Is Gold Investment A Hedge against Inflation in Pakistan? A Cointegtaion and Causality Analysis in the Presence of Structural Breaks

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Abstract

Last few years have witnessed overwhelming investments in the gold market both directly and indirectly. These overwhelming investments in the gold market by individual and institutional investors have gained the attention of the research community. Numerous studies have examined how investment in gold can be used to hedge against high inflation. The current study investigates the gold investment as an effective hedge to deal with inflation in case of Pakistan in long run as well as in short run. In doing so, time series data on gold prices, economic growth and inflation is used for the period 1997-2011 utilizing quarterly frequency. The study applies the ARDL bounds testing technique of cointegration for long run, and innovative accounting approach (IAA) to examine the direction of causality in variables. Our findings reveal that investment in gold is the best hedge to address inflation in both long run and short run in case of Pakistan. The implications and applications of the study have been discussed in detail.

Key Words: Gold prices, inflation, hedging, Pakistan

I. Introduction

Gold is considered as one of the most prestigious commodities in the history of mankind. There are two types of investments in gold; using gold in production of ornaments, medals, minted coins and electrical and medical components etc. and to use gold as an investment avenue by governments, hedge funds, and other institutional and individual investors. Investment in gold is traditionally believed as an effective hedge against inflation and other economic uncertainties. Gold price increases with the rate of inflation, therefore investment in gold can be used as an effective hedge against inflation (Ghosh et al. 2004). Allan Greenspan, the former governor of Federal Reserve Bank of America also stressed the significance of gold-inflation link in his speech in Congress on February 02, 1994. Alan Greenspan stated gold as “store of value measure which has shown a fairly consistent lead on inflation expectations and has been over the years a reasonably good indicator” (The Wall Street Journal, 28 February, 1994). Historically, gold played an important role in monetary system around the globe. However, due to the demise of the Bretton Woods System in 1971, its role as classical gold standard reduced. But the significance of gold in the financial system is very persistent due to the great interest of large institutional and individual investors.

Investment decision making is a complex process especially for people having limited or no investment related knowledge. Such investors usually follow the market trends and go for investment options, which offer handsome returns with modest risk. Therefore, in different spans of times particular investment alternatives gain more focus of such investors. For instance, in previous decade people made an abundant investment in real estate sector in Pakistan. Many people earned abnormal returns by investing in real estate. There was an increasing trend of investing in real estate that caused over investment and price hikes in this sector. The flow of investment is towards gold now-a-days and people are increasingly investing in gold to earn maximum return. Gold is a more durable, transportable, universally acceptable and authentic asset among all physical assets. Although gold is very much liked by the women globally, the traditional use of gold as ornaments is higher in Pakistan and other regional countries including India, Bangladesh, Sri Lanka, Nepal, and Afghanistan etc. In Pakistan and India gold jewelry is an important part of dowry. The gold prices are recording historically high levels across the globe. The increasing gold prices are affecting people in various ways. People with meager income resources are making less traditional use of gold in the shape of ornaments. The demand of gold bullion is more than traditional gold ornaments now. The increasing price of gold is also compelling low income communities to use artificial jewelry or light weight ornaments. People with additional money are investing in gold to protect their wealth from inflationary effect. The high level of inflation is inducing people to invest in gold because banks and other investment alternatives are offering rates of return, which are below the prevailing inflation rate in Pakistan. Many gold jewelers are also buying old gold ornaments to recycle and export them for earning better prices abroad.

The higher rate of return in gold investment has also attracted huge institutional investors. Investment in gold is paying more returns than offered by bank deposits, national saving schemes, mutual funds, high yield corporate bonds and Pakistan investment bonds, which offer less than 15% return (Aazim, 2011). Investment in gold is also boosted due to depression in the real estate market, exchange rate fluctuations and low economic growth rate across the globe, especially in Pakistan. The increase in gold jewelry demand in India, China and the Middle East is also among the factors, which have boosted gold demand in international markets (Worthington and Pahlavani, 2007). In a nutshell, individual and institutional investors are buying gold in physical and gold futures market directly and indirectly as a strategic investment alternative. Gold is largely traced to hedge against currency and inflation risks not only in physical markets but also in futures market. Trading in gold futures consists of more than one half of overall traded volume in Pakistan Mercantile Exchange (PMEX), which also indicates the increasing investment in gold by sophisticated investors.

The present study makes four contributions. First, it is a pioneering effort to investigate the relationship between gold investment and inflation in case of Pakistan. Secondly, we have applied unit root test accommodating structural breaks stemming in the series to examine the integrating order of the variables. Thirdly, the ARDL bounds testing approach is also employed to test long run relationship in the presence of structural breaks. Finally, the VECM Granger causality is employed to investigate the causal direction, and the robustness of causality results is tested by applying innovative accounting approaches (IAA). Our results indicate that gold investment is a hedge against inflation and feedback effect is found between gold investment and inflation in case of Pakistan.

II. Literature Review

Baur and Lucy, (2006) and Kaul and Sapp, (2006) defined hedge as an asset that is un-correlated or has an inverse relationship with a given asset in economic depression times, not necessarily so in routine. Numerous studies have highlighted the significance of investing in gold to build a well diversified portfolio to hedge against currency prices, inflation, political uncertainty, low economic growth and the related dimensions. For instance; Adrangi et al. (2000); Chua et al. (1990); Capie et al. (2005); Dooley et al. (1995); Ghosh et al. (2004); Ho, (1985); Jaffe, (1989); Koutsoyiannis, (1983); Lucey and Tully, (2006a, 2006b); Mahdavi and Zhou, (1997); Sherman, (1986); Smith, (2002); Solt and Swanson, (1981). More specifically, many studies have investigated the benefits that can be accrued by investing in gold, for instance Chua et al. (1990); Jaffe, (1989) and Sherman, (1986) have highlighted the portfolio diversification benefits of investing in gold. Capie et al. (2005) pointed out the significance of gold to hedge against inflation, political uncertainty and currency risks. Basu and Clouse, (1993); Koutsoyiannis, (1983) and Lucey et al. (2004); Mahdavi and Zhou, (1997) have also indicated other multi-dimensional uses of investment in gold.

The empirical results on long run relationship between gold prices and use of gold to hedge against inflation are mixed. For instance; Moore, (1990) reported that gold and general prices are a good hedge against inflation for long run and short run. Aggarwal et al. (1992) noted the existence of long run relationship in gold prices and inflation and significant price volatility in short run. Ghosh et al. (2004) proposed a model that investigated the existence of long run linkage between gold prices and inflation and, influence of investment in gold on price volatility under certain conditions. Tkacz, (2007) also analyzed the gold prices and inflation data of 14 countries over the period 1994-2005 and found that gold can be used to predict the future inflation for various countries. Blose, (2010) also agreed with interesting findings that inflation does not affect gold prices, and an investor cannot estimate the inflation level by analyzing the movements in gold prices. Ranson and Wainwright, (2005) explored the association between gold prices and inflation using data of USA and UK. They found positive linkage between inflation level and gold prices and noted that gold prices are 2-3 times higher than the rise in inflation in the study period. This implies that gold prices are hedges against inflation in both countries. Levin and Wright, (2006) used supply and demand framework to investigate the relationship between gold investment and inflation utilizing data on US economy over the period of 1976--2005. They found cointegration among variables towards a long-term relationship. Moreover, they noted that there is unit elastic positive relationship from inflation to gold prices. The results showed long run cointegration between variables in the data series. Moreover, the results proved that inflation has a positive effect on gold prices i.e. investment in gold could be a good hedge against inflation.

