

Macroeconomic Variables and Structural Breaks: Empirical Evidence from the Turkish Economy

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ABSTRACT

The goal of this paper is to examine whether macroeconomic series of Turkey are stationary when the estimated break points are taken into account. In addition, we attempted to determine the existence of significant structural breaks in the selected macroeconomic variables for the specific case of Turkey by employing the procedure by Perron (1997) and Zivot and Andrews (1992). The evidence based on Turkish data reveal that the hypothesis of a unit root cannot be rejected for the selected macroeconomic series of Turkey even if we allow for the presence of an estimated break point in the series. The results of sequential break tests suggest that the majority of structural break points detected coincides with a regime shift (i.e., 1980) in the recent economic history of Turkey. On the other hand, the estimated structural break in some other macroeconomic variables occurred in 1994.

1. Introduction

Testing the presence of a unit root in macroeconomic time series has been the subject of great concern in economics over the past decade. The time series properties of macroeconomic variables have important implications for economic theories. The effect of a random shock on the level of a nonstationary series will persist indefinitely. This is contrary to the conventional business cycle theory arguing that these cycles are transitory fluctuations around a stable trend path (Nelson and Plosser, 1982). Because of their serious implications for macroeconomic theories, testing for unit roots in macroeconomic variables by reliable methods is of critical importance for economists.

In a well known paper, Nelson and Plosser (1982) could not reject the null hypothesis of a unit root in the most macroeconomic variables for the United States. However, Perron (1989) argued that allowing for a single break in either the intercept or the slope of the trend function, most macroeconomic time series are stationary around a deterministic trend. He suggested that the economic shocks in 1929 and 1973 have had permanent effects on the macroeconomic time series of the United States. Furthermore, Banarjee, et al. (1992), Perron and Vogelsang (1992), Zivot and Andrews (1992), and Perron (1997) formed their models by allowing stationarity around an endogenously estimated structural break point under the alternative hypothesis.

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The main objective of this paper is to investigate whether the macroeconomic series of Turkey are stationary when the estimated break points are taken into account. The methodologies recently developed by Perron (1997) and Zivot and Andrews (1992) are employed to test for unit roots in macroeconomic time series. Moreover, this paper examines endogenously determined structural breaks in the selected macroeconomic series of Turkey during the period 1970-1999.

The rest of the paper is organized as follows. Section 2 presents a brief information about the Turkish economy during the period 1970-1999. Section 3 will describe structural break tests proposed by Perron (1997) and Zivot and Andrews (1992). Section 4 outlines the data and empirical results. Finally, Section 5 summarizes the paper and its conclusions.

2. The Outlook of the Turkish Economy During the Period 1970-1999

Before embarking upon an empirical analysis, it may be useful to review the major structural changes in the economic policies of Turkey during the period 1970-1999. Turkey's industrialization strategy was based on import substitution and protectionist policies during the 1970s. While the Turkish economy registered a relatively good performance in the period 1970-73, the adverse impact of the two main factors influenced the following years: first, successive oil shocks in the 1970s and secondly, the recession in Europe. The upsurge of oil prices together with demand-led growth of the period 1970-73 increased domestic inflation and trade deficit. Moreover, the foreign debt burden of Turkey grew steadily during the 1970s. Although the deterioration in the balance of payments remained tolerable due to workers' remittances, eventually those remittances decreased because of the overvalued Turkish Lira. Turkey experienced rampant inflation and a full-scale balance of payments crisis at the end of 1970s (Nas and Odekon, 1988).

The traditional industrialization strategy based on import-substitution and protectionist policies ended with the introduction of an orthodox program of stabilization and structural adjustment in 1980. The program included radical measures to control high inflation, reduce external deficit, and gradually realize Turkey's transition to an outward oriented market economy (Hershlag, 1988). The Turkish economy showed a significant improvement in some spheres such as exports and foreign debt situation during the 1980s. However, the performance of the Turkish economy was relatively poor with respect to inflation, unemployment, budget deficits and income distribution (Nas and Odekon, 1988).

