International Journal of Academic Research in Business and Social Sciences
2016, Vol. 6, No. 12
ISSN: 2222-6990

Analysing the Efficiency of the Turkish Stock Market with Multiple Structural Breaks

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DOI: 10.6007/IJARBSS/v6-i12/2531 URL: http://dx.doi.org/10.6007/IJARBSS/v6-i12/2531

Abstract

Analysing the structural changes in the economy is important. Cruical financial, economic and social events may cause structural breaks. Not taking into account the existing structural breaks causes reduction in the ability to reject the null hypothesis of unit root equal to zero. In the previous studies, usually structural breaks are either not taken into account or in more recent studies one or two structural breaks are included. This study investigates the informational efficiency of the Turkish market in weak form considering multiple structural breaks and taking into account the effect of financial structural changes for the period of 1988-2011. The results indicated that BIST 100 National Index is informationally efficient in the weak form. With Clemao2 and Clemio2 analyses, the structural breaks in 1988:01-2011:11 period are 2007:11 and 2009:1; 2007:12 and 2009:2 respectively. When 1988:01-2011:11 period is separated into two subperiods as 1988-1996 and 1997-2011, in 1988-1996 period with clemao2 analysis 1995:9 and 1996:5, with clemio2 analysis 1995:10 and 1996:6 are the structural break dates. In 1997-2011 period, with clemao2 2007:11 and 2008:12, with clemio2 2007:12 and 2008:9 are the structural break dates. These structural breaks reflect the effects of 1994 national crisis and 2008 global crisis.

Keywords: Multiple structural breaks, BIST, Istanbul Stock Exchange, Augmented Dickey Fuller test, efficient market hypothesis.

INTRODUCTION

In an efficient market, new information is rapidly reflected in the price of the security. Market efficiency depends on the speed and the accuracy of adjustment upon the arrival of new information. In an efficient market, each security has a return consistent with its risk level. Without taking an extra risk exceeding the normal level, an investor cannot get a return more than the normal level. The prices already reflect all the information available. Market efficiency takes place in the form of informational effiicency, operational efficiency and resourse allocation efficiency. In the efficient market hypothesis, informational efficiency is considered.

Informational efficiency means that the prices fully reflect all the available and relevant information. In an efficient market, the actual rate of return might deviate positively or negatively from the expected rate of return. These deviations should be randomly distributed around the expected return and the mean of these deviations should be equal to zero. The efficient market hypothesis depends on the random walk hypothesis (Kendall, 1953).

In 1970, Fama described the market efficiency in three forms: weak, semi-strong and strong form. Weak form efficiency is the lowest form of efficiency. In weak form of efficiency, the stock prices reflect all the past relevant information. Since all the past information is reflected in the prices, past rate of returns and other market information is not related to the future rate of returns. Returns are independent of each other. An investor can not get an extra return by using past price information. In the weak form of efficiency, stock prices are described by random walk. Random walk means stock returns cannot be predicted from past returns and price movements over time are random and independent of each other. Current price changes are not related to past price changes. When the stock prices have a unit root, they can be described by random walk. If the stock price has a random walk, any shock to the stock price becomes permanent and there will be no tendency to return to the trend level. On the contrary, trend stationary means any shock affecting the stock price is temporary and over time the prices get back to the mean trend level, indicating market inefficiency. One can develop strategies to achieve more than normal returns.

Till now, many studies have been done on the stationarity of stock markets both in the world and in Turkey. However, there has been no consensus on this issue. Analysing the structural changes in the economy is important. Cruical financial, economic and social events may cause structural breaks. Not taking into account the existing structural breaks causes reduction in the ability to reject the null hypothesis of unit root equal to zero (Perron,1989). In the studies, usually structural breaks are either not taken into account or in more recent studies one or two structural breaks are included. Lee et al. (2010), for the period of 1999:01-2007:05 compared the stock markets of developed and developing countries including Turkey by using multiple structural breaks. For Turkey, the results indicated that the structural break dates are May 2000, August 2003 and September 2005. They concluded that Istanbul Stock Exchange (BIST) is not an efficient market.

In this study, I used multiple structural breaks for the period starting from 1988 till 2011. The research question of the study is 'Is BIST 100 National Composite Index informationally efficient in the weak form considering multiple structural breaks?' The results are expected to contribute to the literature by informing us about the efficiency of the Turkish market considering multiple structural breaks and taking into account the effect of financial structural changes for twentythree years' period.

LITERATURE REVIEW

In the previous studies, usually univariate unit root tests without breaks, like ADF, PP, DF-GLS, and KPSS have been used. These studies concluded that stock prices can not be described by random walk (unit root) (Choudry-1997, Kawakatsu&Morey-1999, Chanduri&Wu-2003). Chaudhuri and Wu (2003), for the period of 1985-1977 analysed seventeen emerging markets' stock prices by using univariate unit root test with one break. They found that there is trend reversion for eleven countries and the six remaining countries could be described by random walk.

Univariate unit root tests with breaks have also been used and they concluded that the market is efficient (Lee ve Strazicich-2003, Narayan-2005, Narayan-2006, Narayan ve Smyth-2007, Qjan vd.-2008, Chancharat vd.-2009). Lee&Strazicich (2003) used LM unit root test with two breaks. For the period of 1860-1979, they councluded that S&P 500 is efficient.

Narayan&Smyth (2007), for the period of 1975-2003 using monthly data and LM unit root test with two breaks, concluded that G7 countries are efficient. Chaudhuri and Wu (2003), for the period January 1985-February 1997 found that seventeen emerging markets are not efficient. Chancharat et.al. (2009) found out that for the period of December 1987-December 2005 Thai stock market is efficient. They figured out that the structural breaks are at 1993 and 2000 and these coincide with the global recession periods.

