Comparing of Unit Root with and without Structural Breaks: Monte Carlo Evaluation

Submitted By

Muhammad Aslam

Registration No. PIDE2017FMPHILETS18

Supervised By

Dr. Atiq-ur-Rehman

Associate Professor

Department of Economics and Econometrics

Pakistan Institute of Development Economics, Islamabad

2020

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"Comparing of Unit Root with and without Structural Breaks: Monte Carlo Evaluation"** submitted by Mr. Muhammad Aslam is accepted in its present form by the Department of Economics & Econometrics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Econometrics**.

External Examiner:

Dr. Mudassar Rashid Khawaja
Assistant Professor
Department of Economics
COMSATS, Islamabad

Supervisor:

Dr. Atiq ur Rehman
Associate Professor
City Campus, The University of Azad
Jammu and Kashmir, Muzaffarabad

Head, Department of Economics & Econometrics:

Dr. Karim Khan
Associate Professor/Head
Department of Economics &Econometrics
PIDE, Islamabad

Dedicated to My beloved

Parents

Whose prayers for me, were what

DECLARATION

I Muhammad Aslam, solemnly declare that this is an original piece of my work. I am the sole author of this dissertation during the period of registered study at Pakistan institute of development economics (PIDE). This work has not been submitted for an award of a degree in any other university.

Muhammad Aslam

ACKNOWLEDGEMENT

Interdependence is a higher value than independence.

Praise be to Allah for it is He who granted me good health throughout my work and I was able to complete my thesis successfully.

I would like to extend my sincere gratitude to my supervisor **Professor Dr. Atiq-ur-Rehman** for sharing his pearls of wisdom with patience and encouragement; my research work wouldn't have been possible without his assistance, guidance and support. He has always been available for valuable suggestions and recommendations on my drafts and his guidance and expertise facilitated me to complete my thesis.

Beside this, I would like to thank PIDE faculty members, especially all my teachers and administration, for their support and encouragement throughout this endeavor.

I will take this opportunity to place on record, my sincere gratitude especially to my family & colleagues for their unceasing support and assistance throughout this venture. I would like to thank my friends Mr. Shakeel shahzad, Mr. Tariq Majeed, Mr. Rizwan Ahmad, Mr. Fazlullah, Mr. Adeel Amir and Ch. Zahid for their assistance, guidance, support and criticism that encouraged me throughout the journey.

Last but not the least; I also want to place on record, my sense of gratitude to one and all who, directly or indirectly, have lent their helping hand in writing this dissertation.

Thanking you!

Muhammad Aslam.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

The unit root became the most important feature that directed to the construction of new time series econometrics, and study of time series structural breaks was a specific area of unit root research. Conventional procedures assume the break and apply a test accordingly. This leads to identification of spurious breaks, and therefore biased results, Lee and Strazicich, (2001). We suggest an alternative strategy where we propose to test for structural breaks before applying unit root test. The debates of Structural breaks in unit root testing starts with Perron (1989). Nelson and Plossor (1982) found unit roots in 1 out of 14 macroeconomic time series of US economy and Perron (1989) taking the Nelson and Plossor's data set, reversed the findings for 11 out of 14 series. The later development in unit roots with structural breaks developed procedures for endogenizing structural breaks (Zivot and Andrew, 1992; Christiano 1992 etc). However, the original Perron's Procedures and the later development in unit root testing with structural breaks, assume that there is a structural break. The studies endogenizing structural breaks also assume the break and determine the break date endogenously. We propose that structural breaks should be tested for existence. The purpose of this study is to compare the existing strategy with the proposed strategy using Monte Carlo experiments. Our results are indicating that existing strategy is significantly suffering in power problems but the proposed strategy is better and significantly perform as compare to conventional or existing strategy.

Key words: Unit root Structural Break, Monte Carlo Simulation

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Structural breaks with unit root test are among the popular tools of the time series econometrics. The breaks are important because they can change the decision about existence of unit root. A major area of unit root research has been the study of structural breaks in time series. Perhaps the issue discussed most in the history of econometric literature is the debate on unit root initiated by Nelson and Plosser (1982) found that most of US macroeconomics series are having unit root. They used the Dickey Fuller test for the unit root deduction in the macroeconomics series of US economy. And they found that twelve out of fourteen series had unit root in U.S. economy on fourteen historical macroeconomics series, including GNP, wage employment prices, stock prices, and interest rates. Perron (1989) suggested that Nelson and Plossor's strong evidence in favor of the unit root hypothesis was unable to capture the structural changes in the data, and illustrated this by adding an exogenous structural break for the crash of 1929. He reversed the Nelson-Plossor (1982) conclusion for 11-14 series and break date was assumed be known in Perron (1989) and they formulated the test statistics by incorporating variable showing different intercepts and slopes and they extended the conventional Dicky-Fuller procedure. Neverheless, this approach was questioned most notably by Banerjee in the early 1990s, Banerjee et al. (1992), Christiano (1992) and Zivot and Andrews (1992) argued that selecting the structural break a priori based on past knowledge of the data could lead the unit root hypothesis being over-rejected For four series which Perron concluded stationary, Zivot and Andrews (1992), endogenizing the structural breaks, were unable to reject unit root. This discussion continues to this date and so far several approaches have been created and evaluated for endogenizing, selecting and analyzing structural breaks.Furthermore, Piehl et al. (1999) pointed out that the dummy variable may not actually enter at the appropriate time due to uncertainty about the exact timing of the break and for this reason, the estimated model may not be accurate. In addition, numerous studies in the analysis of unit roots for break dates have developed different methodologies [e.g., Zivot and Andrews (1992), Lumsdaine and Papell (1997), Perron (1997)]. This break-point endogenisation had a significant impact on the results of the unit root. Zivot and Andrews (1992), for example, suggested a minimum unit root LM test that endogenously determines one structural break in level and trend. The single break LM root test presented here with the two break LM test in Lee and Strazicich (2003) allows researchers to determine more precisely the correct number of structural breaks in their unit root test. Banerjee et al. (1992), Christiano (1992) Zivot and Andrews (1992), Lumsdaine and Papell (1997), Perron (1997), Lee and Strazicich (2003)] these all Studies discussed the Size and Power . Lee and Strazicich (2001) mentioned the both procedure of Perron (1997) and Zivot Andrew (1992) are incorrected to find the break date and they called it spurious Breaks.

Riechlin and Zivot (1992) as they mentioned the size and power of ADF test and its performance including Markov regime switches. They investigate the power and size performance of unit root tests when the true data generating process undergoes Markov regime-switching. All tests, including those robust to a single break in trend growth rate, have very low power against a process with a Markov-switching trend growth rate as in Lam (1990). Dejang et al. (1992) found that choi and Perron (1998) unit root procedures suffer from size distortion and low power issuses in the presence of moving average (MA) structural break. While Augmented Dicky Fuller (ADF) behaved well.Schwert (2002) investigated that the Dicky Fuller (1979, 1981) is responsive to pure autoregressive peocess assumption. It means the data generating process of series is pure autoregressive (AR). When moving average competenrt is involed in fundamental process, then the Dickey Fuller reported distribution and test statistics distribution can be quite different. Many other unit root tests are being proposed and to some extent they all are facing similar problems. Lutz and Ohanian (1998) that unit root against trend break alternative are based in previous that the dating of the breaks happen together with major economic events with permanent effect on economics activity such as war and depression. Standard economic theory, however suggest that these events have large transitory, rather than permanent effect on economic activity. Conventional unit root against trend break alternative based on linear ARMA models do not capture these transitory effects and can result severely in distorted inferences. They quantify the size distortions for a simple model in which the effects of wars and depression can reasonably by interpreted as transitory. Monte Carlo simulations show that moderate samples, the widely used the Zivot Andrew (1992) test mistakes transitory dynamic for trends breaks with high probability. They conclude that this test should be used only if there are no plausible economic explanations for apparent trend breaks in the data. They used different methodologies such as Pierre Perron (1989), Rappoport and Reichlin (1989), Banerjee, Dolado and Galbraith (1990), Balke and Fomy (1991), Perron and Volgelsang (1992, 1993), park and sung (1994) Bradly and Jansen (1995), Newbold and Kuan (1996) these are used the same methodology as they trend stationary alternative. Finally they found that Zivot Andrew test likely useful for macro econometrics data not for all. Serena NG and Perron (2001) worked on the selection of lag length via AIC, BIC, MIC for the unit root test ADF, MZ and checking the size and power and then make comparison between unit root tests. So finally they found that modified information criteria is best for selecting the lag length and unit root test is best on the basis of size and power.

Ignoring stationarity can lead to spurious results and wrong asymptotic for traditional econometric techniques. This has led to a huge amount of research in the past 30 year,s but consensus on several important issues and implications has not emerged to date. Even though vast numbers of unit root structural break tests have been proposed and studied, conflicting opinions exist on the simplest of problems. For example, there is a list of the conclusions of authors who have studied the USA annual GNP series:

Stationary structural break; Nelson and Plossor (1982),Trend Stationary structural break ; Perron (1989),Trend Stationary structural break; Zivot and Andrews (1992),Riechlin and Zivot Structural break (1992), Banerjee and Christiano structural break (1992),Trend stationary structural break; Diebold and Senhadji (1996),Lumsdaine and Papell structural break (1997), Difference stationary structural break; Murray and Nelson (2002), NG and Perron structural break (2001),Kilian and Ohanian structural break (2002),

These studies are exploring that these are lead to spurious results in terms of size distortion and low power problems, further we explained in literature below in next chapter 2. The purpose of this study is to provide the Alternative solution for conventional econometrics when there is size distortion and power problem.

We offer the new procedure and called it proposed strategy. In proposed procedure where we first of all test the structural break then apply the unit root accordingly. Conventional procedure assumes the break and then apply the unit root accordingly.

As we have seen, unit root process often shows spurious breaks Lee and Strazicich, (2001). Therefore, the many series which are in fact unit root are treated as may be stationary with Structural Break (size distortion).

One option is first to Test for Structural Break using any suitable test like rolling chow and then apply unit root test accordingly. If Structural Break exists, then apply the Perron type unit root test. If Structural Break is not found, then use ADF type test. We want to see what will happen to (Size and Power) if the proposed strategy is used?

1.2 Objective of the study

The main objective of this study is to compare two strategies i.e. existing strategy and proposed stretegy. Structural breaks with unit root test and structural break then unit root test on the basis of size and power.

1.3 Significance of the study

Unit root test has a key role in time series analysis however, the strategy of application of unit root test with structure break is subject to size distortion. This particular study explores if it is possible to avoid size distortion and power problem by adopting alternative strategy. Moreover, the study will be helpful for researchers who works on data with structural breaks.

1.4 Organization of the study

The organization of study consist of 5 chapters, 1^{st} chapter introduction of study, 2^{nd} chapter provides a brief discussion on structural break literature 3^{rd} chapter provides the methodology of study 4^{th} chapter provides analysis of size and power of study and 5^{th} chapter provides summery conclusion and recommendation of study.

CHAPTER 2

LITERATURE REVIEW

A huge amount of studies on structural break subject are available in time series econometric literature. In this section we discuss briefly the theoretical and empirical research suggested in the literature for the treatment of structural break. A summary of the literature is structured as follows.

