STRUCTURAL BREAKS IN ISE SECTORAL INDICES*

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ABSTRACT

Economic or political crises may cause structural change in many time series. In this paper we document structural breaks in daily sectoral indices of Istanbul Stock Exchange (ISE). The time period under study ranges from January 1997 to July 2012. We propose Zivot and Andrews (1992) test that endogenously determines a structural break. Test results show the evidence of a structural break for most of the sectors.

Keywords: Unit root, Structural break, Sectoral Indices, ISE, Zivot and Andrew*s*.

Jel Classification Code: G10, G11,G14

IMKB SEKTÖR ENDEKSLERİNDE YAPISAL KIRILMALAR

ÖZ

Ekonomik ve politik krizler zaman serilerinde yapısal kırılmalara sebep olabilir. Bu çalışmada İMKB'de yer alan sektör endeksleri için yapısal kırılmalar analiz edilmiştir. Çalışılan dönem Ocak 1997 ile Temmuz 2012 tarih aralığıdır. Yapısal kırılmaları içsel bir şekilde belirleyen Zivot ve Andrews (1992) testi kullanılmıştır. Test sonuçları tüm sektörler için yapısal kırılmaların olduğunu göstermektedir.

Anahtar Kelimeler: Birim kök, Yapısal Kırılma, Sektör Endeksleri, İMKB, Zivot ve Andrews.

Jel Kodları: G10, G11,G14

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INTRODUCTION

Eugene Fama (1970) has argued that efficient stock markets accurately reflect all available information at all times. He also distinguished different types of efficiency depending upon the information set considered. Weak-form efficiency implies that current prices reflect all historical price information. In a weak-form efficient market prices will adjust to news without delay and therefore no excess returns can be earned by studying the past pattern of price changes. Weak-form efficiency is often associated with the random-walk hypothesis, where future price changes are independent of price changes in the past.

A substantial number of studies have attempted to determine the extent to which the Istanbul Stock Exchange (ISE) is weak-form efficient or semi-strong efficient (Muradoğlu and Önkal, 1992; Metin and Muradoğlu, 1996; Balaban, Candemir and Kunter, 1996; Buguk and Brorsen, 2003; Aga and Kocaman, 2008). The results of most studies show the weak form efficiency in ISE.

Although these studies have attempted to determine the extent to which the ISE is weak-form efficient, it is difficult to draw conclusions from those while most of them did not take into account the presence of possible structural breaks. A structural break is an external shock which arouses randomly and influences the behavior of a time-series. Economic or politic crises or regime switches can cause structural change in time-series.

In this paper we test indices for unit roots in the presence of structural breaks. To the best of our knowledge, there have not been any studies on the efficiency of ISE sectoral indices under structural breaks. The remainder of this paper continues as follows. Part two gives a brief review of literature, part three gives information about data and our model. Part four is the conclusion.

1. LITERATURE

It is widely accepted that most of the economic and financial time series are non-stationary. But, it is also known that breaks in the deterministic trend affects the results of conventional unit root tests. Nelson and Plosser (1982) stated that most of the macroeconomic time-series are characterized by presence of a unit root. As an opposing argument, Perron (1989) suggested that most of the time-series analyzed by Nelson and Plosser (1982) were stationary around a deterministic trend function. Standard unit-root tests cannot reject the unit root hypothesis due to the persistent effect of one- time break. Perron (1989) initiated the literature on structural break tests by suggesting to identify these random shocks. The influence of Perron's (1989) method was significant. However, the pitfall of the method is that the structural break date was exogenously determined. Christiano (1992), Zivot and Andrews (1992), Banerjee, Lumsdaine and Stock (1992) and Perron and Vogelsang (1992) suggested that the break date should be identified endogenously when testing for breaks, otherwise the test would have a tendency to reject the unit root hypothesis. The literature about structural changes in time series can be classified in two groups. The first group is about the estimation of the timing of a structural break. The second group tests for a structural break of unknown timing.

Zivot and Andrews (1992) is an Augmented Dickey-Fuller (ADF) based endogenous structural break test which estimates the model assuming a possible break at each point and chooses the break date where the t-statistic of unit root is at minimum. This approach guarantees the rejection of unit-root hypothesis in terms of evidence against the unit-root null. The pitfall of Zivot and Andrews (1992) approach is that the testing procedure does not include the structural break under the null hypothesis, and one structural break under the alternative. Banerjee, Lumsdaine and Stock (1992) and Perron and Vogelsang (1992) have different approaches which contributes to the literature on structural break tests. Nevertheless, none of them includes the structural break under the null hypothesis but the alternative. Besides, one structural break assumption reduces the power of the test in the presence of more than one break. Lumsdaine and Papell (1997), Clemente, Montañés and Reyes (1998) and Lee and Strazicich (2003) allow two structural breaks. Among these, Lee and Strazicich (2003) use a minimum Lagrange Multiplier test which eliminates the spurious rejection in the presence of a break under the null. Lumsdaine and Papell (1997), Ohara (1999) and Kapetanois (2005) allow multiple structural breaks but not breaks under the null hypothesis. Herein, it can be said for certain that the most significant contribution of Kim and Perron (2009) is the unit root testing procedure they suggest allows an unknown-time break under both the null and the alternative hypotheses.

In this work, we begin through testing for the presence of a unit root in each of the series using ADF test. In addition to ADF test, we perform Zivot and Andrews' (1992) procedure to determine significant structural breaks for indexes.

2. DATA AND METHODOLOGY

The daily data for sectoral indices used in this study was obtained from ISE. The actual time period under study ranges from January 1997 to July 2012. ISE indices are introduced in order to calculate price and return performances of all shares as well as on the basis of relative markets and sectors. Until the end of 1996, the ISE used to compute only the ISE 100, Financials and Industrials price indices. As of 1997, the ISE began to calculate sector and sub-sector indices on the basis of prices and total return.

