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A time series analysis of structural break time in the macroeconomic variables in Ethiopia

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This research examines the structural break dates for export, import and GDP in Ethiopia using annual macroeconomic time series data spanning the years from 1974 through 2009. The study revealed that Ethiopia economy has been subject to a structural change and regime shift during the sample period. This paper reviews tests for structural change in linear regression models with Chow test which was formalised from Perron (1989) to perform tests on time series data on three assumed dates 1992, 1993 and 2003 to determine the date(s) at which there was a statistically significant structural break. The study infers that endogenously determined structural break time for the macroeconomic variables (export, import and GDP) of Ethiopian economy was found to be 2003. Noteworthy is that the structural break occurred after eleven years of the regime shift suggesting the policy change is not corresponding with the anticipated structural break in Ethiopian economy. This implies that structural break taken place endogenously well after policy announcement.

Key words: Ethiopia, macroeconomic variables, structural break.

INTRODUCTION

The methods of estimation of economic relationships and modeling fluctuations in economic activity have been subjected to fundamental changes in last four decades. Most of the work has concentrated on detecting the pre-sence of structural break(s) and estimating the location of the break(s). The method of estimation of the standard regression model, OLS (Ordinary Least Square) method, is based on the assumption that the means and variances of these variables being tested are constant over the time. Variables whose means and variances change over time are known as non- stationary or unit root variables. Therefore, incorporating non-stationary or unit root variables in estimating the regression equations using OLS method give misleading inferences. Instead, if variables are non-stationary, the estimation of long-run relationship between those variables should be based on the cointegration method. Since the testing of the unit roots of a series is a precondition to the existence of

cointegration relationship, originally, the Augmented Dickey-Fuller (1979) test was widely used to test for stationarity. However, there are two well-known problems with structural break estimation. The first one is the diffi-culty of differentiating data that is subject to a structural break (before and after which data shows stationary and trend stationary patterns) from data having a unit root. The second one is that although break locations in data can be estimated consistently, there is no efficiency condition for the limiting distribution of the estimates. Although consistency is a sufficient condition for the purpose of many empirical studies, efficiency could still be of interest if the aim is to obtain the smallest confidence intervals around the break dates.

The stated reason behind these difficulties of estimating structural breaks is that the problem is nonstandard; a break date only appears under the alter-native hypothesis, not under the null of no break. Perron (2005) empirical study makes a comprehensive review of both problems; however it is very technical, and seemingly there is a lack of resources summarizing the relevant literatures. To overcome this, Perron proposed allowing for a known or exogenous structural break in the

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Augmented Dickey-Fuller (ADF) tests. The regime shift in Ethiopia took place in 1992 which intricately linked with the political macro-economy of Ethiopia. The following dates are considered important milestones:

1992: Policy change/ political liberalization commenced
1993: Devaluation of exchange rate
2003: steady growth in Ethiopian economy.

This sequence of political and economic events puts the dating problem into context. Should 1992 be the date when political liberalization commenced, or should 1993 be the date of devaluation of exchange rate, or should 2003 be the year when steady growth began in Ethiopian economy? The objective of this study is to investigate empirical observation and related empirical research in addressing this problem of endogenously determined structural break time for the macroeconomic variables in Ethiopia. The F test (chow test, 1960) was employed to test the existence of endogenously determined structural break time.

LITERATURE REVIEW

Structural break(s) is/are sudden policy change(s) in government or serious international disaster (civil war). This sudden change can occur in time series data or cross sectional data, when there is a sudden change in the relationship being examined. A data can be found to be non-stationary if it has a unit root, or if it includes a structural break, before and after which data shows different patterns. As it is sometimes called in literature, this is part of the intricate play between unit roots and structural breaks (Perron 1989, 2005). Most tests that attempt to distinguish between a unit root and a (trend) stationary process will favor the unit root model when the true process is subject to structural changes, but is otherwise (trend) stationary within regimes specified by the break dates. Also, most tests trying to assess whether a structural change is present will reject the null hypothesis of no structural change when the process has a unit root component but also constant model parameters. Accordingly, there is voluminous literature on testing for a unit root under structural break(s). These tests also give break dates as a by-product, but they are not as efficient as the break estimators. The early influential empirical study of Perron (1989) tests null hypothesis of unit root under the assumption of known (exogenous, pre-tested) break date in both null and alternative hypotheses. Later Christiano (1992) criticizes Perron's known date assumption as data mining. He argues that the data based procedures are typically used to determine the most likely location of the break, that is. by pre-test examination of the data, and this approach invalidates the distribution theory underlying conventional testing. Zivot and Andrews (1992) and Perron (1997)