Rubbaniy et al. (2011) argued that gold is the only metal that cointegrates with the consumer price index for Germany. Wang et al. (2010) found that price rigidity of gold and general price level influence the hedging ability against inflation in the long run. They further explored that during low momentum regime, gold prices are unable to hedge against inflation, whereas in the high momentum regime, gold prices can be used to hedge against inflation in case of USA. Ciner et al. (2010) used data of the USA and UK to answer the question whether gold prices are hedged and safe heaven against inflation. They reported that gold investment is not only hedged against inflation but also against exchange rate volatility. Dicle et al. (2011) unveiled that nominal interest rate has a positive impact on inflation and inflation leads gold prices in the US economy. Beckmann and Czudaj, (2012) applied the time varying coefficient framework to analyze that investment in gold is a safe place in case of USA, UK, Euro area, and Japan. Their results indicated that gold investment is a safe place for investors against inflation but this effect is stronger in USA and UK relative to Euro area and Japan and depends upon time horizons. In case of Turkey, Omag, (2012) found that nominal interest rates lead inflation and inflation has a positive impact on gold prices which validates that gold prices are hedges against inflation in case of Turkey. Recently; Bilal et al. (2013) investigated the relationship between gold prices and stock prices using data of Karachi and Bombay stock markets. Their results reported no cointegration between the series. The causality analysis revealed neutral effect between gold prices and stock prices for both stock markets.

The present study provides various contributions to existing research on the relationship between gold prices and inflation. The conventional cointegration techniques failed to confirm the presence of long run relationship between gold prices and inflation. All above studies applied bivariate models and results are inconclusive. Furthermore, they did not incorporate the important structural changes that occur in global markets. The data sets of these studies were also not up to date. The data for recent years where a significant shift of investment is witnessed from real estate and other sectors to gold can produce quite different results. Also the use of structural breaks and data analysis techniques other than conventional cointegration (as used in this study) can also yield ambiguous results. This paper is is a humble effort to fill this gap in the existing financial economics literature in case of Pakistan.

II. Modeling and Data Collection

We follow log-linear specification to test whether or not gold investment is a hedge against inflation in case of Pakistan. The log-linear modelling provides unbiased and consistent results (Shahbaz, 2010). For empirical purpose, the estimable equation is modelled as follows:

$$\ln G_t = \beta_0 + \beta_{INF} \ln INF_t + \beta_{EC} \ln EC_t + \mu_i \qquad (1)$$

where G_t is gold investment proxied by gold prices, INF_t is inflation as measured by consumer price index, EC_t is economic growth proxied by industrial production index and μ_i is the residual term assumed to be independent and identically normally distributed. $\partial G_t / INF_t > 0,$ if gold investment is hedge against inflation otherwise $\partial G_t / INF_t < 0$. If people tend to purchase gold ornaments with an increase in their income level then it is $\partial G_t / EC_t > 0,$ otherwise $\partial G_t / EC_t < 0$. The study covers the data period of 1997QI-2011QIV. We have collected data on consumer price index and industrial production index from international financial statistics (CD-ROM, 2012). The data on gold prices (spot prices) has been collected from Economic Survey of Pakistan (various issues).

Methodological Framework

Numerous unit root tests are available in applied economics to test the stationarity properties of the variables. These unit tests are ADF by Dickey and Fuller (1979), P-P by Philips and Perron (1988), KPSS by Kwiatkowski et al. (1992), DF-GLS by Elliott et al. (1996) and Ng-Perron by Ng-Perron (2001). These tests provide biased and spurious results due to not having information about structural break points occurring in the series. In view of this, Zivot-Andrews (1992) developed three models to test the stationarity properties of the variables in the presence of structural break point in the series: (i) the first model allows a one-time change in variables at level form, (ii) the second model permits a one-time change in the slope of the trend component i.e. function and (iii) the third model has one-time change in both the intercept and the trend function of the variables used for empirical purpose. Zivot-Andrews (1992) used the following three models to check the hypothesis of one-time structural break in the series.

$$\Delta x_t = a + ax_{t-1} + bt + cDU_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (2)$$

$$\Delta x_t = b + bx_{t-1} + ct + bDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (3)$$

$$\Delta x_t = c + cx_{t-1} + ct + dDU_t + dDT_t + \sum_{j=1}^{k} d_j \Delta x_{t-j} + \mu_t \qquad (4)$$

In these models, the dummy variable is indicated by DU_t showing mean shift occurred at each point with time break while trend shift variable is show by DT_t [1]. So,

$$DU_t = \begin{cases} 1 \ldots if \quad t > TB \\ 0 \ldots if \quad t < TB \end{cases} \text{ and } DU_t = \begin{cases} t - TB \ldots if \ t > TB \\ 0 \ldots if \ t < TB \end{cases}$$

The null hypothesis of unit root break date is $c = 0$ which indicates that series is not stationary with a drift not having information about structural break point while $c < 0$ hypothesis implies that the variable is found to be trend-stationary with one unknown time break. Zivot-Andrews unit root test fixes all points as potential for possible time break and does estimation through regression for all possible break points successively. Then, this unit root test selects that time break which decreases one-sided t-statistic to test $\hat{c}(= c - 1) = 1$. Zivot-Andrews intimate that in the presence of end points, asymptotic distribution of the statistics is diverged to infinity point. It

[1] We have used model-4 for empirical estimations following Sen (2003)

is necessary to choose a region where end points of the sample period are excluded. Further, Zivot-Andrews suggested the trimming regions i.e. (0.15T, 0.85T) are followed.

To overcome this issue, Pesaran et al. (2001) introduced the autoregressive distributive lag modelling also known as ARDL bounds testing approach. The ARDL bound testing is superior to convectional approaches due to its merits. This approach is more suitable for small samples. The ARDL bounds testing approach helps in estimating long-and-short run relationship between the series contemporaneously. The unrestricted error correction model (UECM) version of ARDL model is as follows:

$$\begin{aligned}\Delta \ln G_t &= \varphi_{G0} + \varsigma_G T + \pi_{G1} \ln G_{t-1} + \pi_{G2} \ln INF_{t-1} + \pi_{G3} \ln EC_{t-1} + \sum_{i=1}^{p} \lambda_{Gi} \Delta \ln G_{t-i} \\ &+ \sum_{j=0}^{q} \gamma_{Gi} \Delta \ln INF_{t-j} + \sum_{k=0}^{r} \alpha_{Gi} \Delta \ln EC_{t-k} + \varepsilon_{1t}\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta \ln INF_t &= \varphi_{INF0} + \varsigma_{INF} T + \pi_{INF1} \ln G_{t-1} + \pi_{INF2} \ln INF_{t-1} + \pi_{INF3} \ln EC_{t-1} + \sum_{i=1}^{p} \lambda_{INFi} \Delta \ln INF_{t-i} \\ &+ \sum_{j=0}^{q} \gamma_{INFi} \Delta \ln G_{t-j} + \sum_{k=0}^{r} \alpha_{INFi} \Delta \ln EC_{t-k} + \varepsilon_{2t}\end{aligned} \tag{6}$$

$$\begin{aligned}\Delta \ln EC_t &= \varphi_{EC0} + \varsigma_{EC} T + \pi_{EC1} \ln G_{t-1} + \pi_{EC2} \ln INF_{t-1} + \pi_{EC3} \ln EC_{t-1} + \sum_{i=1}^{p} \lambda_{ECi} \Delta \ln EC_{t-i} \\ &+ \sum_{j=0}^{q} \gamma_{ECi} \Delta \ln G_{t-j} + \sum_{i=0}^{r} \alpha_{ECi} \Delta \ln INF_{t-i} + \varepsilon_{3t}\end{aligned} \tag{7}$$

where Δ is the difference operator, φ is the constant term, π_s are the long run estimates while short run coefficients are shown by λ, γ, α. T represents the trend variable. The selection of appropriate lag order for ARDL model is based on minimum value of Akaike Information Criteria (AIC). Empirical models $F_G(G / INF, EC)$, $F_{INF}(INF / G, EC)$ and $F_{EC}(EC / G, INF)$ are investigated to compute F-statistics. The hypothesis of cointegration between the series may be rejected if the estimated F-statistic exceeds upper critical bound (UCB). We use critical bounds generated by Narayan, (2005) to decide whether or not cointegration exists between the variables. Furthermore, stability tests such as CUSUM and CUSUMSQ are also adopted.