ISE price indices are computed and published throughout the trading session while the return indices are calculated and published at the close of the session only. The ISE 100 Index is used as the main indicator of the National Market. Sector and sub-sector indices used for analysis are listed in Table 1. Sector and sub-sector indices are composed of the companies traded on ISE Markets except Investment Trusts.

Table 1 : ISE sector and sub-sector indices

ISE Industrial	Sector	XUSIN
ISE Food, Beverage	Sub-sector	XGIDA
ISE Textile, Leather	Sub-sector	XTEKS
ISE Wood, Paper, Printing	Sub-sector	XKAGT
ISE Chemical, Petroleum, Plastic	Sub-sector	XKMYA
ISE Non-Metal Mineral Products	Sub-sector	XTAST
ISE Basic Metal	Sub-sector	XMANA
ISE Tourism	Sub-sector	XTRZM
ISE Financials	Sector	XUMAL
ISE Banks	Sub-sector	XBANK
ISE Insurance	Sub-sector	XSGRT
ISE 100 Index	Main indicator of the National Market	XU100

Economic crises may cause structural change in many time series. A problem common with the conventional unit root tests such as the ADF is that they do not allow for the possibility of a structural break. Zivot and Andrews (1992) propose a testing procedure where the time of the break is estimated. They proceed with three models to test for a unit root: (1) model A, which permits a one-time change in the level of the series; (2) model B, which allows for a one-time change in the slope of the trend function, and (3) model C, which combines one-time changes in the level and the slope of the trend function of the series. The null hypothesis in all the three models is that the series contains a unit root with a drift that excludes any structural break, while the alternative hypothesis implies that the series is a trend-stationary process with a one-time break occurring at an unknown point in time.

Zivot and Andrews (1992) defines the null hypothesis for the three models as in equation (1) which implies that the series Y_t is integrated without an exogenous structural break. Besides the alternative hypothesis implies that Y_t can be represented by a trend stationary process with a one-time break occurring at an unknown point in time (Zivot and Andrews, 1992).

$$H_0 : Y_t = \mu + Y_{t-1} + \varepsilon_t \quad (1)$$

Zivot and Andrews (1992) procedure estimates the breakpoint that gives the most weight to the trend-stationary alternative. Similar to the Perron's (1989) ADF testing strategy, Zivot and Andrews sequential process uses the following regression equations to test for a unit root:

Model A

$$Y_t = \mu^A + \beta^B t + \varphi^B Y_{t-1} + \gamma^A DU_t(\hat{\lambda}) + \Sigma^p_{j=1} \delta^A_j \Delta Y_{t-j} + \varepsilon t$$

Model B

$$Y_t = \mu^B + \beta^B t + \varphi^B Y_{t-1} + \gamma^B DU^*_t(\hat{\lambda}) + \Sigma^p_{j=1} \delta^A_j \Delta Y_{t-j} + \varepsilon t$$

Model C

$$Y_t = \mu^C + \beta^C t + \varphi^C Y_{t-1} + \gamma^C DU_t(\hat{\lambda}) + \gamma^C DT^*_t(\hat{\lambda}) + \Sigma^p_{j=1} \delta^C_j \Delta Y_{t-j} + \varepsilon t$$

where,

$DU_t(\lambda) = 1$ if $t > T\lambda$, 0 otherwise;

$DT^*_t(\lambda) = t - T\lambda$ if $t > T\lambda$, 0 otherwise.

The results for Zivot and Andrews unit root test results are presented in Table 2 (for maximum lags 8) and Table 3 (for maximum lags 4) in appendix. These results clearly contradict the results obtained from the unit root test without structural breaks for these series in Table 1 in appendix. ADF unit-root test results justifies the findings of earlier studies about ISE, thereby the weak-form efficiency argument. Nevertheless, it is known that if structural breaks are taken into consideration, some of the non-stationary time series could be found stationary.

At the same time, Zivot and Andrews test identifies endogenously the point of the single most significant structural break in every time series examined in this paper. The break-date for each time series is reported in Table 2 and Table 3 in appendix. Most of the series exhibits structural breaks during 2008's, associated with global financial crises. Zivot and Andrews test estimated a crash in 2008. We could observe the same from the plot of the price series in Figure 2 in appendix.

3. CONCLUSION

Turkish economy experienced imbalances and severe financial crises in the years of 1994, 2000 and 2001. Turkey is quite familiar with financial crises. The last one is the global financial crises and European sovereign debt crisis. Economic crises may cause structural change in many time series. Since index series have been subject to structural change over time, a new unit root testing procedure is employed which allows for the timing of significant breaks to be estimated. The timing of the most significant structural breaks for sector indexes has been determined using Zivot and Andrews' (1992) procedure. It is found that most of the series exhibit structural breaks during 2008's, associated with global financial crises. However, there is a strong possibility that there could be more than one structural break in these index series. Therefore, a further study is needed to detect multiple breaks and identify the intrinsic behavior of ISE.

This research raises many questions: Are these breaks permanent or transitory? Can we identify the sources of the breaks? Is the timing of the structural break simultaneous across sectors or subsectors? Are there spillover effects into other sectors? Are these breaks unique to the Turkey, or have they occurred in other countries as well? We expect that these and related questions will be exciting subjects for future research. It is also expected that there could be multiple structural breaks in these index series. Therefore, a further study is needed to detect these by using several multiple structural break tests.