2.1 Theoretical literature review

In econometrics literature there is a long historical debate on the topic of nonsense correlation (spurious regression), at least looking back to Yule's well known analysis (1926). According to study he presented that during 1866 to 1911 the presence of a strong correlation of 0.95 between mortality rate and proportion of Church of England marriages to all marriages. According to Yule (1926) that the spurious regression was a result of relevant variables that were missing. This idea was also supported by Simon (1954) that the missing variable is a source of spurious correlation. If we are unsure as to whether the apparent correlation is spurious, we need to add new variable that might be found in the actual correlation explained by Simon.

New Experiment of Granger and New bold (1974)

The results of experiment of Granger and New bold (1974) showed that if the series were non-stationary the results would be significant. They generated independent, autoregressive series such as, x_t and y_t in their experiment. Where x_t and y_t both express their own values of the lag.

$$y_t = y_{t-1} + \varepsilon y_t \quad \text{...} \quad (1)$$

$$x_t = x_{t-1} + \varepsilon x_t \quad \text{...} \quad (2)$$

In development of both equation no third variable involued. They regressed $x_t$on y_t and $y_t$on x_t.

$$y_t = a + \beta x_t + \varepsilon y_t \quad \text{...} \quad (3)$$

$$x_t = a + \beta\ y_t + \varepsilon x_t \text{..} \quad (4)$$

They also found that there is spurious results and the alternative explanation of spurious regression become more common with in literature, and the rest of explanation went in darkness. After Nelson and plosser (1982) found that the majority of the U. S economy's macroeconomics series has unit root. The study of Nelson and Plosser is generally recognized as an important contribution which has theoretical and imperical implications. They used the Dickey Fuller test for detection of unit root for the U.S. economy on 14 historical macroeconomics series including GNP, wage employment prices, stock prices, and interest rates, and found that twelve out of fourteen series had unit root. In ormality, Nelson an Plosser's(1982) study is a significant contribution to time series econometric literature that increased the interest of researchers in unit root testing. That is why progress has been fashioned in unit root theory

Nelson an Plosser (1982) main damaging critique of the hypothesis that U.S. output has a unit root came under the alternative hypothesis of trend stationarity by allowance of structural change. This was attributable to Peron (1989) and to Rappopoort and Reuchlin (1989) who believed, by not allowing one-time structural changes, that Nelson an Plosser over-estimated the frequency of permanent shocks. Perron showed that the real GNP series used by Nelson and Plosser is no longer consistent with the unit root hypothesis if a change in level, occurring at 1929, is considered. Perron's conclusion is that from 1909 to 1970, there is only one permanent shock, a negative one, and the rest of the variation in output is transitory around a time trend. In Perron (1989), the date of the trend break, 1929, was assumed to be known a priori. This drew criticism originally from Christiano

(1992) who suggested that Perron's results may be tainted by the assumption that the break date was known. Using both Monte Carlo and Bootstrap procedure, he found that if the break date is allowed to be data dependent, then the critical values are much larger (in absolute value) than those tabulated by Perron. Zivot and Andrews (1992) and Banerjee et al. (1992) derived the limiting distribution of the unit root statistic when the break date is endogenized. Zivot and Andrew (1992) found that Perron's conclusion that U.S. GDP is stationary around a broken time trend still holds once critical values are adjusted to reflect estimation of the break date. Peron and Zivot Andrew literature has been collected by papers which study the asymptotic distribution of unit root and/or Structural break statistics under various methods for selecting the break date. In this study they also mentioned the size distortion and power problem as well.

2.2 Comparison on the basis of Size and Power

There are many existing studies which compare the methods of testing unit root with Structural Break. This include a brief review of these studies is as follows. The main purpose of this study is to compare two strategies the unit root with Structural Break and Structural Break than unit root test on the basis of Size and power. Where existing strategy assumes break then apply unit root accordingly and proposed strategy test structural break then apply unit root test.

Riechlin and Zivot (1992) as they mentioned the size and power of ADF test and its performance including Markov regime switches. They investigate the power and size performance of unit root tests when the true data generating process undergoes Markov regime-switching. All tests, including those robust to a single break in trend growth rate, have very low power against a process with a Markov-switching trend growth rate as in Lam (1990). However for the case of business cycle non-linearities, unit root tests are very powerful against models used as alternatives to Lam (1990) that specify regime-switching in the transitory component of output. Under the null hypothesis, they received literature documents size distortions in Dickey-Fuller type tests caused by a single break in trend growth rate or variance. Finally they found these results do not generalize to most parameterizations of Markov-switching in trend or variance. Dejang et al. (1992) found that choi and Perron (1998) unit root procedures suffer from size distortion and low power issuses in the presence of moving average (MA) structural break. While Augmented Dicky Fuller (ADF) behaved well.Schwert (2002) investigated that the Dicky Fuller (1979, 1981) is responsive to pure autoregressive peocess assumption. It means the data generating process of series is pure autoregressive (AR). When moving average competenrt is involed in fundamental process, then the Dickey Fuller reported distribution and test statistics distribution can be quite different. Many other unit root tests are being proposed and to some extent they all are facing similar problems. Lutz and Ohanian (1998) that unit root against trend break alternative are based in previous that the dating of the breaks happen together with major economic events with permanent effect on economics activity such as war and depression. Standard economic theory, however suggest that these events have large transitory, rather than permanent effect on economic activity. Conventional unit root against trend break alternative based on linear ARMA models do not capture these transitory effects and can result severely in distorted inferences. They quantify the size distortions for a simple model in which the effects of wars and depression can reasonably by interpreted as transitory. Monte Carlo simulations show that moderate samples, the widely used the Zivot Andrew (1992) test mistakes transitory dynamic for trends breaks with high probability. They conclude that this test should be used only if there are no plausible economic explanations for apparent trend breaks in the data. They used different methodologies such as Pierre Perron (1989), Rappoport and Reichlin (1989), Banerjee, Dolado and Galbraith (1990), Balke and Fomy (1991), Perron and Volgelsang (1992, 1993), park and sung (1994) Bradly and Jansen (1995), Newbold and Kuan (1996) these are used the same methodology as they trend stationary alternative. Finally they found that Zivot Andrew test likely useful for macro econometrics data not for all.

Serena NG and Perron (2001) worked on the selection of lag length via AIC, BIC, MIC for the unit root test ADF, MZ and checking the size and power which and then make comparison between unit root tests. It is widely known that when there are errors with a moving-average root close to -1, a high order augmented auto regression is necessary for unit root tests to have good size, but that information criteria such as the AIC and the BIC tend to select a truncation lag (k) that is very small. They consider a class of Modified Information Criteria (MIC) with a penalty factor that is sample dependent. It takes into account the fact that the bias in the sum of the autoregressive coefficients is highly dependent on k and adapts to the type of deterministic components present. They use a local asymptotic framework in which the moving-average root is local to -1 to document how the MIC performs better in selecting appropriate values of k. In Monte-Carlo experiments, the MIC is found to yield huge size improvements to the DFGLS and the feasible point optimal PT test developed in Elliott, Rothenberg, and Stock (1996). They also extend the M tests developed in Perron and Ng (1996) to allow for GLS detrending of the data. The MIC along with GLS detrended data yield a set of tests with desirable size and power properties. So finally they found that modified information criteria is best for selecting the lag length and unit root test is best on the basis of size and power.

Lee, Strazicich (2004), this paper, propose is a minimum LM unit root test that endogenously determines a structural break in intercept and trend. Critical values are provided, and size and power properties are compared to the endogenous one-break unit root test of Zivot and Andrews (1992). Nunes, Newbold, and Kuan (1997) and Lee and Strazicich (2001) previously demonstrated that the Zivot and Andrews test show size distortions in the presence of a break under the null and that shows spurious break. In contrast, the one-break minimum LM unit root test exhibits no size distortions in the presence of a break under the null. As such, rejection of the null unambiguously implies a trend stationary process. They used different methodology of Perron Newbold etc. such as Crash Model as well as innovative outlier model. Finally, this paper proposes a minimum LM unit root test that endogenously determines one structural break in level and trend. Properties of the test were discussed and critical values presented. by combining the one-break LM unit root test presented here with the two-break LM test in Lee and Strazicich (2003), researchers can more accurately determine the correct number of structural breaks in their unit root test.

Shrestha and Chowdhury (2005) Testing for unit roots has special significance in terms of both economic theory and the interpretation of estimation results. As there are several methods available, researchers face method selection problem using the General to specific procedure while conducting the unit root test on time series data in the presence of structural break? The purposes are sequential search procedure to determine the best test method for each time series. Different test methods or models may be appropriate for different time series. Therefore, instead of sticking to one particular test method for all the time series under consideration, selection of a set of mixed methods is recommended for obtaining better results.

Waheed and Ghauri (2006) the purpose of this study is to examine the unit root properties of eleven Pakistani macroeconomic series using annual data. Along with traditional unit root tests, they use the procedure developed by Zivot and Andrews to test the null of unit root against the break stationary alternative. Conventional unit root tests indicate that all variable are nonstationary at the levels. Results from Zivot and Andrews test suggest that they can reject the null of unit root for CPI and WPI at 5 percent significance level while they fail to reject the unit root hypothesis for the remaining 9 series. At the same time, the Zivot and Andrews test identifies endogenously the point of the single most significant structural break in every time series examined. The results show that ten of the eleven series studied bear witness to the presence of a structural break during the period 1972 to 1976.

As Glynn, Perera and Verma (2007) worked on the paper reviews the available literature on unit root tests taking into account possible structural breaks. An important distinction between testing for breaks when the break date is known or exogenous and when the break date is endogenously determined is explained. They also describe tests for both single and multiple breaks. Additionally, the paper provides a survey of the empirical studies and an application in order for readers to be able to find the underlying problems that time series with structural breaks are currently facing. They conclude that there is no consensus on the most appropriate methodology to perform unit root tests or no consensus about the empirical results of unit root tests has emerged from this survey. An important point to note here is that testing for structural breaks when the series is otherwise non-stationary will affect whether there is evidence of a structural break. They also checked different tests for structural break.

Rehman and Zaman (2008) investigated that the two main causes for inadequate performance of unit root tests are observational equivalence and model misspecification. They mainly targeted four specification decisions: choice of the deterministic part; the structural breaks; autoregressive lag length choice and innovation process distribution, and examine their role in an inference from unit root tests. They explored that these specification decisions seriously impact the performance of unit root tests. Also investigated that the existing unit root tests do not provide any set criteria regarding these specification decisions, that is why they came up with unreliable results.

Narayan ,Popp (2011) In this paper, they compare the small sample size and power properties of a newly developed endogenous structural break unit root test of Narayan and Popp (NP, 2010) Narayan, PK and Popp, S (NP). 2010. A new unit root test with two structural breaks in level and slope at unknown time with the existing two break unit root tests, namely the Lumsdaine and Papell (LP, 1997) Lumsdaine, R and Papell, D (LP). 1997. Multiple trend break and the unit root hypothesis. And the Lee and Strazicich (LS, 2003) Lee, J and Strazicich, M (LS). 2003. Minimum Lagrange multiplier unit root test with two structural breaks. In contrast to the widely used LP and LS tests, the NP test chooses the break date by maximizing the significance of the break dummy coefficient. Using Monte Carlo simulations, they show that the NP test has better size and high power, and identifies the structural breaks accurately. Power and size comparisons of the NP test with the LP and LS tests reveal that the NP test is significantly superior.

