GETTING THE RESULT THAT YOU WANT FROM THE UNIT ROOT

M.Phil Thesis

(Econometrics)

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January 2012

APROVEL SHEET

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DECLARATION

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ABDUL GHAFAR SHAH

January 2012.

بسم الله الرحمن الرحيم

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List of Abbreviations:

ADF	Augmented Dickey Fuller
AR	Auto-regressive
ARMA	Autoregressive Moving Average
CPI	Consumer Price Index
CV	Critical value
DGP	Data Generating Process
DF	Dickey Fuller
Eq	Equation
GDP	Gross Domestic Product
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LM	Lagrange Multiplier
ma	Moving Average
PP	Phillips Perron
WN	White Noise

ABSTRACT

Unit root test are getting importance day by day and the literature on unit root is literally proliferated. However enormous literature has increased the complexity involved in unit root testing instead of solving it. This study shows that using the existing battery of tests it is possible to bring any type of results according to the wish of researchers. The simulation results show that for any data generating process, there are certain unit root tests that will decide the series to be stationary and there are tests which will conclude the series to be unit root. Therefore this study illustrates how one can take the advantage of a large number of existing unit root tests to bring the desired result.

ACKNOWLEDGMENT

All praises to Almighty Allah, who has given me the privilege to be amongst those who are awarded with the blessing of wisdom and knowledge.

At this occasion, I am thankful to all my teachers who taught me at any stage of my studies. I am very indebted to Dr.Atiq-ur-Rehman for his continuous Encouragement, valuable comment in this thesis and at every moment of my academic pursuit.

First of all my heartiest thanks are to my supervisor Prof Dr. ASAD ZAMAN for his proper guidance and valuable suggestions at time which enabled me to accomplish this hard work.

I would like to thank all of my class fellows for their cooperation's throughout M.Phil program and especially of Muhammad Irfan Malik for helping me in MATLAB programming to make all the possible.

At the end I would like to pay my regards and love to my parents for empowering my thoughts throughout my life. Special thanks of my eldest brother Abdul Satar Shah for their priceless and unforgettable support throughout my study life, for which I have no appropriate words to acknowledge.

Abdul Ghafar Shah

CHAPTER 1

INTRODUCTION

1.1 Introduction:

Many economic and financial time series exhibit trending behavior or non-stationary in the mean. In order to make the data stationary, unit root tests can be used to determine whether the trending data should be first differenced or regressed on deterministic functions of time. Some examples are asset prices, CPI, exchange rates and the levels of macroeconomic aggregates like real GDP. The main fundamental econometric task is to determine the most appropriate form of the trend in the trending data series. For ARMA modeling the data are usually transformed to stationary form prior to analysis. If the data show trending behavior, then some form of trend removal is required. Two important de-trending or trend removal methods are;

(i) First differencing (ii) Time-trend regression

First differencing is suitable for unit root denoted by I(1) time series and time-trend regression is suitable for trend stationary denoted by I(0) time series. Different results about stationarity of same series are obtained by adopting different procedures for testing unit root stationarity. Several tests are used for unit root i-e Dickey Fuller test (1979, 1980), Augmented Dickey Fuller test, Kwiatkowski-Phillips-Schmidt-Shin test (1992), Ng-Perron test (2001), Phillips-Perron test (1988). When unit root tests are applied in different scenario, different results can be obtained.

The purpose of this study is to show that for any series we can bring the desire results that we want from the unit root/ stationary tests & to summarize the techniques the methods for bringing desired results.

1.2 Motivation:

The time series research usually starts from unit root testing. Researcher does usually decide about the usage of a unit root test among all the existing unit root tests on the basis of their own choice. By change the test results exactly opposite to those already published can be brought by little efforts, here are some examples. First we select the GDP of Germany which has been used by Antonios (2010) in his study "Stock market &Economic growth: An empirical analysis for Germany", using annual data from (1965-2007) taken from International Financial Statistics (IFS). According to the author, the GDP was found to be integrated of order one denoted by I(1) and the series was found to be unit root. He used the ADF & KPSS tests. We apply the ADF, KPSS tests using the same data series and with the same other conditions for confirmation of his results through E-views.

Table 1.2.1: Results of different unit root tests for GDP of Germany:

Tests	Test Statistic	Null Hypothesis	1% CV	5% CV	Lag length	Drift	Trend	Decision
ADF	-2.54321	Unit root (1)	-3.6009	-2.9350	1	YES	No	I(1)
KPSS	0.80775	Stationary I(0)	0.739	0.463	5	YES	No	I(1)
ADF	-3.99584	Unit root I(1)	-3.6055	-2.9369	2	YES	No	I(0)
PP	-3.70306	Unit root I(1)	-3.5966	-2.9331	1	YES	No	I(0)

From the Table: 1.2.1, ADF test with lag length=1 and KPSS test it can be observed that the result is same i-e unit root which has been used in the study of Antonios. If ADF test with lag length=2 and Phillips-Perron test are used, then the same series is shown as staionary.

In the second example we select the annual data from the study of Waheed et-al (2006) "Structural breaks and unit root: evidence from Pakistani macroeconomic time series" is taken. The authors used two important macroeconomic variables i-e Broad Money (M_2) and Consumer Price Index (CPI) from the year 1957 to 2005 in their study. In their study it was shown that both M_2 and CPI is unit root. They used ADF test and Phillips Perron test for unit root testing.

When the same series of Broad Money is analyzed by us for existence of unit root, the results are given in the Table 1.2.2.

Table: 1.2.2 Results of different unit root tests for Broad Money (M_2) of Pakistan:

Tests	Test Statistic	Null Hypothesis	1% CV	5% CV	Lag length	Drift	Trend	Decision
ADF	-3.460866	Unit root I(1)	-4.1657	-3.508	1	YES	Yes	I(1)
PP	-3.349587	Unit root I(1)	-4.1611	-3.508	0	YES	Yes	I(1)
ADF	-3.621417	Unit root I(1)	-3.1856	-3.513	3	YES	Yes	I(0)
KPSS	0.130943	Stationary I(0)	0.216	0.146	5	YES	Yes	I(0)

From the above Table: 1.2.2 it can be observed that the series Broad Money (M_2) is unit root when ADF test (with lag length=1) and Phillips Perron test are used. But when we apply the ADF test (with lag length=3) and KPSS test the result is opposite i-e the two tests show that the series M_2 is stationary.

Similarly when the same series of Consumer Price Index (CPI) is analyzed by us for existence of unit root, the results are given in the Table 1.2.3.

Table: 1.2.3 Results of different unit root tests for Consumer Price Index (CPI) of Pakistan:

Tests	Test Statistic	Null Hypothesis	1% CV	5% CV	Lag length	Drift	Trend	Decision
ADF	-3.403893	Unit root I(1)	-4.1657	-3.5085	1	YES	Yes	I(1)
PP	-2.730743	Unit root I(1)	-4.1611	-3.5085	3	YES	Yes	I(1)
DFGLS	-2.41265	Unit root I(1)	-3.770	-3.1900	1	YES	Yes	I(1)
KPSS	0.088114	Stationary I(0)	0.216	0.146	4	YES	Yes	I(0)
PP	-14.83371	I(1)	-4.1611	-3.5085	6	YES	Yes	I(0)

From the above Table: 1.2.3 it can be observed that the series Consumer Price Index (CPI) is unit root when ADF test (with lag length=3) and Phillips Perron test (with lag length=6) are used. But when we apply the Phillips Perron test (with lag length=6) and KPSS test the result is opposite i-e the two tests show that the series Consumer Price Index (CPI) is stationary.

1.3 OBJECTIVES OF THE STUDY:

This study is to investigate the situation which we get the opposite result of unit root test for same data by applying different unit root tests. We are using Monte Carlo simulation to identify the situation under which we can get opposite result from unit root for same DGP. In this case we have used different DGP model with or without constant, trend and negative moving averages and changes in test equation. It is to provide a guide to researcher that how opposite result can be derived from same data under different circumstances.

1.4 SIGNIFICANCE OF THE STUDY:

Our task is to show reverse result of unit root & these tests are different in properties & criteria, as in the literature that the selection criterion of a model is not unique. Some one using one technique of selection of model will give one result unit root/stationary while for the same data if another person uses any other criteria then he will get another result. As in the existing literature many of researches are affected from this flow to show their inverse result of the existing researches. This means that serious doubts exist about validity results which rely on unit root tests.

CHAPTER 2:

EVIDIENCES FROM LITERATURE

Said and Dickey Fuller (1984) documented that by including large amount of augmentation, the rejection rate of Augmented Dickey Fuller test decreases. It implies that if a series is stationary l(0), then by including large lag of augmentation that series can be shown as l(1) that is unit root by using ADF test.

Schwart (1987) finds that with a large and negative moving average (MA) term, then mostly ADF test and Phillips Perron test show that the series to be stationary when in fact the series is unit root. Schwart (1989) and Cochrane (1991) presented Monte Carlo simulation showing that unit root tests can have high probability of false rejection when applied to unit root processes with moving average roots approaching to -1.