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APPENDIX

Table 1 : ADF Test Results

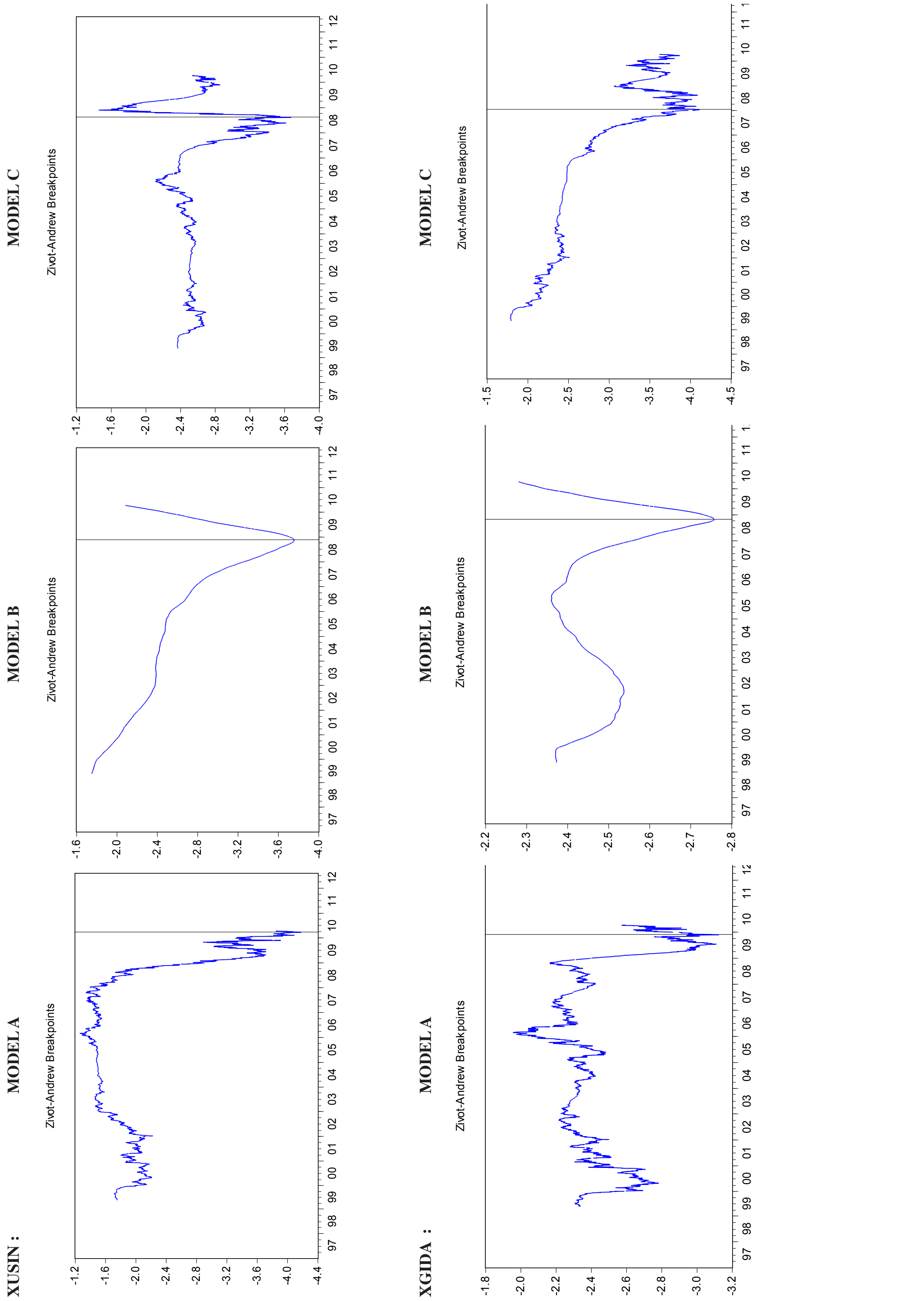
	ADF (Level)			ADF (First Difference)		
	Intercept	**Trend& Intercept**	**None**	**Intercept**	**Trend& Intercept**	**None**
XUSIN	-0.199526 (0.9362)	-2.441223 (0.3579)	-0.154993 (0.9415)	-56.85774 (0.0001)	-56.85784 (0.0000)	-56.80493 (0.0001)
XGIDA	0.736696 (0.9929)	1.236862 (0.9984)	1.236862 (0.9984)	-46.98765 (0.0001)	-47.01766 (0.0000)	-46.90414 (0.0001)
XTEKS	-0.595225 (0.8693)	-0.752493 (0.8315)	-0.752493 (0.8315)	-56.27208 (0.0001)	-56.27014 (0.0000)	-56.24646 (0.0001)
XKAGT	-0.935298 (0.7775)	-0.938522 (0.7764)	-0.938522 (0.7764)	-59.08830 (0.0001)	-59.08171 (0.0000)	-59.06484 (0.0001)
XKMYA	-0.865459 (0.7995)	-0.742452 (0.8341)	-0.742452 (0.8341)	-40.41087 (0.0000)	-40.40724 (0.0000)	-40.38330 (0.0000)
XTAST	-0.863872 (0.8000)	-0.879192 (0.7953)	-0.879192 (0.7953)	-56.12411 (0.0001)	-56.11695 (0.0000)	-56.09551 (0.0001)
XMANA	-0.921739 (0.7819)	-0.851407 (0.8037)	-0.851407 (0.8037)	-57.68212 (0.0001)	-57.67556 (0.0000)	-57.66848 (0.0001)
XTRZM	-1.999736 (0.2872)	-1.974280 (0.2985)	-1.974280 (0.2985)	-57.87860 (0.0001)	-57.87716 (0.0000)	-57.88337 (0.0001)
XUMAL	-0.750516 (0.8320)	-0.771246 (0.8265)	-0.771246 (0.8265)	-60.54380 (0.0001)	-60.53760 (0.0000)	-60.52126 (0.0001)
XBANK	-0.771038 (0.8265)	-0.777369 (0.8248)	-0.777369 (0.8248)	-61.02503 (0.0001)	-61.01913 (0.0000)	-61.00622 (0.0001)
XSGRT	-0.895543 (0.7902)	-0.985262 (0.7606)	-0.985262 (0.7606)	-56.28200 (0.0001)	-56.27631 (0.0000)	-56.26540 (0.0001)
XU100	-0.496428 (0.8895)	-0.517749 (0.8854)	-0.517749 (0.8854)	-60.37142 (0.0001)	-60.36697 (0.0000)	-60.33626 (0.0001)

*Values in parentheses are the p-values.