Marcus Nordstrom (2017) that study examines the properties of the two recent structural break unit root tests developed in Harvey, Leybourne and Taylor (2013) and Narayan and Popp (2010). The properties are investigated by Monte Carlo simulations in an environment where two trend breaks of small to large magnitudes are present. They find that the Harvey, Leybourne and Taylor (2013) test has superior size and power properties compared to the Narayan and Popp (2010) test. In addition, they investigate the accuracy of the break detection of the two procedures. The results show that the former test is more accurate than the later test except for when the breaks are very large and the null is true.

2.3 Gap in literature

From theoritical econometrics literature we have found the gap that many conventional unit root tests are facing the size and power problems. As we discussed in details in the above literature the conventional or exixting strategy is not much reliable to tackle the problem of size distiortion and power problem in stationary time series. For this reason we offer an alternative procedure or proposed strategy for the treatment of significant size and power in stationary and non-stationary time series.

CHAPTER 3

METHODOLOGY

The testing unit root with structural breaks is a popular technique used in econometrics. The usual strategies for this purpose are of two types: first is Peron type strategy where one assumes known break date applies the test. Second is Zivot Andrew type strategy, where the researcher assumes that there is break and then chooses the break date endogenously. These two strategies do not test for the break.

In fact, it is important to make sure that there is structural break and apply the unit root tests with breaks only if there is evidence of break. This would require testing for structural break first and then application of break point unit root test would be needed only if the evidence of breaks is found. Though this strategy makes sense, it has not been used with literature. The objective of this study is to apply this proposed or alternate strategy and compare its performance with the existing strategies. This chapter discussed, data generating process existing and proposed strategy data and simulation have the following hypothesis.

3.1 Brief sketch of existing and proposed methodology

1) Existing methodology

In existing or conventional methodology, the break assumed and then apply unit root test accordingly. If the break date known than applying Pierre Peron test. If the break date is not known than they apply the Zivot Andrew test. We introduced the new methodology proposed strategy is given below.

2) Proposed Strategy

Proposed strategy does not assume the break, rather, it asks to test the break. Therefore, following this strategy, first we apply the rolling chow test, if the break exists then we apply structural break test Pierre Peron type test, if the break does not exist then we apply the DF test.

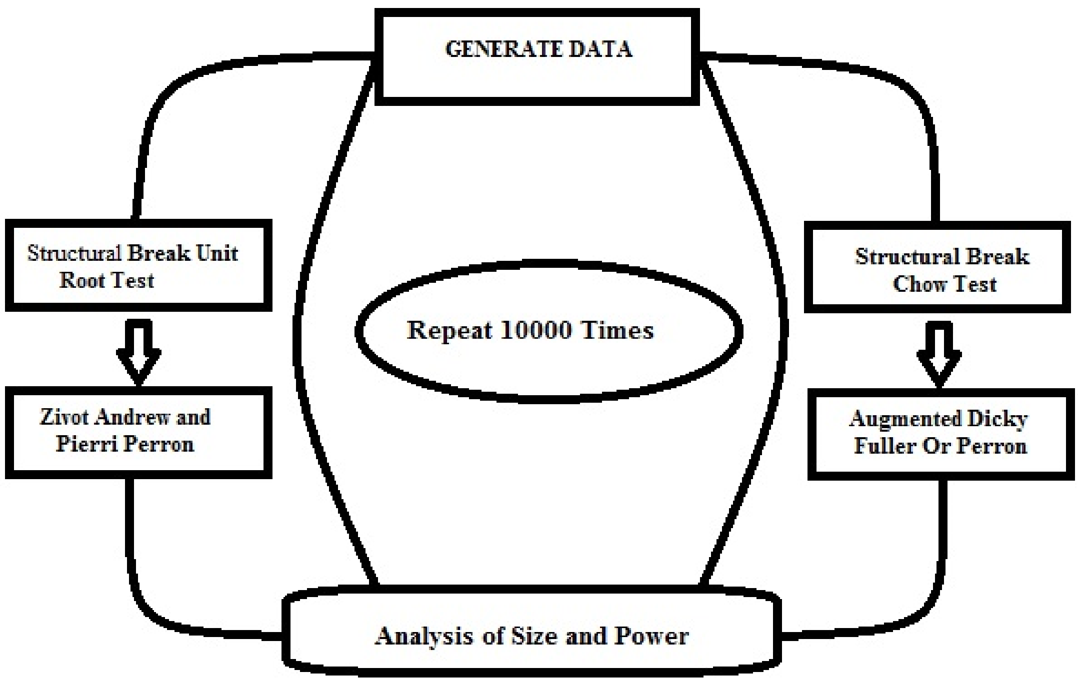
The existing procedure and proposed procedure shall be compared on the basis of Size and Power through Monte Carlo simulation the Data generating process and the simulation design are mentioned as under.

3.2 Experiment design

The steps involved in comparison of existing and proposed methodology are summarized in the Fig 3.1 below.

The Experiment flow chart

Figure 3.1: Author's own source of experimental design



We generate the data generating process under the null and alternate hypothesis. The data generating process are given below for two strategies.

3.3 Data generating process proposed by Peron (1989) existing strategy

Data generating process of Peron (1989) is as under:

Null hypothesis

Pulse dummy

Model A: $yt = u + dD(T_B)t + y_{t-1} + \epsilon t$

Trend dummy

Model B: $yt = u_1 + y_{t-1} + (u_2 - u_1)DU_t + \epsilon t$

Model C: $yt = u_1 + y_{t-1} + dD(T_B)t + (u_2 - u_1)DU_t + \epsilon t$

$D(TB)_t = 1$ if $t = T_B + 1$ 0 otherwise

$DU_t = 1$ if $t > T_B$ 0 otherwise and

$A(L)et = B(L)vt,$

vt - i.i.d. $(0,\sigma^2)$,with $A(L)$ and $B(L)$ pth and qth order polynomials, respectively, in the lag operator L. The innovation series $\{et\}$ is taken to be of the ARMA (p, q) type with the orders p and q possibly unknown. This allows the series $\{yt\}$ to represent quite general process . More general conditions are possible and will be used in subsequent theoretical derivations. Instead of considering the alternative hypothesis that yt is a stationary series around a deterministic linear trend with time invariant parameters, we shall analyze the following three possible alternative models:

Alternate hypothesis

Level dummy

Model A: $yt = u_1 + \beta t + (u_2 - u_1)DU_t + \epsilon t$

Trend dummy

Model B: $yt = u_1 + \beta t + (\beta 2 - \beta 1)DT^* + \epsilon t$

Model C: $yt = u_1 + \beta t + (\beta 2 - \beta 1) + (u_2 - u_1)DU_t + \epsilon t$

Where $DT^* = t - T_B$, and DT_t= t if $t > T_B$ and 0 otherwise

Here, T_B refers to the time of break, i.e., the period at which the change in the parameters of the trend function occurs. Model (A) describes what we shall refer to as the crash model. The null hypothesis of a unit root is characterized by a Pulse dummy variable which takes the value one at the time of break. Under the alternative hypothesis of a "trend-stationary" system, Model (A) allows for a one-time change in the intercept of the trend function. We called it Level dummy, For the empirical cases we have in mind, T_B is the $u_2 < u_1$. Model (B) is referred to as the "changing growth" model. Under the alternative hypothesis, a change in the slope of the trend function without any sudden change in the level at the time of the break is allowed. Under the null hypothesis, the model specifies that the drift parameter, u changes from u_2 to u_1 at time T_B .Model (C) allows for both effects to take place simultaneously, i.e., a sudden change in the level followed by a different growth path.

H_0: $\delta = 0$ And $\rho = 1$ non stationary

H_1: $\delta = 1$ And $\rho < 1$ stationary

3.4 Data generating process proposed by Zivot and Andrew (1992) existing strategy

Data generating process of Zivot Andrew is as under:

With the Zivot Andrew test the T_B (time of the break) is chosen to minimize the statistics of α=1 in equations below. In other words, a break point is selected which is the least favorable to the null hypothesis. The Zivot Andrew model endogenises one structural break in a series such as yt as follows.

Null hypothesis

$$yt = \mu + y_{t-1} + \epsilon t$$

Alternate hypothesis

Level dummy

$$Model\ A: \quad \Delta yt = \mu + \beta t + \theta DU1_t + \alpha y_{t-1} + \sum_{i=0}^{n} ci\Delta y_{t-1} + \epsilon t$$

Trend dummy

$$Model\ \ B: \quad \Delta yt = \mu + \beta t + \theta DT1_t + \alpha y_{t-1} + \sum_{\boldsymbol{i=0}}^{\boldsymbol{n}} \boldsymbol{ci\Delta y_{t-1}} + \epsilon t$$

$$Model\ \ C: \quad \Delta yt = \mu + \beta t + \theta DT1_t + \gamma DT1_t \alpha y_{t-1} + \sum_{i=0}^{n} ci\Delta y_{t-1} + \epsilon t$$

Model A: allows for a one-time change in the intercept. Model B: is used to test for stationarity of the series round a broken trend, in broken trend and finally, Model C: accommodates the possibility of a change in the intercept as well as a broken trend. DU_t is a Level dummy variable capturing a shift in the intercept, and DT_t is another dummy variable representing a shift in the trend occurring at time T_B is called trend dummy. The alternative hypothesis is the series, yt is with one structural break T_B is the break, and $DU_t = 1$ if $t > T_B$ and zero otherwise DT_t is equal to $(t - T_B)$ if $(t > T_B)$ and zero otherwise. The null is rejected if the α coefficient is statistically significant.

$$yt = \mu + \beta t + \alpha y_{t-1} + \epsilon t$$

The OLS regression equation including the *drift* and *trend* for all three models. Where yt is the data generating process having μ, drift βt trend α is the coefficient of the AR and ϵt is the error term.

3) Brief sketch of Experiment design

According to experiment flow chart, first we generate data and following the data generating process mentioned in figure 3.2.

1) Under the Null hypothesis, there is no structural break in the Data Generating Process,

2) Under Existing strategy generating the DGP H_0 null hypothesis: it means that series is unit root with one exogenous break. Under $H_1$the alternate hypothesis generating the DGP it means that series is stationary with one exogenous break for Pierre Peron test.

3) Existing strategy assume the break if the break exists and the break date known than apply Peirre Peron type test, if the break does not exist than apply simple Dickey Fuller test.

4) Under Existing strategy generating the DGP H_0null hypothesis, it means that series is unit root with one endogenous break. Under $H_1$the alternate hypothesis

generating the DGP it means that series is stationary with one endogenous break for Zivot Andrew test.

5) Existing strategy assume the break if the break exist but the break date unknown than apply Zivot Andrew type test.

6) Checking the Null and alternate hypothesis, significance level and decision on the basis of critical value and probability value.

7) Generate the data under H_0 : compute the test statistics. Compute the critical values for very large number of times and that are significance level (α) it shows the size of the tests.