The long run association between gold investment, inflation and economic growth can be investigated through the following equation:

$$\ln G_t = \Phi_0 + \Phi_1 \ln INF_t + \Phi_2 \ln EC_t + \mu_t \quad (8)$$

where $\Phi_0 = \varphi_{y0} / \pi_{y1}, \Phi_1 = -\pi_{y2} / \pi_{y1}, \Phi_2 = -\pi_{y3} / \pi_{y1}, \Phi_3 = -\pi_{y4} / \pi_{y1}$ and μ_t is the iid error term.

It is suggested by Morley, (2006) that there must be at least unidirectional Granger causality once the series are co-integrated at I(1). In doing so, we have applied the VECM Granger causality approach to test the direction of causal relation between gold investment, inflation and economic growth in case of Pakistan. The detection of causal relationship will help policy makers in formulating comprehensive economic policy to control inflation and to sustain economic growth. An error correction term is included in the vector error correction model

(VECM) to estimate short-and-long run relation. Estimable equation of the VECM is modelled as follows:

$$(1-L)\begin{bmatrix}\ln G_t \\ \ln INF_t \\ \ln EC_t\end{bmatrix} = \begin{bmatrix}a_1 \\ a_2 \\ a_3\end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix}b_{11i}b_{12i}b_{13i} \\ c_{21i}c_{22i}c_{23i} \\ d_{31i}d_{32i}d_{33i}\end{bmatrix} \times \begin{bmatrix}\ln G_{t-1} \\ \ln INF_{t-1} \\ \ln EC_{t-1}\end{bmatrix} + \begin{bmatrix}\theta \\ \vartheta \\ \varphi\end{bmatrix}[ECT_{t-1}] + \begin{bmatrix}\varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t}\end{bmatrix} \quad (9)$$

where difference operator is indicated by $(1-L)$, ECT_{t-1} is the lagged error correction term and $\varepsilon_{1t}, \varepsilon_{2t}$ and ε_{3t} are residual terms assumed to be independently and identically normally distributed. The short run causal relation is valid once F-statistic is found to be significant using Wald-test or F-test. Inflation Granger causes gold investment if $b_{12,i} \neq 0 \forall_i$ is statistical significant using t-test statistic. The same hypothesis can be drawn for economic growth and gold investment or inflation and economic growth.

IV. Results and Their Discussion

Numerous unit root tests are available to test the stationarity properties of the series. These tests are ADF by DF-GLS by Elliot et al. (1996), and KPSS by Kwiatkowski et al. (1992). We have applied these tests to investigate the order of integration of the variables. These tests indicate that all the series are found to be non-stationary at their level and the variables are integrated at I(1). It is pointed by Baum, (2004) that these unit root tests may produce biased results due to the small size when the data sample is small (Dejong et al. 1992). To solve this problem, we have applied Ng-Perron unit root test that produces more reliable and consistent results. The analysis presented in Table-1 indicates that gold investment, inflation and economic growth have a unit root problem at the level and the series are stationary in the 1st difference form.

Table-1: Unit Root Analysis

Ng-Perron Unit root test at level				
Variables	MZa	MZt	MSB	MPT
$\ln G_t$	-0.4391	-0.2034	0.4632	50.6763
$\Delta \ln G_t$	-36.2953*	-4.2431	0.1169	2.6033
$\ln INF_t$	-1.7274	-0.6254	0.3620	31.6838
$\Delta \ln INF_t$	-27.0182*	-3.6754	0.1360	3.3727
$\ln EC_t$	-6.1345	-1.6855	0.2747	14.8091
$\Delta \ln EC_t$	-21.4620**	-3.2686	0.1523	4.2898
Note: * and ** show significance at 1% and 5% respectively.				

There is a problem with traditional unit root tests. These tests do not seem to accommodate structural breaks stemming in the series. The appropriate information about structural breaks would help policy makers in designing a comprehensive economic and financial policy to maintain long economic growth and lower inflation at a sustainable level in the country. To overcome this issue, we have applied Zivot-Andrews, (1992) unit root test accommodating unknown single structural break in the series. The results are reported in Table-2. We find that all the series have unit root problem at level in the presence of structural breaks. At 1st difference, all the variables are found to be stationary[2]. This shows that all the variables are integrated at I(1).

Table-2: Zivot-Andrews Structural Break Unit Root Test

Variable	At Level		At 1st Difference	
	T-statistic	Time Break	T-statistic	Time Break
$\ln G_t$	-3.850 (4)	2005Q2	-6.753 (2)*	2009Q2
$\ln INF_t$	-3.191 (3)	2006Q1	-5.580 (3)*	2001Q3
$\ln G_t$	-3.457 (2)	2007Q4	-8.505 (5)	2005Q2
Note: *and ** represent significant at 1% and 5% level of significance. The critical value at1% is -5.93 and at 5% is -4.42. Lag order is shown in parentheses.				

The unique level of integration of the variables leads us to apply the ARDL bounds testing approach to cointegration. To proceed, it is necessary to have appropriate information about lag order of the variables. The computation of F-statistic is very much sensitive with lag length selection. We have used AIC and SBC criterion to select appropriate lag length[3]. Our decision about lag order of the series is based on the minimum value of AIC that has superior predicting properties in small samples[4]. The AIC test indicates that 2 lag is appropriate (Table-3). We conclude that our calculated F-statistics are higher than upper critical bounds generated by Narayan, (2005) at 1% and 5% significance levels respectively. This shows that there are three

[2] The diagrams of all the veraibles of non-stationarity and stationarity levels are given in appendix-A.
[3] Results are not shown but they are available upon request from the authors.
[4] For more details (see Lütkepohl, 2006)

cointegrating vectors found at 1 and 5 per cent levels when gold investment, inflation and economic growth are treated as dependent variables.

Table-3: Results of ARDL Cointegration Test

Variable	$\ln G_t$	$\ln INF_t$	$\ln EC_t$
F-statistics	15.746*	5.302**	5.602**
Break Year	2005Q2	2006Q1	2007Q4
Lag Order	2, 2, 1	2, 1, 2	2, 2, 2
Critical values#	1 per cent level	5 per cent level	10 percent level
Upper Bound	6.503	4.938	4.235
Lower Bound	5.620	4.180	3.540
Diagnostic tests			
R^2	0.8159	0.8059	0.9154
$Adj-R^2$	0.7091	0.6550	0.8618
F-statistics	7.6364*	5.3395*	17.0947*
Note: * and ** depicts the significance at 1% and 5% levels respectively.			