Table 2 : Zivot and Andrew Test Results (For Maximum 8 lags)

INDEX	ZA		
	Model A	Model B	Model C
XUSIN	-3. 123485 (0.034911) Chosen break point: 11/23/2009 Chosen lag length: 8 (maximum lags: 8)	-2.757022 (0.163918) Chosen break point: 10/20/2008 Chosen lag length: 8 (maximum lags: 8)	-3.674592 (0.007831) Chosen break point: 8/05/2008 Chosen lag length: 8 (maximum lags: 8)
XGIDA	-4.177736 (9.84E-05) Chosen break point: 3/22/2010 Chosen lag length: 7 (maximum lags: 8)	-3.757948 (0.000996) Chosen break point: 11/14/2008 Chosen lag length: 7 (maximum lags: 8)	-4.112698 (0.002107) Chosen break point: 1/11/2008 Chosen lag length: 7 (maximum lags: 8)
XTEKS	-4.257147 (3.84E-05) Chosen break point: 11/04/2009 Chosen lag length: 8 (maximum lags: 8)	-3.317141 (0.005103) Chosen break point: 10/06/2008 Chosen lag length: 8 (maximum lags: 8)	-3.988057 (0.024249) Chosen break point: 1/02/2008 Chosen lag length: 8 (maximum lags: 8)
XKAGT	-4.373070 (2.93E-05) Chosen break point: 1/10/2008 Chosen lag length: 1 (maximum lags: 8)	-2.627556 (0.267447) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 9/30/2005	-4.282355 (1.16E-05) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 1/10/2008
XKMYA	-3.561045 (0.017271) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 11/23/2009	-2.979885 (0.182450) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 10/13/2008	-3.576957 (0.026870) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 5/20/2008
XTAST	-2.687082 (0.027506) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 9/21/2004	-1.926971 (0.239381) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 10/19/2006	-2.702672 (0.055399) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 5/03/2005
XMANA	-3.412176 (0.054860) Chosen lag length: 6 (maximum lags: 8) Chosen break point: 10/09/2006	-2.856592 (0.344543) Chosen lag length: 6 (maximum lags: 8) Chosen break point: 2/08/2001	-3.377914 (0.032688) Chosen lag length: 6 (maximum lags: 8) Chosen break point: 10/09/2006
XTRZM	-3.229764 (0.007360) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 12/13/2004	-2.585168 (0.135829) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 10/27/2006	-3.698243 (0.008115) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 4/19/2005
XUMAL	-3.212698 (0.116603) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 5/27/2005	-2.856635 (0.341040) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 9/14/2001	-3.231364 (0.030261) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 7/15/2009
XBANK	-3.096996 (0.105705) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 5/27/2005	-2.719559 (0.351350) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 9/14/2001	-3.096996 (0.105705) Chosen lag length: 7 (maximum lags: 8) Chosen break point: 5/27/2005
XSGRT	-3.676039 (0.012907) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 4/29/2005	-2.670128 (0.582966) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 6/19/2001	-3.649518 (0.016627) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 5/02/2005
XU100	-3.167875 (0.072243) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 6/24/2009	-2.889659 (0.268474) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 4/24/2002	-3.254160 (0.006041) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 1/02/2008