Perron (1989) showed that if a series is stationary with structural break, the ordinary unit root tests will not reject the null hypothesis of unit root. This implies if we want a stationary series with structural break to be unit root, it can be done by applying a test without structural break like DF test, ADF test, PP test and so on. Hence if we apply Perron unit root test on a unit root series without structural break, the probability of rejection of unit root under the null increases. This implies that if we want to show a unit root series without structural break to be stationary, we can apply Perron test.

Campbell and Perron (1991) showed that power of unit root test falls if numbers of deterministic regressors in unit root test equation are less than the number of deterministic regressors in DGP. This implies if we want to show a stationary series to be unit root, we can apply a unit root test with lower specification of deterministic regressors.

Cochrane (1991) demonstrated by showing that there are difference-stationary series whose likelihood functions and autocorrelation functions are arbitrarily close to those of any trend stationary processes and vice versa. Hence with these manipulations the series can be shown as stationary and/or unit root.

According to Banerjee et al, Christiano and Zivot and Andrews (1992) the selection of structural break a priori based on an ex post examination or knowledge of the data could lead to over-rejection of the unit root hypothesis. This implies that application of Perrron test to a series with unit root over rejects the true null hypothesis.

Blough (1992) extended the result of Schwart and Cochrane (1991) proposed that the distribution of unit root and stationary are very close to each other. So the two types of series are not easily distinguishable. He said that some time unit root processes which behave like White noise and stationary series which behave like random walks and showed that power must be less than the size of unit root for such a model.

Spanos and Mc Guirk (2002) documented that a unit root series can be shown stationary by including deterministic trend in unit root test equation. They also stated that unit root series is shown I(1) if deterministic trend is not included in test equation.

Atiq-ur-Rehman and Zaman (2008) also discussed a series by applying Ng-Perron test. They showed that the outcome of Ng-Perron unit root test differ with the choice of deterministic part.

This study is conducted to find out how the result of one's choice can be brought by using different choices of unit root tests and the other specification decision. To get the desired results of various series for both real data series as well as artificially generated series (unit root/stationary) by applying different unit root tests.

CHAPTER 3:

Methodology

In this chapter we have to explain the methodology that how we can find the different scenarios in which desired results can be brought by applying different tests of unit root to the same series. We take different data generating processes and for each data generating process, we try to find the test having high frequency of rejection of the unit root and the test with high frequency of acceptance of null hypothesis. Hence for the same series we will be able to recommend the test which can show the series to be stationary and the tests which show the series to be unit root. The procedure is described as follows:

3.1 Data generating process:

In this study the data is generated using the following three data generating processes (DGPs).

- DGP-I , $y_t = \rho y_{t-1} + e_t$, No trend and no constant. ...... (3.1.1)
- DGP-II , $y_t = a + \rho y_{t-1} + e_t$, without trend and with constant. ...... (3.1.2)
- DGP-III , $y_t = a + bt + \rho y_{t-1} + e_t$, with both trend and constant. ...... (3.1.3)

Where $e_t = ma^* e_{t-1} + u_t$ and u_t is $(0, \delta^2)$

'ma' is known as moving average coefficient, 'a' is constant where 't' is trend and 'ρ' coefficient of autoregressive (AR) term.

In this study the values of 'ma' are taken from the set {-0.1, -0.5, -0.8} and the values of 'ρ'= {1, 0.9, 0.8, 0.6}.

3.2 Monte Carlo Simulation Design:

Following steps are followed in order to calculate power and size of unit root tests.

1. The data is generated using any of the three DGPs mentioned in section 3.1.
2. Different unit root tests are applied to the data generated in first step using lag length 'l' from '0 to 6'.
3. Size of each unit root test at 5% level of significance calculated for Monte Carlo sample size 'MCSS'= 1000 at different lag length as,

   Size = P (Reject H_0/ H_0 is false)
4. Power of each unit root test at 5% level of significance calculated as,

   Power = P (Reject H_0/H_0 is true)

3.2 Tests to be used:

In this section we explain the unit root tests, the following tests have been used in this study.

3.2.1 Dickey Fuller Test:

Dickey Fuller test (1979, 1980) or simply called DF test. Suppose the AR (1) process as,

$y_t = \rho y_{t-1} + e_t$, random walk without drift and trend. .... Eq(3.2.1.1)

The testing technique is based on the assumption that e_t is random variable with zero mean & constant variance which is called White noise. The null Ho and alternative hypothesis H_1 for Dickey Fuller test are:

H_0: p=1 (unit root/ difference stationery) or $y_t \rightarrow I(1)$

H_1: $|\rho|<1$ (stationary) or $y_t \rightarrow I(0)$

The Dickey Fuller test statistic is , $t_p = (\hat{\rho}-1)/se(\hat{\rho})$

$$\bar{y} = \frac{1}{n}\sum_{t=1}^{n} y_t \quad , \quad s^2 = \frac{1}{n}\sum_{t=1}^{n}(y_t - \bar{y})^2 \quad \text{and} \quad se(\hat{\rho}) = \frac{s}{\sqrt{n}}$$

If $t_p > t_{tab}$ than accept Ho and the series will be unit root and reverse will be stationary. Where $se(\hat{\rho})$ is the usual standard error estimate and $\hat{\rho}$ is the least squares estimate of the lag coefficient of y_t. The test is left tail test. The critical values are obtained from McKinnon (1993).

One of the assumptions of the Dickey & Fuller test is that the disturbance term is white noise. However, the Dickey & Fuller regression cannot be used to test for unit root if this assumption does not hold. We use Augmented Dickey Fuller test which includes more dynamic than the Dickey & Fuller regression.

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + b1\Delta y_{t-1} + b_2\Delta y_{t-2} \ldots\ldots + b_q\Delta y_{t-q} + e_t \qquad \ldots\ldots\ldots (3.2.1.2)$$

Or $$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \sum_{t=1}^{q} b_i \Delta y_{t-i} + e_t \qquad \ldots\ldots\ldots (3.2.1.3)$$

x_t' is the set of constant or constant and linear trend where 'q' is choose to ensure white noise residuals in the regression model. Lagged first differences are included in the model to eliminate serial correlation. The lag length can be chosen using Lagrange multiplier test for serial correlation. When more lag terms are introduced in ADF, the power of the test falls. This implies that the choice of the number of lag is a key element when using ADF test.

3.2.2 DF-GLS test:

Elliott, Rothendurg and Stock (1996) modified ADF tests by including linear trend and constant in test regression equation. Here he define the Quasi-difference of y_t for Dickey Fuller Generalized Least Square (DFGLS) depend upon the value 'α' which denoting the specific point H_1 against H_0.

$$d(y_t/\alpha) = y_t \quad , \quad \text{if } t=1 \qquad \dots\dots\dots (3.2.1.4)$$

$$d(y_t/\alpha) = y_t - \alpha y_{t-1} \quad , \quad \text{if } t > 1$$

Let least square regression of Quasi-differenced $d(y_t/\alpha)$ on Quasi-differenced $d(x_t/\alpha)$ as,

$$d(y_t/\alpha) = d(x_t/\alpha)'\,\delta(\alpha) + u_t \qquad \dots\dots\dots (3.2.1.5)$$

x_t is a set of drift [1] or drift with trend [1, t] and t = 1,2,3, ... , n

$$\bar{\alpha} = 1 - 7/n \quad , \quad \text{if } x_t = [1] \qquad \dots\dots\dots (3.2.1.6)$$

or $$\bar{\alpha} = 1 - 13.5/n \quad , \quad \text{if } x_t = [1, t]$$

n = {40, 80, 150, ……, ∞}

Then detrended GLS as,

$$y_t^d = y_t - x_t'\,\delta(\bar{\alpha}) \qquad \dots\dots\dots (3.2.1.7)$$

The DFGLS test consists estimating the standard augmented DF test eq(3.2.1.2) then putting y_t^d as,

$$\Delta y_t^d = \alpha\, y_{t-1}^d + b_1 \Delta y_{t-1}^d + \dots\dots + b_q \Delta y_{t-q}^d + e_t \qquad \dots\dots\dots (3.2.1.8)$$

As y_t^d are detrended, therefore we have not included the x_t in the detrending FGLS test equation and consider the t-ratio for $\overline{\alpha}$ from this test equation, with ADF test statistics.