Table-4: Long Run and Short Run Analysis

Dependent variable = $\ln G_t$				
Long Run Analysis				
Variables	Coefficient	Std. Error	T-Statistic	Prob. Values
Constant	-0.2032	0.1387	-1.4653	0.1492
$\ln INF_t$	1.9093*	0.0378	50.4689	0.0000
$\ln EC_t$	0.0968***	0.0508	1.9020	0.0631
Short Run Analysis				
Variables	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.0160	0.0142	1.1214	0.2678
$\ln INF_t$	1.1519*	0.4112	2.8010	0.0074
$\ln EC_t$	-0.0812***	0.0473	-1.7147	0.0930
ECM_{t-1}	-0.5653*	0.1211	-4.6670	0.0000
R^2	0.8500			
F-statistic	26.0760*			
D. W	1.7280			
Short Run Diagnostic Tests				
Test	F-statistic	Prob. value		
$\chi^2 NORMAL$	1.2824	0.5266		
$\chi^2 SERIAL$	1.4228	0.2469		
$\chi^2 ARCH$	0.2848	0.5959		

$\chi^2 WHITE$	5.7435	0.0067		
$\chi^2 REMSAY$	1.4861	0.2290		
Note: * and *** depicts the significance at 1% and 10% levels.				

The long run results reported in Table-4 reveal that a 1 per cent increase in inflation increases gold prices by 1.9 per cent, all else being the same. The positive effect of inflation in gold prices is more elastic indicating that investment in gold is a hedge against inflation in case of Pakistan. This implies that gold prices are affected by inflation dominantly. These findings are contradictory with traditional theory which assumes that the relative prices of assets such as gold are not affected permanently by inflation (see, Fledstein, 1978). In case of Pakistan, gold prices change relatively more as compared to changes in inflation. Our results support the view reported by Worthington and Pahlavani, (2007) for USA; Tiwari, (2011) for India; Dicle et al. (2011) for US; Omag, (2012) for Turkey; Beckmann and Czudaj, (2012) for USA and UK. The positive and statistically significant impact of economic growth on gold prices is found at 1 per cent level, keeping the others constant. This shows that people make investment in gold to save their money with the rise in their income levels. A 0.09 per cent rise in gold prices is linked with a 1 per cent increase in economic growth. This supports the view that gold demand is linked with income level of an individual. Economic growth indicates a rise in per capita income which raises aggregate demand of gold as people think that gold investment is a safe place against inflation (see, Fledstein, 1978).

In short run, the effect of inflation on gold prices is positive and statistically significant while gold prices are negatively affected by economic growth. The negative effect of rise in income level on gold prices indicates that people prefer to invest in more liquid assets rather than gold in short run. This shows that a change in response variable is a function of both the levels of disequilibrium in the cointegrating relationship and the changes in other explanatory variables. It implies that the gold demand model is corrected by 56.53 per cent in each quarter from short run shocks towards long run stable relationship.

Sensitivity Analysis and Stability Test

Results of stability tests i.e. LM test for serial correlation, normality of residual term and White heteroskedasticity test are detailed in the lower part of Table-4. The empirical evidence implies that all short run diagnostic tests are passed successfully for the short run model.

Figure 1: Plot of Cumulative Sum of Recursive Residuals

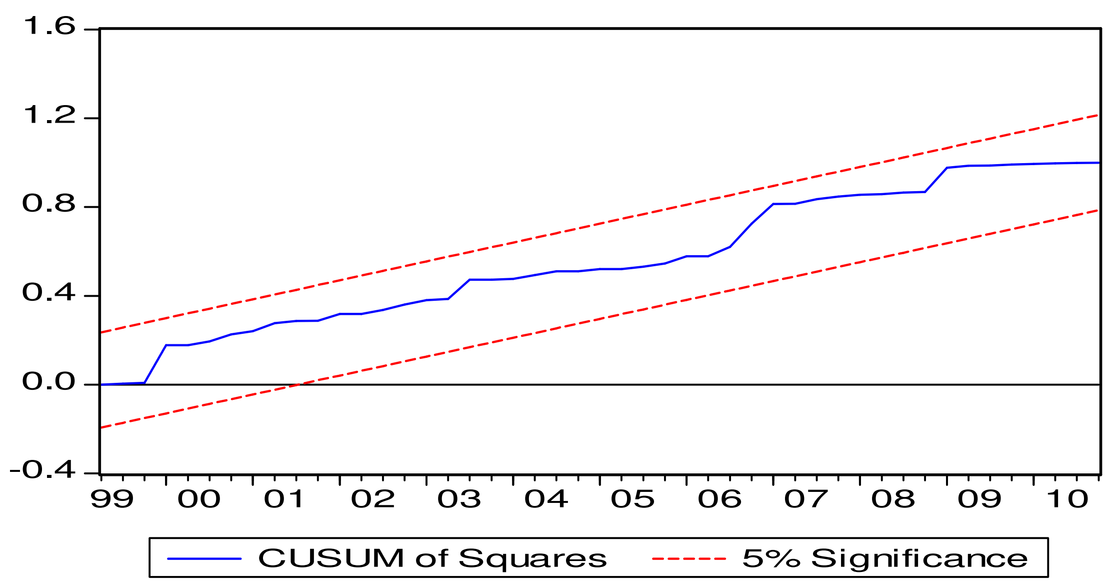
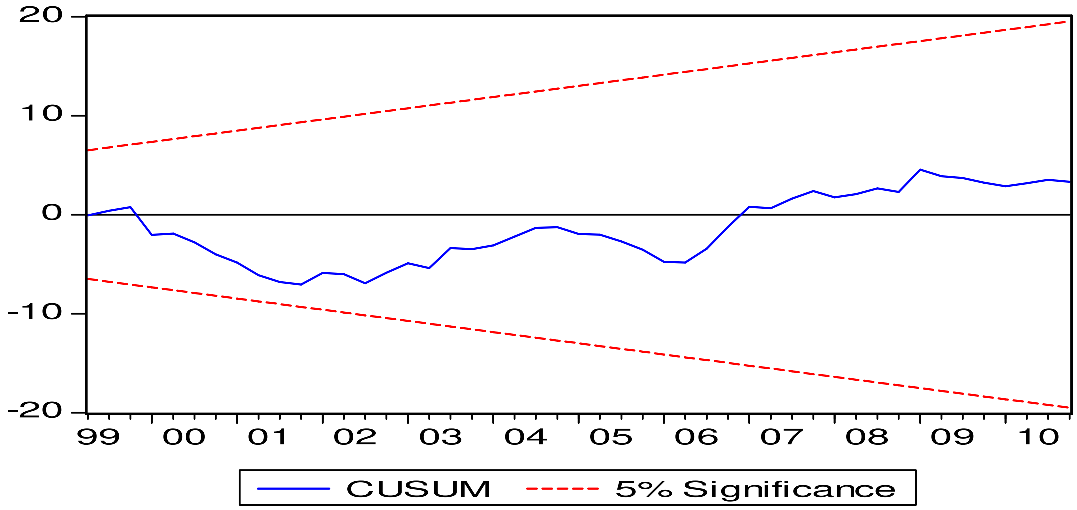


Figure 2: Plot of Cumulative Sum of Squares of Recursive Residuals



The statistics of cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMsq) are shown in Figures 1 and 2. The results indicate that both graphs are found between the critical bounds at 5 per cent level of significance. The presence of cointegration among the variables sets the stage for testing the Granger causality. Knowledge about causality helps policy makers in formulating appropriate economic policies to control inflation. For short run causality, we apply the LR test for the joint significance of the lagged explanatory variables. For instance, unidirectional Granger causality running from inflation to gold investment is shown by statistical significance of $\alpha_{1,i} \neq 0 \forall_i$ while gold investment Granger-causes inflation is validated by statistical significance of $a_{2,i} \neq 0 \forall_i$. Same hypothesis can be induced for other variables.

