***Original Research Article***

# Testing for the Efficiency of Coal Firm Stock Markets in China


## ABSTRACT

**Aims:** The main purpose of this paper is testing for the efficiency of coal firm stock markets in the Chinese A-Share market.
**Study design:**Existence of a unit root implies an efficient market. To improve the test results, conventional unit root tests must be conducted in line with structural break tests. Acomparison of the unit roots of stock prices of two coal production-related firms in China's Shanxi Province may lead us to conclude whether the market is efficient.
**Place and Duration of Study:**The study appliedstock prices of two coal-related firms that come from Shanxi Province, China.The Shanxi Coking Co., Ltd registers in Lingfeng.The Shanxi Xishan Coal and Electricity Power Co., Ltd registers in Taiyuan. Data was the monthly prices. The data period was from August 1996 to July 2014 for the Shanxi Coking, and from July 2000 to October 2015 for the Shanxi Xishan Coal and Electricity Power.
**Methodology:**The paper conducted a unit root test applyingregular ADF and PP techniques. Also, it carried out a break date test using the Perron test and the Zivot-Andrews test (Model C).
**Results:** Tests advocate that stock prices of two coal stocks beI(0) and both contain a break datearound2007.
**Conclusion:**So, the study provides new evidence for the inconsistency of energy stock markets with the efficient market hypothesis. Opaque and incomplete information disclosure may account for the inefficiency of coal equity markets. Investors could profit from trading on coal equities. However, the paper suggests more and panelunit root tests for coal stock prices.


*Keywords: A-Share market, break date, stock price, coal firm*

## 1. INTRODUCTION

Institutions and individuals can trade on energy related stocks, which is an indirect investment in energy property. Whether an investor incorporates energy firm stocks into his or her portfolio in part depends on the efficiency of a stock market. The efficient market hypothesis (EMH) argues that property prices fully reflect all currently available market information. So investors could not profit in an efficient market in the long run[1-6]. An examination of the EMH for coal firm stock markets is significant.

Shanxi is one of the most important coal producers in China. In 2012, China produced 443.23 million tons of coke. Of which Shanxi Province contributed 19.43% (86.12 million tons)[7]. Shanxi Province is one of China's largest coke producers. The representative coal production firms include Shanxi Coking Co., Ltd (hereafter Shanxi Coking) and Shanxi Xishan Coal and Electricity Power Co., Ltd (henceforthXishan Coal and Power).

Shanxi Coking was established in August 1996. It produces coke and coke chemical products, and ammonium sulfate (for agricultural uses). The company also conducts methanol production, sales, and management. Coke production contributes 70.74% of the firm's 2016 total income. Shanxi Coking was listed on August 8, 1996. There are 665.683 million shares trading on the Chinese A-Share market. On March 10, 2017, the firm's market capitalization was RMB5.28 billion. Its stock price surged between September 2007 and February 2008 (Figure 1)[8].

Xishan Coal and Power was established in April 1999. It produces coal, and processes and sells coal products like coke. The firm also purchases and sells electricity. Coal and coke production contribute 49.02% and 23.10% of the firm's 2016 total income, respectively. Xishan Coal and Power was listed on July 26, 2000. There are 3.1512 billion shares trading on the Chinese A-Share market. On March

10, 2017, the market capitalization was RMB28.68 billion. The firm's stock price surged in September 2007 (Figure 2)[8].

Therefore, by a visual inspection of Figures 1 and 2, stock prices of these two coal-related companies might contain a shift around September 2007.

