GOVERNMENT BEHAVIOR AND INFLATION IN TURKEY
AN INTERPRETATION BASED ON TWO ALTERNATIVE APPROACHES

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ABSTRACT

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In this study, two alternative forms of government behavior are proposed and their connections with the inflationary process in Turkey are analyzed using post-1980 data. The theory of optimal seigniorage predicts that if government's aim is to minimize the welfare costs of financing a given amount of revenue needs by taxation and seigniorage, the optimal fiscal policy for the government is to increase ordinary income tax rates and inflation together. Using a model developed by Trehan and Walsh (1990), we showed the testable restrictions of the theory of optimal seigniorage on data: both the tax rate and inflation must be nonstationary series and the two series must be cointegrated. Post-1980 Turkish data, however, did not support these predictions of the optimal seigniorage theory. As an alternative, we used a deficit-oriented approach developed by Bruno (1989), and Bruno and Fischer (1986 and 1990). This approach investigates the connections between the fiscal fundamentals and inflation and models the inflationary process as the failure of the government to correct the fundamentals. Our findings were consistent with the predictions of this alternative view: the inflation being shaped by the fiscal and monetary fundamentals. Our results can be interpreted as a demonstration of the non-optimality of the inflationary process in Turkey and as an indication of the increased fragility of the economy.

ÖZETÇE

TÜRKİYE'DE HÜKÜMET DAVRANIŞLARI VE ENFLASYON

İKİ FARKLI YAKLAŞIM

Bu çalışmada, iki farklı hükümet davranış biçimi ortaya atılmış ve bu davranış biçimlerinin Türkiye'deki enflasyon süreci ile olan ilişkileri 1980 sonrası Türkiye verileri kullanılarak incelenmiştir. Optimal senyoraj teorisi, amacı belli bir gelir gereksinimini normal vergilerin ve senyorajın refah maliyetini en aza indirerek karşılamak olan bir hükümet için optimal maliye politikasının, normal vergi oranlarını ve enflasyonu beraber artırmak olduğunu öngörmektedir. Çalışmada, Trehan ve Walsh (1990) tarafından geliştirilen bir model kullanılarak, optimal senyoraj teorisinin veriler üzerine getirdiği sınanabilir kısıtlamalar gösterilmiştir: Hem vergi oranları hem de enflasyon durağan olmayan seriler olmalı ve bu iki seri birlikte hareket etmelidir (koentegre olmalıdır). Ancak, 1980 sonrası Türkiye verileri optimal senyoraj teorisinin bu beklentilerini desteklememektedir. Farklı bir görüş olarak, Bruno (1989) ve Bruno ve Fischer (1986 ve 1990) tarafından geliştirilen açıklara dayalı yaklaşım kullanılmıştır. Bu yaklaşım mali esaslar ve enflasyon arasındaki ilişkileri incelemekte ve enflasyon sürecini hükümetin bu mali esasları düzeltmekteki başarısızlığı olarak modellemektedir. Bulgularımız bu yaklaşımın beklentileriyle uyuşmaktadır: enflasyon mali ve parasal esaslar tarafından şekillenmektedir. Sonuçlar, Türiye'deki enflasyon sürecinin optimal olmadığının ve ekonominin gittikçe kırılganlaştığının göstergeleri olarak değerlendirilebilir.

I. INTRODUCTION

Turkey entered the end of 1970s with the accumulated (and postponed) imbalances of inward looking import substituting industrialization strategy. When the situation was unsustainable in 1980, inflation reached its historical high level of 110%. Comprehensive January 1980 stabilization and structural adjustment program reduced inflation to 36.6% in 1981, and alongside with successful demand management and liberalization policies, the inflation remained in a 30% plateau between 1981 and 1987. The picture altered, however, towards the end of 1980s: alongside with the more populist policies fiscal situation deteriorated, macroeconomic stability could not be established and public began to anticipate the resurgence of inflation. After a public prices shock in December 1987, inflation was stabilized at a new and higher plateau of 70%.

The primary purpose of the present study is to analyze some of the possible connections between the inflationary process and the government's behavior in Turkey during 1980-1993 period. Inflation is a multi-dimensional phenomena, and different models, based on alternative assumptions about how economy in general and economic agents in particular behave, will produce different explanations and solutions.