Panel data is used to increase the power of unit root test. Studies using panel unit root tests without structural breaks had different results. Chaudhuri&Wu (2004) for the period of January 1985-April 2002, found that seventeen emerging markets are not efficient. Narayan&Narayan (2007) for January 1975-April 2003 for G7 countries, Narayan&Prasad (2007) for January 1988-March 2003 for seventeen European countries concluded that the markets are efficient. Several later studies used unit root tests with one or two structural breaks. Narayan and Smyth (2005), are the first to test random walk hypothesis with LM panel unit root test with breaks. With and without breaks, for all the countries of OECD panel and G7 countries panel, for the period of January 1991-June 2003, using monthly data concluded that the markets are efficient. Lean ve Smyth (2007), for January 1998-June 2005 period, for eight Asian countries using panel unit root test with one or two structural breaks found that the markets are inefficient. Narayan (2008), for the period of January 1975-April 2003 usinh panel unit root test with one or two structural breaks concluded that the markets are inefficient.

Lee et al. (2010), for the period of January 1999-May 2007, using Carrion-i Silvestre et.al. (2005) panel data stationarity test which includes multiple structural breaks, concluded that efficient market hypothesis does not hold in thirtytwo developed and twentysix developing countries including Turkey (except for India and Malaysia). Özdemir (2008), for the period of 02.01.1990-14.06.2005, using weekly data and unit root test with two structural breaks, figured out that BIST 100 Index could be described by unit root with two structural breaks and it is an efficient market in the weak form. First break is in the third week of January 1993 and second break is in the first week of November 2000. These breaks concide with the April 1994 and November 2000 financial crisis in Turkey.

DATA

This study investigates the informational efficiency of BIST 100 National Index using an analytical research model. Secondary data have been used and these data is retrieved from BIST official web site. This research is longitudinal and quantitative. Monthly data covering the period of 1988:01-2011:11 is used.

BIST 100 index was established in 1986 and it initially consisted of 40 firms' stocks. Over the years the number of stocks in the index rose up to 100. BIST 100 consists of selected stocks traded in the national market with the exception of the investment trust securities (Aslanoğlu, 2008). The study focuses on the BIST 100 because it is used as the basic index in the national market and it automatically includes BIST 30 and BIST 50 indices. It also incorporates stocks from several different sectors. BIST 100 index data is from the official web site of Istanbul Stock Exchange (data, index data, price indices, daily/historical, XU 100-BIST 100). Data is continuous.

The operational definition for BIST National 100 Index is as follows:
BIST National 100 Index: End of the month BIST 100 index closing value for the period 1988:01-2011:11
The measurement unit for BIST 100 Index is the index value.

METODOLOGY

I investigate the hypothesis of 'BIST National 100 Index is informationally efficient in the weak form considering multiple structural breaks'. The hypothesis is modelled as:

H0: BIST National 100 Index has a unit root.

H1: BIST National 100 Index does not have a unit root.

I investigate the time series properties of data. Time series is achieved by sorting the values of a variable sequentially during a certain period. If a time series is stationary, the mean, variance and covariance of the series do not change over time. If it is not stationary, it has a trend.

For time series analysis, firstly we should assess the stationary of the variables to be used. If the mean and variance of the series do not change over time and if the variance between the two periods is not dependent on the period used for calculations, we conclude that the time series is stationary. In other words, when we reject the null hypothesis of a unit root, there is stationarity. To test the stationarity of the data, I used the Augmented Dickey-Fuller (ADF) unit root test. By the use of ADF, we test the null hypothesis of unit root existence in the series.

$$\Delta Y = \alpha + \beta t + \phi^* Yt\text{-}1\ \Sigma{=}pi\ 1 + \delta\ \Delta\ Yt\text{-}1 + e$$

If H0 is rejected, we find out that the variable Y is stationary in its original level; if not it is not stationary in its original level. When the variable is not stationary in its original level, we should take its lagged differences till we reach stationarity. The unit root test results are in Appendix 1. According to these results, since all the variables are not stationary in their original levels (They have a unit root (I(0))), they become stationary when we take their first differences. The integration level for the series is 1 (I(1)). By taking the logaritmic differences of the daily closing values, we achieved logaritmic series. The stationarity of the Log series is tested by Augmented Dickey Fuller test and we concluded that they are stationary. This means that BIST 100 National Index is efficient in the weak form.

The statistical analysis to test structural breaks (Appendix 2), is done by using STATA 10.1. For the period 1988:01-2011:11, clemao2 analysis shows that the structural breaks are 2007:11 and 2009:1. Clemio2 analysis shows that the structural breaks are 2007:12 and 2009:2.

If we seperate 1988:01-2011:11 period into two parts as 1997-2011 and 1988-1996, the structural breaks are, in the 1988-1996 period with clemao2 analysis 1995:9 and 1996:5, with clemio2 1995:10 and 1996:6. For 1997-2011 period, with clemao2 the structural braks are 2007:11 and 2008:12, with clemio2 2007:12 and 2008:9.

BIST 100 Index has decreased during global and national economic crisis periods (Appendix 3). It has increased during recovery periods. BIST has decreased before 1994 economic crisis in Turkey. It has reached its bottom level during crisis period and then after crisis it has continued decreasing; afterwards it has started recovering. BIST 100 Index has decreased significantly starting from February before the 1994 crisis. At the end of January 1994, the Index was 201,05. At the end of February 1994, it has decreased by 25,37% reaching a level of 150,04. At the end of March, the Index was 140,87, and it was 150,97 at the end of April when crisis took place. During May, it was about 147,49 and at June with a 34,02% increase it reached 197,66. After then, it continued increasing during the rest of 1994. During 1995 and 1996 in which the structural breaks took place, BIST 100 Index started recovering. After 1997, BIST 100 Index rose from 3 digit values to four digit values. At the end of December 1996, the index value was 975,89; it increased by 64,43% by the end of January 1997 and reached 1.604,66.

