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ABSTRACT

This paper considers the issue of whether shocks to ten commodity prices (gold, silver, platinum, copper, aluminum, iron ore, lead, nickel, tin, and zinc) are persistent or transitory. We use two recently developed unit root tests, namely the Narayan and Popp (NP, 2010) test and the Liu and Narayan (LN, 2010) test that allow for two structural breaks in the data series. Using the NP test, we are able to reject the unit root null for iron ore and tin, while, using the GARCH-based unit root test of LN, we are able to reject the unit root null for five commodity prices; namely, iron ore, nickel, zinc, lead, and tin. Our findings, thus, suggest that only shocks to gold, silver, platinum, aluminum, and copper are persistent.

Keywords: Commodity Prices; Unit Root Test; GARCH.

1. INTRODUCTION

Searching for persistence in data series began with the seminal work of Nelson and Plosser (1982), whose analysis was based on US macroeconomic series. The theoretical motivation was business cycle theory. A number of studies have examined persistence in macroeconomic variables for a range of countries (see, *inter alia*, Rapach, 2002; Murray and Nelson, 2000). The strong theoretical and policy relevance of understanding whether or not a series is persistent has attracted research on non-macroeconomic data series. For example, there are studies on health expenditures (Narayan, 2006, 2008), tourism (Narayan, 2005, Narayan and Bhattacharya, 2005; Smyth et al., 2009), and energy (Maslyuk and Smyth, 2009; Narayan *et al.* 2008). It is the latter that is of particular interest to us in this paper. A test of persistence of energy variables was motivated by the work of Narayan and Smyth (2007), following which numerous studies have been undertaken on this subject matter. The most recent contributions are Maslyuk and Smyth (2009), Mishra *et al.* (2009), Lean and Smyth (2009) and Narayan and Popp (2010).

There are two main features of the literature on energy persistence. First, a wide range of panel and univariate unit root tests have been used to examine persistence. There is a general consensus from these studies that energy variables are stationary—hence, stocks do not have a persistent effect on energy variables. Second, studies have considered energy variables at the national, sub-national and sectoral levels. The main conclusion has remained unchanged, however: that shocks to energy variables have a transitory effect.

The goal of this paper is to examine the persistence or otherwise of 10 commodity prices, namely zinc, tin, nickel, lead, iron ore, copper, and aluminum. We use daily price data. The sample size varies depending on data availability. We make two contributions to the commodity price persistence literature. First, this is the first study that examines persistence in commodity prices based on daily data. Second, we use two recent unit root testing methodologies that have not been used not only in the applied energy literature but also in the applied economics literature. We use the Narayan and Popp (2010) unit root test, which allows for two structural breaks in the intercept of the data series, and in the intercept and trend of the data series. Secondly, because our sample size is daily data, it is now widely known that this data is relatively noisier and suffers from heteroskedasticity. To address the issue of heteroskedasticity, we use a recent GARCH-unit root test developed by Liu and Narayan (LN, 2010). The added advantage of the LN test is that it is flexible enough to accommodate two structural breaks in the data series. It follows that in this paper our contributions are both applied as well as methodological, which is likely to lay the foundation for additional work not only on the application of the testing procedures but also on commodity prices in general.

Briefly foreshadowing the main results, we find that when we apply the conventional Augmented Dickey and Fuller (ADF, 1981) unit root test, the unit root null is not rejected for any of the 10 commodity price series, implying that shocks to commodity prices were persistent. In the applied econometrics literature it is well established that the failure of the ADF model to reject the null is largely due to its inability to cater for structural breaks. Hence, we apply a recently developed unit root test that endogenously determines two structural breaks from the data series. The results from

the Narayan and Popp (2010) test reveal that the unit root null could only be rejected for two out of the 10 commodity prices. Liu and Narayan (2010) argue that when subjecting low frequency data to ADF-type unit root tests, such as the Narayan and Popp (2010) test, the unit root model is likely to suffer from heteroskedasticity. We, thus, consider the Liu and Narayan (2010) GARCH-two-break model and find that the unit root null hypothesis is rejected for five out of the 10 commodity prices. We thus conclude that there is mixed evidence on whether shocks have a persistent effect on commodity prices.

The balance of the paper is organized as follows. In the next section, we discuss the relevance of commodity prices and its relation to our proposed work. This places our work in the broader literature on commodity prices. In section 3, we review the related literature and place the contribution of our study to this literature. In section 4, we discuss the data series. In section 5, we present the econometric methodology and discuss the results. In the final section, we provide some concluding remarks.