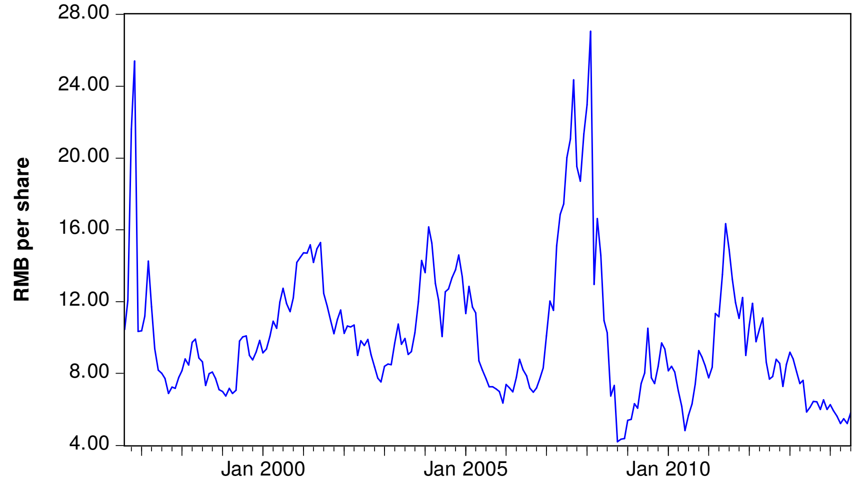


**Fig. 1.Shanxi cokingstock prices on the A-share market, China (1996-2014)**

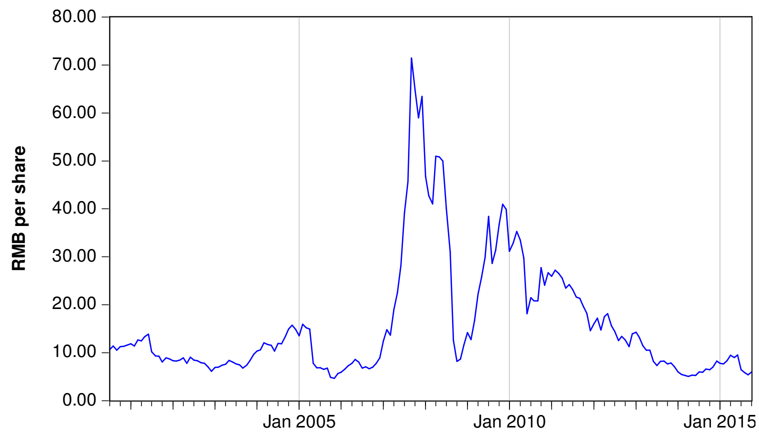


**Fig. 2. Shanxi Xishan coal and electricity power stockprices on the A-share market, China (2000-2015)**

## 2. LITERATURE REVIEW

The efficient market hypothesiswas suggested in [2, 4, 9]. Stock prices often contain a unit root and so the stock market may be consistent with the EMH. Empirical evidence for the EMH includes five developed stock markets [10], the Turkish stock market [11], the Chinese A-Share market[12], the Hong Kong Stock Exchange [13], the Australian and New Zealand share markets[14], and UK FTSE100 futures [15].

However, the empirical evidence against the EMHhas been found. Cases include the U.S. stock market [16], the South Korea's stock market [17], the Taiwan stock index (TAIEX) [18], the Asia-Pacific equity markets [19], the FTSE 30 share index on the London Stock Exchange [20], and the Athens stock market [21].

Particularly, futures prices of the daily crude oil, heating oil, and unleaded gasoline did not contain a unit root while allowing for a one-time break both in the intercept and in the slope at an unknown time[22].

However, a very small literature has dealt with the persistence or long-run memory of coal firm stock prices.

Therefore, if a coal market is informationally efficient is to a large extent an empirical issue.

## 3. MATERIAL AND METHODS

### 3.1Methods

Conventional methods of testing for a unit root include the augmented Dickey-Fuller (ADF) test [23, 24], the Phillips-Perron (PP) test [25], the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test [26], and the Elliott-Rothenberg-Stock (ERS) test [27]. The paper employs the ADF and PP tests.