8) Generate the data under H_1 : apply the test and simulate the number for many times then count rejection region that tells us the power of test.

We generate the random data and we apply proposed strategy:

1) Proposed strategy does not assume break. First we apply the *rolling chow* test, if the break exist then apply structural break test Pierre Perron type test, if the break does not exist then we apply the Dickey Fuller test.

2) Test for Structural Break; apply the rolling chow test. If test accepts Structural Break, apply Perron test with known Structural Break.

3) If test rejects Structural Break, apply Dickey Fuller unit root test.

4) Generate the data under H_0 : compute the test statistics. Compute the critical values for very large number of times and that are significance level (α) it shows the size of the tests.

5) Generate the data under H_1 : apply the test and simulate the number for many times then count rejection region that tells us the power of test.

6) Checking the Null and alternate hypothesis, significance level and decision on the basis of critical value and probability value.

For this objective we compare the empirical size and power calculates from existing methodology and proposed methodology. That is simulated for 10000 times. Now selection of the test is on the basis of performance of size and power.

3.5 Testing and simulation

We will evaluate the performance of unit root through Monte Carlo simulation and compare on the basis of size and power of Pierre Peron and Zivot Andrew between the existing and proposed strategies. The size analysis is performed to quantify the distortion in probability of type I error. It can be expressed in following way; Size = Prob (reject H_0| when $H_0$is true) as well as Power analysis is executed to evaluate the probability of rejection the null hypothesis, when the alternative hypothesis is true. As the statistical power of test increases, the probability of type II error is decreased. It can be expressed in following way: Power = Prob (reject H_0 | whenH_1 is true).

CHAPTER 4

SIZE AND POWER: THE MONTE CARLO RESULTS

In this chapter we briefly discuss the size and power, where we have calculated the size for proposed strategy but not for existing strategy, and the power is calculated for both strategies.

4.1 Analysis of size under proposed strategy for models A.B and C

There is no need of size analysis in existing strategy we only calculated critical values for existing procedure. But we calculated the size analysis for proposed strategy. We generated the random series and apply the rolling chow test to detect the break, if break exist than we apply the Pierre Peron type test if the break does not exist then we apply the Dickey Fuller test. Empirical size of the proposed strategy is 1- step test where we match the nominal size with actual size and count the rejection of the test and called it total size. The data generating process is discussed in third chapter for both tests.

$$yt = \mu + \beta t + \alpha y_{t-1} + \epsilon t \qquad 4.1.1$$

The OLS regression in figure 4.1.1 equation including the drift and trend for all three models . Where yt is the data generating process having μ, drift βt trend α is the coefficient of the AR process and ϵt is the error term. We constructed the three models (A, B, C) for proposed strategy. We test the null hypothesis for H_0 (1): $\mu = 0$, H_0(2): $\beta = 0$, and H_0 (3) (μ, β) = 0 since all three hypothesis are true. Probability of rejection of three null hypothesis should not exceed the nominal size. The size analysis is performed to quantify the distortion in probability of type I error. It can be expressed in following way; Size = Prob (reject $H_0|$ when$H_0$is true). For this analysis, the autoregressive non-stationary time series are being generated with different models;

with drift with trend, with drift and trend both. The probability of getting significant α would be the actual size and it is different from nominal size. It would be considered as size distortion.

The data generating process are simulated for 10000 times the results are summarized in the below figure 4.1

Figure 4.1: Average empirical Size of proposed strategy Model A, B and C

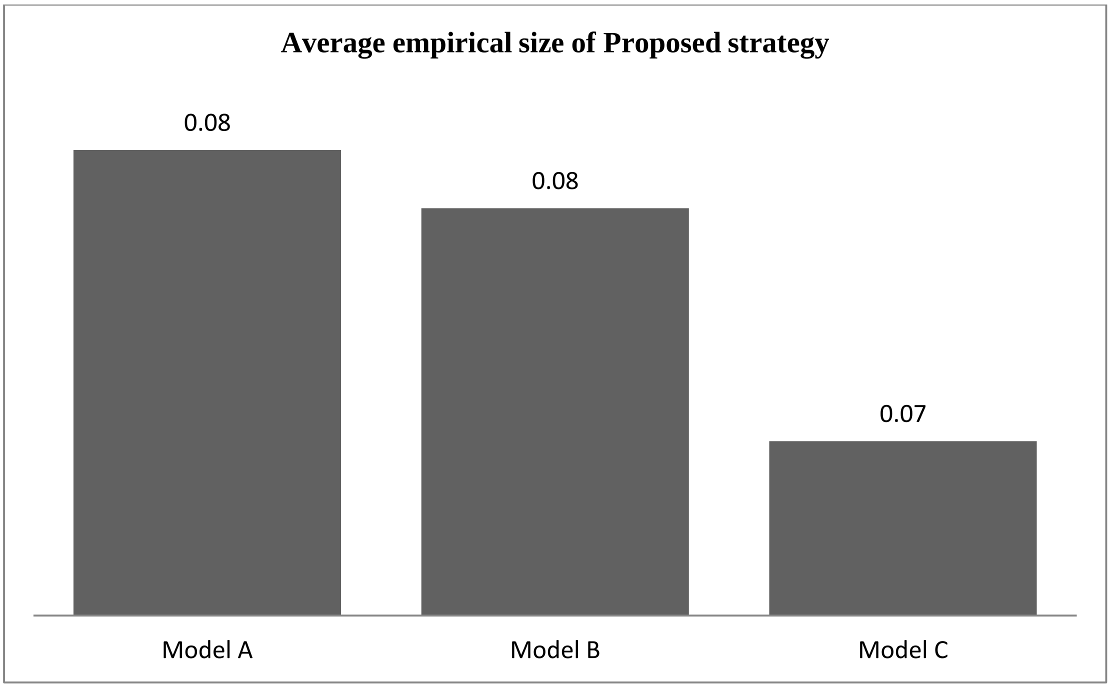


figure 4.1 summarized the average empirical size results of proposed strategy for three Models (A, B, C) where we have equation for Model (A) $yt = u + dD(T_B)t + y_{t-1} + \epsilon t$ equation Model A for Proposed Strategy states the level change where pulse dummy for intercept change and call it crash model. We can see the vertical bar model (A) shows the average empirical size 8% at the sample of 100. So on the basis of nominal size 5%, the probability of size distortion is 3 %. For model (B) proposed strategy $yt = u_1 + y_{t-1} + (u_2 - u_1)DU_t + \epsilon t$ equation states that permits one time change in the slope, where we can see the model B shows the average empirical size 8% at the sample of 100, so on

the basis of nominal size 5%, the probability of size distortion is 3%. Both models A and B show the same size distortion and affected by size distortion. Model (C) proposed strategy equation $yt = u_1 + y_{t-1} + dD(T_B)t + (u_2 - u_1)DU_t + \epsilon t$ states that both permit the change in intercept and slope. Vertical bar model C shows the average empirical size distortion 7% at the sample of 100. So on the basis of nominal size 5%, the probability of size distortion is 2%. By visual inspection of the graph model (A) and (B) have more size distortion than model (C). by this graph we concluded that proposed strategy has no a hug size distortion. The data generating process are simulated 10,000 times and the results are summarized in table 4.1.

Table 4.1: Empirical size of Proposed Strategy for models A, B and C

Coefficient of size	Empirical size of Proposed strategy		
α=0.1,α=1	Model A	Model B	Model C
0.1	0.02	0.01	0.01
0.2	0.05	0.03	0.02
0.3	0.06	0.05	0.04
0.4	0.07	0.07	0.06
0.5	0.08	0.08	0.07
0.6	0.09	0.09	0.08
0.7	0.09	0.10	0.09
0.8	0.10	0.10	0.10
0.9	0.11	0.12	0.11
1	0.12	0.13	0.16

In this table we can see as the coefficient of size from 0.1 to 1 increasing the empirical size of proposed strategy model $A.B.C$ is also increasing but the results are spurious or size distortions as coefficient of size is increasing from 0.4 on word. In first row of second column of table (4.1), the results are indicating that when series are non-stationary, the autoregressive parameters $\rho = 1$ having drift (μ = 0) we get proposed strategy model A, 2% empirical size at 0.1 coefficient of size at sample size of 100. So this value is less than nominal size 5% there is no size distortion. At 0.1 coefficient of size Proposed Model B empirical size is 1% at sample size of 100. So this value is less than nominal size 5% there is no size distortion, in the same coefficient of size point proposed strategy model C empirical size is 1% both shows model A, B and C that no size distortion. In 0.2 coefficient of size proposed strategy model A empirical size is 5% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 0.0%, at the same coefficient of size the proposed strategy Model B empirical size 3% which is less than nominal size 5%. So there is no size distortion. At the same coefficient of size the proposed strategy Model C empirical size 2% which is less than nominal size 5%. The value of size is significant indicating that no size distortion. By visual inspection of the table, 4.1 Model A, B and C of Proposed strategy empirical size are increasing with coefficient of size but showing size distortion. At 0.3 coefficient of size the proposed model A empirical size is 6% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 1%, in the same coefficient of size the proposed model B and C empirical break size are 5% and 4%, and it shows that there are no size distortion. In 0.4 break size proposed strategy model A empirical size is 7% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 2%, at the coefficient of size proposed strategy model B and C empirical size are 7% and 6%, so on the basis of nominal size 5%, the probability of size distortion are 2% and 1%. At 0.5 coefficient of size proposed strategy model A empirical size is 8% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 3%, at the same break proposed strategy model B and C empirical size are 8% and 7%, so on the basis of nominal size 5%, the probability of size distortion are 3% and 2%. %. At

0.6 coefficient of size proposed strategy model A empirical size is 9% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 4%, at the same break proposed strategy model B and C empirical size are 9% and 8%, so on the basis of nominal size 5%, the probability of size distortion are 4% and 3%. At 0.7 coefficient of size proposed strategy model A empirical size is 9% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 4%, at the same break size proposed strategy model B and C empirical size are 10% and 9%, so on the basis of nominal size 5%, the probability of size distortion are 5% and 4%. At 0.8 coefficient of size proposed strategy model A empirical size is 10% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 5%, at the same break size proposed strategy model B and C empirical size are 10% and 10%, so on the basis of nominal size 5%, the probability of size distortion are 5% and 5%. At 0.9 coefficient of size proposed strategy model A empirical size is 11% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 6%, at the same coefficient of size proposed strategy model B and C empirical size are 12% and 11%, so on the basis of nominal size 5%, the probability of size distortion are 7% and 6%. At 1% coefficient of size proposed strategy model A empirical size is 12% at sample size of 100. So on the basis of 5% nominal size, the probability of size distortion is 7%, at the same coefficient of size proposed strategy model B and C empirical size are 13% and 16%, so on the basis of nominal size 5%, the probability of size distortion are 8% and 11%. We found the results from table 4.2 as the coefficients are increasing from 0.1 to 0.3 the results of proposed strategy three models are significant. when the coefficient from 0.4 to 1 the results are insignificant and empirical size exceed the nominal size 5% than the results are undergo in size distortion.