2. The Relevance of Commodity Prices

There is now a substantial body of research on commodity prices. The aim of this section is to highlight the key areas in which research on commodity prices has been undertaken. This will help us identify the strength of our contribution to the literature on commodity prices. At the outset, two features of the literature on commodity markets need to be recognized. First, commodity prices, particularly on precious metals such as gold, platinum and silver, have traditionally had monetary value and have been used as a medium of international exchange. Second, commodity prices are volatile and numerous studies have shown this. This volatility has been induced by:

(a) macroeconomic factors, such as changes in the interest rate and exchange rate; (b) business cycle phases (recessions and expansions); and (c) political events, such as wars or threats of wars and terrorist attacks. What is the meaning of volatility in commodity prices and our research question in this paper? Volatility is a source of structural changes in commodity prices. It is now well established, following the work of Perron (1989), that structural breaks have a direct effect on persistence or otherwise of a data series. Subsequent work, such as that by Lumsdaine and Papell (1997) and Lee and Strazicich (2003), among others, have also demonstrated this empirically. Hence, in our work, we specifically model these structural breaks in testing for persistence, and we find that allowing for structural breaks does reduce the number of cases of commodity price persistence.

A second observation we make, based on the work of Xu and Fung (2005), is that arbitrageurs and speculators keenly follow metal (commodity) prices globally, and because metal commodities are characterized by standard quality it enables arbitrage in cross-market futures trading. It follows that understanding the behavior of commodity prices; that is, whether shocks to commodity prices are persistent or transitory has direct relevance to arbitrageurs and speculators in the commodity trading market. Our work, thus, makes a direct contribution to the functioning of market participants in the commodities market.

Finally, we make a general observation in terms of the various strands of the literature on commodity prices. We find that studies on commodity prices can be divided into three categories. The first category of studies (Akgiray *et al.*, 1991; Urich, 2000) examines the distributional properties of futures prices. The second category of

studies considers the effect of business cycle and macroeconomic news releases on futures prices of precious metals (Fama and French, 1988; Christie-David *et al.*, 2000; Cai *et al.*, 2001). The third strand of this literature examines the relationship between cash market and futures market (Chow, 2001) or the metal futures trading in multiple markets (Dhillion *et al.* 1997; Xu and Fung, 2005). The implication of this finding for our work is that none of these studies have specifically considered whether shocks to commodity prices are persistent. We do so for the first time.

3. An overview of related literature

Slade (1988) was the first study to examine the integrational property of commodity prices. She used a Hotelling-type linear trend model in the spirit of a random walk type difference stationary model. She examined eight commodity prices and found that seven of them were characterized by a random walk.

Berck and Roberts (1996) examined the unit root properties of nine commodity prices, using annual data for the period 1940 to 1991. They used the Lagrange Multiplier (LM) test proposed by Schmidt and Phillips (1992) and the conventional ADF test. They found that only silver price was stationary.

Ahrens and Sharma (1997) considered a large number of commodity prices. They used real commodity price for 11 series for the time period 1870 to 1990. They test the unit root null hypothesis based on the ADF and the Perron (1989) one exogenous structural break model. They found that five series—copper, iron, nickel, petroleum, and silver – are trend stationary.

The most recent contribution on this subject has been Lee *et al.* (2006). They used annual real commodity price for 11 series. They examined the unit root null hypothesis by using the new two endogenous break LM test proposed by Lee and Strazicich (2003). They found strong evidence that commodity prices were stationary around deterministic trends with structural breaks.

It follows that the literature on the unit root null hypothesis of commodity prices has the following features. First, the initial study by Slade (1988) has several limitations. The two most common ones are: (1) her proposed model does not include a constant and a time trend; and (2) the proposed model does not allow for structural changes in the data series. This explains, in light of the evidence provided by Lee *et al.* (2006) that structural breaks and trends are important considerations for commodity prices, why she failed to reject the unit root null hypothesis.

Second, the next two studies by Berck and Roberts (1996) and Ahrens and Sharma (1997) attempt to address the limitations in the Slade study by incorporating an exogenous structural break. While they do find some cases of stationarity of commodity prices, there are two main limitations of their study: (1) they only consider an exogenous structural break, which is really a biased selection of the break date; and (2) they only consider one structural break, when, as Lee *et al.* (2006) show, there are more than one structural break in commodity prices. Third, Lee *et al.* (2006) improve upon the extant studies significantly by using a unit root model that accounts for two endogenous structural breaks.

Our study contributes to this literature through testing the unit root null hypothesis for commodity prices based on daily data. It is the first study to do so. Daily data matters directly for investors. When investors decide on investment portfolio selection they monitor the behavior of daily. Moreover, our study uses two tests that are shown to be more powerful and precise in selecting the endogenous break dates compared with the Lee and Strazicich (2003) test. Our use of the GARCH-unit root model accounting for two structural breaks caters for any potential ARCH effects, which are common in daily data.