proposed determining the break point endogenously from the data.

However, these endogenous tests were criticized for their treatment of breaks under the null hypothesis. They do not allow for break(s) under the null hypothesis of unit root and derive their critical values accordingly. So they exclude the possibility that there may be a unit root process with a break. One way of overcoming this problem would be taking log difference of the data, which made the series stationary, and look for a break in the growth rate of the series. Nonetheless, it would be wise to avoid data conversions that smooth the data; especially when the data is not long enough or includes outliers. It is because under these conditions break estimation tends to catch any kind of one time deviation in the data rather than finding a change in trend or in mean. In this case, these tests declare data as stationary with breaks. So it seems literature on this subject arrives at the approach of Lee and Strazicich (2003 and 2004), employing minimum Lagrange Multiplier (LM) tests. One test allows for two-breaks in time series data, and the other allows one. While testing for a unit root, they both estimate break date(s) endogenously from the data, and also allow break(s) both under the null and alternative hypotheses. By simulation exercises they show that their test outperforms existing ones. Besides, recently Glynn et al. (2007) analysed existing tests and mentioned the superiority of Lee and Strazicich's test. Conversely, they also point out that instead of univariate models, common feature analysis of unit root with breaks has more potential, while indicating the development in this area is very limited. Hendry and Massmann (2007) applied to test unit roots under structural breaks, or directly to test for structural breaks, which rests on the principle that there is an appropriate combination of variables, having a break in common, that does not display the breaks any longer. But this very reason also prevents co-feature analysis from always being applicable. Applying them requires using more than one series, which are suspected to have common breaks. In order to deal with breaks in the growth rate of export, import and GDP, it requires using different type regressions and cannot be tested at a time with co-breaking analysis. Alternatively, each variable may have been tested for a break independently from the other.

Structural break tests can be divided into three categories. The Chow test is used within the first category. It tests whether the series has a break in the tested date. The tests in the second category look for the presence of a break in the series, which may exist at any time within the sample period. Some tests in this category also reveal the most possible break date as a by-product. The tests in the last category are in fact estimators, they first estimate the unknown date of the break, then test it. For any type of break, the date of the break, if it exists, is unknown so that it falls into the third category. But to understand the basics of the structural break estimators

that are used to find unknown break dates and test them, it is better to start with the Chow Test. It is because unknown date estimators that use more complicated tests basically rest on the same principles as this test. Chow test looks for the following. Whether splitting data from the possible break point and estimating two generated sub-samples separately by least square gives significantly better than using the whole sample at once; if the answer is yes, the null hypothesis of no break is rejected. The resulting statistics would be; F-statistics, log likelihood ratio or the Wald statistic. However, as there can be more than one break in the data, the estimators can be further divided into two categories; single break estimators and multiple break estimators. Actually it is theoretically proven that consistency for the break date estimates is satisfied for single break estimators even more than one break in the data exist (Bai, 1997b; Bai and Perron, 1998). This works by first finding one break in the data, and then splitting the data from there and searching for new breaks in the new samples. However, as there is no efficiency condition for any estimator, multiple break estimators are used to get more precise estimates, that is. to find smaller confidence intervals around the breaks, and also to increase the rate of convergence to the break dates. This increases efficiency in the estimation of parameter values subject to the structural change. Conversely, Multi-Equations Systems is used to get more precise estimates for any type of estimator.