3.2.3 Phillips and Perron test:

Phillips and Perron (1988) introduce a nonparametric method of unit root test to correct the serial correlation which is very popular in financial time series. ADF tests use a parametric auto regression to estimate the ARMA structure of the errors, where the PP tests eliminate any serial correlation in the test regression. The first advantage is that Phillips Perron tests are opposite to general forms of hetroskedasticity in the error term. The second advantage is it does not need the specification of lag length/truncation in the regression equation. The test regression for the PP tests is from eq (3.2.1.2),

$$\Delta y_t = \alpha y_{t-1} + x_t^{'}\delta + e_t \qquad \text{.........} (3.2.2.1)$$

Where X_t contains deterministic components (constant or constant plus time trend), & e_t is I(0). The PP tests discuss the correction of serial correlation and hetroskedasticity in the errors term e_t of the test regression. Then modified Phillips and Perron test statistic as:

$$t_0 = t_\alpha\left[\frac{h_0}{f_0}\right]^{1/2} - \frac{n(f_0 - h_0)se(\alpha)}{2\sqrt{f_0}\cdot S_t}$$

And $$t_\alpha = \frac{\alpha}{se(\alpha)}$$

$$f_0 \text{ (Estimator of residual spectrum at zero frequency)} = \frac{1}{n}\sum_{i=1}^{r} E(e_t^{\,2})$$

$$h_0 \text{ (Consistent estimate of error variance)} = \frac{(n\text{-}k)*S_t^{\,2}}{n}$$

Where k = number of regressors and $S_t = \sum_{i=1}^{r} e_t$

The sample variance of the least squares residual $\hat{ut}$ is a consistent estimate of δ^2.The PP test statistic has the same asymptotic distributions as the ADF t-statistic.

3.2.4 Ng-Perron Test:

An important problem for the ADF test is how to specify the lag length 'q'. Ng and Perron(1995) introduced that proper lag length selection bring stable size and minimal power loss. He sets q_{max} upper lag limit and then apply ADF test.

If t_{adf} is greater than the quantity 1.6 then $q = q_{max}$ and to perform the unit root test. Otherwise to reduce q by one and repeat the procedure. Then

$$q_{max} = {}^{12}\left[\frac{n}{100}\right]^{1/4}$$

Ng-Perron (2001) construct a set of more small tests which are modified form of Phillips and Perron test statistic based on the GLS detrended, which are given below.

$$MZ\alpha = \frac{n^{-1}(y_t^{\,d})^2 - f_0}{2k} \quad , \qquad MSb = \sqrt{\frac{k}{f_0}}$$

$$MZ_t = MZ_\alpha \times MSb$$

$$MP_T = \frac{[c^2k - c*n^{-1}(y_n^{\,d})^2]}{f_0} \quad , \quad c = -7 \qquad \text{if} \quad x_t = [1]$$

or

$$MP_T = \frac{[c^2k + (1-c)*n^{-1}(y_n^{\ d})^2]}{f_0} \quad , \ c = -13.5 \qquad \text{if } \ x_t = [1, t]$$

$$k = \frac{\sum_{t=2}^{n} (y_{t-1}^{\ d})^2}{n^2}$$

Hence 'MZα, MZ_t, MSb, MP_T' all show equal results denotes the Ng-perron test statistic. The MZa and MZt are efficient version of Phillips Perron test statistic that has smaller size in the presence of negative moving average errors.

3.2.5 KPSS Test:

When we test the unit root than the null hypothesis consist of the series is I(1) and alternatives I(0). But when we have the null hypothesis that the series is stationary than in this situation a common test is used called KPSS test introduced by Kwiatkowski, Phillips, Schmidt and Shin (1992). It is one sided Lagrange Multiplier (LM) test which have null as I(0). KPSS documented about the size of the test which depends upon the sample size 'n' and lag length 'l'. When these two are large than KPSS test has correct size.

$$y_t = x_t^{'}\delta + \mu_t + u_t \qquad \ldots\ldots\ (3.2.4.1)$$

$$\mu t = \mu_{t-1} + \varepsilon_t \,, \quad \varepsilon_t \rightarrow WN(0,\sigma^2) \qquad \ldots\ldots\ (3.2.4.2)$$

Where *xt* contains deterministic terms (constant or constant and time trend), μ_t is a pure random walk with innovation variance $\delta\varepsilon^2$, u_t is I(0) and may be heteroskedastic. The null hypothesis that yt is I(0) is H_0: $\delta\varepsilon^2 = 0$, which provided that μ_t is a constant term. The KPSS test is some time called LM test and the test statistic is given below,

$$\text{KPSS} = \frac{1}{n^2 f_0} \sum_{t=1}^{n} S^2$$

$$S = \sum_{r=1}^{n} \hat{u}_r$$

S is the cumulative residual function. The LM test is a simple one-sided test so that one rejects the null of l(0) at the α% level if the test statistic is greater than the (1 − α)% quintile from the definite asymptotic distribution. The critical values of LM test statistic are based upon the asymptotic results presented in KPSS (Table: 1, P.166).

3.2.6 Perron Test:

This test was introduced by Perron (1989) when there are unit root in the presense of structural break of time series data. Perron explains that most of the economic series have no characteristics of unit root but sudden change in diversion of the mean due to the presence of structural breaks. Nelson and Plosser (1982) discuss the unit root series that the breaks totally affect the long run relationship and the fluctuations are not temporary. Perron modified Dickey-Fuller test used dummy/indicator variables (0, 1) in which '1' shows that the structural break is present and '0' when there is no structural break. Perron test has lower power then Dickey Fuller test when there is no break. Following are the three equations of Perron unit root test.

$$y_t = a_0 + a_1 DUt + d(\,DTb)t + bt + \rho y_{t-1} + \sum_{i=1}^{p} \varphi_i y_{t-i} + e_t \qquad \ldots\ldots\ (3.2.5.1)$$

$$y_t = a_0 + rDTt' + bt + \rho y_{t-1} + \sum_{i=1}^{p} \varphi_i y_{t-i} + e_t \qquad \ldots\ldots\ (3.2.5.2)$$

$$y_t = a_0 + a_1 DUt + d(\,DTb)t + bt + rDTt + \rho y_{t-1} + \sum_{i=1}^{p} \varphi_i y_{t-i} + e_t \qquad \ldots\ldots\ (3.2.5.3)$$

Eq(3.2.5.1) called crash model which show structural break in the level, eq(3.2.5.2) is changing growth allows structural break in the slope means the rate of growth, and the third eq(3.2.5.3) mention both the changes.

DUt = change in the level and Tb= break date, when DUt =1 and ($t > Tb$) and zero otherwise.

DTt denote the slope dummy *and* DTt′ (change in the slope of the trend) DT′ = t-Tb (or DTt′ = t if $t > Tb$) and zero alternatively. DTb (crash dummy) = 1 when t= Tb +1, and zero otherwise.

H_0 (null hypothesis) of the test consists of unit root with structural break and H_1 (alternative hypothesis) as break trend stationary.

CHAPTER 4:

Analysis

In this chapter we apply unit root tests for all the data generating process (DGP) of section (3.1) by Monte Carlo simulations. We have to choose unit root test which gives our desire result then in the test equations in the test equations we change deterministic part.

Case1: When the series is unit root:

4.1 Simulation results for DGP-I with constant and no trend in the test equation:

DGP-I: $y_t = \rho y_{t-1} + e_t$

Test equation: $y_t = a + \rho y_{t-1} + e_t$

In this DGP model we use $\rho = 1$, no trend and no drift and ma =0. Different unit root tests with different sample sizes are applied, Table (4.1.1) shows the simulation results.

Table (4.1.1) Probability of Rejection of Unit Root of DGP-I with constant in test equation:

	n=40	lag length						
Test	Test St	0	1	2	3	4	5	6
Ng.Perron	mzt	5.2	6.8	4.9	5.2	6.2	6.3	5.2
KPSS	LM	0	0.1	0.4	1	2.1	3.7	3.3
PP	t0	3.9	5.8	4.7	4.7	5.7	6.5	4.7
DF	tdf	5.7	7.3	5.6	6	7.3	7.2	6.8
Perron	tp	97.4	95.7	95.4	96.5	96.6	96.7	97.3

Fig4.1.1 to Fig4.1.4 Probability of Rejection of Unit Root of DGP-I with constant in test equation for different sample sizes:

Fig4.1.1 Sample size is 40

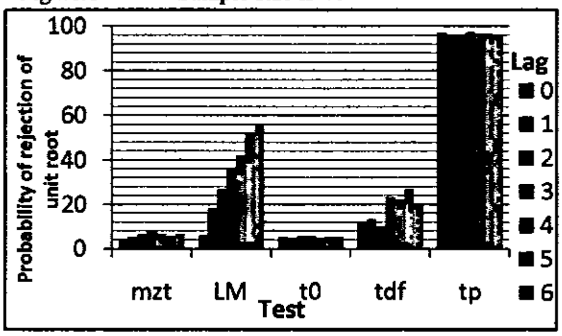


Fig4.1.1 Sample size is 80

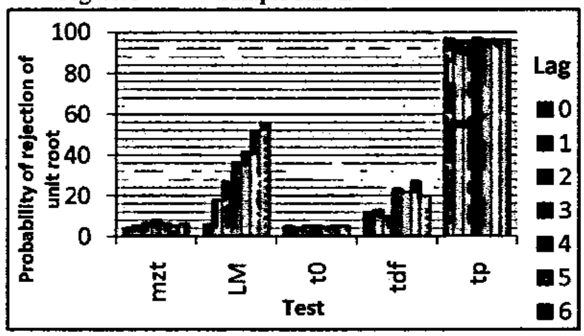


Fig4.1.3 Sample size is 150

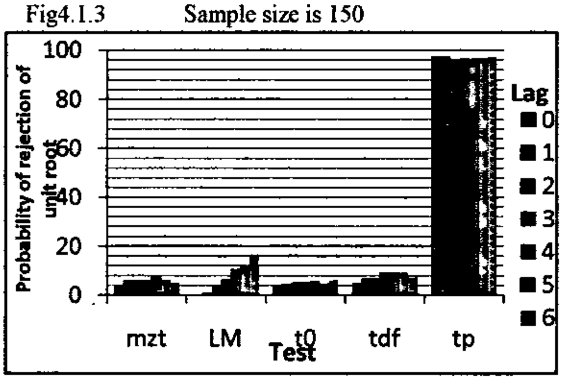
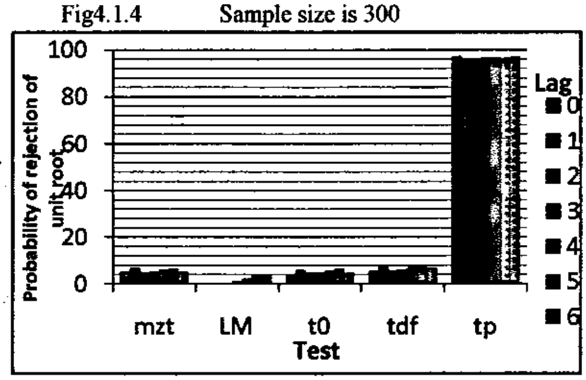


Fig4.1.4 Sample size is 300



Here Ng-Perron test, Dicky Fuller test and PP test bring the same result that the series is unit root. For KPSS test, the acceptance of null hypothesis is considered as rejection of unit root because the null of this test is stationarity contrarily to the other tests. Therefore Perron test and KPSS test bring the opposite result that the series is stationary with the high probability. The results clearly show that if we apply any test other than the KPSS test and Perron test, the series generated by DGP-1 will appear to be unit root. If we apply KPSS test and Perron test, we can show the series to be stationary with very high frequency. If we include the constant with linear trend in the test equation, then we also get approximately same conclusions like in above Fig (4.1.1) to Fig (4.1.4).

4.2 Simulation results for DGP-I with ma= -0.5 and test equation include constant with no trend:

DGP-I , $y_t = \rho y_{t-1} + e_t$, where $e_t = ma*e_{t-1} + u_t$

Test equation: $y_t = a + \rho y_{t-1} + e_t$

The following are the DGP-I results when we include the moving average term. Hence we are taking $\rho = 1$, this implies that the series is unit root.

Table (4.2.1) Probability of Rejection of Unit Root of DGP-I with ma=-0.5, constant in test equation:

	n=150			lag length				
Test	Test St	0	1	2	3	4	5	6
Ng.Perron	mzt	52.6	37.8	32.9	33.8	32.2	33.2	41
KPSS	LM	0.6	2.9	4.1	5.6	10	10.8	15.9
PP	t0	60.2	42.1	39.6	39.9	37.4	38.7	44.1
ADF	tdf	57.3	26.9	12.8	12.8	9.7	9.7	9.1
Perron	tp	85.7	88.4	88.2	86.2	88.4	86.2	86.1

Fig (4.2.1) to Fig (4.2.4) Probability of Rejection of Unit Root of DGP-I with ma=-0.5, constant in test equation for different sample size:

Fig.4.2.1 n=40

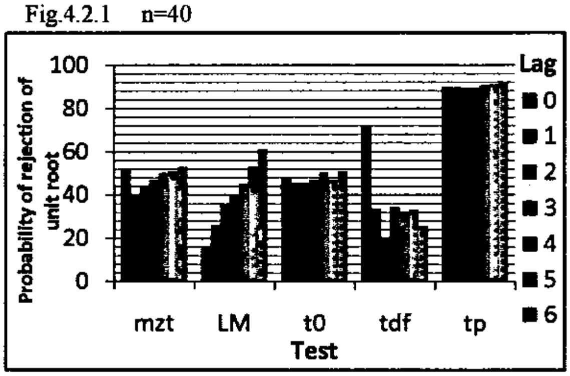


Fig.4.2.2 n=80

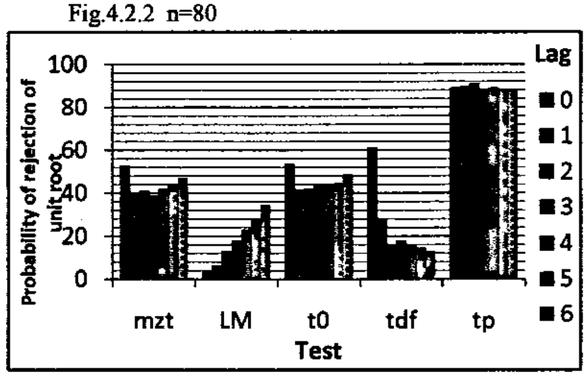


Fig.4.2.3 n=150

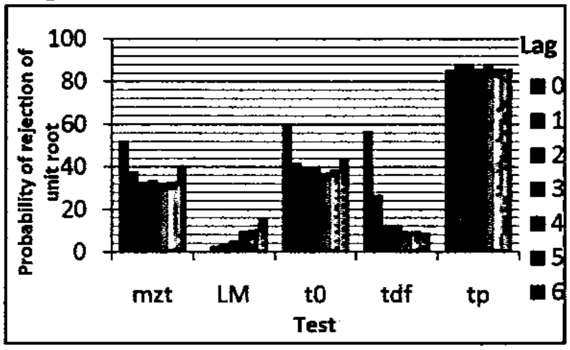
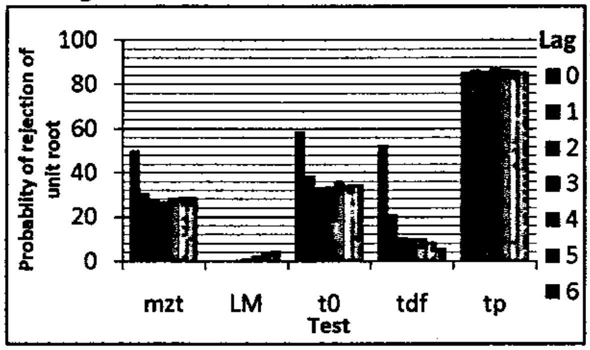


Fig.4.2.4 n=300



However if we apply Ng-Perron test, ADF test and Phillips Perron test, the probability of getting unit root result is high and if we apply Perron test and KPSS test, probability of getting stationary is higher. Also with the increase of lag-length the power of KPSS test increases and probability of rejection of unit root of Phillips Perron and ADF test decreases.

4.3 Simulation results for DGP-I with ma= -0.5, test equation include constant and trend:

DGP-I , $y_t = \rho y_{t-1} + e_t$, where $e_t = ma^* e_{t-1} + u_t$

Test equation: $y_t = a + bt + \rho y_{t-1} + e_t$

Fig (4.3.1) to Fig (4.3.4) Probability of Rejection of Unit Root of DGP-I with ma=-0.5, constant and trend in test equation for different sample size:

Fig.4.3.1 n=40

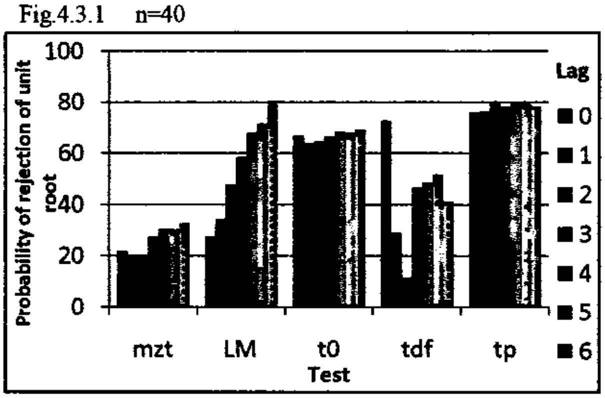


Fig.4.3.2 n=80

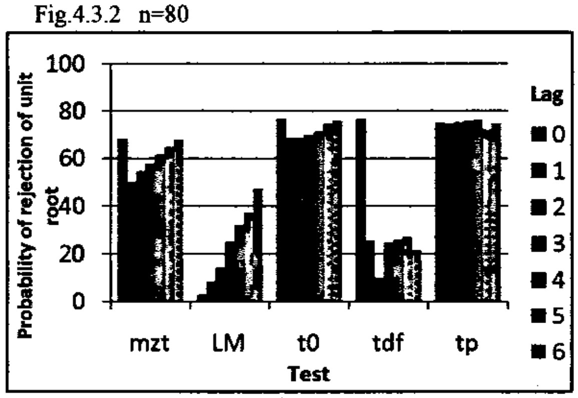


Fig.4.3.3 n=150

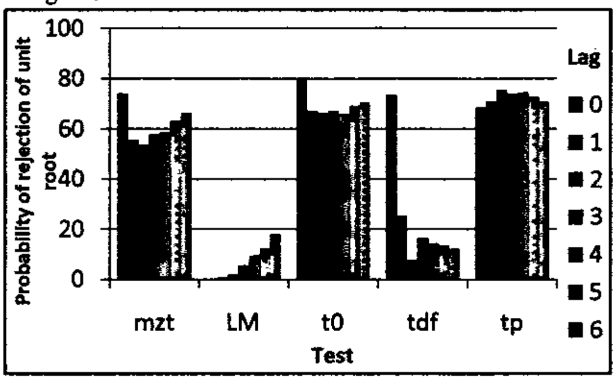
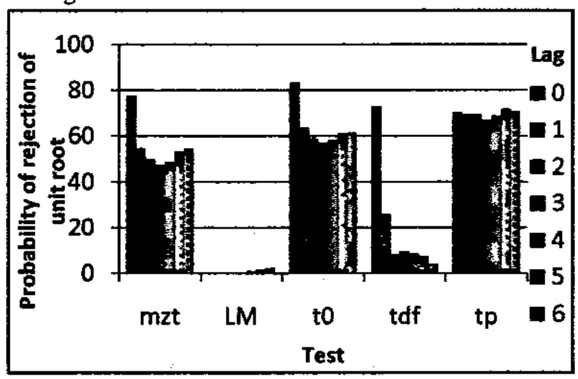