4. Data

In this section, we take a closer look at the data series. Since this is the first study to consider a wide range of commodity prices, it is important to understand some basic features of the 10 commodities studied in this paper before we undertake the test for persistence. However, before we begin with this description of data, a note on sample size and data source is in order. The data series is daily. The sample size for each of the series is reported in column 2 of Table 2. The sample size varies depending on data availability, and ranges from as low as 904 observations in the case of iron ore to 8738 observations in the case of gold. All data is downloaded from BLOOMBERG.

We begin with an inspection of the plots of each of the 10 commodity prices. The plots are presented in Figure 1. Two observations from the graphs and are worth highlighting here, as they have implications for the econometric modeling to follow in the next section. First, we notice that almost all the 10 commodity prices have a

positive trend for most of the time period; however, over the last couple of years, the trend has been negative. We attribute this to the oil price crisis. Second, we notice some obvious structural breaks in all the 10 price series. The implication is that we need to test its statistical significance and extract them, and then use the knowledge on structural break dates to conduct unit root tests. This is important as the literature on structural break unit root test has shown that including structural breaks improves the power of the test (see Narayan and Popp, 2010; Lee and Strazicich, 2003).

INSERT FIGURE 1

Based on selected descriptive statistics on each of the commodity prices, the following features of the data can be obtained. First, on the basis of the mean and standard deviation reported in columns 2 and 3, respectively, we find that the coefficient of variance is the highest for aluminum (3.49), followed by iron ore (2.51), gold (2.2), silver (1.98), zinc (1.94) and tin (1.91). This seems to imply that these commodities prices are amongst the most volatile. On the other hand, the least volatile price commodities are nickel (1.37), lead (1.39), copper (1.60), and platinum (1.77). Second the statistics on skewness, Kurtosis and J-B clearly reveal that the 10 commodity prices are non-normal.

INSERT TABLE 1

5. Methodology and Empirical Findings

We begin the empirical analysis with the Augmented Dickey and Fuller (ADF, 1981) test that examines the null hypothesis of a unit root. The regression model is of the following form:

$$\Delta C_{p,t} = \alpha_0 + \alpha_1 C_{p,t-1} + \alpha_2 T + \sum_{j=1}^k \alpha_3 \Delta C_{p,t-j} + \varepsilon_t \quad (1)$$

In Equation (1), $C_{p,t}$ is commodity price at time t ; $\Delta C_{p,t-j}$ is the lagged first differences of the dependent variable, included to accommodate for serial correlation in the error term, ε_t . Equation (1) examines the null hypothesis of a unit root against the alternative that the variable is stationary around a trend.

The results are reported in Table 2. The main finding is that we are unable to reject the unit root null hypothesis for any one of the 10 commodity price series. It follows that on the basis of the ADF test, all 10 commodity prices are nonstationary.

INSERT TABLE 2

It is now widely known that the failure to reject the unit root null is likely to be a result of unaccounted structural breaks, which when correctly accommodated becomes a source of power to reject the null hypothesis in unit root testing. To accommodate for structural breaks in commodity prices, we follow the recent unit root procedure developed by Narayan and Popp (2010). Essentially, they propose two models, both allowing for two structural breaks. Their first model, which they term M1, is one which allows for two structural breaks in the intercept of the data series, while their second model, which they term M2, is one where two breaks are allowed for simultaneously in the intercept and trend of the data series.

NP define the deterministic component of $y_t = d_t + \mu_t$, where μ_t behaves like an AR (1) process, as follows for models M1 and M2, respectively:

$$d_t^{M1} = \beta_0 + \beta_1 t + \Psi^*(L)(\delta_1 DU'_{1,t} + \delta_2 DU'_{2,t}) \quad (2)$$

$$d_t^{M2} = \beta_0 + \beta_1 t + \Psi^*(L)(\delta_1 DU'_{1,t} + \delta_2 DU'_{2,t} + \kappa_1 DT'_{1,t} + \kappa_2 DT'_{2,t}) \quad (3)$$

Where $DU'_{i,t} = 1(t > T'_{B,i})$, $DT'_{i,t} = 1(t > T'_{B,i})(t - T'_{B,i})$, $i = 1, 2$.

Here, $T'_{B,i}$, $i = 1, 2$, denotes the true break dates. The parameters δ and κ denote the magnitude of the level and slope breaks, respectively. Narayan and Popp (2010) show that the inclusion of $\Psi^*(L)$ allows breaks to occur slowly over time. Hence, the proposed model is an innovative outlier class of models, as it is based on the idea that a series responds to shocks to the trend function in the same way as it reacts to shocks to the innovation process, ε_t .