4.2 Analysis of Power of existing strategy and proposed strategy

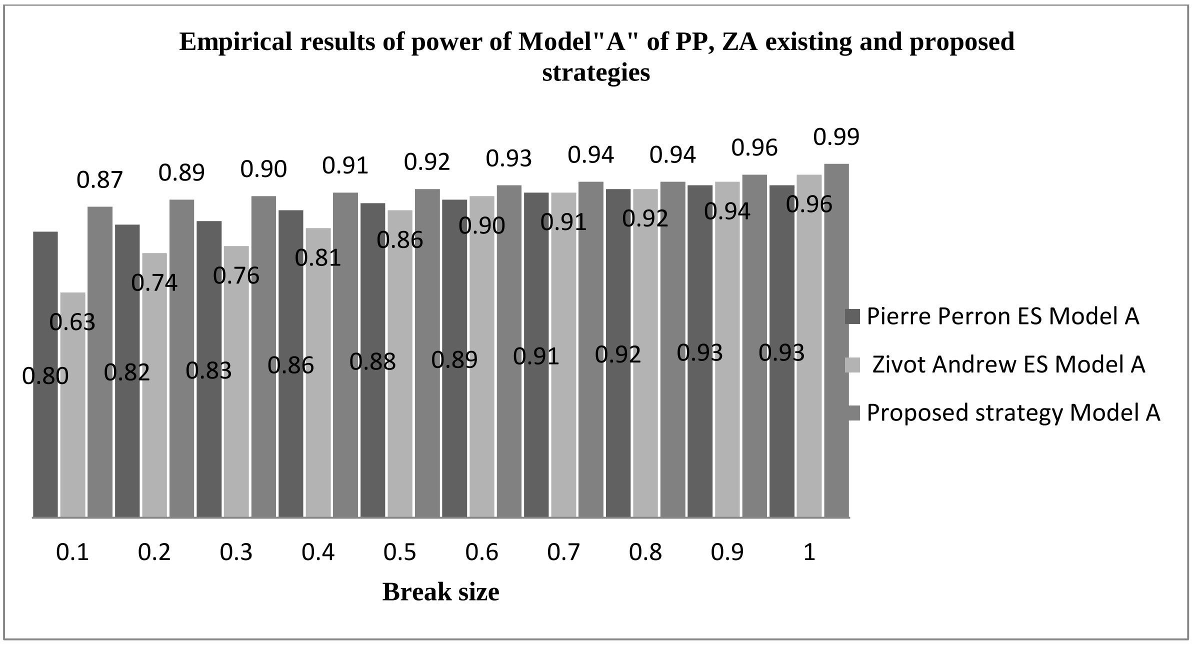
The main objective of this study is to evaluate the performance of existing methodology and proposed methodology and compare them on the basis size and power.

We constructed the three models $A.B.C$ for Pierre Peron and Zivot Andrew in chapter three. We estimate $yt = \mu + \beta t + \alpha y_{t-1} + \epsilon t$. We test the null hypothesis for H_0 (1): $\mu = 0$, H_0 (2): $\beta = 0$, and H_0 (3) $(\mu, \beta) = 0$ since all three hypothesis are not true. So they should be rejected. Power analysis is executed to evaluate the probability of rejection the null hypothesis, when the alternate hypothesis is true. As the statistical power of test increases, the probability of type II error is decreased. It can be expressed in following way:

Power = Prob (reject H_0 | when H_1 is true)

In this study, we use power analysis to compare the power of conventional or existing methodology Pierre Peron and Zivote with proposed methodology. The Monte Carlo simulations have been used in this analysis. All the results in the tables and graph given below have been summarized after 10000 times simulations.

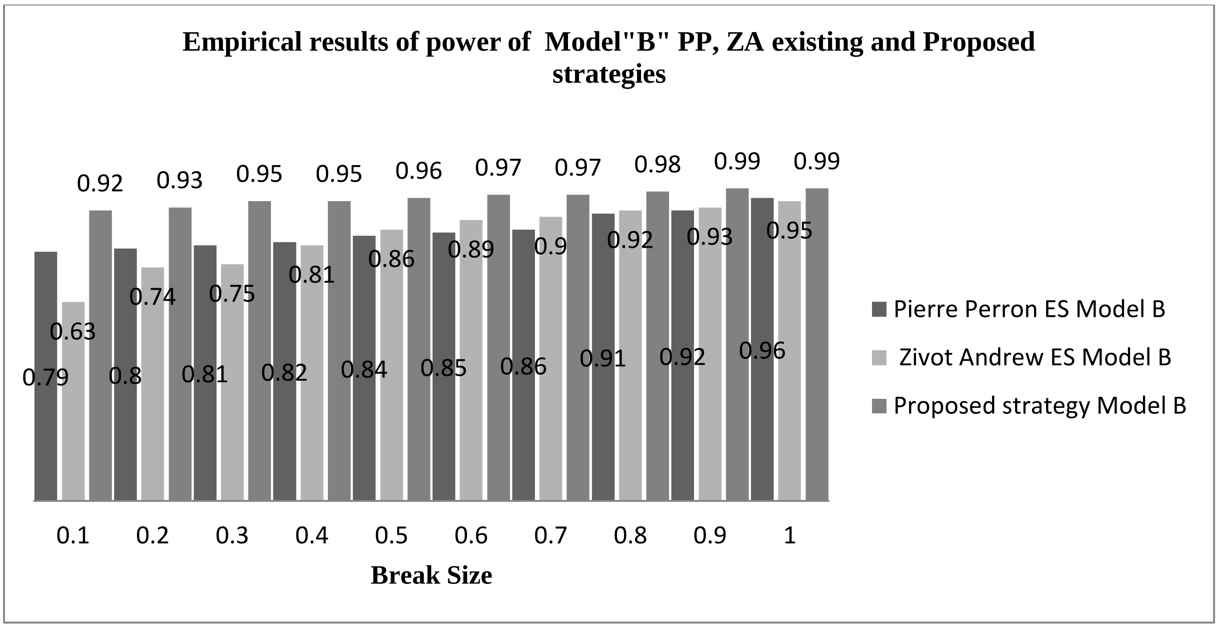
Figure 4.2: Analysis of Power of Zivot Andrew, Pierre Perron existing strategy and proposed strategy for Model A



In this figure 4.2 the results are summarized that when series are stationary $\rho < 1$ having drift the power of Model A Pierre Perron full dark color bar show the existing strategy and light color bar show the existing strategy Zivot Andrew as well as light dark color bar show the Proposed strategy. At $\alpha = 0.1$ break size the power of Pierre Perron model A existing strategy is 80%, which shows 15% power loss on the basis of 5% nominal size means critical value (-3.544) we calculated, and at $\alpha = 0.1$ break size the power of Zivot Andrew model A existing strategy 63% which shows 32% power loss on the basis of 5% nominal size at the same break size the power of model A proposed strategy is 87% which shows 8% power loss on the basis of 5% nominal size . At $\alpha = 0.2$ break size the power of Pierre Perron model A existing strategy is 82%, which shows 13% power loss on the basis of 5% nominal size, at $\alpha = 0.2$ break size the power of Zivot Andrew model A existing strategy 74% which shows 21 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 89% which shows 6% power loss on the basis of 5% nominal size. At $\alpha = 0.3$ break size the power of Pierre Perron model A existing strategy is 83%, which shows 12% power loss on the basis of 5% nominal size, at $\alpha = 0.3$ break size the power of ZA model A Existing strategy 76% which shows 19 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 90% which shows 5% power loss on the basis of 5% nominal size. As the break size increases the power of proposed strategy is increases as compare to existing strategy and works better than existing strategy. In existing strategy where we can see Zivot Andrew is not perform well as compare to Pierre Perron Existing strategy. At $\alpha = 0.4$ break size the power of Pierre perron model A existing strategy is 86%, which shows 9% power loss on the basis of 5% nominal size, at $\alpha = 0.4$ break size the power of ZA model A Existing strategy 81% which shows 14 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 91% which shows 5% power loss on the basis of 5% nominal size. At $\alpha = 0.5$ break size the power of Pierre perron model A existing strategy is 88%, which shows 7% power loss on the basis of 5% nominal size, at $\alpha = 0.5$ break size the power of ZA model A Existing strategy 86% which shows 9% power loss on the basis of 5%

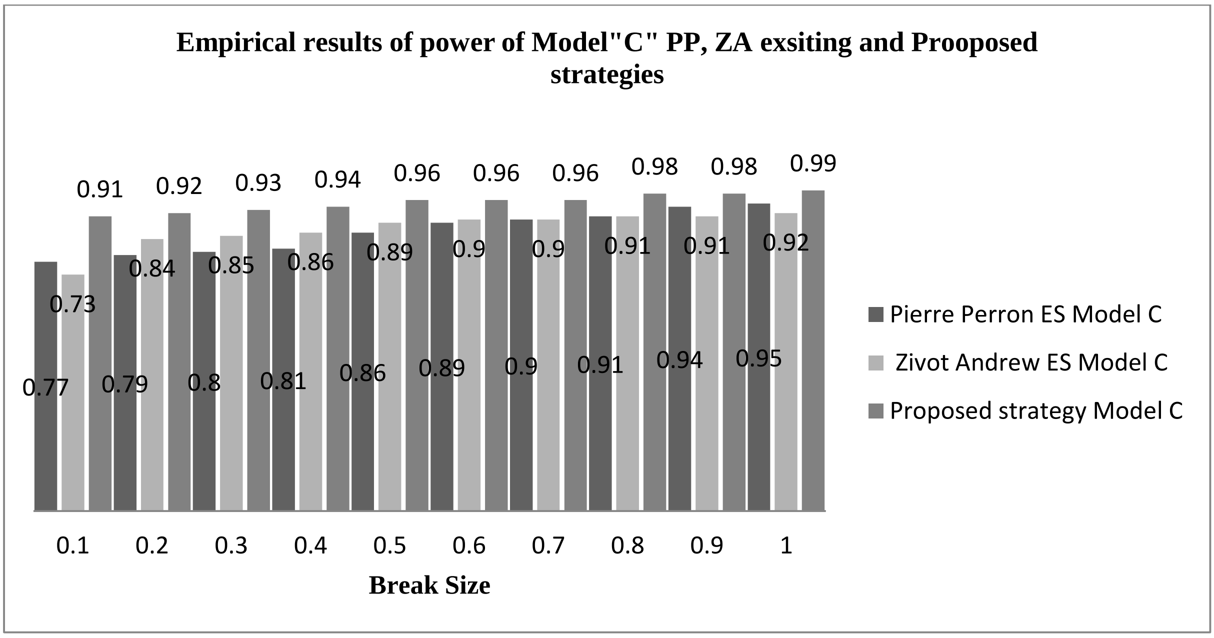
nominal size. At the same break size the power of proposed strategy is 92% which shows 3% power loss on the basis of 5% nominal size. At α = 0.6 break size the power of Pierre perron model A existing strategy is 89%, which shows 6% power loss on the basis of 5% nominal size, at α = 0.6 break size the power of ZA model A Existing strategy 90% which shows 5% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 93% which shows 2% power loss on the basis of 5% nominal size. At α = 0.7 break size the power of Pierre Perron model A existing strategy is 91%, which shows 4% power loss on the basis of 5% nominal size, at α = 0.7 break size the power of ZA model A Existing strategy 91% which shows 4% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 94% which shows 1% power loss on the basis of 5% nominal size. At α = 0.8 break size the power of Pierre Perron model A existing strategy is 92%, which shows 3% power loss on the basis of 5% nominal size, at α = 0.8 break size the power of ZA model A Existing strategy 92% which shows 3% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 94% which shows 1% power loss on the basis of 5% nominal size. At α = 0.9 break size the power of Pierre perron model A existing strategy is 93%, which shows 2% power loss on the basis of 5% nominal size, at α = 0.9 break size the power of ZA model A Existing strategy 94% which shows 1% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 96% which shows 0.0% power loss on the basis of 5% nominal size. At α = 1 break size the power of Pierre perron model A existing strategy is 93%, which shows 2% power loss on the basis of 5% nominal size, at α = 1 break size the power of ZA model A Existing strategy 96% which shows 0.0% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 99% which shows 0.0% power loss on the basis of 5% nominal size. We can see that break size increases the Proposed strategy power are increasing and close to one and better performed than existing strategy . by visual inspection of the graph proposed strategy over all better than existing strategy.