The 2008 global economic crisis took place during the last months of 2008 and it negatively affected many countries all over the world. Especially, its effects became apparent in September 2008. The crisis had its roots in real estate and the subprime lending crisis. The real estate market witnessed great losses and consequently individual bankruptcies increased and these triggered the crisis. 2008 crisis changed the global and national macroeconomic balances.

Although global economic crisis started in August 2007 in U.S., BIST 100 Index increased till the end of December 2007. After January 2008 the effects of the crisis became apparent and BIST 100 Index started decreasing afterwards. BIST 100 Index was 55.381,1 in December 2007, with a 22,9% decrease it fell down to 42.697,6. After January 2008, with a 15,6% decrease it fell down to 36.051,3. BIST 100 Index decreased approximately 35% from December 2007 to September 2008. In November, it decreased to 25.715 by 25,72% decrease compared to September. These losses indicate that the financial markets were so sensitive that the the first signs of the crisis was observed there.

In 1997-2011 period, 2007, in which the structural breaks took place, is the beginning of the losses in the BIST 100 Index. The losses continued in 2008. After the end of 2008, in which the other structural break took place, the index started recovering and it started increasing in 2009.

CONCLUSION

This study investigated the informational efficiency of the Turkish market in weak form considering multiple structural breaks and taking into account the effect of financial structural changes for the period of 1988-2011.

The analysis showed that BIST 100 Index is informationally efficient in the weak form. With Clemao2 and Clemio2 analyses, the structural breaks in 1988:01-2011:11 period are

2007:11 and 2009:1; 2007:12 and 2009:2 respectively. The structural breaks coincide with the 2008 global financial crisis period and after 2009 BIST 100 Index started recovering.

When 1988:01-2011:11 period is separated into two subperiods as 1988-1996 and 1997-2011, in 1988-1996 period with clemao2 analysis 1995:9 and 1996:5, with clemio2 analysis 1995:10 and 1996:6 are the structural break dates. In 1997-2011 period, with clemao2 2007:11 and 2008:12, with clemio2 2007:12 and 2008:9 are the structural break dates. These structural breaks reflect the effects of 1994 national crisis and 2008 global crisis.

This results of this study is considered to be informative for individual and corporate investors. This study has been done for BIST 100 Index. Further studies may be done with other indices from all over the world.

APPENDIX 1. UNIT ROOT TEST RESULTS

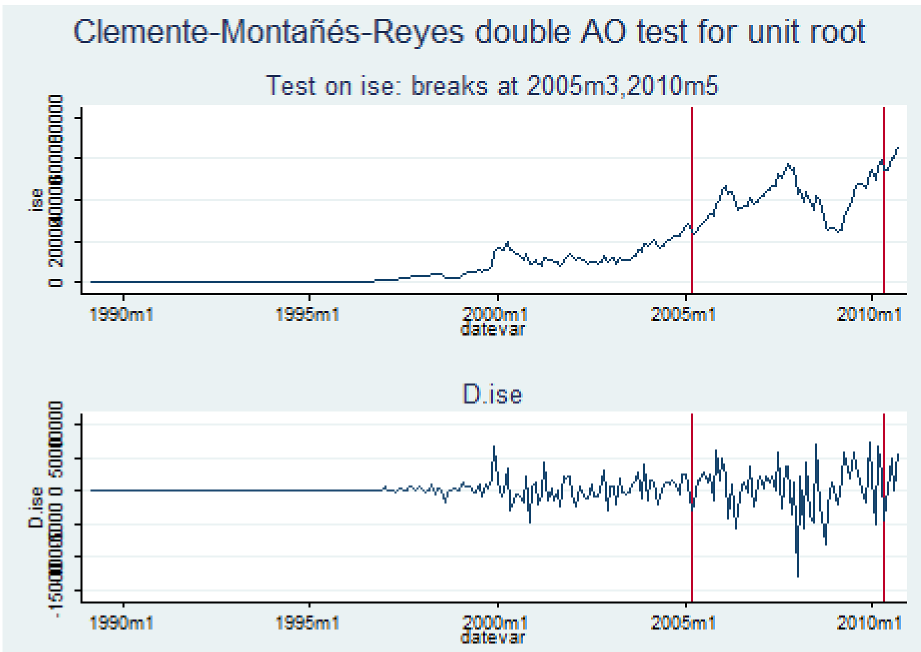
Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model

BIST T = 259 optimal breakpoints : 2005m3 , 2010m5

AR(0)	du1	du2	(rho - 1)	const
Coefficients:	35707.77918	20967.28923	-0.10591	5083.00937
t-statistics:	33.488	10.633	-3.898	
P-values:	0.000	0.000	-5.490 (5% crit. value)	

‘There is unit root’ hypothesis can not be rejected. There is unit root.