We will not attempt to present all of the theories on inflation which cover a large body of literature from monetarists to structuralists and about which much have been written. We will not try to apply all of their empirical implications for Turkey, either. Hence, this is not a study of inflation in Turkey. Our focus is much more restricted. We will investigate some possible answers for a fundamental economic problem which have gained importance recently: What determines the behaviors of policy makers and consequently how countries fiscal policies evolve? And how these policies affect the inflationary process in a country? More specifically, is high or low inflation can be explained as the result of different government behaviors and policies. Such questions are not very easy to answer and they stand at the crossroad of different areas of research: theories of taxation in the public finance, the role of government in the macroeconomics, credibility and reputation in the newly emerging game-theoretic macroeconomic analysis, any political instability and populism in the political economy literature.

In this study, two alternative explanations are proposed on the interaction between government behavior and inflation and their implications are tested using post-1980 Turkish data. Our interest is to see if the Turkish data (or inflationary process in Turkey) is consistent with the predictions of these two alternative views. The finding that one theory or the other is more consistent with the Turkish data does not mean that it explains all the features of the problem or it is the only possible explanation. The finding must be interpreted simply as the clues about certain aspects of the problem.

In the first alternative, which is a new classical macroeconomic model, we present a model in which government is pictured as an optimizing agent that acts rationally in its environment by using the available information efficiently. Such a government tries to minimize the distortionary costs (or welfare costs) of taxation and seigniorage (two alternative forms of raising revenue) to finance a given amount of the revenue needs. This **theory of optimal seigniorage**, which have been developed along the works of Phelps (1973), Barro (1979), and Mankiw (1987), tries to explain inflation as the deliberate action of such an optimizing government. This theory, as it will be shown and tested in this study, have important empirical implications for the time series properties of the data on inflation and tax rates: both series must be nonstationary and contain a unit root, and the two series must be cointegrated.

In the second model, which might be labeled as a **simple-minded public-finance view** as it is called by Rodrik (1991), we have a different picture of the government. In this model, our government is no more an optimizing user of inflation, but rather inflation is dictated by the fundamentals of the economy such as the budget deficits and money demand. In this deficit-oriented approach, the government inflates because it is unable to reduce the deficits and to reverse the flight from money. Hence, inflation is the result of government's failure rather than its conscious behavior. Obviously, the problem does not end there: One should also ask why government is unable to reduce the deficits or to increase the ordinary taxes and to stop the flight from money. But this is beyond the scope of this study, and one needs to enter the domain of the political economy(1). Consequently, our second scenario, which is based on a model developed by Bruno (1989) and Bruno and Fischer (1986 and 1990), will present the evidence on the connection between the fiscal fundamentals and inflation but will not try to explain the deficits or why the governments are unable to reduce them.

The study is organized as follows. Section II reviews the main concepts and assumptions which are necessary to develop the optimal seigniorage theory; then the model is developed and its empirical implications are presented. The alternative deficit-oriented model and its results are shown in Section III. Section IV contains concluding remarks. An Appendix on the econometric concepts and methods is also included.

(1) For a recent study in which political factors are used to explain the inflation in developing countries see Edwards and Tabellini (1991). For a discussion of the connections between political factors, deficits and inflation in Turkey see Öniş and Webb (1992).

II. THE THEORY OF OPTIMAL SEIGNIORAGE

II.I. PRELIMINARIES

II.I.a. New Classical Macroeconomics

The new classical macroeconomics or rational expectations-equilibrium approach to macroeconomics, which emerged in early 1970s from the leading works of Robert Lucas and Thomas Sargent, shaped the perspectives of macroeconomists very fundamentally. This new approach tried to establish macroeconomics on the foundations of market clearing and optimization by economic agents and to supply its microfoundations(2).

Within this framework, costs of obtaining information and costs of adjustment became main tools of analysis to explain the observed fluctuations in the economy. Since markets are assumed to clear all the time, any disequilibrium must reflect imperfect information and failure to use existing market opportunities.

New classical approach produced two significant results for the macroeconomic theory: Policy ineffectiveness argument and econometric policy evaluation critique.