Single break estimators

For the unknown break date, Quandt (1958, 1960) proposed likelihood ratio test statistics for an unknown change point, called Supremum (Max)-Test, while Andrews (1993) supplied analogous Wald and Lagrange Multiplier test statistics for it. Then Andrews and Ploberger (1994) developed Exponential (LR, Wald and LM) and Average (LR, Wald and LM) tests. These tests are calculated by using individual Chow Statistics for each date of the data except from some trimmed portion from both ends of it. While the Supremum test is calculated for and finds the date that maximizes Chow Statistics, the most possible break point, the Average and Exponential tests use all the Chow statistic values and are only informative about existence of the break but not its date. The deficiencies of the Supremum test are, however, as follows. It only has power if one break occurs under the alternative hypothesis, and is valid as long as residuals from the regression follow ibid. This means they do not show heterogeneity before and after the break, as is also a necessary condition for the Chow test. Heteroscedasticity and autocorrelation robust version of this test (also called Quandt Likelihood Ratio or Andrews-Quandt statistics, which is the estimator used most commonly in this literature) can be used, even though it still gives the most possible break date (it is so because

of small sample properties). It also strongly suffers from large confidence intervals around the break date.

Finally, and again for the single break model, Bai et al. (1998) use quasi likelihood estimation in a VAR setting and show that with common breaks across equations, the precision of the estimates increases with the number of equations in the system.

However, their methodology obviously can only be carried out as long as equations are expected to show a break in the same time period. This could be the case when several variables are co-integrated. Besides, this test is designed for a single break and there could be more than one break date in the data, in which case these test exhibits non-monotonic power function (Vogelsang, 1997, 1999).

Multiple break estimators

Perron and Qu (2006), following the work of Bai and Perron (1998, 2003), first define minimum segment length (in proportion to the total data). Given this constraint, they then search for the optimal partition of all possible segments of data to obtain global minimisers of the sum of squared residuals. By this way, they obtain the location of breaks, minimizing their objective function for any possible number of breaks. Then they sequentially test for whether an additional break date significantly reduces the sum of squared errors. Their methodology inherits both pure and partial structural change models. Though this method consistently identifies the break dates, Perron's (2005). This is due to when estimating a single break model in the presence of multiple breaks, the estimate of the break fraction will converge to one of the true break fractions, the one that is dominant in the sense that taking it into account allows the greatest reduction in the sum of squared residuals (in the case of two breaks that are equally dominant, the estimate will converge with probability half (½) to either break).

Comment on this procedure states the fact that method of estimation is based on the least-squares principle implies that, even if changes in the variance of error terms are allowed, provided they occur at the same dates as the breaks in the parameters of the regression, such changes are not exploited to increase the precision of the break date estimators. This is due to the fact that the least-squares method imposes equal weights on all residuals allowing different weights, as needed when accounting for changes in variance, requires adopting a quasi-likelihood framework.