GRAPHIC 1:



To make it stationary:

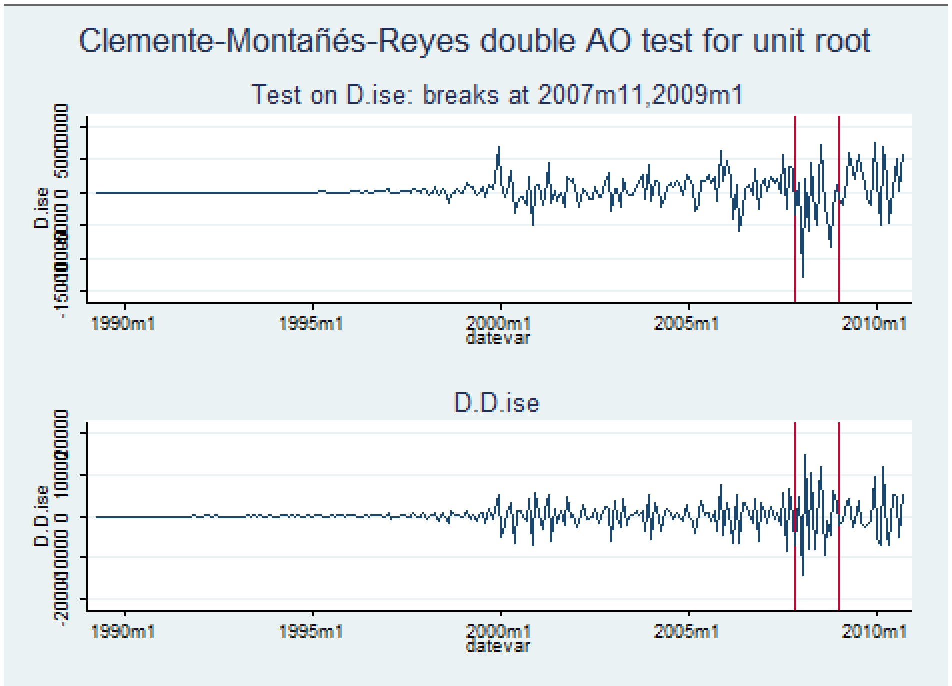
Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model

D.BIST T = 258 optimal breakpoints : 2007m11 , 2009m1

AR(4)	du1	du2	(rho - 1)	const
Coefficients:	-2247.71382	2860.64866	-0.98953	227.75311
t-statistics:	-3.671	4.047	-6.985	
P-values:	0.000	0.000	-5.490 (5% crit. value)	

Now, we can reject the existence of unit root hypothesis.

GRAPHIC 2:



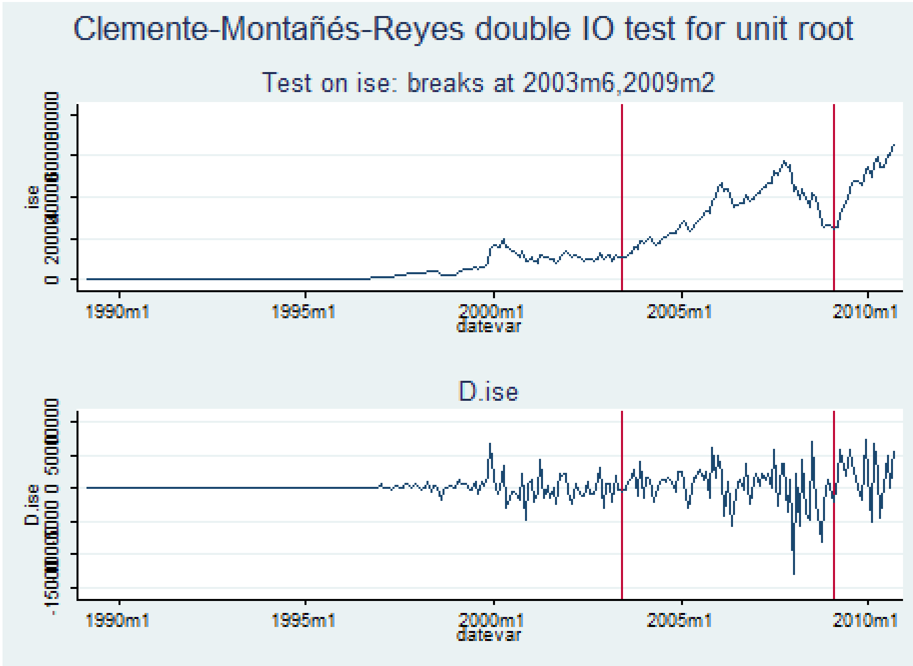
Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model

BIST T = 259 optimal breakpoints : 2003m6 , 2009m2

AR(3)	du1	du2	(rho - 1)	const
Coefficients:	2410.68814	2264.83166	-0.07695	322.54433
t-statistics:	4.170	3.851	-4.699	
P-values:	0.000	0.000	-5.490 (5% crit. value)	

‘There is unit root’ hypothesis can not be rejected. There is unit root.

GRAPHIC 3:



To make it stationary:

Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model

D.BIST T = 258 optimal breakpoints : 2007m12 , 2009m2

AR(2) du1 du2 (rho - 1) const

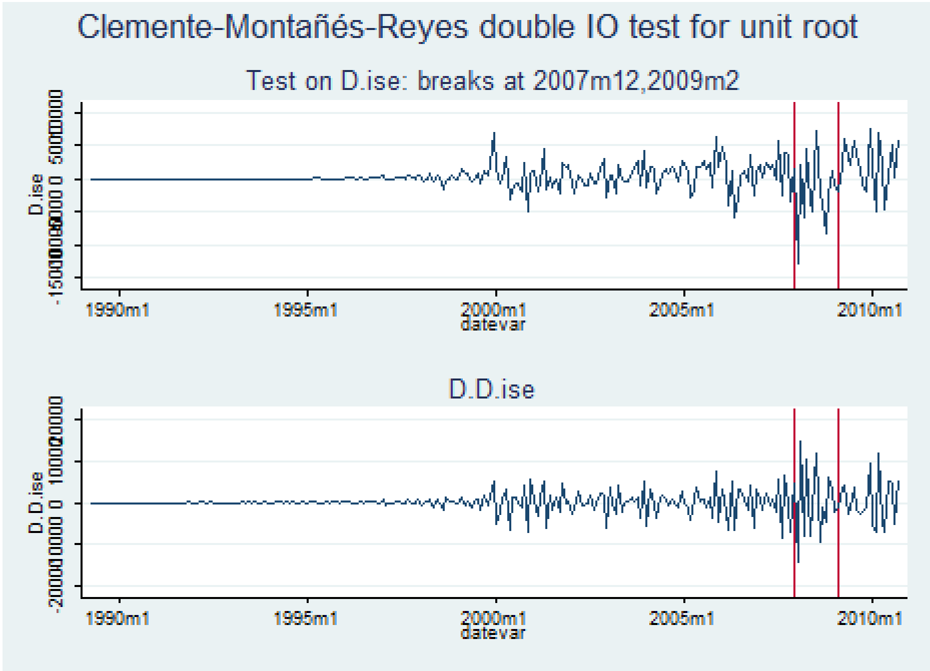
Coefficients: -1679.09696 2375.46021 -1.01384 238.77762

t-statistics: -2.545 3.049 -9.048

P-values: 0.011 0.003 -5.490 (5% crit. value)

Now, we can reject the existence of unit root hypothesis.

GRAPHIC 4:


Clemente-Montañés-Reyes double IO test for unit root
Test on D.ise: breaks at 2007m12,2009m2
D.ise
1990m1
1995m1
2000m1
2005m1
2010m1
datevar
D.D.ise
datevar

APPENDIX 2. MULTIPLE STRUCTURAL BREAKS:

time variable: datevar, 1988m1 to 2011m11

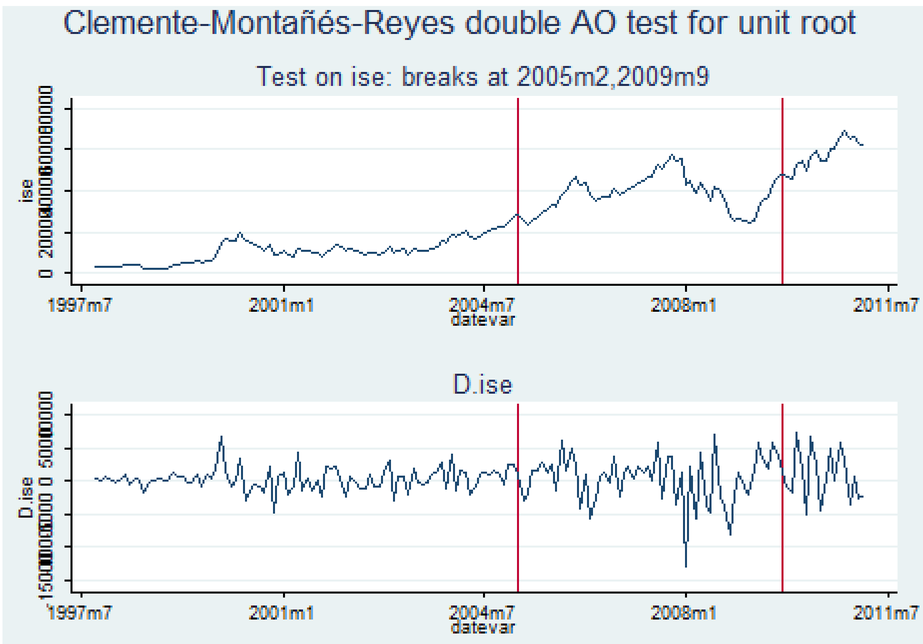
delta: 1 month

Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model

BIST T = 161 optimal breakpoints : 2005m2 , 2009m9

AR(0)	du1	du2	(rho - 1)	const
Coefficients:	28535.35508	20076.02299	-0.17344	1.028e+04
t-statistics:	23.503	11.706	-4.197	
P-values:	0.000	0.000	-5.490 (5% crit. value)	

GRAPHIC 1:

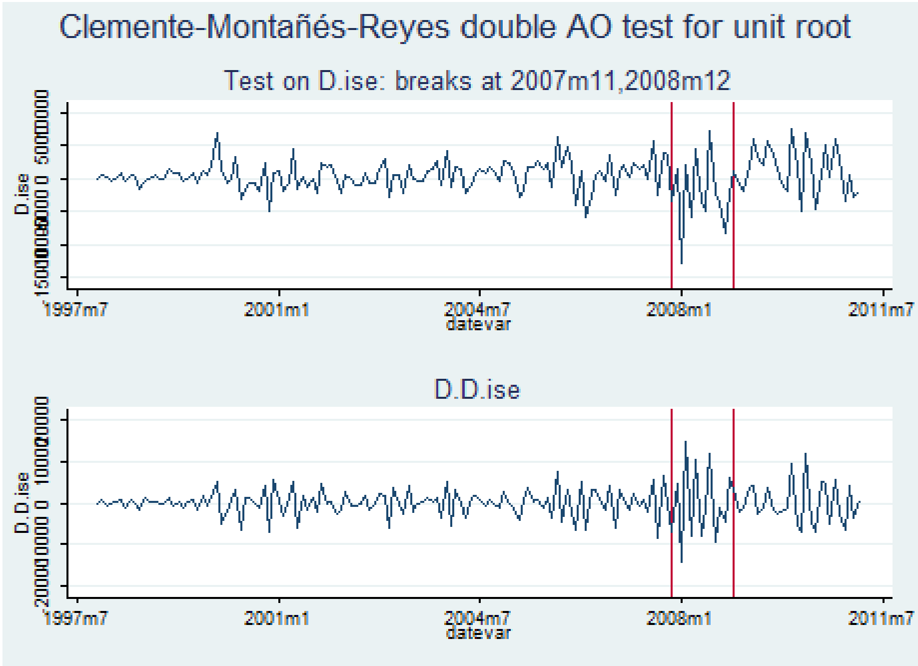


Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model

D.BIST T = 160 optimal breakpoints : 2007m11 , 2008m12

AR(4)	du1	du2	(rho - 1)	const
Coefficients:	-2508.51277	2893.93235	-1.02609	404.68585
t-statistics:	-3.055	3.156	-5.545	
P-values:	0.003	0.002	-5.490 (5% crit. value)	