The test regressions are then simply the reduced form of the corresponding structural model as follows:

$$y_t^{M1} = \rho y_{t-1} + \alpha_1 + \beta^* t + \delta_1 D(T'_B)_{1,t} + \delta_2 D(T'_B)_{2,t} + \delta_1 DU'_{1,t-1} + \delta_2 DU'_{2,t-1} + \sum_{j=1}^k \beta_j \Delta y_{t-j} + \varepsilon_t \quad (4)$$

$$y_t^{M2} = \rho y_{t-1} + \alpha^* + \beta^* t + \theta_1 D(T'_B)_{1,t} + \theta_2 D(T'_B)_{2,t} + \gamma_1 DU'_{1,t-1} + \gamma_2 DU'_{2,t-1} + \vartheta_1^* DT'_{1,t-1} + \vartheta_2^* DT'_{2,t-1} + \sum_{j=1}^k \beta_j \Delta y_{t-j} + \varepsilon_t \quad (5)$$

The break dates are selected using the sequential procedure; for specific details, see Narayan and Popp (2010: 3-4). The null hypothesis of a unit root is tested as $\rho = 1$ against the alternative hypothesis of $\rho < 1$, based on a t -statistic of $\hat{\rho}$ in Equations (4)

and (5). The critical values are tabulated in Table 3 for both M1 and M2 models. We extract appropriate critical values from their Table 3.

The results from the M1 model are reported in Table 3. The results are organized as follows: in column 1, we report all the 10 data series, in column 2 the time period is reported, in column 3, the t-test statistic used to test the null hypothesis is reported, and in the last two columns the structural break points are reported. The test statistics reveal that we can reject the null hypothesis of a unit root in two of the 10 series. For example, the null is rejected at the 1 per cent level in the case of iron ore and at the 5 per cent level in the case of tin. Hence, based on the M1 model, iron ore and tin are stationary while the rest of the eight series are non-stationary. In terms of break dates, while this is not the main theme of this study, it is still worth commenting on the likely locations of the break dates, as these break dates are used in the next test based on the GARCH structural break testing model. We notice that most of the first break date tends to occur around the mid-point of the sample. In terms of the second break, it varies by commodity type. For example, for Tin and Zinc the second break occurs at around the 75th percentile, while for gold and silver the second break occurs around the 60th percentile. For lead and Nickel, we observe that the two breaks are very close to each other. The graphs actually are consistent with these statistical break dates, although the endogenous break dates produced by the model are tested for statistical significance, and the most statistically significant one is reported. Hence, sometimes it is likely that the observed break date is not the most statistically significant. This needs to be kept in mind in reconciling the graphs with the statistical tests. In our case, there seems to be some change in the series for almost all the 10 commodity

prices at around the mid-point of the sample followed by high volatility (responsible for the second break) towards the last quarter of the series.

INSERT TABLE 3

Next, we consider the M2 model to check whether allowing for two breaks in the trend function will make any difference to the results. The results are reported in Table 4 and are organized as for the M1 results. The results suggest that the unit root null hypothesis can only be rejected for the iron ore series at the 1 per cent level; for the rest of the nine series the null is not rejected, implying that these are non-stationary. Taken together, then, based on both models (M1 and M2), we find that at best we can reject the unit root null hypothesis for iron ore and nickel. This means that iron ore and nickel are stationary while the rest of the eight commodity prices are non-stationary.

INSERT TABLE 4

One problem we encountered when we considered the descriptive statistics was that of non-normality of the series, given that we are using daily data. We address this issue through the use of a GARCH-based unit root structural break model. This model was proposed by LN (2010) and it accounts for two structural breaks in the data series. The model has the following form:

$$y_t = \rho y_{t-1} + d_1 B_{1,t} + d_2 B_{2,t} + \varepsilon_t \quad (6)$$

Where $B_{i,t} = 1$, for $t \geq T_{Bi}$, otherwise $B_{i,t} = 0$, where T_{Bi} are the structural break points with $i = 1,2$.

$$\varepsilon_t = h_t v_t \quad v_t \rightarrow N(0,1) \quad (7)$$

$$h_t = \omega + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} \quad (8)$$

LN (2010) propose a joint maximum likelihood (ML) estimation of the unit root equation and GARCH process. The unit root null hypothesis is examine via the ML t-ratio for ρ . LN (2010) tabulate appropriate critical values for different break fractions and we extract critical values from there and report them as notes to Table 5 where the results are reported. The results for each of the 10 commodity price series follows the previous results in that the test statistics are reported together with the sample size.

Our main finding is that the unit root null is rejected for five out of the 10 commodity price series. For instance, we are able to reject the null at the 1 per cent level for iron ore, nickel and zinc, and at the 5 per cent level for lead and tin. It follows that these five series are stationary, while the remaining five series (gold, silver, platinum, aluminum, and copper) are not non-stationary. Compared with the two break test of NP (2010), the new GARCH based structural break test is able to reject the unit root null hypothesis in three additional cases, namely for lead, nickel and zinc. We expected the GARCH model to perform better, for as Liu and Narayan (2010) argue and show, the GARCH unit root test with two structural breaks is superior in terms of rejecting the unit root compared with existing two break unit root tests, such as those from Narayan and Popp (2010), Lee and Strazicich (2003), and Lumsdaine and Paper (1997).