* Values in parentheses are the p-values.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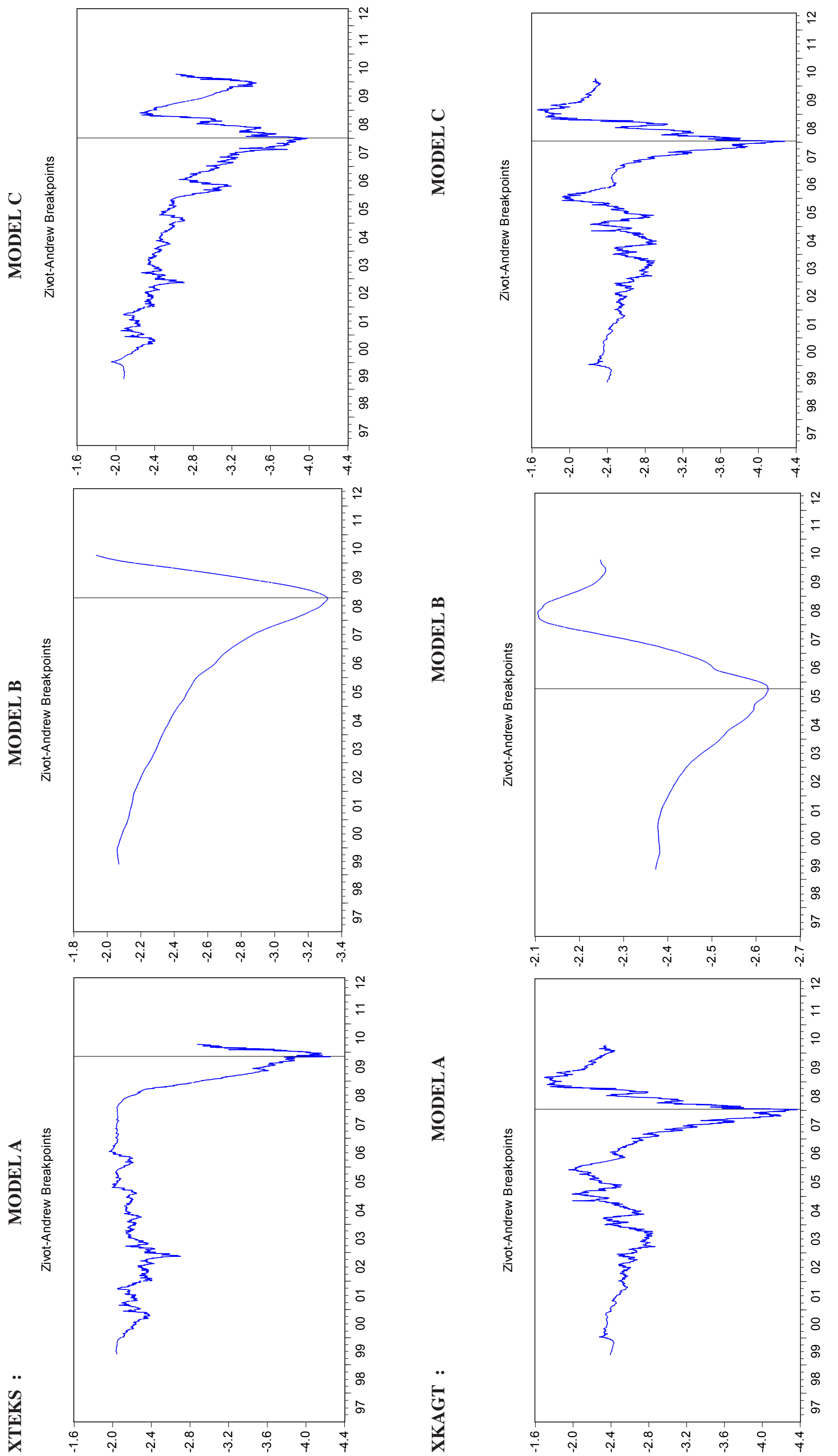
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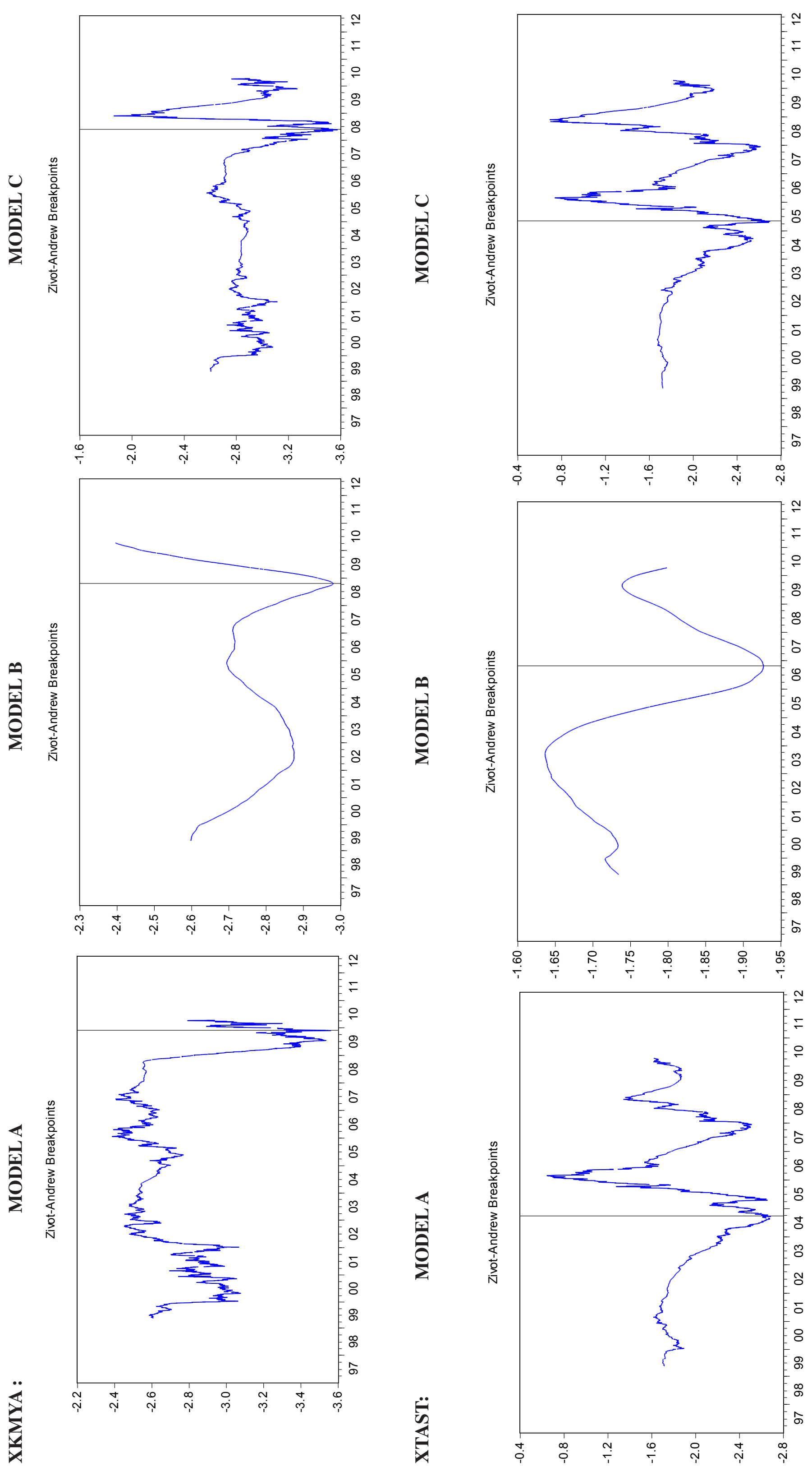