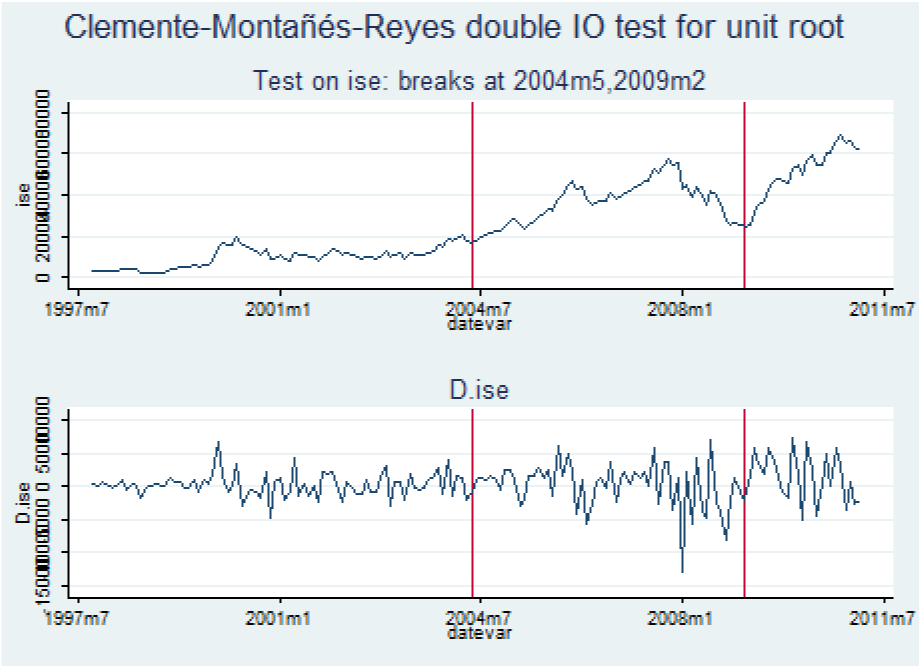
GRAPHIC 2:



Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model
BIST T = 161 optimal breakpoints : 2004m5 , 2009m2
AR(3) du1 du2 (rho - 1) const

Coefficients: 3025.27338 2685.82576 -0.11235 1183.20256
t-statistics: 3.545 3.493 -4.353
P-values: 0.001 0.001 -5.490 (5% crit. value)

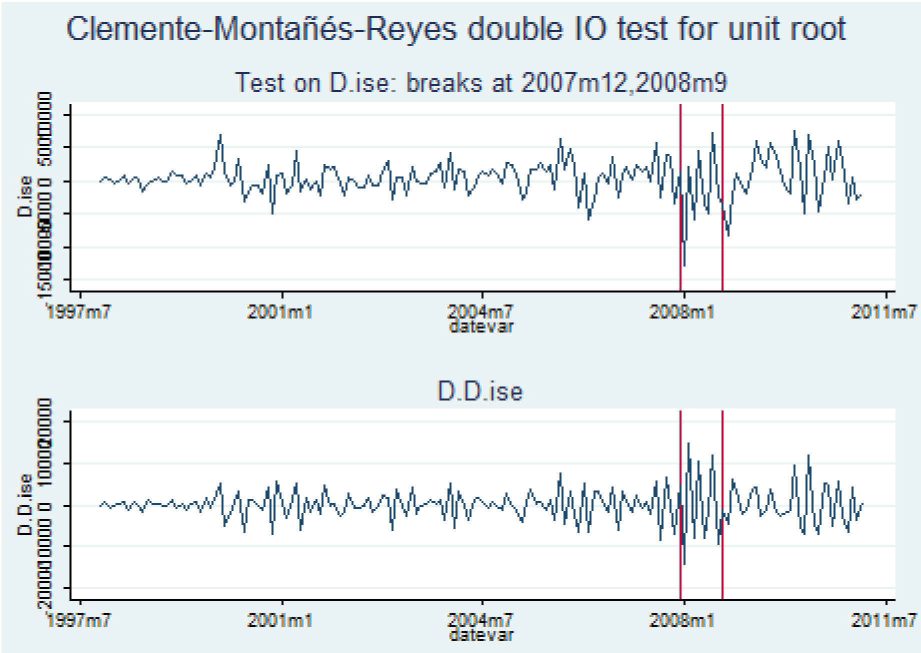
GRAPHIC 3:



Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model
D.BIST T = 160 optimal breakpoints : 2007m12 , 2008m9

AR(2)	du1	du2	(rho - 1)	const
Coefficients:	-861.04750	1199.29962	-0.91570	388.27456
t-statistics:	-0.860	1.126	-7.020	
P-values:	0.391	0.262	-5.490 (5% crit. value)	

GRAPHIC 4:



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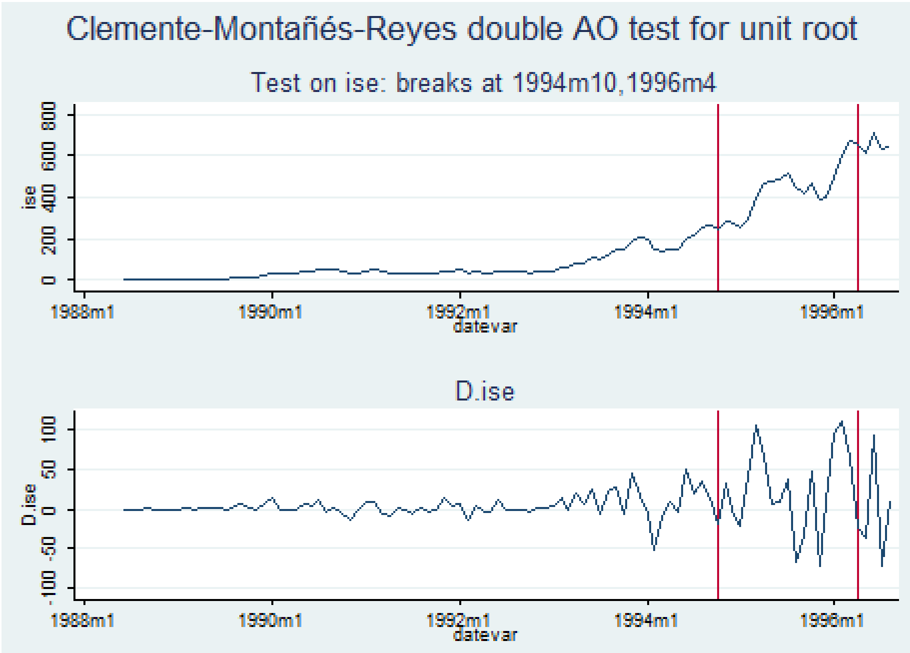
. clemao2 BIST, graph maxlag(6)
Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model

BIST T = 99	optimal breakpoints : 1994m10 , 1996m4			
AR(1)	du1	du2	(rho - 1)	const
Coefficients:	383.32386	405.39722	-0.23116	59.95780
t-statistics:	12.889	8.691	-2.333	
P-values:	0.000	0.000	-5.490 (5% crit. value)	

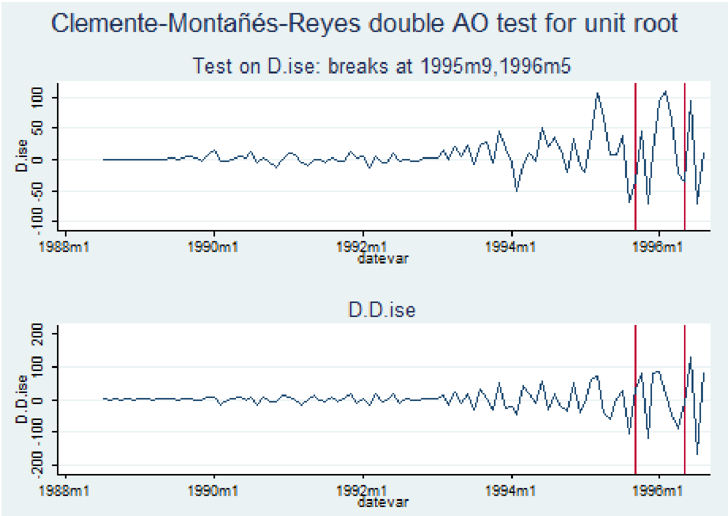
GRAPHIC 1:



Clemente-Montañés-Reyes unit-root test with double mean shifts, AO model
D.BIST T = 98 optimal breakpoints : 1995m9 , 1996m5

AR(6)	du1	du2	(rho - 1)	const
Coefficients:	19.86228	99.84250	-3.24819	4.44022
t-statistics:	0.892	3.306	-7.720	
P-values:	0.375	0.001	-5.490 (5% crit. value)	

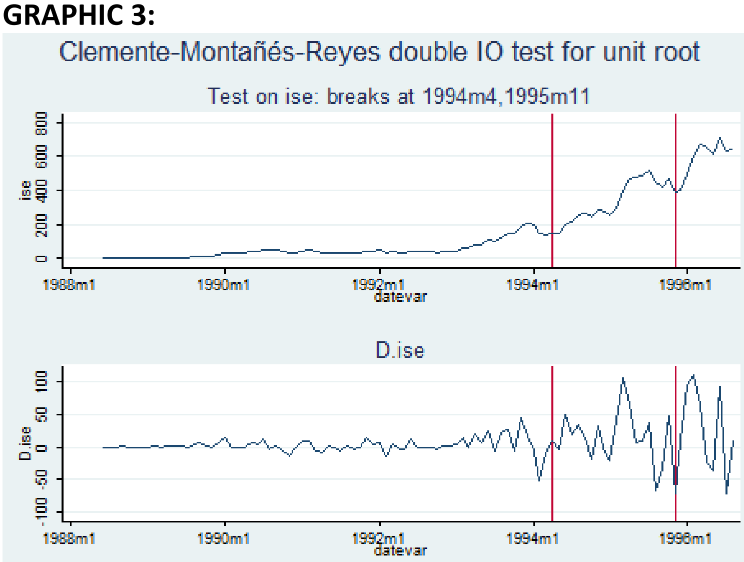
GRAPHIC 2:



. clemio2 BIST, graph maxlag(6)
Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model
BIST T = 99 optimal breakpoints : 1994m4 , 1995m11

AR(6)	du1	du2	(rho - 1)	const
Coefficients:	-59.98287	-40.81729	0.38746	-10.43666
t-statistics:	-2.307	-1.170	3.946	
P-values:	0.023	0.245	-5.490 (5% crit. value)	