INSERT TABLE 5

6. Concluding Remarks

In this paper, motivated by the growing interest in testing for persistence in energy variables, we examine persistence for ten commodity prices. We notice that while the literature on energy persistence has been very comprehensive with a wide range of applications, no work has been done on commodity prices. Recently, particularly with the advent of the oil price crisis, the role of commodity prices in economic growth has come to the forefront. We, thus, take issue with the question: do shocks to commodity prices have a persistence effect? To answer this question, we begin with the conventional ADF test and find persistence in all the ten commodity prices.

Motivated by the literature on structural break unit root testing, we show concern regarding the potential spurious results from the ADF given the absence of structural breaks. To remedy this, we apply a recently developed two structural break unit root test proposed by Narayan and Popp (2010). We find that in two cases—iron ore and tin—we are able to reject the unit root null, meaning that when applying the structural break unit root test, the number of cases of persistent series falls from 10 to eight.

We seek further motivation from the finding that because we use daily data, it is likely to suffer from heteroskedasticity; this has been widely proven to be the case with daily data. A remedy is to use ARCH/GARCH type models. Our approach was that we used the Liu and Narayan (2010) GARCH based unit root test which accounts for two structural breaks in the data series. Using this test, we found that the unit root (or persistence) null was rejected in five (iron ore, nickel, zinc, lead, and tin) of the 10

commodity prices. It follows that we find that only shocks to gold, silver, platinum, aluminum, and copper are persistent.