The policy ineffectiveness result, which was originated from the very important work of Lucas (1973), states that anticipated monetary policy will not affect the output. Since economic agents use the available information efficiently, as long as monetary policy actions are predictable , they will only result in higher or lower expected and actual price levels, without changing real activity. Therefore monetary policy actions must be unpredictable and unsystematic to cause informational confusions and to influence real economy. This conclusion is the main building block of the real business cycle theories that view the business cycles as originating from the real disturbances, such as productivity shocks. The evidence on the monetary policy ineffectiveness remains as an

(2) For a very brief, but useful analysis of new classical macroeconomics see Fischer (1987), for a collection of the main theories and results see Barro (1989). Hoover (1988) is a less technical introduction to new classical macroeconomics where it is analyzed in a comparative perspective.

unsettled issue, and one of the main challenges for new classical economists is to interpret the empirical findings on nonnuetrality of money (3).

The econometric policy evaluation critique, which was also put forward by Lucas (1976), had a fundamental influence on the econometric practice. The argument is that the estimated structural parameters of macroeconomic relations are ineffective to evaluate the outcomes of alternative policy actions, since any policy regime shift will change the environment and information set of the agents and therefore the estimated parameters will be different under the new regime.

This argument resulted in the establishment of models based on deep structural parameters, which consist of tastes, technology, utility and production functions. This new models estimated the parameters of the utility and production function from the maximization conditions for representative agents and from the restrictions that these maximization condition put on the data.

As an illustrative example, consider the life cycle-permanent income hypothesis of consumption by Hall (1978, 1989) in which the consumers maximize the present value of their life time expected utilities. The representative consumer tries to maximize;

$$V_t = E_t \Sigma_s (1/1+\delta) U(C_{t+s})$$

And the consumer faces the present value of his budget as his constraint;

$$\text{s.t. } \Sigma_s (1/1+r) (C_{t+s} - W_{t+s}) = 0 \quad \text{where;}$$

E_t: mathematical expectations conditional on all information at time t.

δ: rate of subjective time preference

r: constant rate of interest

(3) For a brief discussion of the emprical results on the nonneutrality problem and the reviews of the main articles see the Introduction to Barro (1989) and Fischer (1987).

U( ): a concave utility function

C_t: consumption

W_t: wage earnings

Given the expected value of all future wage earnings and assuming that there are no nonwage income or inherited assets, the consumer tries to maximize the present value of his expected utility from future consumption. In stead of finding an analytical solution for such an optimization problem, we ask how our representative agent should behave along his optimal path[(4)], and look at the Euler equations describing the optimal behavior of such an agent[(5)].

If a consumer allocates its available resources optimally, he must be on an efficient frontier (Pareto frontier), and indifferent between consuming today or consuming tomorrow. We specify the intertemporal behavior of the consumer: the consumer must be indifferent between not consuming today, keeping his available resource and consuming them tomorrow. Stating it formally, the Euler equation for dynamic optimization is;

$$E_t \, dU / dC_{t+1} = (1+\delta/1+r) \, dU / dC_t$$

This condition tells us that marginal utility this year is expected to be equal to marginal utility next year except for a trend from two constant rates δ and r. Expressing it differently;

$$dU / C_{t+1} = (1+\delta/1+r) \, dU / dC_t + v_t \quad \text{where;}$$

(4) For a very systematic and useful explanation and application of this optimal path approach see Mankiw, Rotemberg, and Summers (1985)

(5) For an introduction to the Euler equations and dynamic optimization problem see Lambert (1988).

v_t is a random variable. Hall (1978) assumed a quadratic utility function (where the derivative is equal to two times the level) and reached his random walk result for consumption;

$$C_{t+1} = \alpha C_t + v_t$$

Hall (1978) tested the random walk implication of his theory by putting additional variables in this equation and testing their inclusions. Hall (1978) results were supportive for his theory(6).

This approach, which have been utilized for different economic problems, will be our main tool in driving the implications of the optimal seigniorage theory that we will present below.

II.I.b. Optimal Taxation

The next building block in the construction of the optimal seigniorage theory is the optimal taxation. Stating it very simply, the theories of optimal taxation try to analyze how a government that cares about the welfare of its citizens (hence we have a benevolent government) should set the taxes to obtain the necessary revenue for its transactions(7). This question, put forward decades ago by economists like Wicksell and Ramsey, is very similar in its spirit to the questions raised by the new classical economists.

The main tool of analysis in the optimal taxation literature is the differential taxation: that is the determination of tax rates so that their distortionary effects (excess burden) are minimized for a given tax revenue requirement. In its simplest version of one consumer and many commodities, the answer is well-known Ramsey result: it will be optimal to set higher tax rates for those commodities which have inelastic demands(8).