With the new policy regime of post-1980, several measures were taken to reduce the role of the Central Bank as the basic source of the deficit finance. Moreover, Turkish government reformed the monetary system in 1986 and 1990 by changing the reserve requirement system and restructuring the balance sheet of the central bank. Since the government's access to the Central Bank resources have been heavily restricted during the post-1980 period, the debt finance has become the major source for financing fiscal deficits. The main motivation behind the shift from monetization to internal debt finance may be explained by the government's desire to avoid the acceleration of inflation through the monetary growth. However, an increasing reliance on domestic debt finance has generated an interest payments explosion due to a large internal debt stock and very short debt maturities (Özmen and Koğar, 1998).

The liberalization of the international capital flows and the foreign exchange regime were completed in the early 1990. On the other hand, the policy of continual real depreciation until 1989 encouraged the currency substitution. From the late 1980s onwards, increased public sector borrowing requirements raised the domestic interest rates above foreign rates and attracted capital inflows, which in turn exerted upward pressure on the real exchange rate. However, the liberalization of the capital account without achieving stabilization led to the speculative capital inflows due to high real interest rates.

The Turkish economy experienced large fluctuations in the rate of growth during the 1990s as inflation rates fluctuated at around 65-70 percent during the first part of the decade, and at around 80-90 percent during the second half. On the other hand, the nominal rates of interest reached to the levels of more than 100 percent over the past decade. The Central Bank implemented a controlled peg regime together with a contractionary monetary policy to control inflation. Furthermore, the fragile Turkish financial system with a poorly supervised, weak banking structure suffered from the problems of low capital adequacy and uncovered short-term positions of banks against exchange rate risk (Yeldan, 2001).

The Turkish economy underwent a severe currency crisis in early 1994. Shortly prior to crisis, there was a sizeable real appreciation of the Turkish Lira. The two alternative views have been expressed by economists in Turkey about the fundamental causes of Turkish currency crisis in 1994. First, some authors suggest that 1994 currency crisis of Turkey resulted from problems related to public debt mismanagement (Öztaç, 1996). The alternative view stresses the role of policy mistakes in sequencing of economic liberalization. The external financial liberalization without achieving stabilization limited the ability of policy authorities to use monetary policy instruments such as interest rate and exchange rate, leading to a severe currency crisis (Yeldan, 1996).

On the other hand, the customs union formed between Turkey and the European Union in 1996 further liberalized Turkish foreign trade by removing all trade barriers between the two parties. Thus, 1996 marks a new period in the foreign trade relations of Turkey. After the failure of a series of stabilization attempts through the decade, the Turkish government started a disinflation program in July 1998 under the auspices of International Monetary Fund (IMF). The main objective of the disinflation program was to reduce fiscal deficits and control the inflation. However, the IMF-supported program failed to accomplish its objectives in the wake of the general elections and two earthquakes.

Finally, the heavy interest burden of the government and high double-digit inflation led to the implementation of an exchange rate-based disinflation program in Turkey with the supervision and technical support of the IMF in December 1999. The program entailed exchange rate based disinflation and monetary control by setting the liquidity generation mechanism to the net foreign asset position of the Central Bank. Since the Central Bank practiced a policy of no sterilization, it acted as a semi-currency board (Yeldan, 2001). In addition, the disinflation program set specific targets for non-interest fiscal surpluses. However, the disinflation program failed to prevent the liquidity crisis in November 2000. The banks with highly-leveraged positions started to sell government securities, creating a severe liquidity shortage in the domestic economy. International speculative capital fled the country and interest rates reached to very high levels. Only after the IMF granted additional support in December 2000 and the technical limits of the monetary program were revised, the continued implementation of the disinflation program have been secured. However, shortly after this rearrangement with the IMF, the exchange rate-based disinflation program ended in February 2001 as a result of the increasing pressures of the markets.