Fig.4.3.4 n=300



When the sample size is low then Perron test and Phillips Perron test reject our null hypothesis of unit root. But with the increasing of sample sizes then Ng-Perron test and KPSS test also show that the series is unit root. This implies that when we have the DGP-I, constant and trend in the test equation then we can apply Ng-Perron test, KPSS test, Perron test and Phillips Perron test to show the series is stationary with high probability. With the increase of lag-length the power of KPSS test increases and probability of rejection of unit root of Phillips Perron test and ADF test decreases and size of Ng-Perron test.

4.4 Simulation results for DGP-II with ma= -0.8, test equation include constant and with no trend:

DGP-II , $y_t = a + \rho y_{t-1} + e_t$, where $e_t = ma * e_{t-1} + u_t$

Test equation: $y_t = a + \rho y_{t-1} + e_t$

Fig (4.4.1) to Fig (4.4.4) Probability of Rejection of Unit Root of DGP-II with ma=-0.8, constant in test equation for different sample size:

Fig.4.4.1 n=40

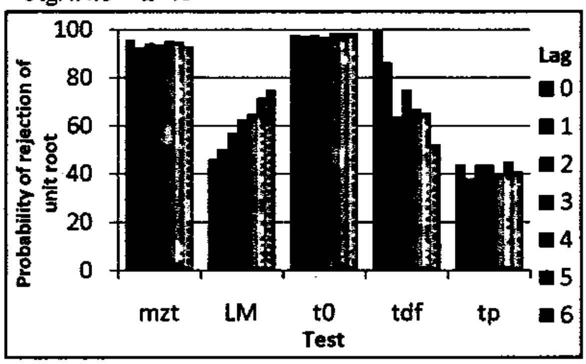


Fig.4.4.2 n=80

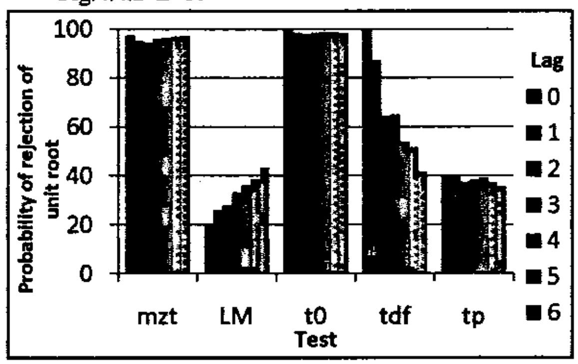


Fig.4.4.3 n=150

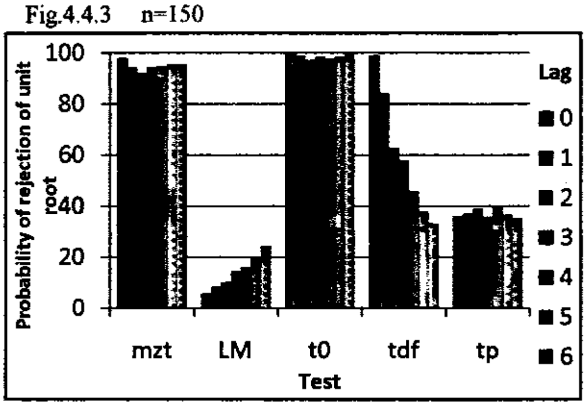
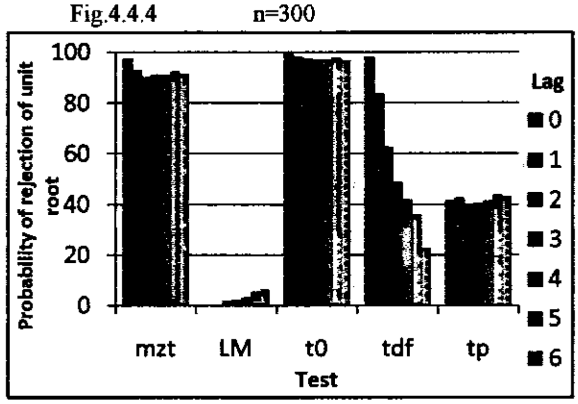


Fig.4.4.4 n=300



Including the moving average term in GDP-II and constant in test equation, then we see that Ng-Perron test, Phillips Perrron test, ADF test and KPSS test reject our null hypothesis with high frequency. It means that these tests are suitable for bringing opposite result of unit root in this scenario. Also with the increase of lag-length the Probability of acceptance of unit root of KPSS test increases and probability of rejection of unit root of Phillips Perron test and ADF test decreases.

4.5 Simulation results for DGP-III with test equation contain constant and trend:

DGP-III: $y_t = a + bt + \rho y_{t-1} + e_t$

Test equation: $y_t = a + bt + \rho y_{t-1} + e_t$

DGP-III with constant and trend in test equation, then simulation analysis show that Perron test and KPSS test reject the null hypothesis which mean that the series is stationary. If we include moving average term in this situation the result changes as follows.

Fig (4.5.1) to Fig (4.5.4) Probability of Rejection of Unit Root of DGP-III with constant and trend in test equation for different sample size:

Fig.4.5.1 n=40

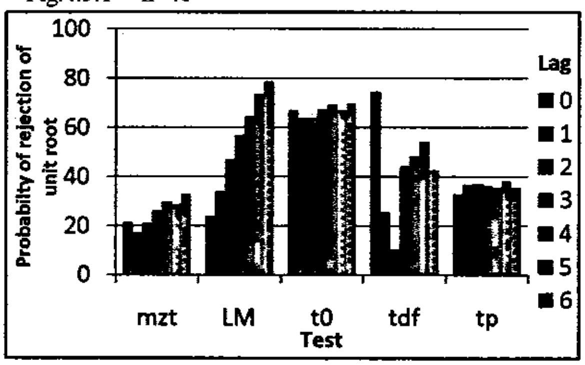


Fig.4.5.2 n=80

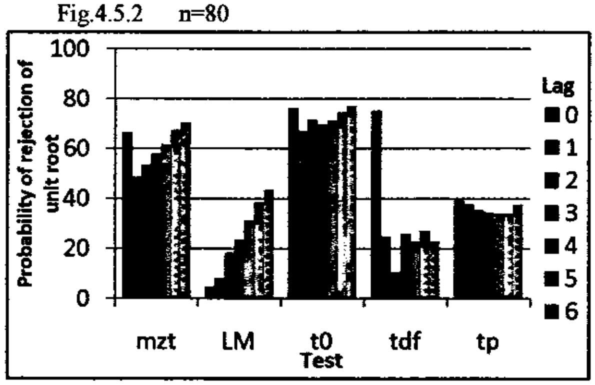


Fig.4.5.3 n=150

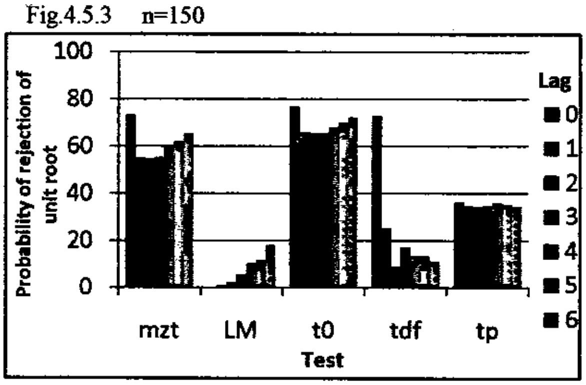
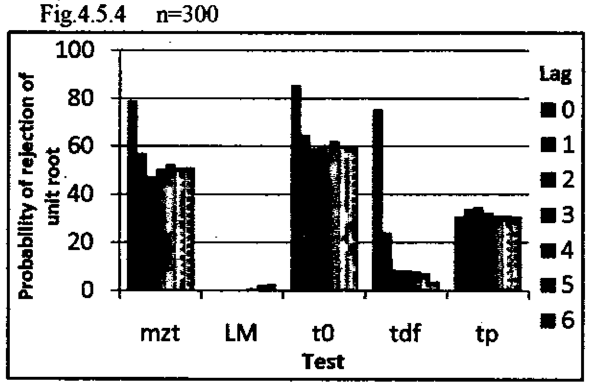


Fig.4.5.4 n=300



When negative moving average is added to DGP-III, then Ng-Perron test, Phillips Perron test and KPSS reject the null hypothesis of unit root and if we apply ADF test and Perron test, it show that the series is stationary. With the increase of lag-length the power of KPSS test increases and probability of rejection of unit root of Phillips Perron test and ADF test decreases and size of Ng-Perron test.