Figure 4.3: Analysis of Power of Zivot Andrew, Pierre Perron existing strategy and Proposed strategy for Model B



In figure 4.3 the results are summarized that when series are stationary $\rho < 1$ having trend the power of model B Pierre Perron full dark color bar show the existing strategy and light color bar show the existing strategy Zivot Andrew as well as light dark color bar show the Proposed strategy. At $\alpha = 0.1$ break size the power of Pierre Perron model B existing strategy is 79%, which shows 16% power loss on the basis of 5% nominal size means critical value (-3.453) we calculated, and at $\alpha = 0.1$ break size the power of Zivot Andrew model B existing strategy 66% which shows 29% power loss on the basis of 5% nominal size at the same break size the power of model B proposed strategy is 92% which shows 3% power loss on the basis of 5% nominal size . At $\alpha = 0.2$ break size the power of Pierre Perron model B existing strategy is 80%, which shows 15% power loss on the basis of 5% nominal size, at $\alpha = 0.2$ break size the power of ZA model B existing strategy 70% which shows 25 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 93% which shows 2% power loss on the basis of 5% nominal size. At $\alpha = 0.3$ break size the power of Pierre perron model B existing strategy is 81%, which shows 14% power loss on the basis of 5% nominal size, at $\alpha = 0.3$ break size the power of ZA model B existing strategy 73% which shows 22 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 95% which shows 0.0% power loss on the basis of 5% nominal size. As the break size increases the power of proposed strategy is increases as compare to existing strategy and works better than existing strategy. In existing strategy where we can see Zivot Andrew is not perform well as compare to Pierre Perron Existing strategy. At $\alpha = 0.4$ break size the power of Pierre perron model B existing strategy is 82%, which shows 12% power loss on the basis of 5% nominal size, at $\alpha = 0.4$ break size the power of ZA model B existing strategy 79% which shows 16 % power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 95% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.5$ break size the power of Pierre perron model B existing strategy is 84%, which shows 11% power loss on the basis of 5% nominal size, at $\alpha = 0.5$ break size the power of ZA model B Existing strategy 80% which shows 15% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 96% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.6$ break size the power of Pierre perron model B existing strategy is 85%, which shows 10% power loss on the basis of 5% nominal size, at $\alpha = 0.6$ break size the power of ZA model B existing strategy 85% which shows 10% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 97% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.7$ break size the power of Pierre perron model B existing strategy is 86%, which shows 9% power loss on the basis of 5% nominal size, at $\alpha = 0.7$ break size the power of ZA model B existing strategy 89% which shows 6% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 97% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.8$ break size the power of Pierre perron model B existing strategy is 91%, which shows 5% power loss on the basis of 5% nominal size, at $\alpha = 0.8$ break size the power of ZA model B existing strategy 90% which shows 5% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 98% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.9$ break size the power of Pierre perron model B existing strategy is 92%, which shows 3% power loss on the basis of 5% nominal size, at α = 0.9 break size the power of ZA model B existing strategy 91% which shows 4% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 99% which shows 0.0% power loss on the basis of 5% nominal size. At α = 1 break size the power of Pierre perron model B existing strategy is 96%, which shows 0.0% power loss on the basis of 5% nominal size, at α = 1 break size the power of ZA model B existing strategy 95% which shows 0.0% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 99% which shows 0.0% power loss on the basis of 5% nominal size. We can see that break size increases the Proposed strategy power are increasing and close to one and better performed than existing strategy. Initially the power of ZA model B is low and gradually increasing with the increasing of coefficient of break size, by visual inspection of the graph proposed strategy overall works better than existing strategy. We have observed that the power of proposed strategy is above the 90% and close to 1, so this strategy is perform better than existing strategy.

Figure 4.4: Analysis of Power of Zivot Andrew, Pierre Perron existing strategy and Proposed strategy for Model C



In figure 4.4 the results are summarized that when series are stationary $\rho < 1$ having trend the power of model C Pierre Perron full dark color bar show the existing strategy and light color bar show the existing strategy Zivot Andrew as well as light dark color bar show the Proposed strategy. At $\alpha = 0.1$ break size the power of Pierre Perron model C existing strategy is 77%, which shows 18% power loss on the basis of 5% nominal size means critical value (-3.443) we calculated, and at $\alpha = 0.1$ break size the power of Zivot Andrew model C existing strategy 73% which shows 22% power loss on the basis of 5% nominal size, at the same break size the power of model C proposed strategy is 91% which shows 4% power loss on the basis of 5% nominal size . At $\alpha = 0.2$ break size the power of Pierre perron model C existing strategy is 79%, which shows 16% power loss on the basis of 5% nominal size, at $\alpha = 0.2$ break size the power of ZA model C existing strategy 84% which shows 11 % power loss on the basis of 5% nominal size, At the same break size the power of proposed strategy model C is 92% which shows 3% power loss on the basis of 5% nominal size. At $\alpha = 0.3$ break size the power of Pierre Perron model C existing strategy is 80%, which shows 15% power loss on the basis of 5% nominal size, at $\alpha = 0.3$ break size the power of ZA model C existing strategy 85% which shows 10 % power loss on the basis of 5% nominal size, At the same break size the power of proposed strategy model C is 93% which shows 2% power loss on the basis of 5% nominal size. As the break size increases the power of proposed strategy is increases as compare to existing strategy and works better than existing strategy. In existing strategy where we can see Zivot Andrew is not perform well as compare to Pierre Perron Existing strategy. At $\alpha = 0.4$ break size the power of Pierre perron model C existing strategy is 81%, which shows 14% power loss on the basis of 5% nominal size, at $\alpha = 0.4$ break size the power of ZA model C existing strategy 86% which shows 9% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 94% which shows 1% power loss on the basis of 5% nominal size. At $\alpha = 0.5$ break size the power of Pierre perron model C existing strategy is 86%, which shows 9% power loss on the basis of 5% nominal size, at $\alpha = 0.5$ break size the power of ZA model C Existing strategy 89% which shows 6% power loss on the basis of 5%

nominal size. At the same break size the power of proposed strategy is 96% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.6$ break size the power of Pierre perron model C existing strategy is 89%, which shows 6% power loss on the basis of 5% nominal size, at $\alpha = 0.6$ break size the power of ZA model C existing strategy 90% which shows 5% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 96% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.7$ break size the power of Pierre perron model C existing strategy is 90%, which shows 5% power loss on the basis of 5% nominal size, at $\alpha = 0.7$ break size the power of ZA model C existing strategy 90% which shows 5% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 96% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.8$ break size the power of Pierre perron model C existing strategy is 91%, which shows 4% power loss on the basis of 5% nominal size, at $\alpha = 0.8$ break size the power of ZA model C existing strategy 91% which shows 4% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 98% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 0.9$ break size the power of Pierre perron model C existing strategy is 94%, which shows 1% power loss on the basis of 5% nominal size, at $\alpha = 0.9$ break size the power of ZA model C existing strategy 91% which shows 4% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 98% which shows 0.0% power loss on the basis of 5% nominal size. At $\alpha = 1$ break size the power of Pierre Perron model C existing strategy is 95%, which shows 0.0% power loss on the basis of 5% nominal size, at $\alpha = 1$ break size the power of ZA model C existing strategy 92% which shows 3% power loss on the basis of 5% nominal size. At the same break size the power of proposed strategy is 99% which shows 0.0% power loss on the basis of 5% nominal size. We can see that break size increases the Proposed strategy power are increasing and close to one and better performed than existing strategy. Initially the power of ZA model B is low and gradually increasing with the increasing of coefficient of break size, By visual inspection of the graph proposed strategy overall works better than existing strategy. We have observed that the power of proposed strategy is above the 90% and close to 1, so this strategy is perform better than existing strategy.

Table 4.2: Comparing the empirical results of model A Pierre Perron existing strategy and Proposed Strategy

Break Size	**Power of Pierre Perron existing strategy and proposed strategy for model A**	
α=0.1,α=1	Pierre Perron existing strategy Model A	Proposed strategy Model A
0.1	0.80	0.87
0.2	0.82	0.89
0.3	0.83	0.90
0.4	0.86	0.91
0.5	0.88	0.92
0.6	0.89	0.93
0.7	0.91	0.94
0.8	0.92	0.94
0.9	0.93	0.96
1	0.93	0.99

In the above table 4.2, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model "A" $yt = u_1 + \beta t + (u_2 - u_1)DU_t + \epsilon t$, in first row of second and third column Model A of Pierre Perron existing and proposed strategy results indicating that as Break size increasing from 0.1 to 1the power of the tests are increasing. At 0.1 break size of Perron model A existing strategy the power of test is 80% which shows 15% power loss on the basis 5% nominal size. Where at 0.1 break size of proposed strategy the power of test is 87% which shows 8% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 7%.The power of proposed strategy is 7% huge than existing perron strategy at 0.1 break size. At 0.2 break size of Perron model A existing strategy the power of test is 82% which shows 13% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy the power of test is 89% which shows 6% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 7%.The power of proposed strategy is 7% huge than existing Perron strategy at 0.2 break size. At 0.3 break size of Perron model A existing strategy the power of test is 83% which shows 11% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy the power of test is 90% which shows 5% power loss on the basis of 5% nominal size. At 0.4 break size of Perron model A existing strategy the power of test is 86% which shows 9% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy the power of test is 91% which shows 4% power loss on the basis of 5% nominal size. At 0.5 break size of Perron model A existing strategy the power of test is 88% which shows2% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy the power of test is 92% which shows 3% power loss on the basis of 5% nominal size. So these results shows that Perron model A existing strategy has high loss of power as compare to proposed strategy model A. From 0.6 to 1 proposed strategy model "A" results shows that the power of test are close to 1, there is no loss of power and works better than Perron existing strategy . The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, the power of the test is more efficient than existing methods.

