. It is finally concluded that can predict DP_t using the information in Sp_t or vice versa and for non-food group using un-weighted measure of relative price variability Vp_t has similar association with Dp_t . The results of this study provide the background of the modeling relationship between Dp_t , Vp_t and Sp_t .

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