Finally, Perron and Qu (2007) bring a novel approach to structural change analyses which enable to find considerably small confidence intervals around the break dates. Perron and Qu (2007) use a multiple equation model. They first define the minimum segment length of the data that could be separated with breaks. Given this
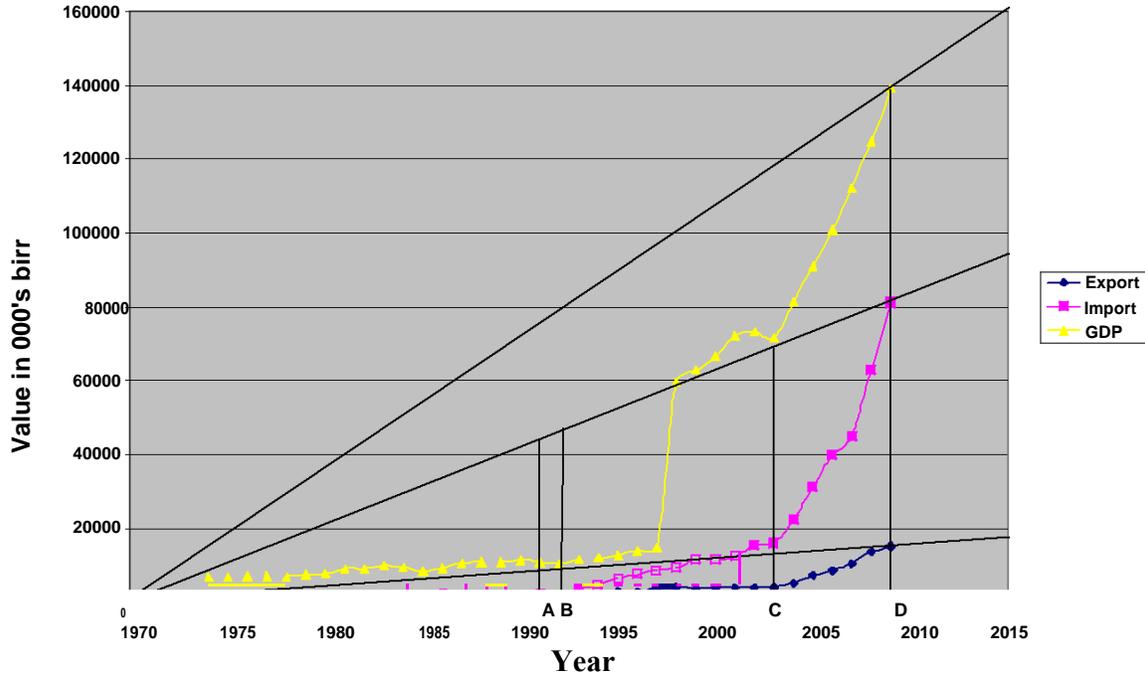
Figure 1. Structural break time for export, import and GDP in Ethiopia (1974 to 2009). Source: Author's computation from data of NBE various years' annual reports.

constraint, they then search for the optimal partition of all possible segments of data which the model fits, where the objective function being maximised is a quasi-likelihood one based on normal errors.

MODEL SPECIFICATION

A series of data can often contain a structural break, due to a change in policy or sudden shock to the economy, that is. 1992 policy change, 1993 exchange rate devaluation and 2003 changes in growth of Ethiopian economy. The F test (chow test) was applied to test the existence of endogenously determined structural break time in these dates. Thus, the study signifies structural break with adopted Chow test of Perron (1989) structural break analysis model. In this case the first model specifies just a single regression line to fit the data points (scatter plot), which can be expressed as:

$$\log s_t = \alpha_0 + \alpha_1 \log x_t + \alpha_2 \log m_t + \alpha_3 \log yt + \mu_t$$
(1)

Where, s refers structural break, x, export, m, import, y, GDP, α's are unknown parameters to be estimated, t, is time in years (1974-2009 and μ is random terms that are independently and identically distributed with mean zero and variance^2 (^{2}). The model in effect determines whether a single regression is more efficient than three separate regressions involving splitting the data into three sub-samples, given as:

$$\log S_t = \beta_1 + \beta_2 \log x_t + \mu_{1t} \; ;$$
$$\log S_t = \delta_1 + \delta_2 \log m_t + \mu_{2t} \; ; \text{and}$$
(2)
$$\log S_t = \theta_1 + \theta_2 \log y_t + \mu_{3t}$$

Where, β's, δ's, $\theta's$ are unknown parameters to be estimated and μ is random terms that are independently and identically distributed with mean zero and variance^2 (^{2}). This suggests that model 1 applies before the break at time t, while model 2 applies after the structural break. If the parameters in the above three models are the same, that is,

$\beta_1 = \delta_1 = \theta_1 \; and \; \beta_2 = \delta_2 = \theta_2$, then the three models can be expressed as a single model as in case 1, where there is a single regression line. The Chow test basically tests whether the single regression line or the three separate regression lines fit the data best.