(6) For a review of the studies and their results on the consumption following Hall (1978), see Hall (1989).

(7) For an introductory survey of the theories of optimal taxation see Sandmo (1976).

(8) For a brief survey of more general cases see Stern (1987).

One can extend this result along the time axis in the intertemporal models of new classical macroeconomics, and investigate how taxes are determined in order to minimize the present value of their excess burden while financing the present value of a given revenue requirement. This is very similar to the problem faced by our representative consumer in his consumer decisions, this time the representative agent being the government. As the optimizing consumer provides us with testable implication on consumption behavior, the optimizing government will produce testable implications on government behavior. Therefore, we will be able to investigate how the tax rates should evolve over time if our government is an optimizing agent. Such an exercise constitutes the basic rationale of the positive theory of optimal public finance in the new classical literature.

II.I.c. Tax Smoothing

Barro (1979) presented such a positive theory of optimal public finance and tested the implications of his model using US data. Barro's model considers a government which faces the following budget constraint;

$G_t + (1+r)b_{t-1} = T_t + b_t$ where;

b_t consists of one period single coupon bonds that are issued at par, G_t is exogenously given government expenditure, and T_t is the total amount of taxes.

Government tries to minimize the cost (excess burden) of taxation (raising revenue);

$Z_t = F(T_t,Y_t) = T_t\, f(T_t/Y_t)$ where;

Y_t is exogenously given total income and Z_t is an homogeneous function with a positive first derivative, $df \,/\, d(T_t/Y_t) > 0$, i.e. the collection costs are increasing functions of tax rates.

The problem of an intertemporal government is to minimize the present value of welfare cost of taxation;

$$Z = \Sigma T_t f(T_t/Y_t) / (1+r)^t$$

subject to the present value of its budget constraint;

$$\Sigma [G_t/(1+r)^t] + b_0 = \Sigma [T_t/(1+r)^t]$$ (9)

What is our government actually doing? The government faces the exogenously given paths of $G_1, G_2,...,G_t$ and $Y_1, Y_2,.....,Y_t$, constant interest rate r, and the initial stock of debt, b_0. Government's problem is to choose $T_1, T_2,...,T_t$ which minimizes the present value of the costs of taxation.

As in the consumption problem above, we can ask how such a government should behave in its optimal path or efficient frontier: government must be indifferent between taxing today and taxing tomorrow, that is the marginal welfare cost of the taxation, dZ_t/dT_t, must be equal in all periods. Otherwise, there exists an option for the government to substitute between present and future taxes. Given the homogeneity assumption, this optimization condition implies that T/Y to be equal in all periods. Hence, the tax rates must be kept purposely constant by the optimizing government and their behavior should be unpredictable. This is the random walk result for tax rates(10). As smoothing of consumption makes the consumption random walk in Hall (1978), tax smoothing makes tax rates random walks.

II.I.d. Inflation as a Tax

Once we have placed the role of inflation in the government's budget, we will be ready to present the theory of optimal seigniorage. Our first question will be if we can analyze seigniorage (the government revenue from money creation) as an alternative to taxation today or to issuance of interest bearing debt (taxation tomorrow). From

(9) The budget constraint in this model is a simpler version of our optimal seigniorage model that we will present in the next section, therefore we did not show the derivation of the intertemporal budget constraint from the budget identity.

(10) For an empirical investigations of the Barro (1979) results on the uniformity and unpredictability of tax rates over time see Sahasakul (1986). Sahasakul's findings do not provide support for the theory. Gupta (1992), using the methodology of the Sahasakul, finds that the theory is supported by Canadian data.

Bailey (1956)'s seminal work onwards, several authors treated the government revenue from inflation as a tax: the tax base being the outside quantity of money holdings (the monetary base) and the tax rate being, depending on the alternative assumptions, one measure of the opportunity cost of holding money.

Putting it very simply, the inflation is a tax on real money balances because it raises the cost of holding a constant amount of purchasing power. Alternatively with inflation people must hold higher amounts of money to maintain the purchasing powers of their money holdings, the higher amount being the revenue of government (the producer of the money). Hence, inflation tax is the change in the real value of money holdings: $\Delta M / P$. We can rewrite it as $(\Delta M / M)(M / P)$ where the first term is the tax rate and the last one is the base. Depending on particular assumptions on money demand, authors defined alternative measures of inflation tax revenues.