Case 2: When the series is stationary:

4.6 Simulation results for DGP-I when p= 0.9 and test equation with constant and without trend:

DGP-I , $y_t = \rho y_{t-1} + e_t$

Test equation: $y_t = a + \rho y_{t-1} + e_t$

Fig (4.6.1) to Fig (4.6.4) Probability of Acceptance of Unit Root of DGP-I with constant in test equation for different sample size:

Fig.4.6.1 n=40

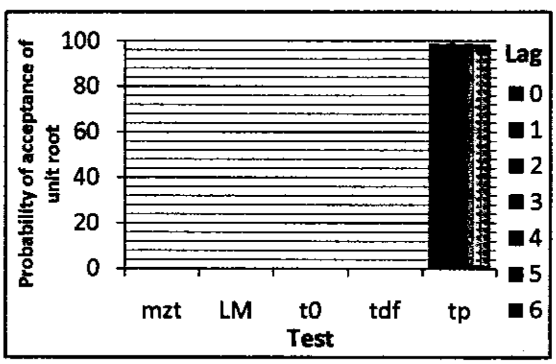


Fig.4.6.2 n=8

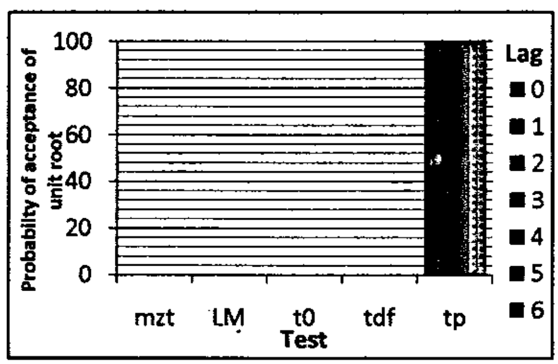


Fig.4.6.3 n=150

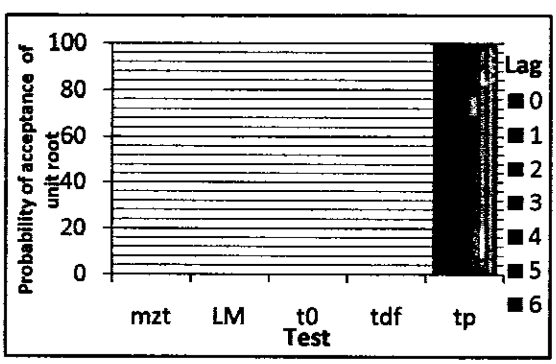
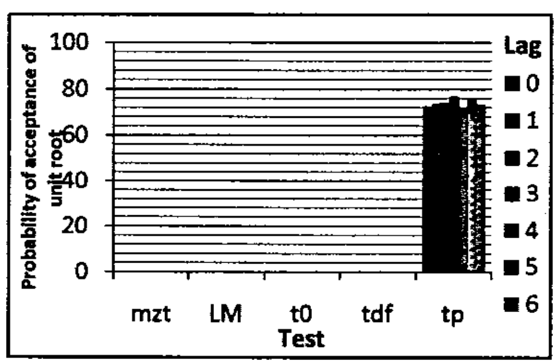


Fig.4.6.4 n=300



When the DGP is stationary, test equation contains constant and we apply different unit root tests, then the probability of getting unit root of Ng-Perron test, Phillips Perron test and ADF test is higher. If we apply KPSS test and Perron test, then probability of getting stationary is higher. The results remain same if we include negative moving average terms in DGP-III.

4.7 Simulation results for DGP-III when p= 0.6, and test equation with const and trend:

DGP-III , $y_t = a + bt + \rho y_{t-1} + e_t$

Test equation: $y_t = a + bt + \rho y_{t-1} + e_t$

Fig (4.7.1) to Fig (4.7.4) Probability of Acceptance of Unit Root of DGP-III constant and trend in test equation for different sample size:

Fig.4.7.1 n=40

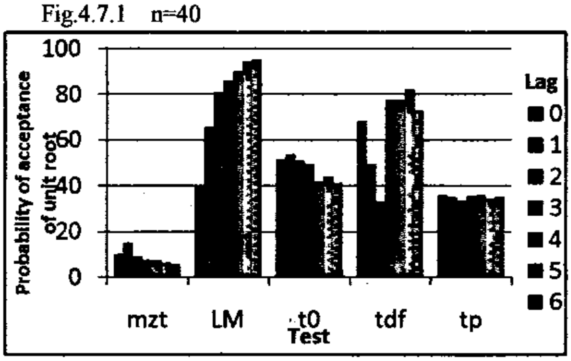


Fig. 4.7.2 n=80

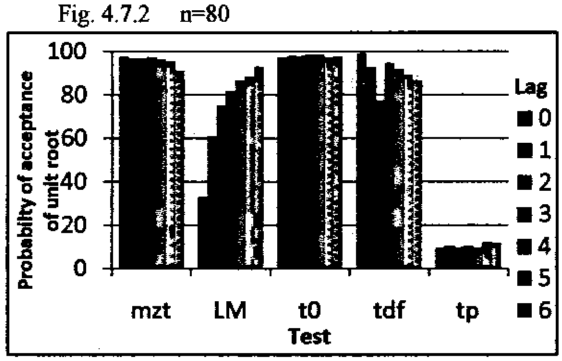


Fig.4.7.3 n=150

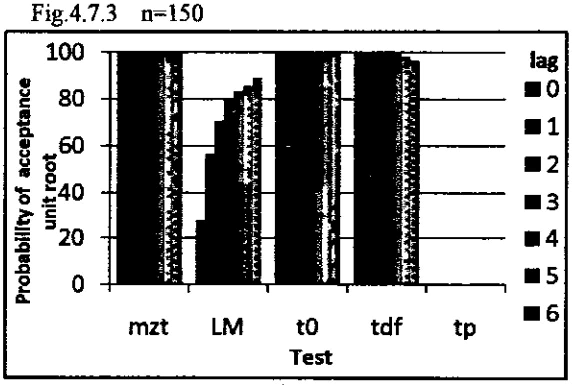
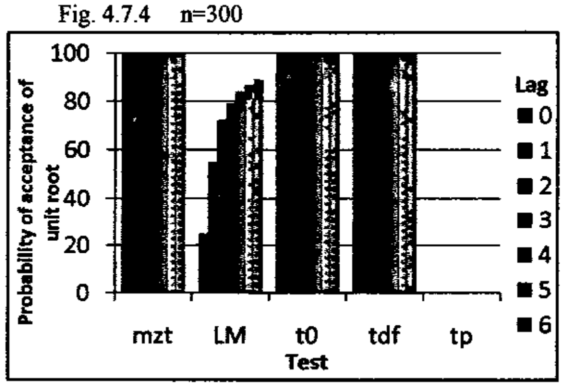


Fig. 4.7.4 n=300



However if we apply Ng-Perron test, ADF test and Phillips Perron test, the probability of getting stationary result is high and if we apply Perron test and KPSS test, probability of getting unit root is higher. Also with the increase of lag-length the probability of rejection of KPSS test increases.