Regressions were run for each of the assumed policy event date, 1992; 1993; and 2003. Then tests for a structural break involves testing whether the coefficients on $\beta_1 \log x_t$, $\delta_2 \log m_t$ and

$\theta_3 \log y_t$ are significantly different from zero. To estimate equation (2) the time-series approach was applied. The empirical results were tested using Eviews 3 and SPSS 15. To test the

hypothesis $H_0 : \alpha$ =structural stability versus $H_1 : \alpha$ = structural break, regression of RSS (regression using all the data, before and after the structural break), RSS$_1$ (regressions on the data before the structural break and RSS$_2$ (regressions on the data after the structural break) is done.

RESULTS AND DISCUSSION

Descriptive evidence

The value of real GDP, exports and imports data presented in Figure 1 indicates that the actual structural
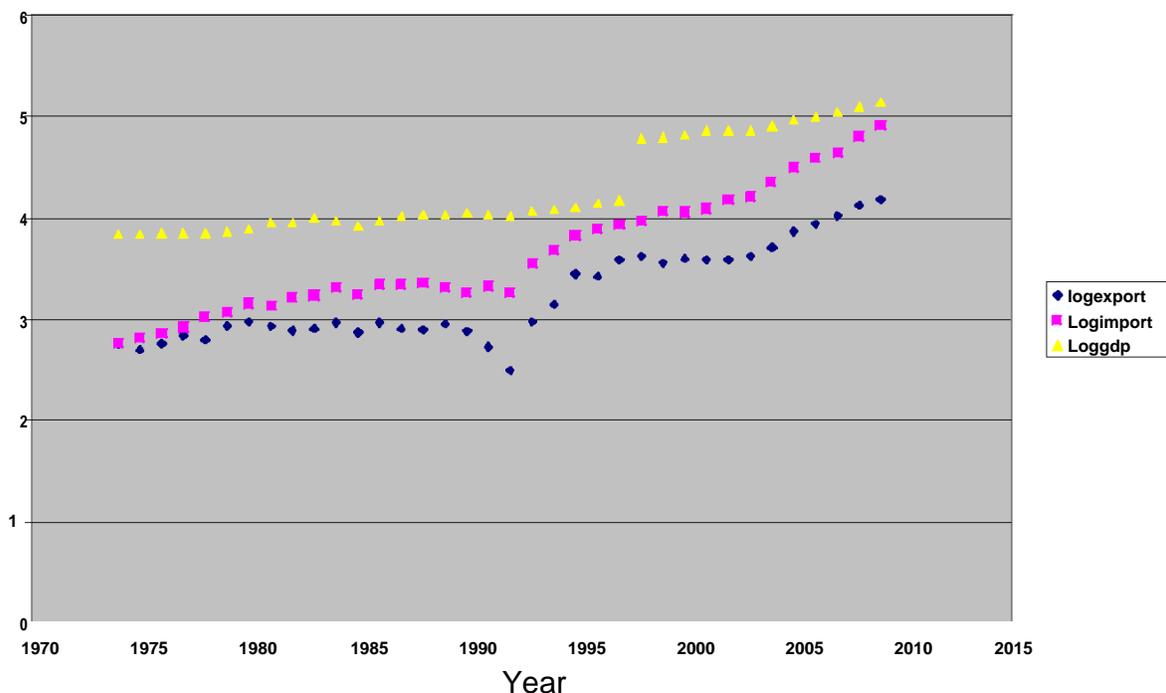
Figure 2. Log export, logimport and loggdp. Source: Author's computation from data of NBE various years' annual reports.

break date for the variables was 2003 at point 'C'. This implies that, although, endogenously determined regime shift date was 1992 at point 'B', it took 11 years to bring structural break in Ethiopian macroeconomic variables.

Empirical estimation

Two levels of analysis were presented. First, graphical analysis of time series is shown and explained. Secondly, results of econometric tests are given.

Graphical analysis

Visual inspection of the series in Figure 2 indicates that they could be trend stationary. GDP, however, tends to be trending upwards more sharply after the 1990s. Imports tend to follow a stationary random walk. Prior the 1990s the three series follow a co-movement fashion, but post-1990s export and import appear to diverge. From the graphs it is probable that a structural break occurred in the 2003. Conversely, graphical analysis is not conclusive; more credence is given to the econometric analysis that follows.