Bailey (1956) defined inflation tax revenue as $\pi M/P$ (inflation times the real value of outside money). Marty (1967), considering the government revenue in a growing economy, defined it as $(g + \pi)M/P$ (gM/P representing the money creation due to the growth or non-inflationary money creation). Along the same lines, Friedman (1971) derived the inflation tax as being $(1/M)(dM/dt)(M/P)$, the growth of monetary base times its real value[(11)].

It is important to note that the analysis following Bailey shared the common characteristic of focusing explicitly on the effects of inflation on the desired money holdings. In these "Chicago discussions" (the name given by Phelps), with the necessary assumption on the institutional setting of the economy, other effects of inflation like uncertainty and distributional problems are kept outside the analysis, and the effects of a perfectly anticipated inflation on money holdings is investigated[(12)].

(11) It is considered unnecessary to repeat the derivations of these papers here.

(12) For the assumptions of the Chicago discussion see Bailey (1956), or Phelps (1973).

Once inflation is considered as a tax on liquidity, it becomes important to estimate its welfare costs (excess burden or deadweight loss) and ask if it is optimal to tax money (liquidity), just as taxing another good. This question was first raised by Bailey (1956) in a partial equilibrium framework , and several authors followed him in estimating the excess burden of inflation tax. In those analysis, money is considered as any other commodity which is demanded and the welfare cost of taxation is calculated from the demand curve as the difference between producer and consumer prices times the amount produced and consumed(13). This analysis led to the estimation of famous "money triangles" by several authors and the estimated welfare cost of inflation was compared with excess burden of other possible taxation tools, like income tax(14). The cost of inflation is generally argued to be high and inflation was not considered to be a part of an optimal taxation program.

Phelps (1973) paper marked a significant turning point in the theory of seigniorage from a partial equilibrium analysis to a general equilibrium framework. Evaluating inflation along with other taxes and using an optimal taxation framework, Phelps reached the important conclusion that as long as other tax rates are positive, it is optimal to tax money. This was a significant result, and initiated an ongoing dispute between the ones who favor taxation of liquidity and those who oppose it(15).

In the model that we will develop in the next section we will assume that it might be necessary for a government to tax liquidity(16). Besides Phelps (1973)'s result, this assumption can be supported from different points. One argument is that as long as

(13) For the calculation of the excess burden for an excise tax see Chapters 15 and 16 of Musgrave and Musgrave (1989).

(14) Tatom (1976) paper provides with a very clear calculation and analysis of the average as well as marginal welfare costs of inflation in this manner.

(15) For a survey of the debates and the place of Phelps paper in the seigniorage literature see Spaventa (1989).

(16) Authors, who consider the inflation as an suboptimal tax, consider money as an intermediate good in the production and show that full-luquidity result in higher production and higher ordinary taxes, and higher government revenue.

there are tax evasions and collection costs in ordinary tax instruments (especially in developing countries), it might be optimal for a government to collect seigniorage. Another interesting argument (which is again relevant for developing countries) is the fact that inflation can be the only way to tax informal economy which is characterized by the extensive use of liquidity.

The assumption of a purposely inflating government will allow us to model our government as one which minimizes the present value of welfare costs of taxation and seigniorage for a given budget requirement. As the tax smoothing model of Barro (1979) produces testable implications on tax rates, this more general model of revenue smoothing will provide us with testable implications on tax rates and more importantly on inflation (the other tax rate in the model), and will enable us to investigate if the inflationary process is the result of our government's optimal behavior.

One should again bear in mind that we ignore in our analysis any other effects and costs of inflation(17). It might be interesting to consider the situation of a government that faces lower ordinary taxes as a result of the lower economic activity originating from inflationary uncertainty. We rule out this possibility by assuming that effects of inflation and taxation are independent from each other. This is obviously a very strong assumption which also disregards the opposite effects of Oliviera-Tanzi (that is the erosion of tax revenues due to the collection lags in an inflationary environment) as well as the nominal rise in the tax revenues due to the rising tax brackets.

As pointed out by Dornbusch (1989), a theory in which government sets the inflation rate as the result of its intertemporal optimization seems to be rather strange. Indeed, when the other effects of inflation, which are set purposely aside in the model, are considered the case against the inflationary finance becomes much more strong. However, the theory of optimal seigniorage provide us a model of the government that can serve as **a benchmark model**, around which alternative views of the government

(17) For a detailed analysis of the other costs of inflation see Fischer (1981) and Driffill, Mizon, and Ulph (1990).

can be analyzed. Furthermore, as we have already mentioned above, several arguments can be proposed for the inclusion of the inflation tax in the government revenue creation process, which justify to question the characteristics of this process.