The results of the VECM Granger causality analysis are reported in Table-5. This indicates that investment in gold is a hedge against inflation not only in the short run but also in the long run as confirmed from the OLS regression analysis.

Table-5: The VECM Granger Causality Analysis

Dependent Variable	Direction of Causality						
	Short Run			Long Run	Joint Long-and-Short Run Causality		
	$\Delta\ln G_{t-1}$	$\Delta\ln INF_{t-1}$	$\Delta\ln EC_{t-1}$	ECT_{t-1}	$\Delta\ln G_{t-1}, ECT_{t-1}$	$\Delta\ln INF_{t-1}, ECT_{t-1}$	$\Delta\ln EC_{t-1}, ECT_{t-1}$
$\Delta\ln G_t$	….	5.3028* [0.0086]	1.8703 [0.1661]	-0.4995* [-3.7302]	….	10.5230* [0.0000]	7.2860* [0.0007]
$\Delta\ln INF_t$	0.6649 [0.5174]	….	0.6718 [0.5159]	-0.1177*** [-1.6702]	0.9429 [0.4281]	….	3.2090** [0.0324]
$\Delta\ln EC_t$	1.4537 [0.2447]	1.3289 [0.2752]	….	-0.2225*** [-1.8990]	4.0767** [0.0112]	2.9637** [0.0423]	….
Note: *, ** and *** show significance at 1, 5 and 10 per cent levels respectively.							

The VECM Granger causality approach only captures the relative strength of causality within sample period and cannot explain anything out of the selected time period. Further, the VECM Granger approach is unable to identify the exact magnitude of feedback from one variable to other variable (Shan, 2005). To solve this issue, Shan (2005) introduced the new term of Innovative Accounting Approach (IAA) i.e. variance decomposition approach and impulse response function. Under the umbrella of IAA, variance decomposition method (VDM) points out the exact amount of feedback in one variable due to innovative shocks occurring in another variable over the various time horizons. The variance decomposition is considered a substitute of the impulse response function (IRF).

The results by VDM and IRF are detailed in Table-6 and Figure-3 respectively. The results of VDM show that shocks stemming from inflation and economic growth explain gold investment by 28.23 and 26.94 per cent and the rest is contributed through innovative shocks of gold investment itself. The contribution of gold investment and economic growth is inflation is 22.69 and 16.49 per cent respectively while 60.80 of inflation is contributed through its own innovative shocks. Finally, a 72.17 per cent share of economic growth is explained by its shocks and rest is by shocks occurring in gold investment and inflation i.e. 9.38 and 18.44 per cent respectively. Overall, results show feedback hypothesis between gold investment and inflation and, inflation and economic growth. Thus gold investment Granger causes economic growth.

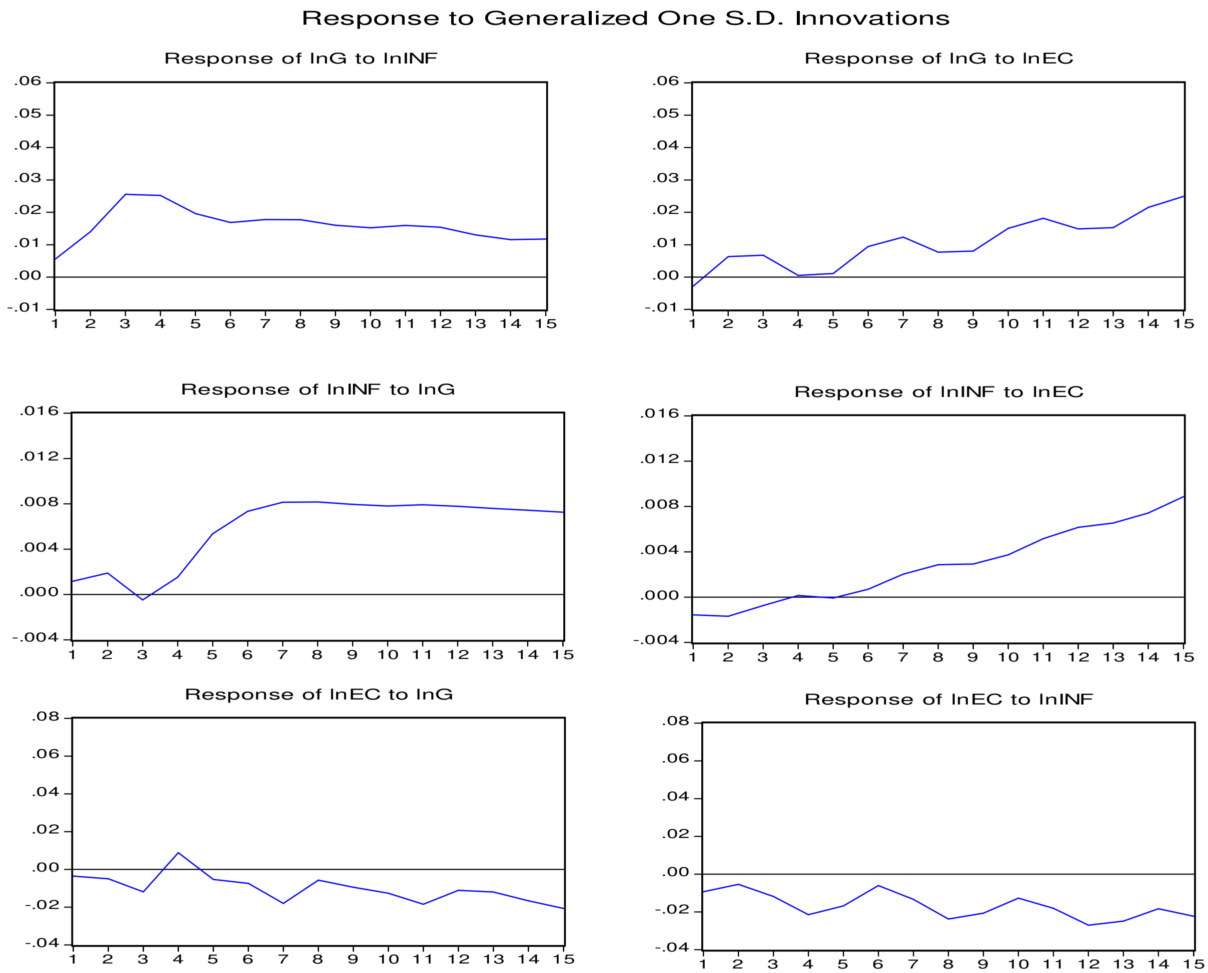
Table-6: Variance Decomposition Method (VDM)