Results of econometric tests

The classical linear regression model (CLRM) and ECM (error correction model) are used to estimate the data.

Proceeding to running the estimation, model diagnostic tests and corrections are made. These include hetero-scedasticity, autocorrelation, multicollinearity and non stationary in the data. In order to detect heterosce-dasticity, a plot of OLS residuals against the dependant variable ($\log s_t$) is made. Although the model passes ANOVA[1] test, plot of OLS residuals against time and formal test to detect autocorrelation using partial autocorrelation function (PACF) are done. The estimation begins with the testing of variables for unit roots to determine whether they can be considered as a stationary or non-stationary process. Table 1 presents the Augmented Dickey Fuller (ADF) tests of variables. The tests showed that the variable $\log gdp$ was

stationary at first difference while the other variables were stationary at second difference. Critical values for tests were found to be -2.95 and - 2.61 at 5% and 10% respectively. Annex Tables 1 to 3 gives details of unit root test outputs of variables.

To examine whether the integrated variables are cointegrated, it was modelled using variables to achieve stationarity which leads to loss of long-run information. The concept of cointegration implies that if there is a long-run relationship between two or more non-stationary variables, deviations from this long-run path are stationary. Johansen's (1988, 1990 and 1991) cointegra-tion multivariate procedure is used to establish whether the variables are cointegrated in the long run. As result, the

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[1] NOVA-Analysis of Variance

Table 1. ADF unit root tests.

Variables	ADF test statistics	Order of integration	Critical values at 5%	Critical values 10 %
log export	-5.402088	I(2)	2.95	2.61
log import	-5.478751	I(2)	2.95	2.61
log gaps	-3.870575	I(1)	2.95	2.61

Table 2. Co-integration tests for logexport and logimport.

Hypothesized no. of (CE)	Eigen value	Likelihood ratio	5% critical value	1% critical value
r=0	0.184169	8.999872	15.41	20.04
r 1	0.059322	2.079244	3.76	6.65

Note: The test assumes linear deterministic trend in the data.

Table 3. RSS (residual sum of squares) for all data.

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	3773.330	3	1257.777	360.427	0.000(a)
	Residual	111.670	32	3.490		
	Total	3885.000	35			

RSS = 111.670.

Table 4. RSS (residual sum of squares) before structural break time.

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	1973.165	3	657.722	289.311	0.000(a)
	Residual	56.835	25	2.273		
	Total	2030.000	28			

RSS$_1$ = 56.835.

likelihood ratio indicates no co-integrating equations at 5% significance level. In other words, it rejects null hypothesis of having more than co-integrating vector. Since the test statistic (8.99) is less than the 95% critical value (15.41) of the likelihood ratio test, it is possible to reject the null hypothesis of more than one co-integrating vector (Annex Tables 4 and 5). The maximum Eigen value test starts with the null hypothesis of at most r co-integrating vector against the alternative of r+1. The result for maximum Eigen value test confirms the rejection of the null hypothesis; that is, more than one co-integrated vectors and ECM (error correction model). Therefore, both maximum Eigen value and likelihood ratio indicate that there is no co-integrating equation at 5% significance levels (Table 2).

Further, it was analysed that a single regression line is not a good fit of the data due to the obvious structural break in 2003. Then analyses of 3 separate regression equations were done which are more efficient than regression lines (Figure 2). This needs the Chow test,

which is a variation of the F-test for a restriction expressed as:

$$F = \frac{RSSR - (RSS_1 + RSS_2)K}{RSS_1 + RSS_2 /(N_1 + N_2 - 2K)}$$

Where, RSSR residual sum of squares of the model on all data; RSS$_1$ and RSS$_2$ sum of residual squares of the models on the two subset of data (before and after structural break time) respectively; and k number of restrictions (parameters to be estimated)

Based on these out puts the test statistic was calculated using the following formulae:

$$F = \frac{RSSR - (RSS_1 + RSS_2)K}{RSS_1 + RSS_2 /(N_1 + N_2 - 2K)}$$

$$F = \frac{111.67 - (56.835 + 0.017)6}{56.835 + 0.017 /(29 + 7 - 12)}$$

Table 5. RSS (residual sum of squares) before structural break time.