3. Empirical Methodology

Perron (1997) and Zivot and Andrews (1992) emphasized that the date of the break point should be endogenously estimated. The null hypothesis of a unit-root without an exogenous structural break is tested against the alternative that the series is trend-stationary with a one-time break. Perron (1997) structural break tests consist of estimating the following regression:

$$y_t = \mu + \theta DU_t + \beta t + \delta D(T_B)_t + \alpha y_{t-1} + \sum_{i=1}^k c_i \Delta y_{t-i} + \varepsilon_t \quad (1)$$

where $DU_t = 1$ ($t > T_B$) and $D(T_B) = 1$, if $t = T_B + 1$; 0 otherwise with $1(\cdot)$ the indicator function. T_B denotes the time of structural break. The model (1) describes Perron 'Model A' which allows a break in the level of the trend.

There are two methods to determine the date of structural break endogenously. First, the time of break is selected as the value which minimizes t-statistic for testing the null hypothesis of a unit-root ($\alpha = 1$). Secondly, the date of structural break is chosen such that the value of $|t_0|$ is maximized. We employed the selection procedure suggested by Perron (1989) in determining the value of the lag truncation parameter k .

The structural break tests developed by Zivot and Andrews (1992) involve the following regressions:

$$y_t = \mu + \theta DU_t + \beta t + \alpha y_{t-1} + \sum_{i=1}^k c_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT^*_t + \alpha y_{t-1} + \sum_{i=1}^k c_i \Delta y_{t-i} + \varepsilon_t \quad (3)$$

where $DU_t = 1$ if $t > T_B$, 0 otherwise, $DT^*_t = t - T_B$ if $t > T_B$, 0 otherwise. Unlike Perron (1989), one-time break dummy, $D(T_B)$, is not included in Zivot and Andrews (1992) model. The second model describes Zivot and Andrews 'Model A' which allows a shift in the mean. In the third model, we estimate Zivot and Andrews 'Model C' which allows a change in both the mean and the trend. The testing procedure in Zivot and Andrews (1992) is similar to that of Perron (1997) described above.

Perron (1997) has tabulated critical values according to the finite sample size and also asymptotic distribution of the t-statistic. Zivot and Andrews (1992) has the same asymptotic distribution with Perron (1997).

4. Data and Empirical Results

All data used in this study are taken from the State Institute of Statistics, Turkey. The data cover the period 1970-1999. All variables are measured in logs. Export and import were deflated by export price index and import price index, respectively. Money supply and budget deficit series were scaled by wholesale price index in order to construct real variables. The variables in this paper are the following:

WPI : Wholesale price index (1963=100)

X : Export

- M : Import
 BD : Budget deficit
 EX : Exchange rate (Turkish lira / \$US)
 M2 : Money supply, M2

This section presents an econometric analysis of the structural breaks in selected macroeconomic variables for Turkey. The preliminary step in our analysis is concerned with examining the integration properties of the series. The results of augmented Dickey-Fuller (ADF) tests portrayed in Table 1 indicate that all series are integrated of first order I(1) at the 5% significance level. However, Perron (1989) suggested that the conventional unit root tests such as ADF tests are biased towards the nonrejection of the unit-root null in the case of a structural change. Banarjee, *et al.* (1992), Perron and Vogelsang (1992), Zivot and Andrews (1992), and Perron (1997) have developed tests which account for structural breaks in order to avoid bias in favor of a unit-root hypothesis.

Table 1 presents the results of sequential unit root tests based on Perron (1997). The sequential ADF test is used to test the null hypothesis of a unit-root against a structural break in the trend function by employing the appropriate critical values for the related model. The results of unit root tests $t_{\alpha,ADF}$ indicate that the unit-root null hypothesis cannot be rejected for any of the variables at the conventional levels. With T_B chosen to maximize $|t_0|$, we fail to reject the unit root null at the 10% level as well. On the other hand, we followed the procedure proposed by Perron (1989) and set the lag truncation parameter, $k=1$.