Nonetheless, Figures 1 and 2 indicate that two series might have a shift in both the level and the slope. A structural break on the trend function of a series could lead to incorrect inferences for conventional unit root tests [28-31]. So, applying Model C proposed in [28], we conducted a breakpoint test. Taking the shift as unknown a priori, Model C can be in the form of [30]:

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + dD(TB)_t + \alpha y_{t-1} + \sum_{i=1}^{k} \Delta y_{t-i} + \varepsilon_t \qquad 1$$

Where *D*(*TB*) and *DU* represents a change in the level and a change in the slope, respectively. *DT* = *tDU*, *t* is the trend. Under the null hypothesis, $\mu \neq 0$ (in general), $\beta = 0$, $\theta = 0$ (except in Model C), $\gamma = 0$, $d \neq 0$, and $\alpha = 1$. Under the alternative hypothesis of trend-stationary, $\mu \neq 0$, $\beta \neq 0$, $\theta \neq 0$, $\gamma \neq 0$ (in general), $d = 0$, and $\alpha < 1$. The null is tested using the *t*-statistic for $\alpha = 1$. The break date $T_b$ is endogenously selected by minimizing the *t*-statistic for $\alpha = 1$; the minimal is termed $t_{\alpha}^{*}$.

Two specific tests using Model C are the Perron test [30] and the Zivot-Andrews test [32]. The study used the two tests. The former rejects the null hypothesis of a unit root more often than the latter [30].

### 3.2Material

We collected the stock prices of the Shanxi Coking (*SHANXI COKING*) and the Xishan Coal and Power (*XISHAN COAL POWER*). Stock prices were the closing values of the last trading day for each month. Access to the data can use the trading system http://www.dfzq.com.cn/dfzq/i/orientsec-software.jsp. Table 1 is a description of the data.

**Table 1.Descriptive statistics for the raw data**

| **Energy firms:** | **Shanxi Coking Co., Ltd** | **Shanxi Xishan Coal and Electricity Power Co., Ltd** |
|---|---|---|
| Variable | *SHANXI COKING* | *XISHAN COAL POWER* |
| Mean | 10.13 | 16.04 |

| | | |
|---|---|---|
| Median | 9.19 | 11.41 |
| Max | 27.05 | 71.49 |
| Min | 4.20 | 4.68 |
| Std. Dev. | 3.85 | 12.79 |
| Skewness | 1.62 | 1.97 |
| Kurtosis | 6.49 | 6.88 |
| Jarque-Bera (*P*-value) | 203.79(0.00) | 234.37(0.00) |
| Period | August 1996 to July 2014 | July 2000 to October 2015 |
| Observations | 216 | 184 |

## 4. RESULTS AND DISCUSSION

For *SHANXI COKING,* the null of a unit root can be rejected at the 1% level. For *XISHAN COAL POWER*, the null can be rejected at the 5% level (Table 2).

For *SHANXI COKING*, the estimated $\alpha$ equaled to 18.38 (Perron test in Table 3) and 24.59 (Zivot-Andrews test in Table 4). The Perron testshowed a change in November 2008,and the Zivot-Andrews test indicated a change in October 1999. So these two tests consistently rejected the null hypothesis of a unit root and suggested a break.

For *XISHAN COAL POWER,*the estimated $\alpha$ equaled to 15.43 (Perron test in Table 5) and 16.03 (Zivot-Andrews test in Table 6). The Perron testshowed a change in September2007,and the Zivot-Andrews test indicated a change in August2007. Also, these two tests consistently rejected the null hypothesis and proposed a break. These two tests suggested a similar break date particularly.

Anyway, testssuggest that a unit root hypothesis for the variables *SHANXI COKING* and *XISHAN COAL POWER*can be rejected but both may contain a breakpoint in the trend.

**Table 2. The unit root tests**

| Log variable | Period | Method | Level | *k* | First difference | *k* |
|---|---|---|---|---|---|---|
| *SHANXI COKING* | Aug 1996-July 2014 | ADF | -7.63*** | 1 | | |
| | | PP | -8.29*** | 7 | | |
| *XISHAN COAL POWER* | July 2000-Oct 2015 | ADF | -3.97** | 1 | | |
| | | PP | -4.14*** | 6 | | |

**All tests encompass an intercept as well as a trend according to [33, 34]. The lag k was decided using the t test for the ADF test [35] and the Newey–West (NW) bandwidth technique for the PP test [36]. *, **, and ***denote rejection of the null of a unit root at the levels of 10%, 5% and 1% , respectively.*