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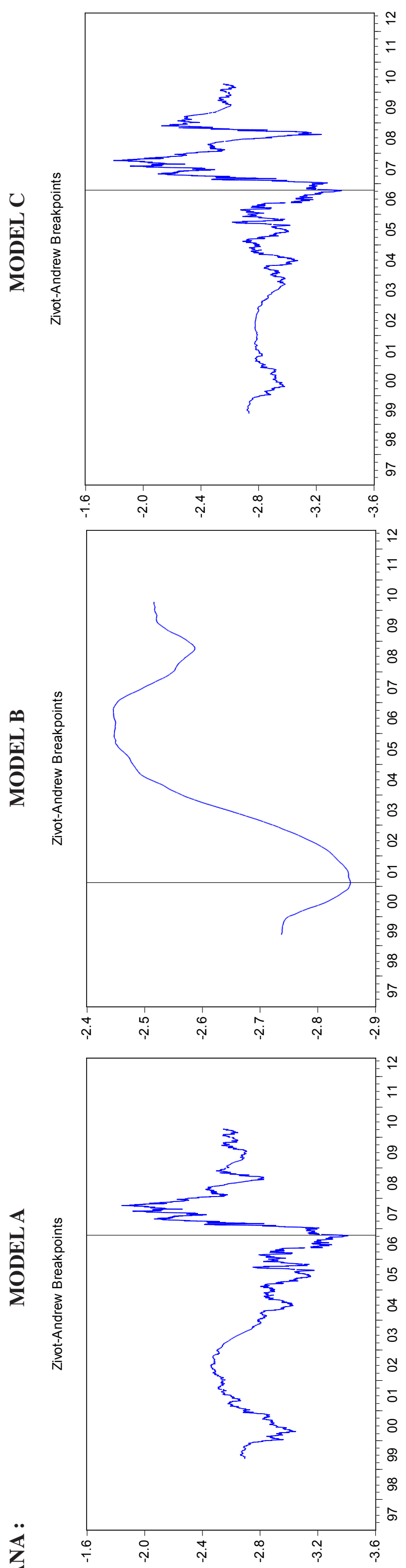
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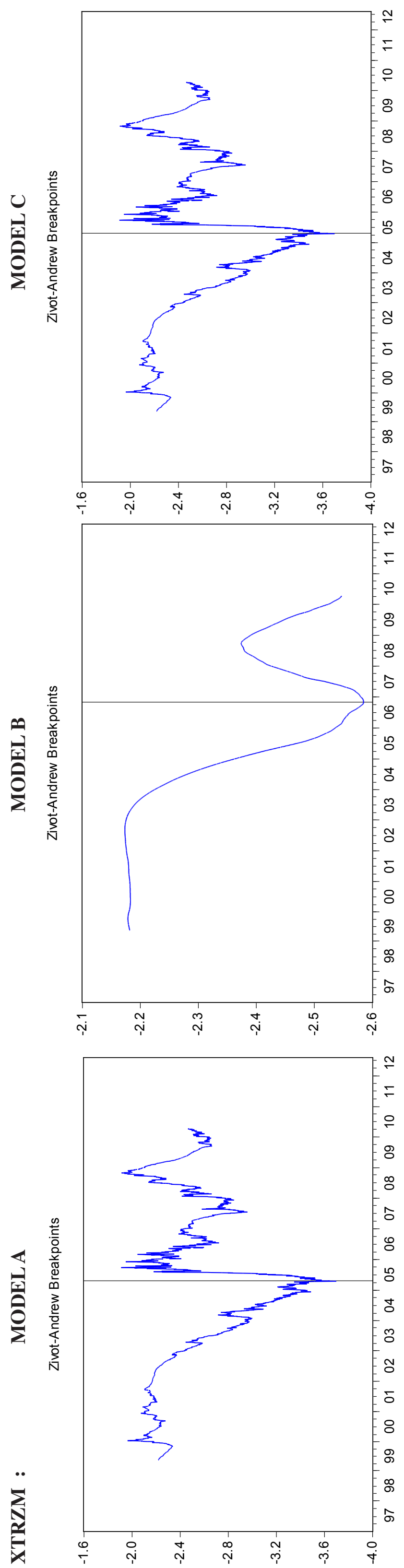