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	27.983	3	9.328	1603.446	0.000(a)
	Residual	0.017	3	0.006		
	Total	28.000	6			

RSS_2= 0.017.

Table 6. Chow test on regression of export, import and GDP (1992).

F-statistic	0.236475	Probability	0.789530
Log likelihood ratio	0.478013	Probability	0.787410

Table 7. Chow test on regression of export, import and GDP (1993).

F-statistic	0.236475	Probability	0.789530
Log likelihood ratio	0.478013	Probability	0.787410

Table 8. Chow Test on regression of export, import and GDP (2003).

F-statistic	2.478815	Probability	0.085301
Log likelihood ratio	4.978949	Probability	0.082954

$$F = \frac{111.67 - (56.852)6}{56.852.(24)}$$

$$F = \frac{111.67 - 9.47}{2.37}$$

$$F = 43.12$$

The critical value for F (6, 24) is 2.51 at 5% significance level. This implies that the test statistic (43.12) is greater than the 95% critical value (2.51) of F-test; it is possible to reject the null of no structural break times in macroeconomic variables under investigation. It was concluded that there is structural break time in Ethiopian macroeconomics variables. Moreover, analysis with chow test using F-test estimation technique indicates that there is structural break time for the variables under investigation. The Chow test results on the regressions of the I (0) variables, export, import and GDP, are follows (Tables 6 - 8). The only significant breakpoint is 2003 at 10% significance level. Thus there was a structural break in the series in 2003 (Table 8).

Conclusion

This research examines the structural break dates for export, import and GDP in Ethiopia using annual macro-economic time series data spanning the years from 1974 through 2009. The Ethiopian economy has been subject to a twofold of structural changes and regime shifts during the sample period. Thus after applying conven-tional unit root tests of Augmented Dickey–Fuller (ADF), time series properties of the data are analysed by F-statistics (chow test) approach to determine endogenously the more likely time of structural breaks in macroeconomic variables of the Ethiopian economy. Based on the above models, the presences of one unknown structural break time in the data are considered. After accounting for the single most significant structural break, the results from the Chow test models clearly indicate that for all series under examination, the null hypothesis of more than one structural break time can be rejected, a result consistent with the conventional unit root tests. In other words, the empirical results based on the conventional unit root tests as well as on the above model of unit root tests which take into account the presence of potential structural breaks, indicate that there is enough evidence to reject the null hypothesis of unit root for any of the variables under investigation. Empirical results indicate that for the variables under investigation the endogenously determined break date closely corres-pond to the important phenomena in the performance of Ethiopian economy since 2003.

REFERENCES

Andrews DWK (1993). Tests for parameter instability and structural change with unknown change point. Econometrica, 61: 821-856 (Corrigendum, 71: 395-397).

Bai J, Perron P (2003a). Computation and analysis of multiple structural change models. J. Appl. Econ., 18: 1-22.

Bai J, Perron P (2003b). Critical values for multiple structural change tests. Econ. J., 6: 72-78.

Bai J, Perron P (1998). "Estimating and Testing Linear Models with Multiple Structural Changes," Econometrica, 66(1): 47-78.

Bai J, Lumsdaine RL, Stock JH (1998). Testing for and dating breaks in

multivariate time series. Rev. Econ. Stud., 65: 395-432.

Bai J (1997b). Estimating multiple breaks one at a time. Econometric Theory, 13: 315-352.

Christiano LJ (1992). Searching for breaks in GNP. J. Bus. Econ. Stat., 10: 237-250.

Chow GC (1960). "Tests of Equality between Sets of Coefficients in Two Linear Regressions," Econometrica, 28: 591-605.