Table 1. ADF and sequential unit root tests based on Perron (1997), $k=1^*$

	(1) ADF (with trend)		(2) Sequential unit root tests		
	Levels	First Differences	T_B^{\S}	t_0	$t_{\alpha,ADF}$
WPI	-1.61	-4.57 ^a	1980	-2.80	-3.31
X	-1.75	-4.30 ^a	1982	-3.05	-3.75
M	-1.92	-3.65 ^b	1982	-2.86	-3.47
BD	-0.14	-6.73 ^a	1994	-3.89	-2.30
EX	-2.52	-4.07 ^b	1980	-1.73	-2.77
M2	-2.06	-3.94 ^b	1980	-1.85	-3.01

Notes: * k indicates the lag length. $\S T_B$ denotes the break date suggested by $t_{\alpha,ADF}$ and $|t_0|$. ^a Rejection of the unit root hypothesis at the 1% level, ^b Rejection of the unit root hypothesis at the 5% level.

**Table 2. Sequential unit root tests based on Zivot and Andrews
(1992), k=1**

Variables	(1) Model A			(2) Model C		
	T_B^{\S}	t_{θ}	$t_{\alpha, ADF}$	T_B^{\S}	t_{θ}	$t_{\alpha, ADF}$
WPI	1980	-3.06	-2.70	1980	-2.19	-2.88
X	1982	-3.47	-3.82	1980	-3.23	-4.08
M	1980	-2.97	-3.57	1982	-2.18	-2.26
BD	1994	-4.48	-2.77	1994	-2.87	-3.78
EX	1980	-1.80	-2.81	1980	-2.15	-2.31
M2	1980	-1.01	-2.13	1980	-1.44	-2.08

Notes: * k indicates the lag length. $\S T_B$ denotes the break date suggested by $t_{\alpha, ADF}$ and $|t_{\theta}|$. The critical values for the 1, 5 and 10 percent significance levels of the $t_{\alpha, ADF}$ statistic are -5.34, -4.80, and -4.58 in the model A and -5.57, -5.08, and -4.82 in the model C.

The test statistics for structural break analysis based on Perron (1997) are represented in Table 1 as well. According to the estimated $t_{\alpha, ADF}$, ADF and $|t_{\theta}|$ test statistics, the break point was 1980 for the money supply, exchange rate and inflation in the case of Turkey. For export and import, the most prominent break point was 1982. On the other hand, the results of Perron (1997) tests reveal that the estimated break point is 1994 for the series of budget deficit.

The test statistics for structural break tests by Zivot and Andrews (1992) are reported in Table 2. The results of Andrews and Zivot (1992) tests reported in Table 2 suggest that the macroeconomic series are non-stationary around a trend break in the mean and slope of the trend function. The break point suggested by $t_{\alpha, ADF}$ and $|t_{\theta}|$ test statistics is 1980 for the money supply, exchange rate and inflation for the specific case of Turkey. The estimated year of structural break is 1980 for export and 1982 for import according to test statistics based on Zivot and Andrews 'Model C'. Moreover, the evidence presented in Table 2 suggest that the estimated year of structural break was 1994 for the budget deficit series.

5. Conclusion

In this article, we formally tested for structural breaks in the selected macroeconomic variables by utilizing the Turkish data covering the period 1970-1999. The presence of these breaks in macroeconomic series were identified for the specific case of Turkey by using the recently developed models of Perron (1997) and Zivot and Andrews (1992). The evidence based on Turkish annual data from 1970 to 1999 suggest that the hypothesis of a unit root

cannot be rejected for the selected macroeconomic series of Turkey even if we employ the recent methodological contributions which allow stationarity around an endogenously estimated structural break.