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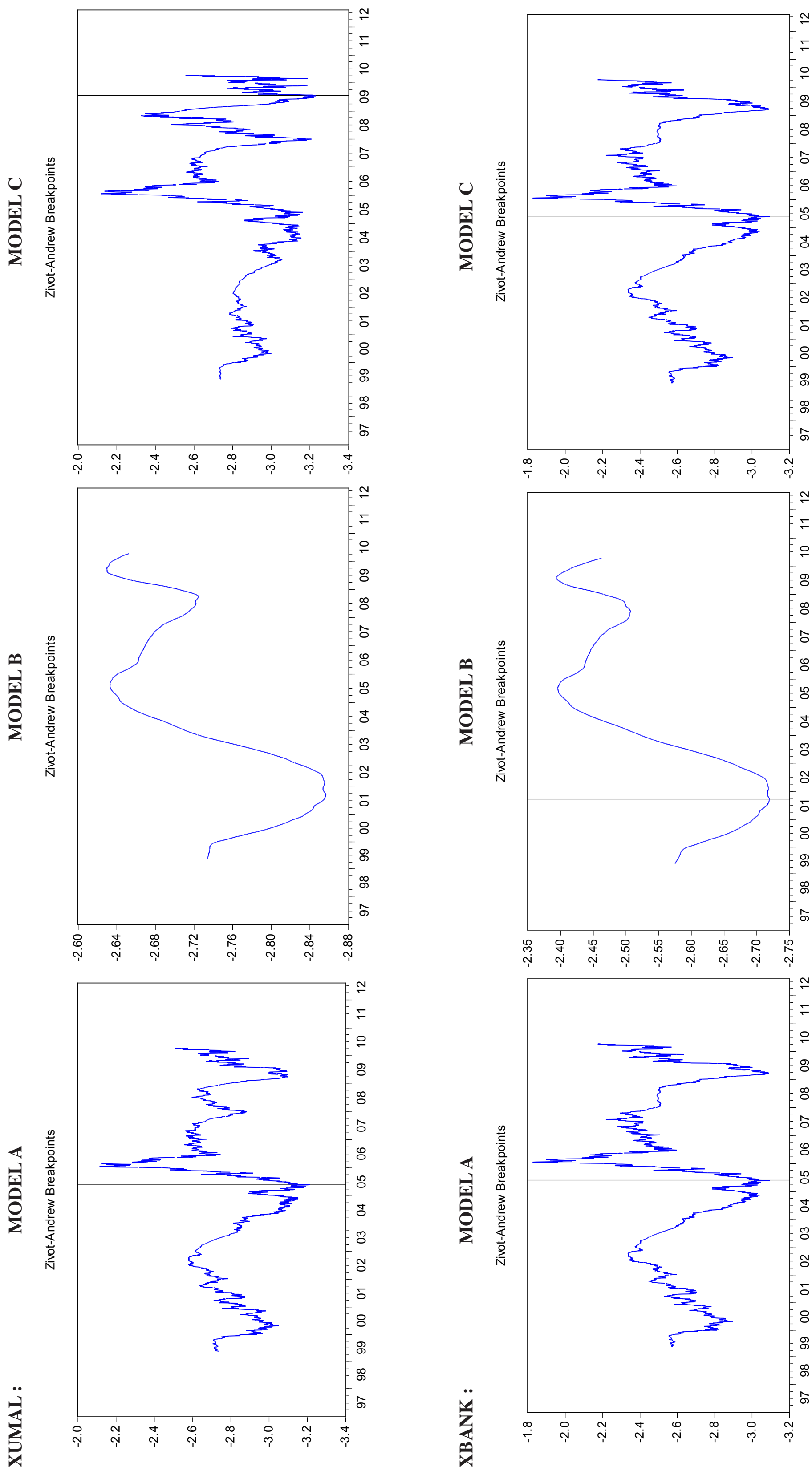
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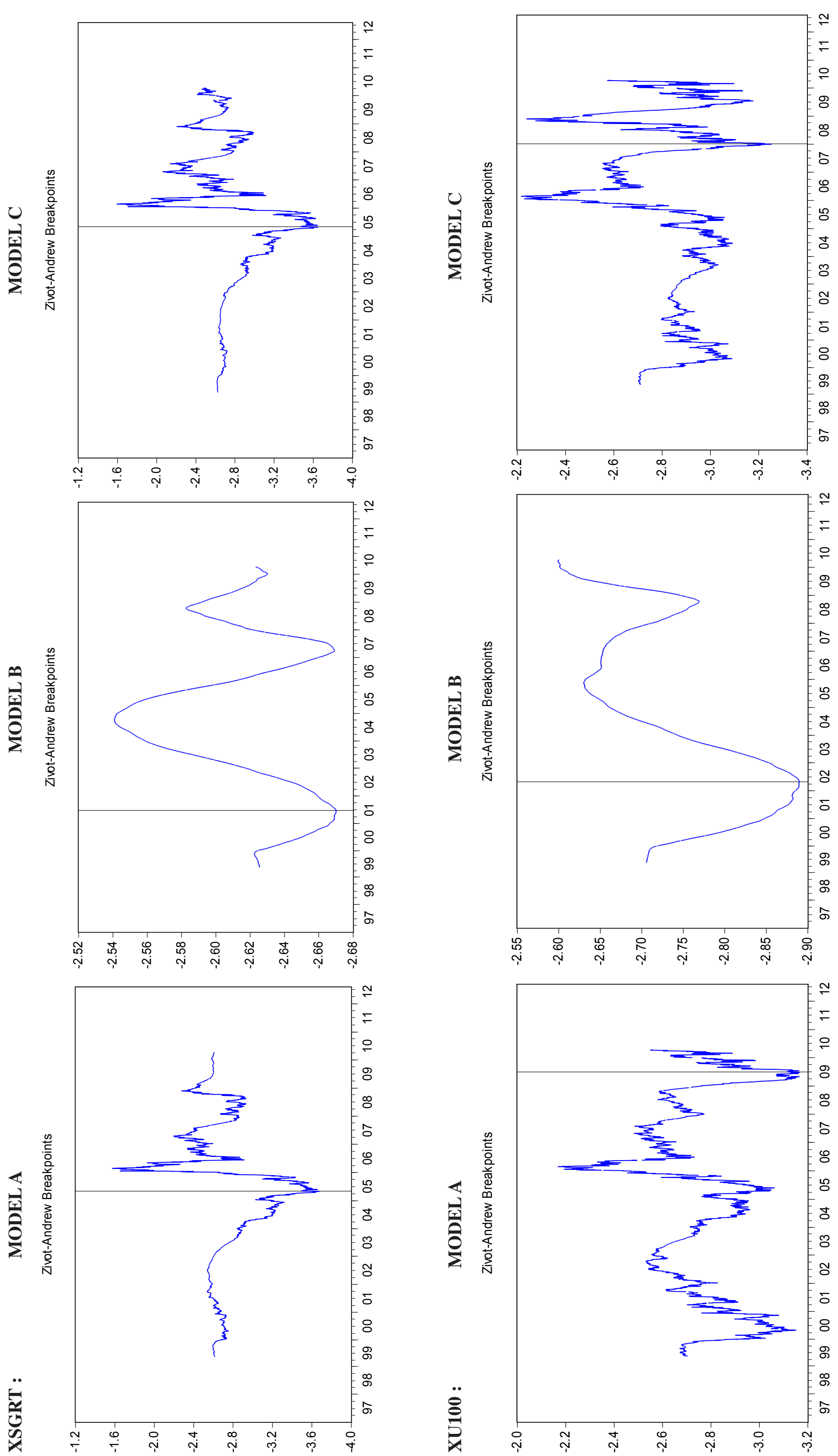