Finally, it is important to note that, in the discussions of inflation in Turkey, some rather popular views are presented in the media which claim that the optimal inflation rate is 50% or some other arbitrary number for Turkey, and only inflation rates above that rate must be considered seriously. In a recent study, Küçüker, Kazdağlı, and Erdemir (1993) found an inflation rate that is equal to about 3.5-4% per month to be the revenue maximizing rate for Turkey, and concluded that the economy has been generally working in the region of maximum feasible seigniorage. But this result does not provide support for the optimal seigniorage theory since the welfare effects are not included in the analysis. This result also contrasts with Akçay (1992) who calculated a much higher rate of 9.7% per month.

II.II. THE THEORY OF OPTIMAL SEIGNIORAGE

The theory of optimal seigniorage was for the first time proposed and tested by Mankiw (1987) for the US. The theory is a generalization of Barro (1979) tax smoothing model for a government that obtains its revenue from taxation and seigniorage and tries to minimize their total welfare costs. Mankiw's findings were supportive for his theory. Mankiw (1987), however, did not test all of the empirical implications of the theory. Following Mankiw, Grilli (1989) applied the optimal seigniorage model to a group of European countries and reached mixed results. Grilli (1989) tested the full empirical implications of the theory, but within a model which was not general enough and which contained some ad hoc assumptions(18). Poterba and Rotemberg (1990) tested Mankiw (1987)'s predictions in a more general model for a group of industrial countries and found that only the US data is consistent with the

(18) For a critic of Grilli see Dornbusch (1989).

predictions of the theory. In this study we will utilize the model developed by Trehan and Walsh (1990), which provides the most general treatment of the problem.

Consider a government which faces the following budget constraint;

(1) $b_t = Rb_{t-1} + g_t - \tau_t y_t - s_t$, where

b_t: real value of interest bearing government debt at the end of period t.
$R=(1+r)$: gross interest factor with a constant interest rate r.
g_t: the exogenously given non-interest government expenditure.
τ_t:tax rate on income
y_t: real income
s_t: real seigniorage which is equal to
$s_t = (m_t - m_{t-1}) / p_t = m_t - m_{t-1}(p_{t-1}/p_t)$, where
M_t: nominal stock of base money
p_t: price level, and
$m_t = M_t/p_t$

In order to drive how our government should optimally behave over time (the intertemporal optimization conditions), we have to first define how this budget identity will evolve over time, and drive the intertemporal budget constraint of the government. Rewriting (1),

(2) $\tau_t y_t = Rb_{t-1} - b_t + g_t - s_t$

and defining the expected present value of the items as;

$R^{-i}(\tau_{t+i} y_{t+i})$
$R^{-i}(s_{t+i})$
$R^{-i}(g_{t+i})$
where $R^{-i} = 1 / (1+r)^i$ is the present value factor.

We can write the present value of budget identity (2) as;

$$(3)\ \Sigma_o R^{-i} (\tau_{t+i} y_{t+i}) = \Sigma_o R^{-i} [g_{t+i} - b_{t+i} + Rb_{t+i-1} - s_{t+i}]$$

opening brackets we reach:

$$(4)\ \Sigma_o R^{-i} (\tau_{t+i} y_{t+i}) = \Sigma_o R^{-i} g_{t+i} - \Sigma_o R^{-i} b_{t+i} + \Sigma_o R^{-i} R\, b_{t+i-1} - \Sigma_o R^{-i} s_{t+i}$$

We can rewrite the third term on the left hand side as;

$$\Sigma_o R^{-i} R\, b_{t+i-1} = \Sigma_o R^{-i+1} b_{t+i-1} = R\, b_{t-1} + \Sigma_1 R^{-i+1} b_{t+i-1}$$

Substituting the result to (4), we get;

$$(5)\ \Sigma_o R^{-i} (\tau_{t+i} y_{t+i}) = \Sigma_o R^{-i} g_{t+i} - \Sigma_o R^{-i} b_{t+i} + R\, b_{t-1} + \Sigma_1 R^{-i+1} b_{t+i-1} + \Sigma_o R^{-i} s_{t+i}$$