Time Horizons	Variance Decomposition of $\ln G_t$			Variance Decomposition of $\ln INF_t$			Variance Decomposition of $\ln EC_t$		
	$\ln G_t$	$\ln INF_t$	$\ln EC_t$	$\ln G_t$	$\ln INF_t$	$\ln EC_t$	$\ln G_t$	$\ln INF_t$	$\ln EC_t$
1	100.0000	0.0000	0.0000	0.9907	99.0092	0.0000	0.2495	1.6377	98.1127
2	94.5244	3.3906	2.0848	1.3779	98.5974	0.0245	0.6837	1.9647	97.3514
3	82.2409	13.7703	3.9886	0.9949	98.8418	0.1631	3.1914	3.9196	92.8888
4	73.2732	22.9206	3.8061	1.1209	98.2827	0.5962	4.0928	11.5790	84.3280
5	69.1618	27.0464	3.79174	4.3877	94.8036	0.8085	2.8526	9.9623	87.1850
6	65.6241	28.6633	5.71247	9.1118	89.6315	1.2566	3.1057	9.3647	87.5295
7	62.1587	29.5158	8.32535	13.3424	84.3847	2.2727	5.8255	10.1742	84.0001
8	60.0980	30.7734	9.12850	16.2647	80.2078	3.5274	5.7142	14.0019	80.2838

9	58.6783	31.4074	9.91420	18.2914	77.2020	4.5065	5.1317	13.7179	81.1503
10	56.2999	31.1406	12.5594	19.7902	74.4919	5.71783	5.6552	13.3505	80.9942
11	53.2901	30.8130	15.8968	20.9525	71.5207	7.52675	7.4146	14.3887	78.1965
12	51.2622	30.9295	17.8083	21.7189	68.6538	9.62712	7.6410	17.2206	75.1383
13	49.7301	30.6363	19.6335	22.2696	66.1348	11.5956	7.2799	17.5517	75.1682
14	47.4987	29.5141	22.9871	22.6209	63.6021	13.7768	7.9162	17.4059	74.6778
15	44.8236	28.2355	26.9408	22.6934	60.8084	16.4981	9.3801	18.4468	72.1729

The impulse response function reveals the response for dependent variable due to shocks occurring only in the independent variables. Firugre-3 indicates that response in gold investment is positive and goes to peak till 3rd time horizon then lowers down but remains positive. The shocks in economic growth lead gold investment to respond positively after a 5th time horizon and go upward till the 15th time limit. Similarly, the response of inflation is increasing due to shocks stemming in gold investment and economic growth after 3rd and 5th time horizons respectively. This shows that inflation leads gold investment and in turn, investment in gold increases inflation. The rise in per capita income i.e. economic growth induces people to make an investment in gold for better rate of returns on their assets. The inflation is also increased following aggregate demand channel due to hike in economic growth. The response in economic growth is negative due to shocks in gold investment and inflation. This implies that a hike in inflation is detrimental to economic growth and an increase in gold investment also does not contribute to economic growth in case of Pakistan. The results are found to be consistent with VECM Granger causality analysis.

Figure-3: Impulse Response Function



V. Conclusions and Policy Implications

This paper contributes to the economic literature by investigating the validation of whether or not gold investment is a hedge against inflation in the short run as well as in the long run, in case of Pakistan. The ARDL bounds testing approach to cointegration is applied in the presence of structural breaks stemming in the series. The causality between gold investment, inflation and economic growth was investigated by the VECM Granger approach, and IAA approach was applied to test the robustness of causality analysis.

Our analysis confirmed that gold investment is a hedge against inflation in case of Pakistan. The causality analysis indicated bidirectional causality between gold investment and inflation, economic growth and inflation, and, economic growth and gold investment. The causality results are robust as confirmed by innovative accounting approach (IAA). Following empirical evidence of our study, we recommend that investors should invest in gold because investment in gold is confirmed as a hedge against inflation in Pakistan. The main reason is that hike in inflation reduces the real value of money and people seek to invest in alternative investment avenues like gold to preserve the value of their assets and earn additional returns. This suggests that investment in gold can be used as a tool to decline inflation pressure to a sustainable level.

For future research, following Capie et al. (2005) this study can be augmented by investigating whether or not gold investment is a hedge against exchange rate. Similarly, following Bodie (1983), commodity future prices as a hedge against inflation can be investigated in case of Pakistan using structural break unit tests to capture the impact of macroeconomic policies. The structural break ARDL bounds testing approach should be used to investigate the long run relationship between the variables. Our study has restricted to use small sample data due to availability of data from 1997QI-2011QIV and could not utilize structural break unit root tests with two structural break as well as structural break cointegration approach as these tests require high frequency data set.