Dickey DA, Fuller WA (1979). "Distributions of the Estimators for Autoregressive Time Series with a Unit Root", J. Am. Stat. Assoc., 74(366): 427-481.

Glynn J, Perera N, Verma R (2007). Unit Root Tests and Structural Breaks: A Survey with Applications. J. Quantitative Methods Econ. Bus. Admin.

Hendry DF, Massmann M (2007). Co-Breaking: Recent Advances and a Synopsis of the Literature. J. Bus. Econ. Statistics, Amer. Statistical Assoc., 25: 33-51, January.

Johansen S (1988). Statistical Analysis of co-integrating vectors. J. Econ. Dynamics. Cont., 12: 231-254.

Johansen S (1991). Estimation and hypothesis testing of Co-integration vectors in Guassian autoregressive models. Econometrica, 59: 1551-1580.

Johasnsen S, Juselius K (1990). Maximum Likelihood estimation and inference in Co-integration with application to demand for money. Oxford Bull.f Econ. Stat., 52: 169-210.

Lee J, Strazicich MC (2003). "Minimum LM Unit Root Test with Two Structural Breaks", Rev. Econ. Stat., 63: 1082- 1089.

Lee J, Strazicich MC (2004). "Minimum LM Unit Root Test with One Structural Break", Working Paper, Department of Economics, Appalachian State University NBE (National Bank of Ethiopia), Annual Reports of various years'.

Perron P (2005). "Dealing with Structural Breaks", Mimeo forthcoming in the Vol. (1): Handbook of Econometrics: Econometric Theory.

Perron P (1997). "Further Evidence on Breaking Trend Functions in Macroeconomic Variables, J. Econ., 80(2): 355-385.

Perron P (1989). "The great crash, the oil price shock, and the unit root hypothesis", Econometrica, 57: 1361-1401.

Perron P, Qu Z (2006). Estimating Restricted Structural Change Models. J. Econ., 134: 373-399.

Perron P, Qu Z (2007). Estimating and Testing Structural Changes in Multivariate Regressions. Econometrica, Econometric Society, 75(2): 459-502.

Quandt RE (1958). The estimation of the parameters of a linear regression system obeying two separate regimes. J. Amer. Statistical Assoc., 53: 873- 880.

Quandt RE (1960). Tests of the hypothesis that a linear regression system obeys two separate regimes. J. Am. Stat. Assoc., 55: 324-330.

Vogelsang TJ (1997). Wald-type tests for detecting breaks in the trend function of a dynamic time series. Econometric Theory 13: 818-849.

Vogelsang TJ (1999). Sources of nonmonotonic power when testing for a shift in mean of a dynamic time series. J. Econ., 88: 283-299.

Zivot E, Andrews K (1992). "Further Evidence On The Great Crash, The Oil Price Shock, and The Unit Root Hypothesis", J. Bus. Econ. Stat., 10(10): 251–70.

ANNEX

Table 1. ADF unit root test on logexport at 2nd difference with intercept.

ADF test statistic	-5.402088	1% critical value*	-3.6496
		5% critical value	-2.9558
		10% critical value	-2.6164

*MacKinnon critical values for rejection of hypothesis of a unit root.
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGEXPORT,3)
Method: Least Squares
Date: 09/02/10 Time: 13:57
Sample(adjusted): 1978 2009
Included observations: 32 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGEXPORT(-1),2)	-1.736557	0.321460	-5.402088	0.0000
D(LOGEXPORT(-1),3)	0.124261	0.182777	0.679851	0.5020
C	0.000524	0.027720	0.018904	0.9850
R-squared	0.775302	Mean dependent var		-0.002500
Adjusted R-squared	0.759805	S.D. dependent var		0.319778
S.E. of regression	0.156722	Akaike info criterion		-0.779623
Sum squared resid	0.712294	Schwarz criterion		-0.642210
Log likelihood	15.47397	F-statistic		50.03092
Durbin-Watson stat	2.044400	Prob(F-statistic)		0.000000