Collecting the revenue terms in the right hand side:

$$(6)\ \Sigma_o R^{-i} (\tau_{t+i} y_{t+i} + s_{t+i}) = \Sigma_o R^{-i} g_{t+i} + R\, b_{t-1} + \Sigma_1 R^{-i+1} b_{t+i-1} - \Sigma_o R^{-i} b_{t+i}$$

Last two terms on the left hand side can be eliminated:

$$\Sigma_1 R^{-i+1} b_{t+i-1} - \Sigma_o R^{-i} b_{t+i} = R^o b_t + R^{-1} b_{t-1} + \dots\dots + R^{-i}+1\, b_{t+i-1} - (R^o b_t + R^{-1} b_{t-1} + \dots\dots\dots + R^{-i} b_{t+i}) = R^{-i} b_{t+i}$$

Using this result, and denoting the expected value of the items with E_t, we obtain the present value of expected budget constraint:

$$(7)\ \Sigma_o E_t R^{-i} (\tau_{t+i} y_{t+i} + s_{t+i}) = \Sigma_o E_t R^{-i} g_{t+i} + R\, b_{t-1} + \Sigma \lim_{n\to\infty} R^{-i} b_{t+i}$$

With the assumption of $\Sigma \lim_{n\to\infty} R^{-i} b_{t+i} = 0$, we obtain the expected value of government budget identity as;

$$(8)\ \Sigma_o\ E_t\ R^{-i}\,(\tau_{t+i}y_{t+i} + s_{t+i}) = R\,b_{t-1} + \Sigma_o\,E_t\,R^{-i}\,g_{t+i}$$

This important assumption of $\Sigma \lim_{n\to\infty} R^{-i} b_{t+i} = 0$ implies that the stock of the debt can not grow faster than the government borrowing rate (r). Trehan and Walsh (1989) showed that this result implies the domestic debt stock, inclusive of interest payments, must be difference-stationary. This guarantees the sustainability of government budget or the solvency of the government. Özatay (1994) tested the econometric implications of this assumption in a different model than Trahan and Walsh (1989) and looked for the stationarity of the discounted value of the debt stock for Turkey. Özatay (1994)'s findings do not support this assumption and implies that the present debt strategy is not sustainable. Grilli (1989) tested this assumption for his sample of European countries and found that, for most of his group, the assumption is not valid. Following Grilli (1989), we continue to test the implications of the optimal seigniorage theory, despite Özatay (1994)'s results. However, Özatay (1994)'s conclusions on the unsustainability of the debt strategy can be considered as an indication of the nonoptimality of the government policies.

After defining the budget constraint for our government, we have to define the welfare costs of taxation and seigniorage which will be minimized by our government. The costs of taxation and the benefit of deflation (that is the inverse of the cost of inflation) are assumed to be time-seperable and constant elasticity functions :

$$(9)\ C_1 = \tau^{1+\alpha}{}_t\,\Phi_t / 1+\alpha$$

$$(10)\ C_2 = (p_{t-1}/p_t)^{1-\Gamma}\ \sigma_t / 1-\Gamma$$

Where α and Γ are positive coefficients which assure that the welfare costs of taxation are increasing in τ_t and the benefits of inflation are decreasing in the rate of deflation. Φ_t and σ_t represent stochastic shifts in distortionary costs. These stochastic shifts might represent a variety of shocks, such as the tax collection technology or permanent shifts in labor supply.

The aim of the government is to minimize the expected present value of the sum of these costs while finding the necessary revenue for its budget identity (8). Hence, our government tries to minimize:

$$(11)\ E_t \Sigma_0 R^{-i} [\ \tau^{1+\alpha}_{t+i} \Phi_{t+i} / 1+\alpha\ -\ (p_{t+i}/p_{t+i+1})^{1-\Gamma} \sigma_{t+i} / 1-\Gamma\ ]$$

As we have already explained in the last section, we will not solve this minimization problem, but define the conditions which must be satisfied by the government if it is in its optimal path of taxes and inflation, and write the Euler equations.