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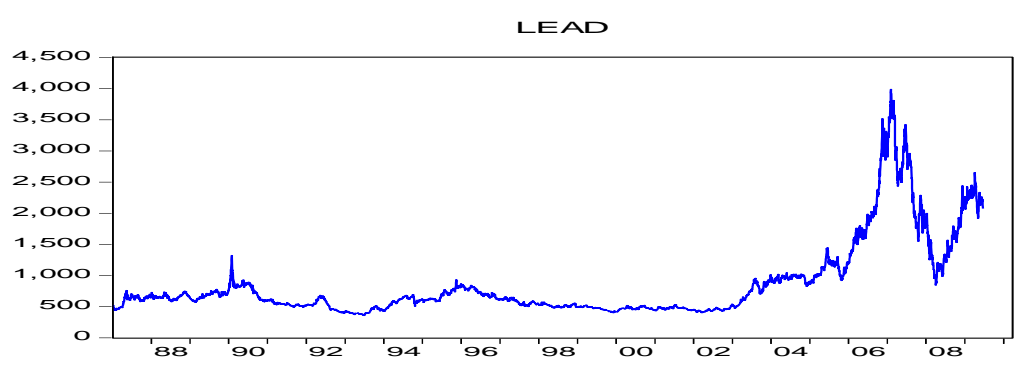
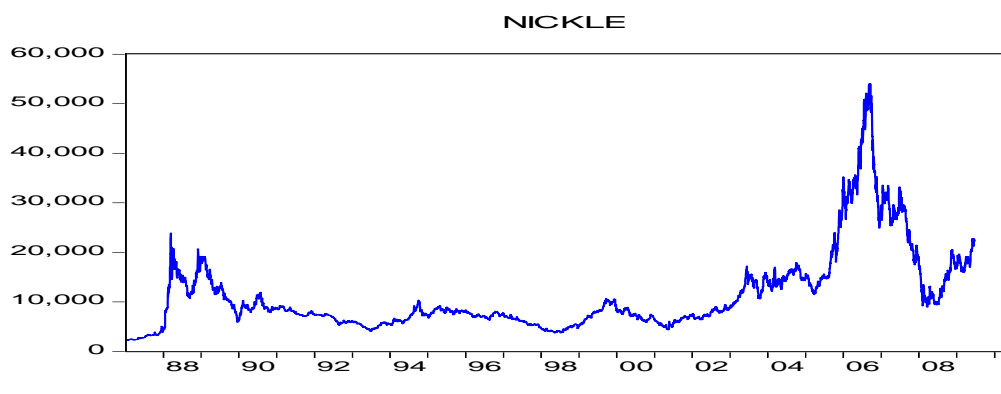
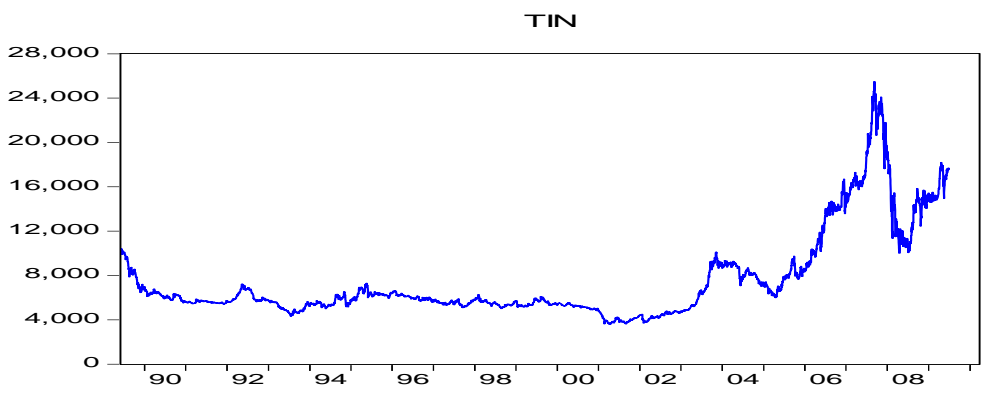
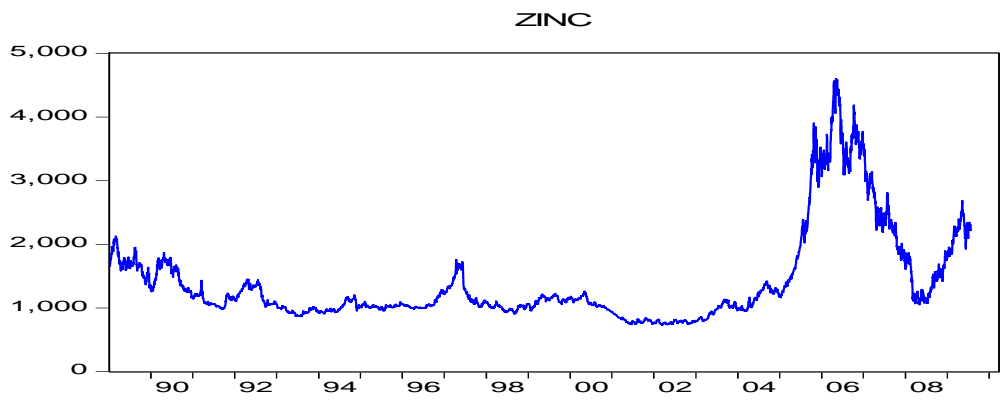
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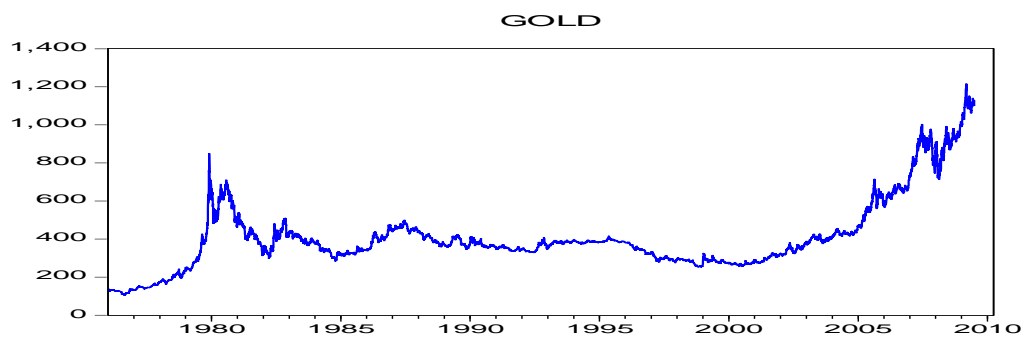
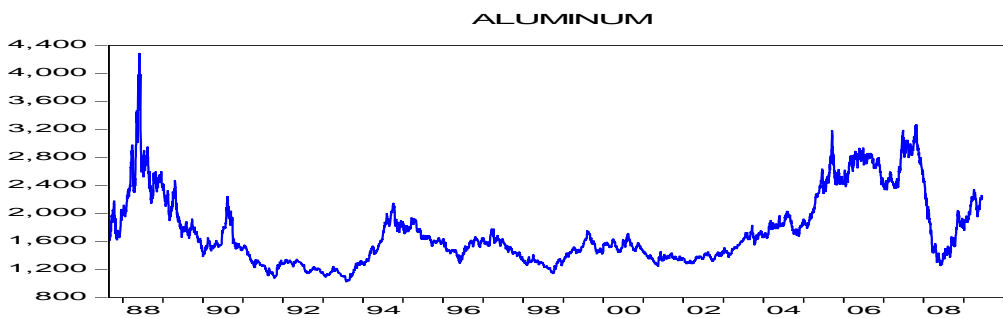
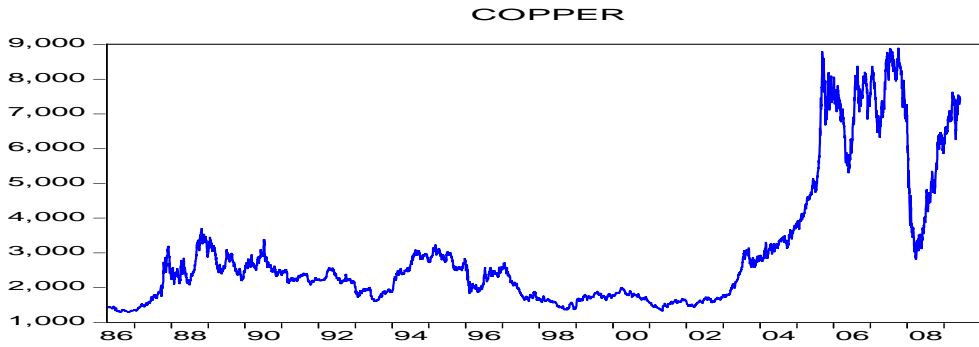
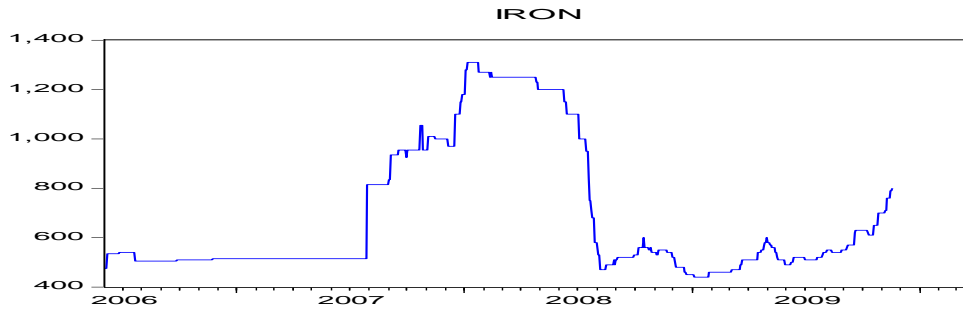
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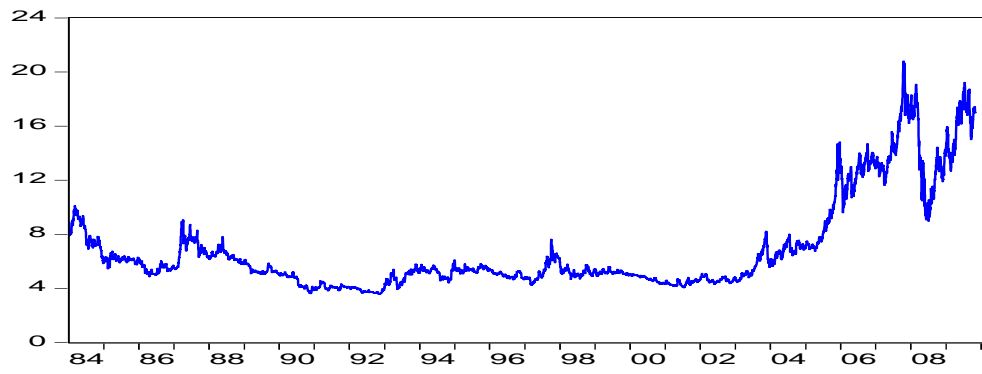
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Figure 1: Plots of each of the 10 commodity price series