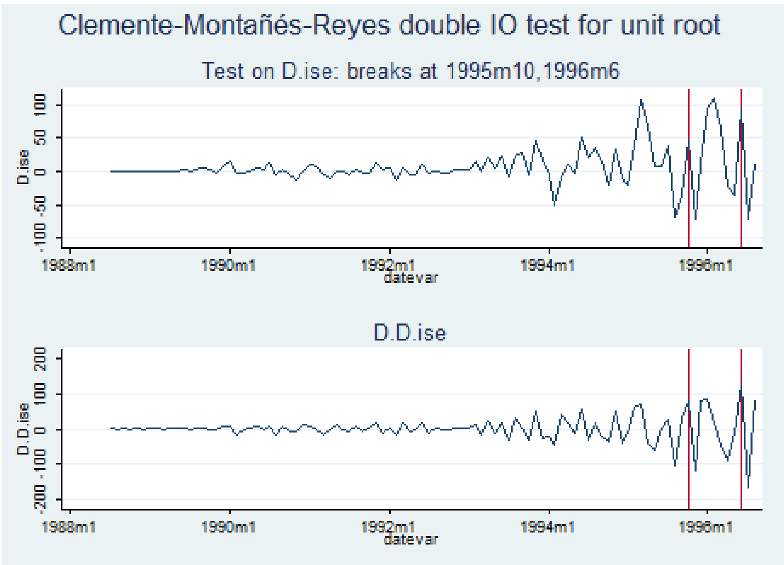
GRAPHIC 3:



clemio2 D.BIST, graph maxlag(6)
Clemente-Montañés-Reyes unit-root test with double mean shifts, IO model
D.BIST T = 98 optimal breakpoints : 1995m10 , 1996m6
AR(6) du1 du2 (rho - 1) const

Coefficients:	21.86501	94.86070	-0.18746	1.47424
t-statistics:	1.051	2.783	-0.306	
P-values:	0.296	0.007	-5.490 (5% crit. value)	

GRAPHIC 4:



APPENDIX 3. BIST 100 INDEX VALUES

YEAR			MONTH			
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
1988	8.58	7.21	6.35	5.54	5.53	4.69
1989	3.80	4.87	4.66	5.34	6.54	7.96
1990	36.41	35.16	32.94	33.08	38.50	41.32
1991	42.13	51.03	45.20	35.54	36.26	35.87
1992	49.26	36.64	40.77	36.86	32.97	44.07
1993	43.83	59.24	58.64	78.08	83.76	107.79
1994	201.05	150.04	140.87	150.97	147.49	197.66
1995	252.29	291.23	398.37	466.15	473.71	482.33
1996	494.9	605.47	670.45	647.23	611.5	704.89
1997	1604.66	1612.18	1613.27	1426.83	1595.23	1857.45
1998	3547.18	3272.21	3259.06	4194.5	3727.75	4100
1999	2568.16	3890.83	4554.07	5354.03	5069.22	4950.21
2000	16714.95	15945.93	15920.1	19205.71	16206.42	14466.12
2001	10685.07	8791.6	8022.72	12367.36	10879.83	11204.24
2002	13252.32	11055.67	11679.43	11441.5	10413.7	9379.92
2003	11032.03	11574.44	9475.09	11509.95	11381.42	10884.43
2004	17259.25	18889.2	20190.83	18022.69	17081.08	17967.6
2005	27330.35	28396.17	25557.76	23591.64	25236.48	26957.32
2006	44590.22	47015.88	42911.32	43880.43	38132.21	35453.31
2007	41182.55	41430.99	43661.12	44984.45	47081.49	47093.67
2008	42697.56	44776.88	39015.44	43468.12	39969.63	35089.53
2009	25934.37	24026.59	25764.83	31651.81	35002.99	36949.20
2010	54650.58	49705.49	56538.37	58959.10	54384.94	54839.46
2011	63278.07	61283.87	64434.51	69250.14	63046.02	63269.40

YEAR			MONTH			
	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
1988	4.93	4.28	4.55	4.04	4.06	3.74
1989	7.01	8.76	14.75	16.64	15.08	22.18
1990	53.84	49.39	50.85	45.70	32.57	32.56
1991	30.41	33.01	29.38	27.47	40.58	43.69
1992	42.64	41.58	39.76	36.43	37.86	40.04
1993	100.78	123.57	150.8	145.01	189.77	206.83
1994	217.52	252.82	268.26	248.9	281.81	272.57
1995	519.44	451.4	417.08	463.25	391.14	400.25
1996	633.66	645.33	724.53	820.06	917.59	975.89
1997	1953.13	1979.63	2592.6	2846.39	2878.6	3451.26
1998	4322.32	2635.14	2265.94	2196.38	2577.54	2597.91
1999	5805.45	5018.28	6071.12	6556.05	8459.48	15208.78
2000	13870.23	13132.06	11350.3	13538.44	8747.68	9437.21
2001	9914.61	9878.88	7625.87	9848.76	11633.93	13782.76
2002	10236.46	9547.3	8842.24	10251.92	13300.4	10369.92
2003	10572.04	11611.84	13055.9	15754.34	14617.53	18625.02
2004	19380.86	20218.37	21953.52	22899.89	22486.2	24971.68
2005	29615.29	30908.02	33333.23	31963.99	38088.65	39777.7
2006	36067.92	37285.94	36924.86	40582.25	38168.53	39117.46
2007	52824.89	50198.6	54044.22	57615.72	54213.82	55538.13
2008	42200.75	39844.48	36051.3	27832.93	25714.98	26864.07
2009	42641.26	46551.19	47910.30	47184.71	45350.17	52825.02
2010	59866.75	59972.59	65774.37	68760.46	65350.85	66004.48
2011	62295.68	53946.09	59693.43	56061.47	54517.76	

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