**Table 3. The break date test for log *SHANXI COKING*: Perron Model C**

| **Parameter & variable** | **Coefficient** | **Standard error** | ***t*-Statistic** | ***P*-value** | $T_b$ |
|---|---|---|---|---|---|
| *θ* | 0.11 | 0.16 | 0.70 | 0.49 | |
| *β* | 0.00 | 0.00 | -0.03 | 0.97 | |
| *γ* | 0.00 | 0.00 | -0.91 | 0.36 | |
| *δ* | 0.34 | 0.15 | 2.28 | 0.02 | |
| *α* | 0.81 | 0.04 | 18.38 | 0.00 | November 2008 |
| t-1 | 0.04 | 0.07 | 0.54 | 0.59 | |
| t-2 | 0.20 | 0.07 | 2.82 | 0.01 | |
| t-3 | 0.15 | 0.07 | 2.02 | 0.05 | |
| t-4 | 0.16 | 0.07 | 2.21 | 0.03 | |
| t-5 | 0.18 | 0.07 | 2.62 | 0.01 | |
| t-6 | -0.09 | 0.07 | -1.31 | 0.19 | |
| t-7 | 0.15 | 0.07 | 2.33 | 0.02 | |
| t-8 | 0.15 | 0.06 | 2.36 | 0.02 | |
| t-9 | 0.03 | 0.06 | 0.54 | 0.59 | |
| t-10 | 0.12 | 0.07 | 1.82 | 0.07 | |
| Intercept | 0.44 | 0.10 | 4.42 | 0.00 | |
| R-squared | 0.87 | Mean dependent var | 2.24 | | |
| Adjusted R-squared | 0.86 | S.D. dependent var | 0.34 | | |
| S.E. of regression | 0.13 | Akaike info criterion | -1.22 | | |
| Sum squared resid | 3.04 | Schwarz criterion | -0.96 | | |
| Log likelihood | 140.64 | Hannan-Quinn criteria | -1.11 | | |
| F-statistic | 82.69 | Durbin-Watson stat | 1.99 | | |
| Prob(F-statistic) | 0.00 | | | | |

**Variable was in logarithms. t–1, t–2, ..., t – k denote lagged terms. The trimming portion is 0.15 [37]. Truncation lag k (between 2 and 14) were selected following [30, 35, 38].* $T_b$ *is the break date. t-statisticfor t – k equals or above 1.60.*

**Table 4.The break date test for log *SHANXI COKING*: Zivot-Andrews Model C**

| Parameter & variable | Coefficient | Standarderror | *t*-Statistic | *P*-value | $T_b$ |
|---|---|---|---|---|---|
| $\theta$ | 0.08 | 0.05 | 1.51 | 0.13 | |
| $\beta$ | 0.00 | 0.00 | -0.53 | 0.59 | |
| $\gamma$ | 0.00 | 0.00 | 0.34 | 0.74 | |
| $\alpha$ | 0.84 | 0.03 | 24.59 | 0.00 | Oct. 1999 |
| *t-2* | 0.01 | 0.07 | 0.19 | 0.85 | |
| *t-3* | 0.16 | 0.06 | 2.43 | 0.02 | |
| *t-4* | 0.07 | 0.06 | 1.03 | 0.31 | |
| *t-5* | 0.16 | 0.06 | 2.64 | 0.01 | |
| *t-6* | 0.21 | 0.06 | 3.52 | 0.00 | |
| Intercept | 0.38 | 0.10 | 3.69 | 0.00 | |
| R-squared | 0.86 | Mean dependent var | | 2.24 | |
| Adjusted R-squared | 0.85 | S.D. dependent var | | 0.33 | |
| S.E. of regression | 0.13 | Akaike info criterion | | -1.20 | |
| Sum squared resid | 3.36 | Schwarz criterion | | -1.04 | |
| Log likelihood | 136.37 | Hannan-Quinn criteria | | -1.14 | |
| F-statistic | 132.01 | Durbin-Watson stat | | 1.96 | |
| Prob(F-statistic) | 0.00 | | | | |