SILVER



PLATINUM

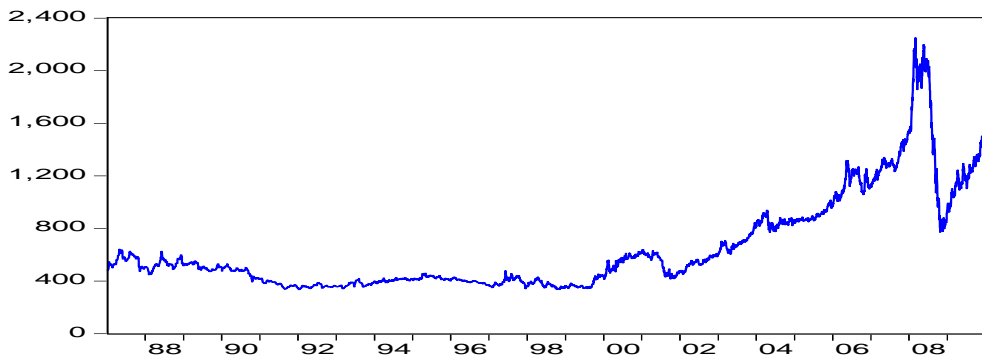


Table 1: Descriptive statistics

	Mean	SD	Skewness	Kurtosis	J-B
Gold	408.41	185.92	1.68	6.32	8117
Silver	6.82	3.44	1.84	5.52	5583
Platinum	653.94	369.32	1.72	5.71	4853
Aluminum	1728.12	494.49	1.24	4.12	1747
Copper	2978.65	1859	1.70	4.77	3720
Iron ore	685.91	272.92	1.16	2.74	206.33
Lead	852.95	613.27	2.40	8.70	1353
Nickel	11193.61	8174	2.27	9.00	13827
Tin	7527.9	3948	2.00	6.64	6393
Zinc	1396.47	720.08	2.13	7.25	8094