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The empirical evidence presented in this paper indicate that the estimated breakpoints for all macroeconomic variables except for the budget deficit approximately coincides with the major regime shift after 1980. The estimated break point (i.e., 1980) marks a significant year in the economic history of Turkey because the structural adjustment program liberalized foreign trade and realized other reforms in monetary and fiscal spheres. On the other hand, sequential break tests indicate that the estimated structural break in the deficit process occurred in 1994. Thus, the estimated year of break for budget deficit coincides with the currency crisis in 1994 for Turkish economy.

Finally, we conclude that the empirical evidence based on data for Turkey suggest that macroeconomic series are nonstationary even if the structural break points are taken into account.

REFERENCES

- BANARJEE, A., LUMSDAINE, R.L. and STOCK, J.H. (1992) "Recursive and Sequential Tests of the Unit-Root and Trend-Break Hypotheses: Theory and International Evidence." **Journal of Business and Economic Statistics**, 10: 271-87.
- HERSHLAG, Z. Y. (1988) **The Contemporary Turkish Economy**. Routledge, London.
- NAS, T.F. and ODEKON, M. (eds.) (1988) **Liberalization and the Turkish Economy**, New York: Greenwood.
- NELSON, C.R. and PLOSSER, C.I. (1982) "Trends and Random Walks in Macroeconomic Time Series." **Journal of Monetary Economics**, 10: 129-62.
- ÖZATAY, F. (1996). "The Lessons from the 1994 Crisis in Turkey: Public Debt (Mis)Management and Confidence Crisis." **Yapı Kredi Economic Review** 7: 21-37.
- ÖZMEN, E., and KOĞAR, C.İ. (1998). "Sustainability of Budget Deficits in Turkey with a Structural Shift." **ERC Working Paper 11**, METU Economic Research Center, Turkey.

- PERRON, P. (1989) "The Great Crash, the Oil Price Shock, and the Unit-Root Hypothesis." **Econometrica**, 57: 1361-401.
- PERRON, P. (1997) "Further Evidence on Breaking Functions in Macroeconomic Variables." **Journal of Econometrics**, 80: 355-85.
- PERRON, P. and VOGELSANG, T. (1992) "Nonstationary and Level Shift with an Application to the Purchasing Power Parity." **Journal of Business and Economic Statistics**, 10: 301-20.
- YELDAN, E. (1996). "Türk Ekonomisinde Krizin Oluşumu, 1990-1993: Bir Genel Denge Analizi." **METU Studies in Development** 23: 427-76.
- YELDAN, E. (2001). "On the IMF-Directed Disinflation Program in Turkey: A Program for Stabilization and Austerity or a Recipe for Impoverishment and Financial Chaos?." **Unpublished Manuscript**, Department of Economics, Bilkent University .
- ZİVOT, E. and 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: 251-70.

Özet

Makroekonomik Değişkenler ve Yapısal Kırılmalar: Türkiye Ekonomisine İlişkin Kanıtlar

Bu çalışmanın amacı, tahmin edilen kırılma noktaları gözönüne alındığında, Türkiye'ye ilişkin makroekonomik zaman serilerinin durağan olup olmadıklarının araştırılmasıdır. Ayrıca, Perron (1997) ve Zivot ve Andrews (1992) yöntemleri kullanarak, seçilmiş bazı makroekonomik değişkenlere ilişkin yapısal kırılma dönemleri belirlenmeye çalışılmıştır. Türkiye ekonomisine ilişkin yıllık verilere göre, serilerdeki kırılma noktaları dikkate alınsa dahi, makroekonomik zaman serileri için birim kök hipotezi reddedilememektedir. Yapısal kırılma testlerinin sonuçları gösteriyor ki, makroekonomik serilerin büyük bölümü için kırılma noktası 1980 yılındaki önemli ekonomik rejim değişikliğine rastlamaktadır. Diğer bazı makroekonomik seriler için ise kırılma yılı 1994 yılındaki finansal krize tekabül etmektedir.