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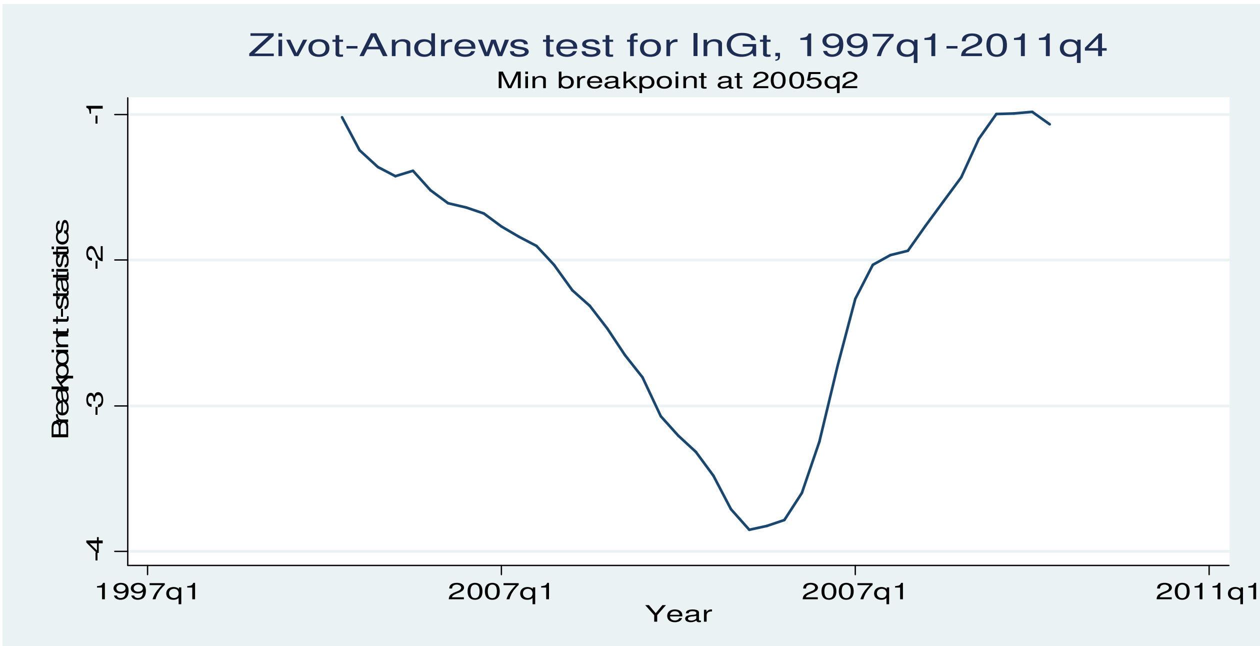
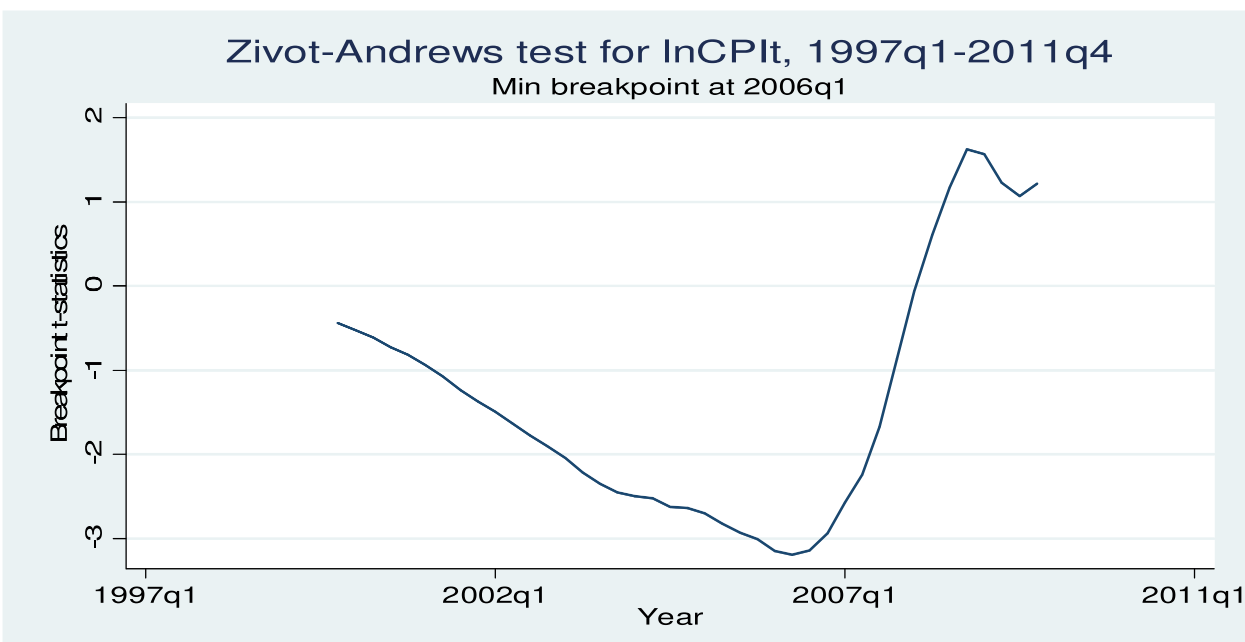
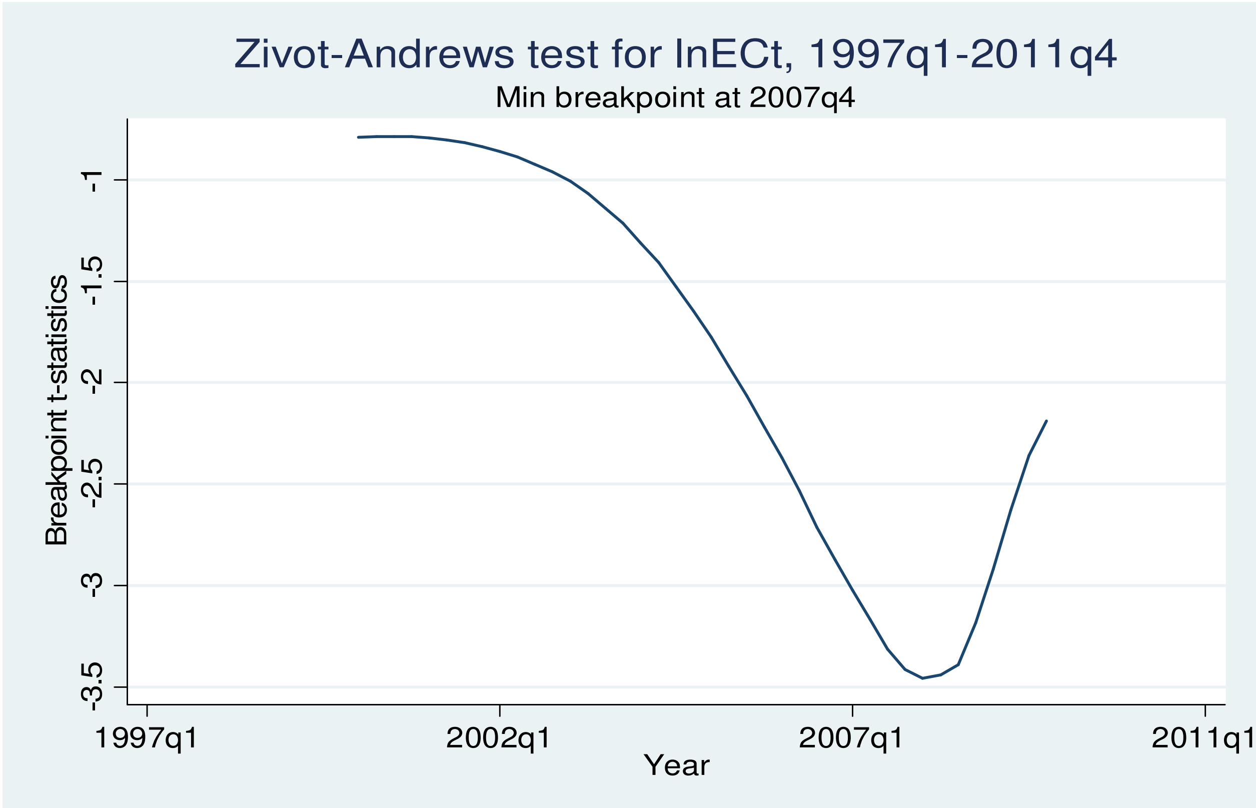
Appendix-A