Table 2: ADF test

Series	Sample size	Number of observations	Test statistic
Gold	2/01/1976 – 23/03/2010	8738	-0.596 (0)
Silver	3/01/1984 – 23/03/2010	6741	-1.995 (2)
Platinum	7/01/1987 – 23/03/2010	6053	-1.663 (1)
Aluminum	28/08/1987- 23/03/2010	5691	-2.738 (1)
Copper	2/04/1986 – 23/03/2010	6052	-1.350 (1)
Iron ore	2/06/2006 – 23/03/2010	904	-1.019 (0)
Lead	6/01/1987 - 23/03/2010	5859	-2.179 (1)
Nickel	6/01/1987 – 23/03/2010	5860	-2.135 (2)
Tin	2/06/1989 – 23/03/2010	5237	-2.125 (0)
Zinc	5/01/1981 - 23/03/2010	5362	-2.139 (0)

Notes: The critical values for the ADF test are -3.959, -3.410, and -3.127 at the 1 percent, 5 percent and 10 percent levels, respectively.

Table 3: The Narayan and Popp (2010) two-break test results—M1

Series	Sample size	Test statistic	TB1	TB2
Gold	2/01/1976 – 23/03/2010	-2.123 (5)	0.56	0.60
Silver	3/01/1984 – 23/03/2010	-1.792 (2)	0.34	0.62
Platinum	7/01/1987 – 23/03/2010	-2.839 (2)	0.45	0.52
Aluminum	28/08/1987- 23/03/2010	-2.762 (2)	0.42	0.48
Copper	2/04/1986 – 23/03/2010	-2.228 (2)	0.23	0.55
Iron ore	2/06/2006 – 23/03/2010	-9.478*** (5)	0.24	0.63
Lead	6/01/1987 - 23/03/2010	-2.834 (2)	0.45	0.51
Nickel	6/01/1987 – 23/03/2010	-2.833 (2)	0.45	0.51
Tin	2/06/1989 – 23/03/2010	-4.477** (2)	0.62	0.76
Zinc	5/01/1981 - 23/03/2010	-3.310 (2)	0.56	0.78

Note: Critical values at the 1 percent and 5 percent levels are -4.672 and -4.081, respectively. Critical values are extracted from Narayan and Popp (2010: Table 3).

Table 4: The Narayan and Popp (2010) two-break test results—M2

Series	Sample size	Test statistic	TB1	TB2
Gold	2/01/1976 – 23/03/2010	-3.656 (5)	0.34	0.60
Silver	3/01/1984 – 23/03/2010	-1.808 (2)	0.28	0.34
Platinum	7/01/1987 – 23/03/2010	-2.889 (2)	0.26	0.45
Aluminum	28/08/1987- 23/03/2010	-3.673 (2)	0.22	0.75
Copper	2/04/1986 – 23/03/2010	-3.648 (2)	0.23	0.80
Iron ore	2/06/2006 – 23/03/2010	-9.978*** (5)	0.24	0.63
Lead	6/01/1987 - 23/03/2010	-2.872 (2)	0.26	0.45
Nickel	6/01/1987 – 23/03/2010	-3.407 (2)	0.26	0.77
Tin	2/06/1989 – 23/03/2010	-4.125 (2)	0.26	0.76
Zinc	5/01/1981 - 23/03/2010	-3.850 (2)	0.21	0.78

Note: Critical values at the 1 percent, and 5 percent levels are -5.287, -4.692, respectively. Critical values are extracted from Narayan and Popp (2010: Table 3).

Table 5: GARCH (1,1)-twobreak-unit root test results

Series	Sample size	Test statistic
Gold	2/01/1976 – 23/03/2010	-0.4349
Silver	3/01/1984 – 23/03/2010	-0.9836
Platinum	7/01/1987 – 23/03/2010	-0.4826
Aluminum	28/08/1987- 23/03/2010	-2.3180
Copper	2/04/1986 – 23/03/2010	-1.7993
Iron ore	2/06/2006 – 23/03/2010	-13.1937***
Lead	6/01/1987 -23/03/2010	-3.6931**
Nickel	6/01/1987 – 23/03/2010	-3.8383***
Tin	2/06/1989 – 23/03/2010	-3.4204**
Zinc	5/01/1981 -23/03/2010	-4.5644***

Notes: Since the break dates fall within the range of 0.2 to 0.8, we extract appropriate CVs from Liu and Narayan (2010), which are -3.807 and -2.869 at the 1 percent and 5 percent levels, respectively. ** (***) denote statistical significance at the 5 per cent and 1 per cent levels, respectively.