4.8 Simulation results for DGP-III when p= 0.9, ma = -0.5, test equation include constant only:

DGP-III: $y_t = a + bt + \rho y_{t-1} + e_t$, where $e_t = ma^* e_{t-1} + u_t$

Test equation: $y_t = a + \rho y_{t-1} + e_t$

Fig (4.8.1) to Fig (4.8.4) Probability of Acceptance of Unit Root of DGP-III with constant in test equation for different sample size:

Fig.4.8.1 n=40

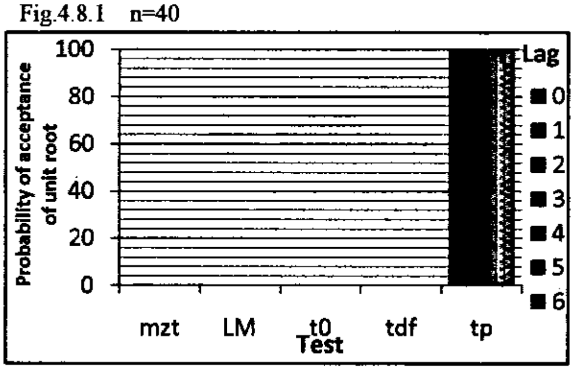


Fig. 4.8.2 n=80

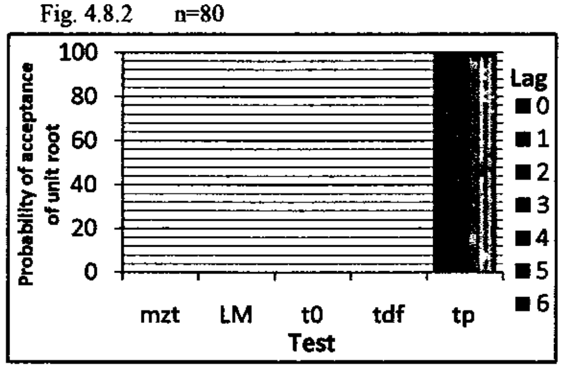


Fig.4.8.3 n=150

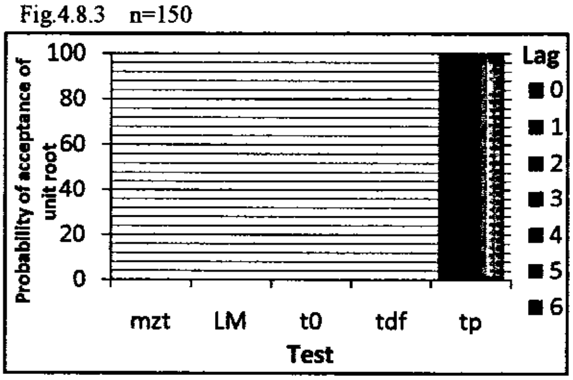
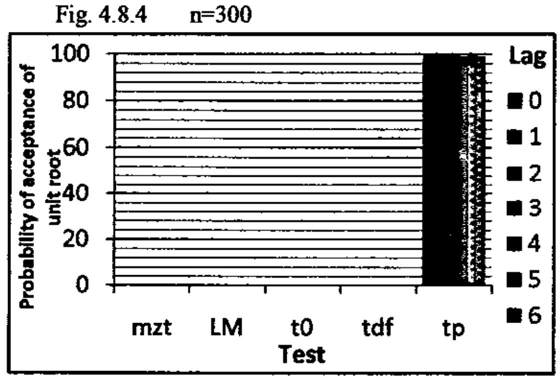


Fig. 4.8.4 n=300



In this situation Ng-Perron test, Dicky Fuller test and PP test show that the series is unit root but KPSS test and Perron test result that the series is stationary. This implies that if we have DGP-III with moving average term and include constant term in test equation as a stationary series, then Ng-Perron test, Dicky Fuller test and PP test bring the result that the series is unit root.

4.9 Summary:

The analysis presented above shows that for every DGP listed in section DGP (4.1 to 4.8) we are able to find out the unit root tests which have high probability of rejection of unit root as well as the tests which has high probability of acceptance of unit root.

CHAPTER 5

Conclusion

In this chapter we study conclusion of unit root test performance to show unit root or stationary.

5.1 Brief Conclusion:

Drawing the conclusion of the unit root tests of opposite result we have to explain in different categories. After studying all of the DGP and simulation results we conclude that how a series can be brought unit root as well as stationary and will be effect by the factors sample size, constant, trend and negative moving average term. Following tables show the result of unit root tests of different DGPs (see section 3.1).

Table 5.1.1 Results of unit root tests of DGP-I, test equation contain Constant:

		Test Eq: Constant only			
	DGP-I	Unit root test Results			
Ma	Rho(ρ)	To get Unit root		To get Stationary	
0	1	PP,ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.1	1	PP,ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.5	1	PP,ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.8	1	ADF test	×	KPSS,PP, Ng-Perron, Perron test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×

Note: Notations (✓) Show opposite result and (×) Show same result.

When the true DGP-I is unit root with constant and no trend in the test equation by applying KPSS test and Perron test we can show the series to be stationary where as by applying Ng-Perron test, ADF test and Phillips Perron test the series to be unit root. In case of stationary DGP-I with constant in test equation the KPSS test show that the series is unit root but applying Ng-Perron test, ADF test and Phillips Perron test and Phillips Perron test the series to be stationary.

Table 5.1.2 Results of unit root tests of DGP-II when test equation contains Constant only:

DGP-II		Test Eq: Constant only			
		Unit root test Results			
Ma	Rho	To get Unit root		To get Stationary	
0	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
-0.1	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
-0.5	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
	0.6	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
-0.8	1	Perron test	×	PP,ADF, Ng-Perron, KPSS, Perron test	✓
	0.9	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
	0.8	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×
	0.6	KPSS, Perron Test	✓	PP, ADF, Ng-Perron test	×

If we include negative moving average in DGP-II if it is unit root with constant only in test equation, then if we apply Perrron test and KPSS test which bring the series is stationary with high probability where ADF test, Phillips Perron test and Ng-Perron test show that the series is unit root.

When the GDP-II is stationary then KPSS test show that the series is unit root but including moving average term the KPSS test and also Perron test show unit root result and Phillips Perron test, ADF test, Ng-Perron test bring stationary with high frequency.

Table 5.1.3 Results of unit root tests of DGP-III when test equation contains Constant only:

		Test Eq: Constant only			
	DGP.III	Unit root test Results			
Ma	Rho(ρ)	To get Unit root		To get Stationary	
0	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS, PP Test	✓	ADF, Ng-Perrron, Perron Test	×
	0.8	KPSS, PP Test	✓	ADF, Ng-Perrron, Perron Test	×
	0.6	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
-0.1	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.8	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.6	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
-0.5	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.8	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.6	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
-0.8	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.8	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×
	0.6	ADF, PP, Ng-Perrron Test	✓	KPSS, Perron Test	×

Above Table 5.1.3 result of DGP-III when in fact it is unit root with constant and without trend in test equation, then also KPSS and Perron test show that the series is stationary. Similarly if we include MA in DGP-III with the two same test KPSS & Perron show that the series is unit root with high frequency. If the DGP-III is stationary then KPSS test and Perron test bring the series is unit root while Phillips Perron test, Ng-Perron test and ADF test show the series is stationary. But including moving average term in DGP-III then Phillips Perron test, Ng-Perron test and ADF test bring the series is stationary.

Table 5.1.4 Results of unit root tests of DGP-I when test equation contains Constant and trend:

DGP-I		Test Eq: Constant and trend			
		Results			
ma	**Rho**	**Unit root**		**Stationary**	
0	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.1	1	PP, ADF, Ng-Perron test	×	KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.5	1	ADF Test	×	PP, Ng-Perron, KPSS, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
-0.8	1	KPSS Test	×	PP, Ng-Perron, ADF, Perron Test	✓
	0.9	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.8	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×
	0.6	KPSS Test	✓	PP, ADF, Ng-Perron, Perron test	×

When the true DGP-I is unit root with constant and trend in the test equation by applying KPSS test and Perron test we can show the series to be stationary where as by applying Ng-Perron test, ADF test and Phillips Perron test the series to be unit root. Including moving average then Ng-Perron test, Phillips Perron test and Perron test bring that the series is stationary. In case of stationary DGP-I with constant and trend in test equation the KPSS test show the series is unit root but applying Ng-Perron test, ADF test and Phillips Perron test and Phillips Perron test the series to be stationary.

Table 5.1.5 Results of unit root tests of DGP-II when test equation contains Constant and trend:

DGP-II		Test Eq: Constant and trend	
		Results	
Ma	Rho	Unit root	Stationary
0	1	PP, ADF, Ng-Perron test ×	KPSS, Perron Test ✓
	0.9	KPSS Test ✓	PP, ADF, Ng-Perron, Perron test ×
	0.8	KPSS Test ✓	PP, ADF, Ng-Perron, Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.1	1	PP, ADF, Ng-Perron test ×	KPSS, Perron Test ✓
	0.9	Perron test ✓	PP,ADF, Ng-Perron, KPSS test ×
	0.8	KPSS Test ✓	PP, ADF, Ng-Perron, Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.5	1	ADF ×	KPSS, Perron, PP, Ng-Perron test ✓
	0.9	Perron test ✓	PP,ADF, Ng-Perron, KPSS test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.8	1	Perron test ×	PP,ADF, Ng-Perron, KPSS test ✓
	0.9	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×

If we include negative moving average in DGP-II if it is unit root with constant and trend in test equation, then if we apply Perrron test and KPSS test which bring the series is stationary with high probability where ADF test, Phillips Perron test and Ng-Perron test show that the series is unit root. Including moving average term Phillips Perron test, Ng-Perron test and bring the series stationary. When the GDP-II is stationary then KPSS test show that the series is unit root but including moving average term the KPSS test also Perron test show unit root result and Phillips Perron test, ADF test, Ng-Perron test bring stationary with high frequency.