Figure 1 : Plot of Zivot and Andrew Breakpoints For All Series

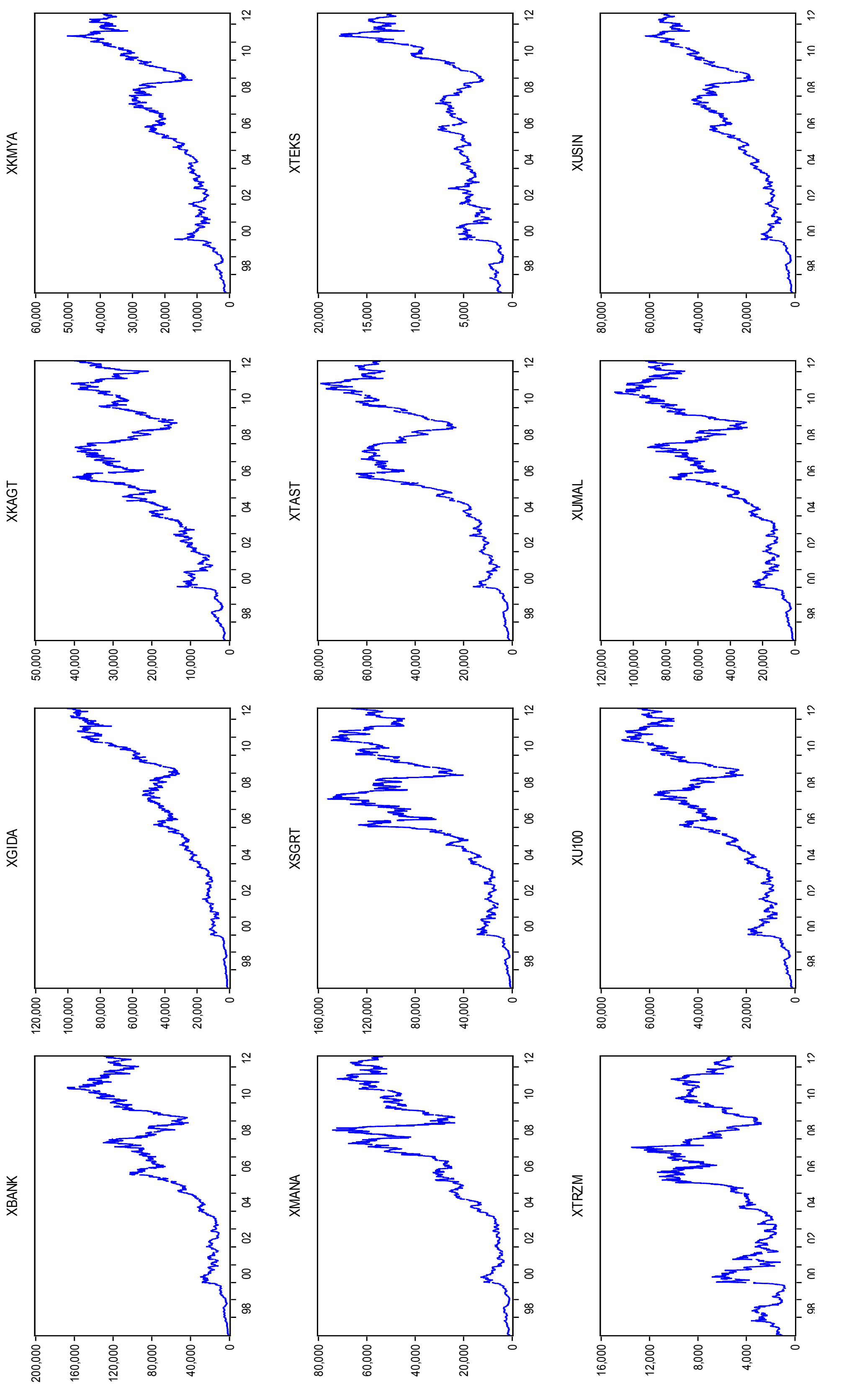

Figure 2 : Plot of Original Series

Table 3 : Zivot and Andrew Test Results (For Maximum 4 lags)

INDEX	ZA		
	Model A	**Model B**	**Model C**
XUSIN	-3.267108 (0.033605) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 11/23/2009	-2.905533 (0.157860) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 10/23/2008	-3.837181 (0.005656) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 8/05/2008
XGIDA	-4.484931 (4.55E-05) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 3/22/2010	-4.119981 (0.000419) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 11/19/2008	-4.470182 (0.012690) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 8/08/2008
XTEKS	-4.176566 (4.43E-05) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 11/04/2009	-3.193487 (0.006968) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 9/17/2008	-3.851841 (0.030328) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 1/02/2008
XKAGT	-4.373070 (2.93E-05) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 1/10/2008	-2.627556 (0.267447) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 9/30/2005	-4.282355 (1.16E-05) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 1/10/2008
XKMYA	-3.934560 (0.012389) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 11/23/2009	-3.367909 (0.140564) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 10/20/2008	-3.957838 (0.021073) Chosen lag length: 3 (maximum lags: 4) Chosen break point: 5/20/2008
XTAST	-2.827091 (0.033052) Chosen lag length: 4 (maximum lags: 4) Chosen break point: 4/19/2005	-2.080574 (0.244330) Chosen lag length: 4 (maximum lags: 4) Chosen break point: 10/19/2006	-2.863162 (0.048833) Chosen lag length: 4 (maximum lags: 4) Chosen break point: 4/19/2005
XMANA	-3.587495 (0.049515) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 10/09/2006	-3.053824 (0.341224) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 6/01/2001	-3.559315 (0.030079) Chosen lag length: 2 (maximum lags: 4) Chosen break point: 10/09/2006
XTRZM	-3.229764 (0.007360) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 12/13/2004	-2.585168 (0.135829) Chosen lag length: 1 (maximum lags: 8) Chosen break point: 10/27/2006	-3.698243 (0.008115) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 4/19/2005
XUMAL	-3.212698 (0.116603) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 5/27/2005	-2.856635 (0.341040) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 9/14/2001	-3.231364 (0.030261) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 7/15/2009
XBANK	-3.308384 (0.095659) Chosen lag length: 0 (maximum lags: 4) Chosen break point: 5/27/2005	-2.951542 (0.353136) Chosen lag length: 0 (maximum lags: 4) Chosen break point: 2/18/2002	-3.482502 (0.011054) Chosen lag length: 0 (maximum lags: 4) Chosen break point: 6/24/2009
XSGRT	-3.676039 (0.012907) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 4/29/2005	-2.670128 (0.582966) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 6/19/2001	-3.649518 (0.016627) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 5/02/2005
XU100	-3.167875 (0.072243) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 6/24/2009	-2.889659 (0.268474) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 4/24/2002	-3.254160 (0.006041) Chosen lag length: 1 (maximum lags: 4) Chosen break point: 1/02/2008

* Values in parentheses are the p-values.