Table 4.3: Comparing the empirical results of model A Zivot Andrew existing strategy and Proposed Strategy

Break Size	Power of Zivot Andrew existing strategy and proposed strategy for model A	
α=0.1,α=1	Zivot Andrew existing strategy Model A	Proposed strategy Model A
0.1	0.63	0.87
0.2	0.74	0.89
0.3	0.76	0.90
0.4	0.81	0.91
0.5	0.86	0.92
0.6	0.90	0.93
0.7	0.91	0.94
0.8	0.92	0.94
0.9	0.94	0.96
1	0.96	0.99

In the above table 4.3, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model "A" $\Delta yt = \mu + \beta t + \theta DU1_t + \alpha y_{t-1} + \sum_{i=0}^{n} ci\Delta y_{t-1} + \epsilon t$, in first row of second and third column Model A of Zivot Andrew existing and proposed strategy results indicating that as the Break size increasing from 0.1 to 1the power of the tests are increasing. But initially Zivot Andrew model A has low power as coefficient of break size increasing the power of the test is also increasing, the reason is that its assume the exogenous break but proposed strategy perform better from 0.1 to 1 as compare to existing strategy At 0.1 break size of Zivot andrew model A existing strategy the power of test is 63% which shows 32% power loss on the basis 5% nominal size. Where at 0.1

break size of proposed strategy model A the power of test is 87% which shows 8% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 24%.The power of proposed strategy is 24% huge than existing perron strategy at 0.1 break size. At 0.2 break size of ZA model A existing strategy the power of test is 74% which shows 21% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy model A the power of test is 89% which shows 6% power loss on the basis of 5% nominal size. . The differences of power between existing and proposed strategies are 15%.The power of proposed strategy is 15% huge than existing strategy ZA model A at 0.2 break size. At 0.3 break size of ZA model A existing strategy the power of test is 76% which shows 19% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy model A the power of test is 90% which shows 5% power loss on the basis of 5% nominal size. At 0.4 break size of ZA model A existing strategy the power of test is 81% which shows 14% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy model A the power of test is 91% which shows 4% power loss on the basis of 5% nominal size. At 0.5 break size of ZA model A existing strategy the power of test is 86% which shows9% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy model A the power of test is 92% which shows 3% power loss on the basis of 5% nominal size. So these results are showing that ZA model A existing strategy has high loss of power as compare to proposed strategy model A. From 0.6 to 1 proposed strategy model "A" results shows that the power of test are close to 1, there is loss of power and works better than ZA existing strategy model A. The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, this strategy increases the power and more efficient than existing methods.

Table 4.4: Comparing the empirical results of Model B Pierre Perron existing strategy and Proposed Strategy

Break Size	Power of Pierre Perron existing strategy and proposed strategy for model B	
α=0.1,α=1	Pierre Perron existing strategy Model B	Proposed strategy Model B
0.1	0.77	0.92
0.2	0.79	0.93
0.3	0.80	0.95
0.4	0.81	0.95
0.5	0.86	0.96
0.6	0.89	0.97
0.7	0.90	0.97
0.8	0.91	0.98
0.9	0.94	0.99
1	0.95	0.99

In the above table 4.4, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model “B” $yt = u_1 + \beta t + (\beta 2 - \beta 1)DT + \epsilon t$ in first row of second and third column Model B of Pierre Perron existing and proposed strategies results are indicating that as Break size increasing from 0.1 to 1the power of the tests are increasing. But initially Pierre Perron model B has low power as coefficient of break size increasing the power of the test is also increasing, the reason is that its assume the exogenous break but proposed strategy perform better from 0.1 to 1 as compare to existing strategy. At 0.1 break size of Perron model B existing strategy the power of test is 77% which shows 18% power loss on the basis 5% nominal size. Where at 0.1 break size of proposed strategy the power of test is 92% which shows 3% power loss on the basis of 5% nominal size.

The differences of power between existing and proposed strategies are 15%.The power of proposed strategy is 15% huge than existing perron strategy model B at 0.1 break size. At 0.2 break size of Perron model B existing strategy the power of test is 80% which shows 15% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy model B the power of test is 93% which shows 2% power loss on the basis of 5% nominal size. . The differences of power between existing and proposed strategies are 13%.The power of proposed strategy is 13% huge than existing strategy perron model B at 0.2 break size. At 0.3 break size of Perron model B existing strategy the power of test is 81% which shows 14% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy the power of test is 95% which shows 0.0% power loss on the basis of 5% nominal size. At 0.4 break size of Perron model B existing strategy the power of test is 82% which shows 13% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy model B the power of test is 95% which shows 0.0% power loss on the basis of 5% nominal size. At 0.5 break size of Perron model B existing strategy the power of test is 84% which shows11% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy the power of test is 96% which shows 0.0% power loss on the basis of 5% nominal size. So these results shows that Perron model B existing strategy has high loss of power as compare to proposed strategy model B. From 0.6 to 1 proposed strategy model "B" results shows that the power of test are close to 1, there is no loss of power and works better than Perron model B existing strategy . The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, this strategy increases the power and more efficient than existing methods.

Table 4.5: Comparing the empirical results of model B Zivot Andrew existing strategy and Proposed Strategy

Break Size	Power of Zivot Andrew existing strategy and proposed strategy for model B	
α=0.1,α=1	Zivot Andrew existing strategy Model B	Proposed strategy Model B
0.1	0.66	0.92
0.2	0.70	0.93
0.3	0.73	0.95
0.4	0.79	0.95
0.5	0.80	0.96
0.6	0.85	0.97
0.7	0.89	0.97
0.8	0.90	0.98
0.9	0.91	0.99
1	0.95	0.99

In the above table 4.5, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model "B" $\Delta yt = \mu + \beta t + \theta DT1_t + \alpha y_{t-1} + \sum_{i=0}^{n} ci\Delta y_{t-1} + \epsilon t$ in first row of second and third column model B of Zivot Andrew existing and proposed strategy results indicating that as the Break size increasing from 0.1 to 1the power of the tests are increasing. . But initially Zivot Andrew model B has low power as coefficient of break size increasing the power of the test is also increasing, the reason is that its assume the exogenous break but proposed strategy perform better from 0.1 to 1 as compare to existing strategy At 0.1 break size of Zivot andrew model B existing strategy the power of test is 66% which shows 29% power loss on the basis 5% nominal size. Where at 0.1

break size of proposed strategy model B the power of test is 92% which shows 3% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 26%.The power of proposed strategy is 26% huge than existing perron strategy at 0.1 break size. At 0.2 break size of ZA model B existing strategy the power of test is 70% which shows 25% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy model B the power of test is 93% which shows 2% power loss on the basis of 5% nominal size. . The differences of power between existing and proposed strategies are 23%.The power of proposed strategy is 23% huge than existing strategy ZA model B at 0.2 break size. At 0.3 break size of ZA model B existing strategy the power of test is 73% which shows 22% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy model B the power of test is 95% which shows 10% power loss on the basis of 5% nominal size. At 0.4 break size of ZA model B existing strategy the power of test is 79% which shows 16% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy model B the power of test is 95% which shows 1% power loss on the basis of 5% nominal size. At 0.5 break size of ZA model B existing strategy the power of test is 80% which shows 15% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy model B the power of test is 96% which shows 0.0% power loss on the basis of 5% nominal size. So these results are showing that ZA model B existing strategy has high loss of power as compare to proposed strategy model A. From 0.6 to 1 proposed strategy model "B" results shows that the power of test are close to 1, there is no loss of power and works better than ZA existing strategy model A. The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, this strategy increase the power and more efficient than existing methods.

Table 4.6: Comparing the empirical results of Model C Pierre Perron existing strategy and Proposed Strategy

Break Size	Power of Pierre Perron existing strategy and proposed strategy for model C	
α=0.1,α=1	Pierre Perron existing strategy Model C	Proposed strategy Model C
0.1	0.77	0.91
0.2	0.79	0.92
0.3	0.80	0.93
0.4	0.81	0.94
0.5	0.86	0.96
0.6	0.89	0.96
0.7	0.90	0.96
0.8	0.91	0.98
0.9	0.94	0.98
1	0.95	0.99

In the above table 4.6, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model "C" $yt = u_1 + \beta t + (\beta 2 - \beta 1)DT + (u_2 - u_1)DU_t + \epsilon t.$ in first row of second and third column Model C of Pierre Perron existing and proposed strategies results are indicating that as Break size increasing from 0.1 to 1the power of the tests are increasing. But initially Pierre Perron model C has low power as coefficient of break size increasing the power of the test is also increasing, the reason is that its assume the exogenous break but proposed strategy perform better from 0.1 to 1 as compare to existing strategy. At 0.1 break size of Perron model C existing strategy the power of test is 77% which shows 18% power loss on the basis 5% nominal size. Where at 0.1 break size of proposed strategy the power of test is 91% which shows 4% power loss on the basis of

5% nominal size. The differences of power between existing and proposed strategies are 14%.The power of proposed strategy is 14% huge than existing perron strategy model C at 0.1 break size. At 0.2 break size of Perron model C existing strategy the power of test is 79% which shows 16% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy model C the power of test is 92% which shows 3% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 13%.The power of proposed strategy is 13% huge than existing strategy perron model C at 0.2 break size. At 0.3 break size of Perron model C existing strategy the power of test is 80% which shows 15% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy the power of test is 93% which shows 2% power loss on the basis of 5% nominal size. At 0.4 break size of Perron model C existing strategy the power of test is 81% which shows 14% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy model C the power of test is 94% which shows 1% power loss on the basis of 5% nominal size. At 0.5 break size of Perron model C existing strategy the power of test is 86% which shows 9% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy the power of test is 96% which shows 0.0% power loss on the basis of 5% nominal size. So these results shows that Perron model C existing strategy has high loss of power as compare to proposed strategy model C. From 0.6 to 1 proposed strategy model "C" results shows that the power of test are close to 1, there is no loss of power and works better than Perron model C existing strategy . The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, this strategy increases the power and more efficient than existing methods.

Table 4.7: Comparing the empirical results of model C Zivot Andrew existing strategy and Proposed Strategy

Break Size	Power of Zivot Andrew existing strategy and proposed strategy for model C	
α=0.1,α=1	Zivot Andrew existing strategy Model C	Proposed strategy Model C
0.1	0.73	0.91
0.2	0.84	0.92
0.3	0.85	0.93
0.4	0.86	0.94
0.5	0.89	0.96
0.6	0.90	0.96
0.7	0.90	0.96
0.8	0.91	0.98
0.9	0.91	0.98
1	0.92	0.99

In the above table 4.7, the results are summarized where we compare the two strategies existing strategy Pierre Perron and proposed strategy of model "C" $\Delta yt = \mu + \beta t + \theta DT1_t + \gamma DT1_t \alpha y_{t-1} + \sum_{i=0}^{n} ci\Delta y_{t-1} + \epsilon t.$ in first row of second and third column model C of Zivot Andrew existing and proposed strategy results indicating that as the Break size increasing from 0.1 to 1the power of the tests are increasing. But initially Zivot Andrew model C has low power as coefficient of break size increasing the power of the test is also increasing, the reason is that its assume the exogenous break but proposed strategy perform better from 0.1 to 1 as compare to existing strategy. At 0.1 break size of Zivot Andrew model C existing strategy the power of test is 73% which shows 22% power loss on the basis 5% nominal size.