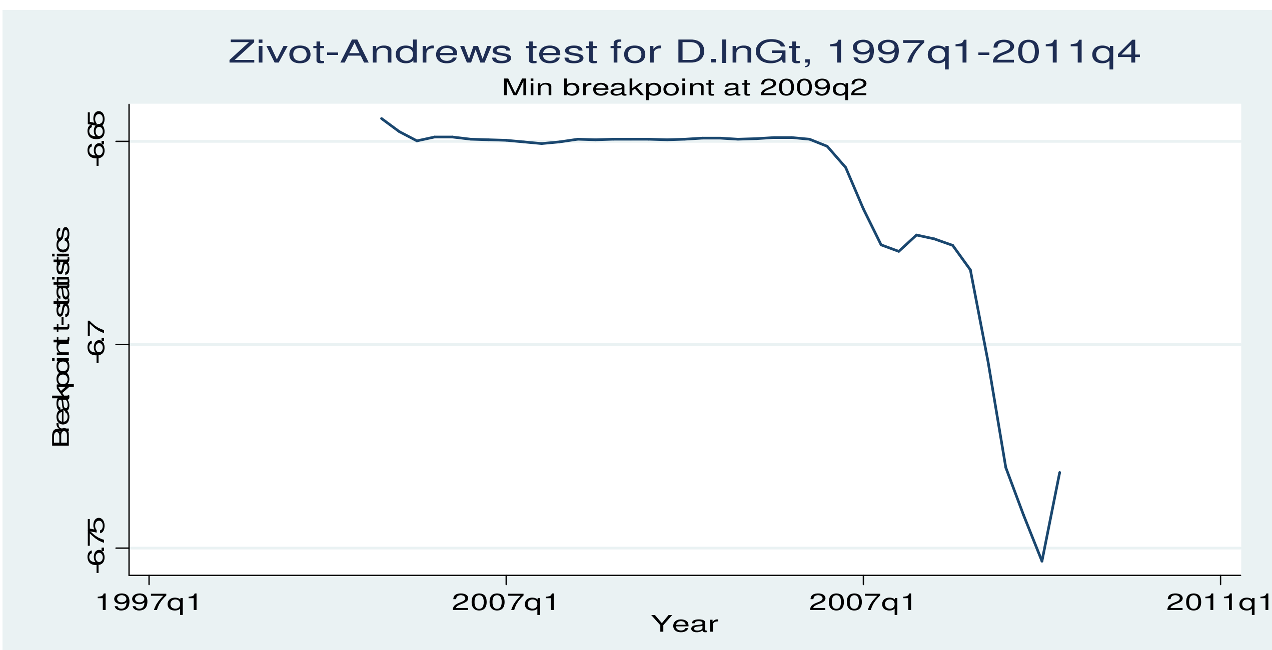
At Level

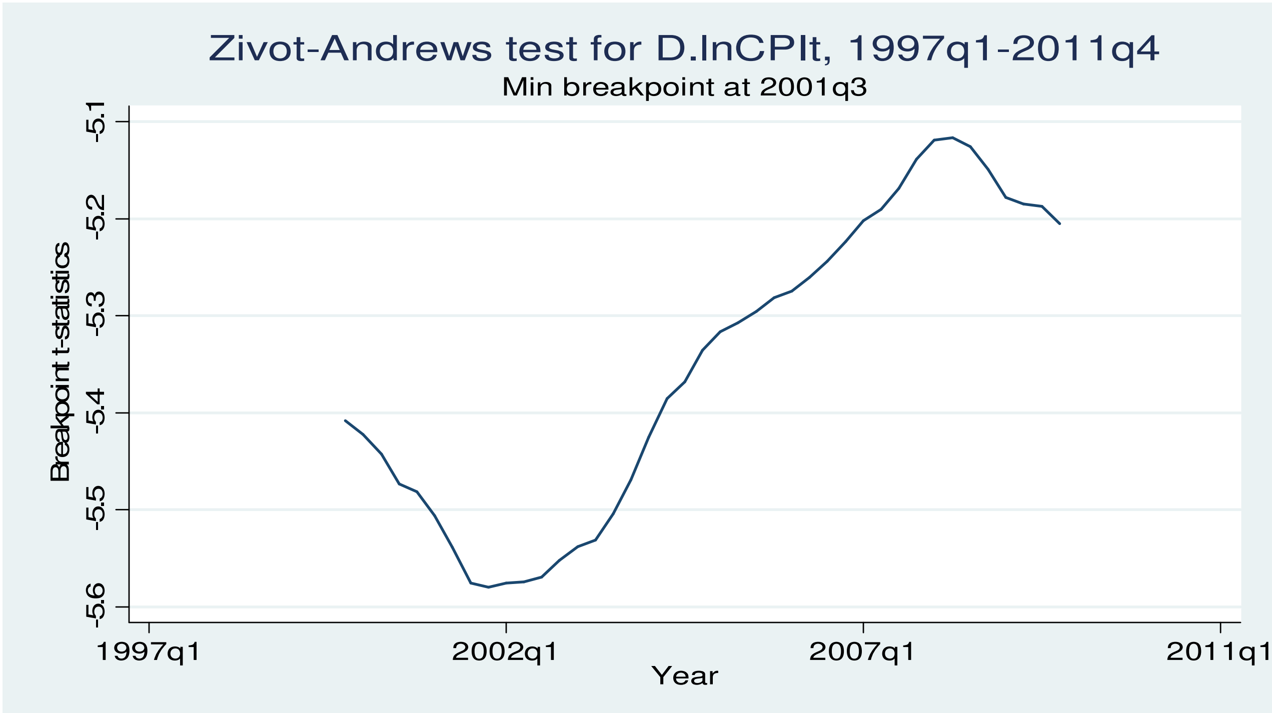


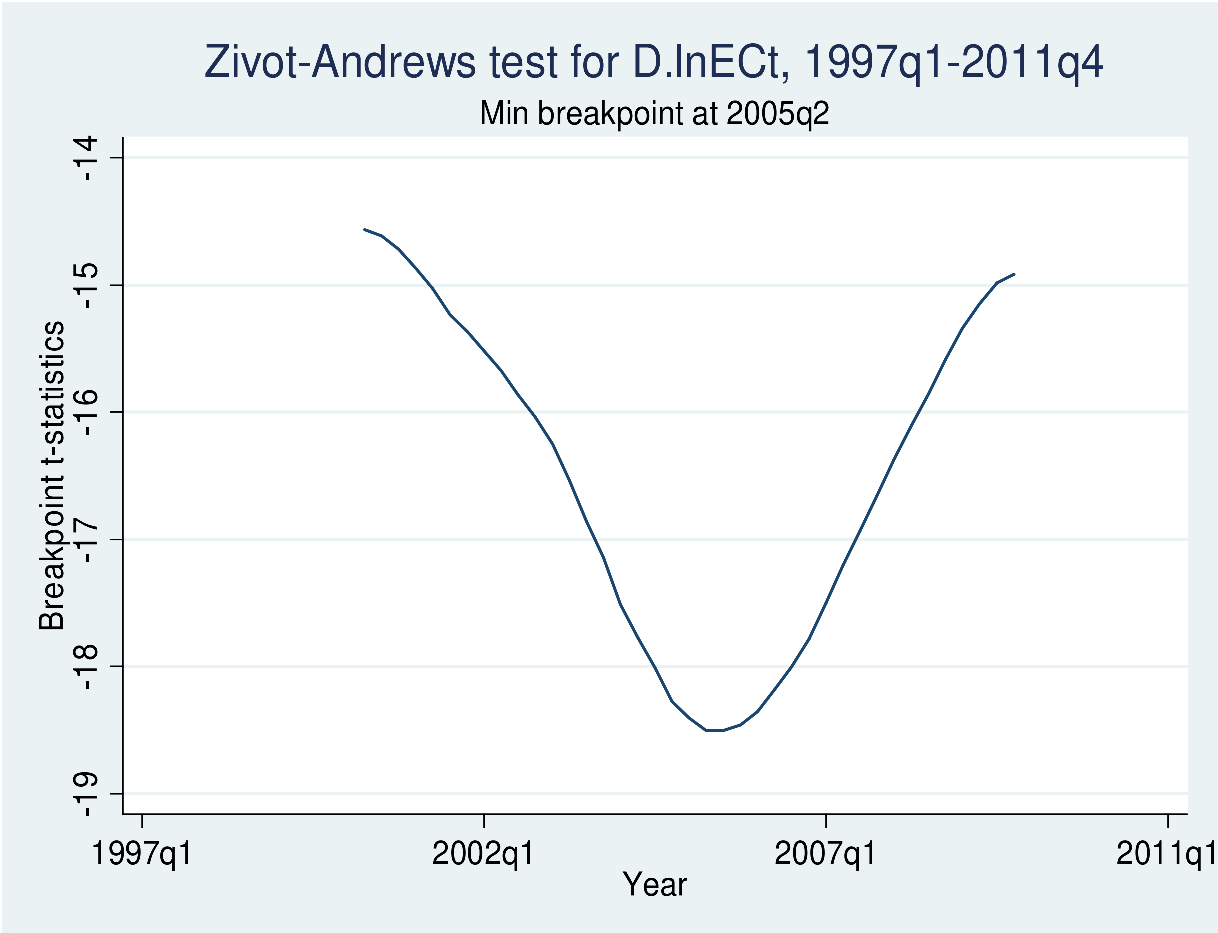




At 1st Difference




Zivot-Andrews test for D.lnCPIt, 1997q1-2011q4
Min breakpoint at 2001q3
Breakpoint t-statistics
-5.1
-5.2
-5.3
-5.4
-5.5
-5.6
1997q1
2002q1
2007q1
2011q1
Year


Zivot-Andrews test for D.lnECt, 1997q1-2011q4
Min breakpoint at 2005q2
Breakpoint t-statistics
-14
-15
-16
-17
-18
-19
1997q1
2002q1
2007q1
2011q1
Year