Table 5.1.6 Results of unit root tests of DGP-III when test equation contains Constant and trend:

		Test Eq: Constant and trend	
DGP-III		Results	
Ma	Rho	Unit root	Stationary
0	1	PP, ADF, Ng-Perron test ×	KPSS, Perron Test ✓
	0.9	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.1	1	PP, ADF, Ng-Perron test ×	KPSS, Perron Test ✓
	0.9	Perron test ✓	PP, Ng-Perron, KPSS, ADF Test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.5	1	ADF,Perron test ×	KPSS,PP, Ng-Perron Test ✓
	0.9	Perron test ✓	PP, Ng-Perron, KPSS, ADF Test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
-0.8	1	PP, ADF, Ng-Perron test ×	KPSS, Perron Test ✓
	0.9	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.8	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×
	0.6	KPSS, Perron Test ✓	PP, ADF, Ng-Perron test ×

Above Table 5.1.3 result of DGP-III when in fact it is unit root with constant and trend in test equation, then also KPSS and Perron test show that the series is stationary. Similarly if we include MA in DGP-III with the two same test KPSS & Perron show that the series is unit root with high frequency. If the GDP-III is stationary either to include or exclude moving average then KPSS test and Perron test bring the series is unit root while Phillips Perron test, Ng-Perron test and ADF test show the series is stationary. But including moving average term in GDP-III then Phillips Perron test, Ng-Perron test and ADF test bring the series is stationary.

5.2 Comparison on the basis of Real data Series:

Following are some example of the real data series and its unit root test results which of the test show unit root or stationary in the light of our analysis.

Table 5.2.1 Results of unit root tests result of real data series:

Series		Results	
		Unit root	Stationary
Pakistan GDP 1970-2007	C	PP,ADF, Ng-Perron test	KPSS, Perron test
	C+T	PP, ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
Pakistan Export 1970-2007	C	PP, ADF, Ng-Perron test	KPSS, Perron test
	C+T	PP, ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
Belgium RER 1996.1-2007.1	C	PP, ADF, Ng-Perron test	KPSS, Perron test
	C+T	PP, ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
Australia CPI 1957.1-2005.2	C	PP,ADF, Ng-Perron test	KPSS, Perron test
	C+T	PP, ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
Pakistan M2 1957-2005	C	PP,ADF, Ng-Perron test	KPSS, Perron test
	C+T	PP, ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP,ADF, KPSS, Ng-Perron test	Perron test
US GDP 1965-2007	C	Ng-Perron, KPSS test	PP, ADF, Perron test
	C+T	PP,ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
US ER 1965-2009	C	PP,ADF, Ng-Perron test	KPSS, Perron test
	C+T	Perron test	PP, KPSS, ADF, NgPerron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
UK GDP 1961-2007	C	Ng-Perron, KPSS test	PP, ADF, Perron test
	C+T	PP,ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
Germony GDP 1961-2007	C	PP,ADF, Ng-Perron test	KPSS, Perron test
	C+T	Perron test	PP, KPSS, ADF, Ng-Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test
UK ER 1961-2007	C	Ng-Perron, KPSS test	PP, ADF, Perron test
	C+T	PP,ADF, Ng-Perron test	KPSS, Perron test
	No C,T	PP, ADF, KPSS, Ng-Perron test	Perron test

Note: *C=constant, *T=trend, RER=Real exchange rate, ER=Exchange rate, M2=Broad money.

If we apply unit root test with constant or constant and trend then Phillips Perron test, ADF test and Ng-Perron test show unit root while KPSS test and Perron test show stationary. Also if we apply unit root test without constant and trend then Perron test bring stationary results but the other entire tests i-e ADF test, Phillips Perron test, KPSS test and Ng-Perron test show unit root.

5.3 Main Conclusion:

The results show that having any series in our hand, we can choose a test which will show the series to be stationary and we can choose another test which will show the series to be unit root. The details for getting this type of results are summarized in Table 5.1.1 to 5.1.5.

This implies that a researcher can get the results according to his/her desire by the appropriate choice of test. This finding supports study of Cochrane (1991) and Blough(1992) who argue that the unit root and stationary series have observational equivalence. This also implies that the theoretical properties of a series should be given appropriate weight deciding about stationary of a series.

For example the real growth rates cannot have unbounded to be unit root because the unit root series has unbounded variance, but real growth rates cannot have unbounded variance. It means that we can get our result on our own choices and there is no uniqueness in the test selection criteria available in the literature.

5.4 Recommendation:

From our analysis KPSS test, Perron test and some cases Phillips Perron test performs well as compared to all of the tests of unit root to bring opposite result in front of deterministic parts in the selection criterion. Hence the researchers should use those unit root tests to bring the desired result unit root/stationary. But when the series is stationary than Ng-Perron test, Phillips Perron test and ADF test show that the series is unit root.

5.5 Positive Implications:

It implies that if we bring our desire result (stationary or unit root) from any test then it is easy due to some manipulation in test equation or lag-length. Furthermore we can say that every test give different results in different situations. It means there is no existing technique in the literature to give the unique result.

From our analysis we can say that if we apply unit root test with constant or constant and trend then Phillips Perron test, ADF test and Ng-Perron test show unit root while KPSS test and Perron test show stationary. Also if we apply unit root test without constant and trend then Perron test brings stationary results but the other entire tests i-e ADF test, Phillips Perron test, KPSS test and Ng-Perron test show unit root. So it is possible to bring our desire results by using the existing tests in the literature.

References:

1. A.Corhy, A.Tourani Rad. J.P. Urban, 1993. Common stochastic trends in Europen stock markets. Economics Letters 42 385-390.
2. Adamopoulos Antonios(2010)."Stock market & Economic growth: An empirical analysis for Germany."Bussiness and economics journal, Vol BEJ-1 1-12.
3. Banerjee, A., Lumsdaine, R. and Stock, J.H. (1992). Recursive and sequential tests of unit root and the trend break hypothsis: theory and international evidence. Journal of Business Economics and Statistics, 10, 271-287.
4. Blough, S.R. (1992). The relationship between power and level for generic unit root tests in finite samples. Journal of Applied Econometrics, 7, 295-308.
5. Campbell, J. Y., and Perron, P. (1991). Pitfalls and opportunities: what macroeconomists should know about unit roots? NBER Macroeconomics Annual. 6. 141-201.
6. Ebru Caglayan.(2010). Does Purchasing Power Parity Hold in OECD Countries? International Research Journal of Finance & Econometrics. ISSN 1450-2887 Issue 37 138-146.
7. Faust, J. (1993). "Near observational equilence and unit root processes: Formal concepts and implications." International Finance Discussion Paper #447, Federal Reserve Boad.
8. Gil-Alana, L.A. (2008) "Fractional integration and structural breaks at unknown periods of time" Journal of Time Series Analysis 29, 1, 163-185.
9. Glynn, John (2007). "Unit Root Tests and Structural Breaks:A Survey with Application."Revista de M'Etodos cuantitativos Para La Econom'ia Y La Empresa (3).P'aginas 63-79.

10. Hye QAM (2009). "Money Supply and Agricultural Prices: A Causality Analysis for Pakistan Economy (Quarterly Data Analysis)". J. Agric.Res., 47(2): 193-199.

11. John H.Cochrane (1991). "A critique of the application of unit root tests."Journal of Economic Dynamics and Control 15 275-284.

12. M.Shahbaz, Hafeez Ur Rehman, N.Amir, 2010. "The Impact of trade & financial Oppeness on Govt size; A case study of Pakistan." Journal of Quality & Technology Management Vol. VI, Issue 1, pg. 105-118.

13. Nelson, C.R. and Ploseer, C.I. (1982). Trends and random walks in macroeconomics time series: some evidience and implications. Journal of Monetary Economics10, 139-162.

14. Perron, P. (1997), "Further Evidence on Breaking Trend Functions in Macroeconomic Variables, *Journal of Econometrics* 80 (2), pp: 355-385.

15. Qazi Muhammad Adnan Hye, masood Mashkoor Siddiqui, 2010. Money supply, exchange, industrial & agricultural product prices: Evidence from Pakistan. African Journal of Agricultural Research Vol. 5(22), pp. 2997-3002.

16. Said, S.E. and Dickey, D.A. (1984). Testing for unit roots in autoregressive moving average models of unknown order. Biometrika, 71, 599-607.

17. Serena Ng and Pierre Perron (2001). "Lag length selection and the construction of unit root tests with good size and power."Econometrica, Vol. 69, 1519-1554.

18. Spanos A. and Anya McGuirk (2006). Revisiting the foundations of unit root testing: why the AR(1) model does not nest the unit root. Virginia Tech working paper series.

19. Waheed, Muhammad, Alam, Tasneem and Ghauri (2006). "Structural breaks and unit root: Evidence from Pakistani macroeconomic time series." Munish Personal RePEc Archieve 7(1797): 1-20.

20. Waliullah, Mehmood Khan Kakar, Rehmat Ullah Kakar (2010). The Determinants of Pakistan's Trade Balance. The Lahore Journal of Economics, 15-1, pp.1-6.

21. Zivot, E. & Andrews, D.W.K. (1992). Further evidence on the great crash, the oil price shock and the unit root hypothesis. Journal of Business and Economic Statistics, 10, 251-270.