**Notes are the same as in Table 3.*

**Table 5.The break date test for log *XISHAN COAL POWER*: Perron Model C**

| Parameter & variable | Coefficient | Standard error | *t*Statistic | *P*value | $T_b$ |
|---|---|---|---|---|---|
| $\theta$ | 0.71 | 0.18 | 3.84 | 0.00 | |
| $\beta$ | 0.00 | 0.00 | 1.85 | 0.07 | |
| $\gamma$ | -0.01 | 0.00 | -3.91 | 0.00 | |
| $\delta$ | 0.00 | 0.17 | 0.00 | 1.00 | |
| $\alpha$ | 0.79 | 0.05 | 15.43 | 0.00 | September 2007 |
| t-1 | 0.34 | 0.08 | 4.25 | 0.00 | |
| t-2 | 0.16 | 0.08 | 1.97 | 0.05 | |

| | | | | |
|---|---|---|---|---|
| t-3 | 0.09 | 0.08 | 1.05 | 0.30 |
| t-4 | 0.00 | 0.08 | 0.02 | 0.99 |
| t-5 | 0.26 | 0.08 | 3.17 | 0.00 |
| t-6 | -0.11 | 0.08 | -1.36 | 0.18 |
| t-7 | 0.10 | 0.08 | 1.25 | 0.21 |
| t-8 | 0.12 | 0.08 | 1.45 | 0.15 |
| t-9 | -0.01 | 0.08 | -0.10 | 0.92 |
| t-10 | 0.00 | 0.08 | 0.03 | 0.98 |
| t-11 | 0.19 | 0.08 | 2.44 | 0.02 |
| Intercept | 0.40 | 0.12 | 3.28 | 0.00 |
| R-squared | 0.95 | Mean dependent var | 2.55 | |
| Adjusted R-squared | 0.95 | S.D. dependent var | 0.66 | |
| S.E. of regression | 0.15 | Akaike info criterion | -0.81 | |
| Sum squared resid | 3.66 | Schwarz criterion | -0.50 | |
| Log likelihood | 86.99 | Hannan-Quinn criteria | -0.69 | |
| F-statistic | 187.15 | Durbin-Watson stat | 1.88 | |
| Prob(F-statistic) | 0.00 | | | |

**Notes are the same as in Table 3.*

**Table 6. The break date test for log *XISHAN COAL POWER*: Zivot-Andrews Model C**

| Parameter & variable | Coefficient | Standarderror | *t*-Statistic | *P*-value | $T_b$ |
|---|---|---|---|---|---|
| $\theta$ | 0.24 | 0.09 | 2.66 | 0.01 | |
| $\beta$ | 0.00 | 0.00 | 1.86 | 0.07 | |
| $\gamma$ | -0.01 | 0.00 | -4.01 | 0.00 | |
| $\alpha$ | 0.79 | 0.05 | 16.03 | 0.00 | August 2007 |
| t-1 | 0.34 | 0.08 | 4.37 | 0.00 | |
| t-2 | 0.16 | 0.08 | 1.99 | 0.05 | |
| t-3 | 0.09 | 0.08 | 1.06 | 0.29 | |

| | | | | |
|---|---|---|---|---|
| t-4 | 0.00 | 0.08 | 0.02 | 0.99 |
| t-5 | 0.26 | 0.08 | 3.19 | 0.00 |
| t-6 | -0.11 | 0.08 | -1.38 | 0.17 |
| t-7 | 0.10 | 0.08 | 1.27 | 0.20 |
| t-8 | 0.12 | 0.08 | 1.45 | 0.15 |
| t-9 | -0.01 | 0.08 | -0.10 | 0.92 |
| t-10 | 0.00 | 0.08 | 0.03 | 0.98 |
| t-11 | 0.19 | 0.08 | 2.45 | 0.02 |
| Intercept | 0.40 | 0.12 | 3.40 | 0.00 |
| R-squared | 0.95 | Mean dependent var | | 2.55 |
| Adjusted R-squared | 0.95 | S.D. dependent var | | 0.66 |
| S.E. of regression | 0.15 | Akaike info criterion | | -0.83 |
| Sum squared resid | 3.66 | Schwarz criterion | | -0.53 |
| Log likelihood | 86.99 | Hannan-Quinn criteria | | -0.71 |
| F-statistic | 200.91 | Durbin-Watson stat | | 1.88 |
| Prob(F-statistic) | 0.00 | | | |