Where at 0.1 break size of proposed strategy model C the power of test is 91% which shows 4% power loss on the basis of 5% nominal size. The differences of power between existing and proposed strategies are 18%.The power of proposed strategy is 18% huge than existing strategy ZA model C at 0.1 break size. At 0.2 break size of ZA model C existing strategy the power of test is 84% which shows 11% power loss on the basis 5% nominal size. Where at 0.2 break size of proposed strategy model C the power of test is 92% which shows 3% power loss on the basis of 5% nominal size. . The differences of power between existing and proposed strategies are 8%.The power of proposed strategy is 8% huge than existing strategy ZA model C at 0.2 break size. At 0.3 break size of ZA model C existing strategy the power of test is 85% which shows 10% power loss on the basis 5% nominal size. Where at 0.3 break size of proposed strategy model C the power of test is 93% which shows 2% power loss on the basis of 5% nominal size. At 0.4 break size of ZA model C existing strategy the power of test is 86% which shows 9% power loss on the basis 5% nominal size. Where at 0.4 break size of proposed strategy model C the power of test is 94% which shows 1% power loss on the basis of 5% nominal size. At 0.5 break size of ZA model C existing strategy the power of test is 89% which shows 6% power loss on the basis 5% nominal size. Where at 0.5 break size of proposed strategy model C the power of test is 96% which shows 0.0% power loss on the basis of 5% nominal size. So these results are showing that ZA model C existing strategy has high loss of power as compare to proposed strategy model C. From 0.6 to 1 proposed strategy model "C" results shows that the power of test are close to 1, there is no loss of power and works better than ZA existing strategy model C. The main reason is that existing strategy assume the break than they loss the efficiency of power and when we test the structural break than apply the unit root accordingly, proposed strategy increase the power and more efficient than existing strategy.

Finally we concluded that the power of proposed strategy is better perform than existing strategy of Pierre Perron and Zivot Andrew.

CHAPTER 5

SUMMERYXCONCLUSION AND RECOMMENDATION

5.1 Summery

One of the common tools of time series econometrics is the unit root test with structural breaks. Breaks are necessary because Unit Root's presence decision can be modified. The number of unit root test have been proposed and studied. Conventional or existing procedures assume the break and apply a test accordingly. This leads to identification of spurious breaks, and therefore biased results, Lee and Strazicich, (2001). We propose an alternative strategy where we propose to test for structural breaks before applying unit root test. The debates of Structural breaks in unit root testing starts with Perron (1989). Nelson and Plossor (1982) found unit roots in 1 out of 14 macroeconomic time series of US Economy and Perron (1989) taking the Nelson and Plossor’s data set, reversed the findings for 11 out of 14 series. The later development in unit roots with structural breaks developed procedures for endogenizing structural breaks (Zivot and Andrew, 1992; Christiano 1992 etc). The original perron’s procedures and later development in unit roots testing with structural breaks, assume that there is a structural break. the studies endogenizing structural breaks also assume the break and determine the break date endogenously. but the results of the size and power are unreliable and unable to tackle the problem of unit root structural break. We purpose that the structural breaks should be tested for existence. The purpose of this study is to compare the size and power of existing strategy with proposed strategy using Mont Carlo experiments. The results of proposed strategy is indicating that the power of test is significant and better perform than existing strategy Pierre Perron (1989) and Zivot Andrew (1992). We briefly summarized the results in conclusion.

5.2 Conclusion and Recommendation

We concluded following results from this research that the unit root and commonly used the existing strategy ordinarily provide misleading results. This procedure provides unreliable results due to assuming the break exogenously and endogenously decisions in data generating process. Under the proposed strategy they provide optimal size and power but in case of size they undergo in size distortion. The reason behind it might be in case of data generating process.so the selection of the two strategies such as existing and proposed on the basis of size and power. We can see size of proposed strategy in figure 4.1 size of proposed strategy of three models results are indicating that initially empirical size is less than nominal size 5% that means there is no size distortion, as the coefficient of size increasing from 0.3 to 1 the results of three models indicating that there is size distortion. In the figures 4.3, 4.4 and 4.5 the power of two strategies results are indicating that proposed strategy better perform than existing strategy in case of three models with drift, with trend and with drift and trend both. We compare Pierre Perron and Zivot Andrew separately with Proposed strategy. In tables 4.6, 4.8 and 4.1.1 the results are indicating that power of Pierre Perron model A, B and C are not significantly perform as compare to proposed strategy. Proposed strategy provides significant and better results in case of model A, B and C. In the case of Zivot Andrew model A, B and C see tables 4.7, 4,9 and 4.1.2 the results shows that the power of test is highly suffers as compare to proposed strategy, the power of proposed strategy is highly significant and better perform in the case of model A, B and C.

The commonly used existing strategy Pierre Perron and Zivot Andrew having sever power problem in case of drift trend and with drift trend both the results are spurious. But proposed strategy power perform well in case of drift trend and with drift trend both as compare to existing strategy but in case of size, proposed strategy suffers in size of all three models drift trend and with drift trend both.

The proposed strategy provides better results as compare to existing strategy in case of random data .this experiment refers to use as alternative to tackle the problem of size and power.

The work of this study can be extended in future by overcoming the limitation of this study. First, research can use more than two tests in data generating process for the comparison of different econometric tools. Someone can check the size and power of these methods by including any other structural break tests in experiment.

REFFERENCE

Atiq-ur-Rehman, A. U. R., & Zaman, A. (2009). Impact of model specification decisions on unit root tests.

Baldwin, D. F., Suh, N. P., Park, C. B., & Cha, S. W. (1994). U.S. Patent No. 5,334,356. Washington, DC: U.S. Patent and Trademark Office.

Banerjee, A., Galbraith, J. W., & Dolado, J. (1990). Dynamic specification and linear transformations of the autoregressive-distributed lag model. Oxford Bulletin of Economics and Statistics, 52(1), 95-104.

Banerjee, A., Lumsdaine, R. L., & Stock, J. H. (1992). Recursive and sequential tests of the unit-root and trend-break hypotheses: theory and international evidence. Journal of Business & Economic Statistics, 10(3), 271-287.

Banerjee, A., Lumsdaine, R. L., & Stock, J. H. (1992). Recursive and sequential tests of the unit-root and trend-break hypotheses: theory and international evidence. Journal of Business & Economic Statistics, 10(3), 271-287.

Christiano, L. J., & Eichenbaum, M. (1992). Current real-business-cycle theories and aggregate labor-market fluctuations. The American Economic Review, 430-450.

Cooray, A., & Wickremasinghe, G. (2007). The efficiency of emerging stock markets: Empirical evidence from the South Asian region. The Journal of Developing Areas, 171-183.

Diebold, F. X., & Senhadji, A. S. (1996). The uncertain unit root in real GNP: Comment. *The American Economic Review*, *86*(5), 1291-1298.

Glynn, J., Perera, N., & Verma, R. (2007). Unit root tests and structural breaks: A survey with applications.

Hansen, B. E. (2001). The new econometrics of structural change: dating breaks in US labour productivity. Journal of Economic perspectives, 15(4), 117-128.

Harvey, D. I., Leybourne, S. J., & Taylor, A. R. (2013). Testing for unit roots in the possible presence of multiple trend breaks using minimum Dickey–Fuller statistics. Journal of Econometrics, 177(2), 265-284.

Kilian, L., & Ohanian, L. E. (1998). Is There a Trend Break in US GNP?: A Macroeconomic Perspective. Federal Reserve Bank of Minneapolis, Research Department.

Kim, C. J. (1994). Dynamic linear models with Markov-switching. Journal of Econometrics, 60(1-2), 1-22.

Kim, C. J., & Nelson, C. R. (1999). Has the US economy become more stable? A Bayesian approach based on a Markov-switching model of the business cycle. Review of Economics and Statistics, 81(4), 608-616.

Lee, J., & Strazicich, M. C. (2001). Break point estimation and spurious rejections with endogenous unit root tests. Oxford Bulletin of Economics and statistics, 63(5), 535-558.

Lee, J., & Strazicich, M. C. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. Review of economics and statistics, 85(4), 1082-1089.

Lee, J., & Strazicich, M. C. (2004). Minimum LM unit root test with one structural break. Manuscript, Department of Economics, Appalachian State University, 1-16.

Lidman, O., Olsson, T., & Piehl, F. (1999). Expression of nonclassical MHC class I (RT1-U) in certain neuronal populations of the central nervous system. European Journal of Neuroscience, 11(12), 4468-4472.

Lumsdaine, R. L., & Papell, D. H. (1997). Multiple trend breaks and the unit-root hypothesis. Review of economics and Statistics, 79(2), 212-218.

Mora, E., Artavia, L. D., & Macosko, C. W. (1991). Modulus development during reactive urethane foaming. Journal of rheology, 35(5), 921-940.

Murray, C. J., & Nelson, C. R. (2004). The great depression and output persistence: A reply to Papell and Prodan. *Journal of Money, Credit, and Banking*, *36*(3), 429-432.

Narayan, P. K., & Popp, S. (2010). A new unit root test with two structural breaks in level and slope at unknown time. Journal of Applied Statistics, 37(9), 1425-1438.

Narayan, P. K., Narayan, S., & Popp, S. (2011). Investigating price clustering in the oil futures market. Applied energy, 88(1), 397-402.

Newbold, P., & Granger, C. W. (1974). Experience with forecasting univariate time series and the combination of forecasts. Journal of the Royal Statistical Society: Series A (General), 137(2), 131-146.

Newbold, P., & Granger, C. W. J. (1974). Spurious regressions in econometrics. Journal of Econometrics, 2(2), 111-120.

Ng, S., & Perron, P. (2001). Lag length selection and the construction of unit root tests with good size and power. Econometrica, 69(6), 1519-1554.

Nordström, M. (2017). From incremental to radical innovation and corporate entrepreneurship

Nordström, M. (2017). Size and power of two recent unit root tests that allow for structural breaks.

Pantelis, A., & Zehtabchi, M. (2008). Testing for unit roots in the presence of structural change IRAN–GREECE CPI case.

Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. Econometrica: Journal of the Econometric Society, 1361-1401.

Perron, P., & Ng, S. (1996). Useful modifications to some unit root tests with dependent errors and their local asymptotic properties. The Review of Economic Studies, 63(3), 435-463.

Rappoport, P., & Reichlin, L. (1989). Segmented trends and non-stationary time series. The Economic Journal, 99(395), 168-177.

Shrestha, M. B., & Chowdhury, K. (2005). A sequential procedure for testing unit roots in the presence of structural break in time series data.

Simon, H. A. (1954). Spurious correlation: A causal interpretation. Journal of the American statistical Association, 49(267), 467-479.

Takeuchi, Y. (1991). Trends and structural changes in macroeconomic time series. Journal of the Japan Statistical Society, Japanese Issue, 21(1), 13-25.

Waheed, M., Alam, T., & Ghauri, S. P. (2006). Structural breaks and unit root: evidence from Pakistani macroeconomic time series.

Yule, G. U. (1926). Why do we sometimes get nonsense-correlations between Time-Series?--a study in sampling and the nature of time-series. Journal of the royal statistical society, 89(1), 1-63.

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. Journal of business & economic statistics, 20(1), 25-44.

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. Journal of business & economic statistics, 20(1), 25-44.

Zivot, E., & Andrews, D. W. K. (2002). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. Journal of business & economic statistics, 20(1), 25-44.