**Notes are the same as in Table 3.*

Prices of two coal firm stocks do not contain a unit root, which implies that the coal stock market is inconsistent with the EMH. This result is similar with that of [22] who shows the stationarity of oil productfutures prices. We may attribute the inefficient coal stock market to an opaque and incomplete information disclosure in China. We cannot collect China's coke production after 2012 in National Bureau of Statistics of China's latest Statistical Yearbook 2015 [7]. Also, we cannot collect Shanxi Province's coke production in Shanxi Provincial Bureau of Statistics[39].So, though an investor knows that the share of coal and coke in the firm's total income, this share provides only necessary but no sufficient information for investors because they do not know national and Shanxi's coal and coke production on time.

The previous study suggests that a sudden change occurred in the Chinese A-Stock market in early 2007. The China Petroleum listing in 2007 might be a shock to the change [12]. So, we argue that the A-Share market crash in 2007 and the China Petroleum listing event may result in a change in the price trend of two coal firms in this study. A Granger causality test may provide evidence for this argument.

It is interesting that the coal stock price may be predictable. Investors might gain from coal stock trading on the A-Share market.

## 5. CONCLUSION

Both the ADF and PP tests suggest that two coal stock prices do not contain a unit root, which implies a violation of the EMH. The inefficiency may be explained by opaque and incomplete information disclosure.Also, both the Perron test and the Zivot-Andrews test rejected the null of a unit root but suggests a break date mostly around 2007. The study argues that the A-Share market crash and the China Petroleum listing event in 2007 may be a shock to the two coal stocks.

So, coal stock prices in the A-Share market might be forecastable. Investors could receive returns from trading on coal stocks. The study provides additional evidence for the inefficiency of energy equity markets and the significant effect of an event on the price trend.

We recommend that subsequent studies test for unit roots for stock pricesof more coal firms. Especially panel unit root and structural break tests are advised. Also, Granger causality tests can be applied to a justification of a specific event impact.

## REFERENCES

1. Laffont JJ, Maskin ES. The efficient market hypothesis and insider trading on the stock market. J. Polit. Econ. 1990, 98(1): 70-93.
2. Fama EF. Efficient capital markets: A review of theory and empirical work. J. Financ. 1970, 25(2): 383-417.
3. Fama EF. Reply. J. Finance. 1976, 31(1): 143-145.
4. Fama EF. Efficient capital markets: Ii. J. Financ. 1991, 46(5): 1575-1617.
5. LeRoy SF. Efficient capital markets and martingales. J. Econ. Lit. 1989, 27(4): 1583-1621.
6. Saunders Jr EM. Testing the efficient market hypothesis without assumptions. J. Portfol. Manage. 1994, 20(4): 28-30.
7. National Bureau of Statistics of China. China statistical yearbook. China Statistical Press. 2016; Accessed 15 October. Available: http://data.stats.gov.cn/easyquery.htm?cn=C01.
8. Sohu. Sohu stock. 2017; Accessed 20 March. Available: http://stock.sohu.com.
9. Laffer AB, Ranson RD. Some practical applications of the efficient-market concept. Financial Management (1972). 1978, 7(2): 63-75.
10. Choudhry T. Stochastic trends and stock prices: An international inquiry. Appl. Finan. Econ. 1994, 4(6): 383-390.
11. Gozbasi O, Kucukkaplan I, Nazlioglu S. Re-examining the turkish stock market efficiency: Evidence from nonlinear unit root tests. Econ. Modelling. 2014, 38(1): 381-384.
12. Zou G, Yan X, Chau KW. Price discovery from the chinesea-share market: Trend break tests using the perron mixed model c. Advances in Social Science, Education and Humanities Research. 2016, 62(1743-1748.
13. Cheung K-C, Coutts JA. A note on weak form market efficiency in security prices: Evidence from the hongkong stock exchange. Appl. Econ. Letters. 2001, 8(6): 407-410.
14. Groenewold N. Share market efficiency: Tests using daily data for australia and new zealand. Appl. Finan. Econ. 1997, 7(6): 645-657.
15. Evans T. Efficiency tests of the uk financial futures markets and the impact of electronic trading systems. Appl. Finan. Econ. 2006, 16(17): 1273-1283.
16. Caporale GM, Gil-Alana LA. Fractional integration and mean reversion in stock prices. Quart. Rev. Econ. Finance. 2002, 42(3): 599-609.
17. Hasanov M. Is southkorea's stock market efficient? Evidence from a nonlinear unit root test. Appl. Econ. Letters. 2009, 16(2): 163-167.
18. Chen TH. Is the taiwan stock market efficient? Evidence from a tar model with an autoregressive unit root. International Research Journal of Finance & Economics. 2011, 77(74-83.

19. Suleman MT, Hamid K, Ali Shah SZ, Imdad Akkash RS. Testing the weak form of efficient market hypothesis: Empirical evidence from asia-pacific markets. International Research Journal of Finance & Economics. 2010, 58(121-133.
20. Al-Loughani N, Chappell D. On the validity of the weak-form efficient markets hypothesis applied to the london stock exchange. Appl. Finan. Econ. 1997, 7(2): 173-176.
21. Dockery E, Kavussanos MG. Testing the efficient market hypothesis using panel data, with application to the athens stock market. Appl. Econ. Letters. 1996, volume 3(2): 121-123.
22. Serletis A. Unit root behavior in energy futures prices. Energy J. 1992, 13(2): 7-14.
23. Dickey DA, Fuller WA. Distribution of the estimators for autoregressive time series with a unit root. J. Amer. Stat. Assoc. 1979, 74(386): 427-431.
24. Dickey DA, Hasza DP, Fuller WA. Testing for unit roots in seasonal time series. J. Amer. Stat. Assoc. 1984, 79(386): 355-365.
25. Phillips PCB, Perron P. Testing for a unit root in time series regression. Biometrika. 1988, 75(2): 335-346.
26. Kwiatkowski D, Phillips PC, Schmidt P, Shin Y. Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? J. Econometrics. 1992, 54(1): 159-178.
27. Elliott G, Rothenberg TJ, Stock JH. Efficient tests for an autoregressive unit root. Econometrica. 1996, 64(813-836.
28. Perron P. The great crash, the oil price shock, and the unit root hypothesis. Econometrica. 1989, 57(6): 1361-1401.
29. Perron P. Testing for a unit root in a time series with a changing mean. J. Bus. Econ. Statist. 1990, 8(2): 153-162.
30. Perron P. Further evidence on breaking trend functions in macroeconomic variables. J. Econometrics. 1997, 80(2): 355-385.
31. Sen A. On unit-root tests when the alternative is a trend-break stationary process. J. Bus. Econ. Statist. 2003, 21(174-184.
32. Zivot E, Andrews DWK. Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. J. Bus. Econ. Statist. 1992, 10(3): 251-270.
33. Hamilton HD. Time series analysis. first. Princeton University Press: Princeton, New Jersey; 1994.
34. Hendry DF, Juselius K. Explaining cointegration analysis: Part i. Energy J. 2000, 21(1): 1-42.
35. Ng S, Perron P. Unit root tests in arma models with data dependent methods for the selection of the truncation lag. J. Amer. Stat. Assoc. 1995, 90(429): 268-281.
36. Newey WK, West KD. A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. Econometrica. 1987, 55(3): 703-708.
37. Banerjee A, Lumsdaine RL, Stock JH. Recursive and sequential tests of the unit root and trend break hypothesis: Theory and international evidence. J. Bus. Econ. Statist. 1992, 10(3): 271-287.
38. Ng S, Perron P. Lag length selection and the construction of unit root tests with good size and power. Econometrica. 2001, 69(6): 1519-1554.
39. Shanxi Statistical Information Net. Statistical data. Shanxi Provincial Bureau of Statistics 2017; Accessed 3 April. Available: http://www.stats-sx.gov.cn/tjsj/.