Our **first optimality condition** requires the government to be indifferent between taxation and inflation, two possible sources of revenue. That is the marginal cost of raising an additional unit of revenue from taxation must be equal to the marginal cost of raising an additional unit of revenue from inflation (or marginal benefit of lowering an additional unit of revenue from deflation). Putting it formally:

$$(12)\ \tau_t^{\alpha} \Phi_t / y_t^{(1+\Theta)} = (p_{t-1}/p_t)^{-\Gamma} \sigma_t / m_{t-1} (1+\mu) \quad \text{where;}$$

Θ is the elasticity of real income with respect to tax rate and μ is the elasticity of real money demand, and the first derivatives of the cost functions are:

$$dC_1 / d\tau_t = \tau_t^{\alpha} \Phi_t$$

$$dC_2 / d(p_{t-1}/p_t) = (p_{t-1}/p_t)^{-\Gamma}\ \sigma_t$$

The equation (12) can be interpreted as the intertemporal optimality condition of the government across the two revenue sources.

Next two conditions require the optimizing government to be indifferent between taxation today or taxation tomorrow and inflating today or inflating tomorrow. That is:

(13) $E_t \, \tau_{t+1}^{\alpha} \, \Phi_{t+1} / y_{t+1} = \tau_t^{\alpha} / y_t$

(14) $E_t \, (p_t/p_{t+1})^{-\Gamma} \, \sigma_{t+1} / m_t = (p_{t-1} / p_t)^{-\Gamma} \, \sigma_t / m_{t-1}$

Equations (13) and (14) are the optimality conditions over time for each of the revenue sources.

To use testable implications of the equations (12), (13) and (14), we take the natural logs and rewrite them. For (12) we obtain:

(15) $\alpha \ln\tau_t + \ln\Phi_t - \ln y_t - \ln(1+\Theta) = \Gamma\pi_t + \ln\sigma_t + \ln m_{t-1} + \ln(1+\mu)$

Substituting $a_o = (1/\alpha)\ln[\, 1+\Theta/1+\mu \,]$ and $\pi = \ln(p_t/p_{t-1})$ to (15) we get:

(16) $\ln\tau_t = a_o + (\Gamma/\alpha)\pi_t + (1/\alpha)\ln[y_t - \ln m_{t-1}] + (1/\alpha)\ln[\sigma_t - \ln \Phi_t]$

Taking the natural logs of (13) and (14) and using $\pi = \ln(p_t/p_{t-1})$, we get respectively:

(17) $E_t \ln \tau_{t+1} = \ln \tau_t + (1/\alpha)\, [E_t \ln y_{t+1} - \ln y_t] - (1/\alpha)\, [E_t \ln\Phi_{t+1} - \ln\Phi_t]$, and

(18) $E_t \, \pi_{t+1} = \pi_t + (1/\Gamma)\, [E_t \ln m_t - \ln m_{t-1}] - (1/\Gamma)\, [E_t \ln\sigma_{t+1} - \ln\sigma_t]$

What these condisions are suggesting to us? The equations (17) and (18) are nonstationarity results for tax rate and inflation. The equation (16) states that although the two series are nonstationary; they must move in the same direction since both should respond to the government revenue needs. Equation (16) also states that the optimal trade-off between taxation and inflation depends on their relative tax bases ($\ln y_t - \ln m_{t-1}$) and their relative costs in terms of current economic distortions ($\ln\sigma_t - \ln \Phi_t$).

Under the assumption of constant velocity and time-invarient cost functions, equation (16) becomes;

(19) $\ln\tau_t = b_o + (\Gamma/\alpha)\pi_t$ where;

$b_o = a_o + (1/\alpha)k$ and k is the natural log of velocity.

Since the equations (17) and (18) imply that $\ln\tau_t$ and π_t are integrated of order one, equation (19) states that $\ln\tau_t$ and π_t must be cointegrated.

Mankiw (1987) looked, as the equation (19) implies, for a positive correlation between tax rates and inflation and found a significant positive coefficient in regressing inflation on the tax rates by OLS[19]. Akçay (1992) applied Mankiw's procedure to the post-1980 Turkish quarterly data and find that there does not exist a positive correlation between inflation and tax rates in an OLS regression. Akçay (1992) estimated a negative coefficient for the tax rates which suggest that inflation tax might be a substitute for lower tax revenues to finance an increase in the expenditure, rather than being a part of the optimal government financing policy[20].

(19) The results of the Mankiw's (1987) regression for the connection between inflation and the tax rates are (standard deviations in parentheses);

$$\Delta INF = -0.1 + 1.44\, \Delta TAX$$
$$(0.4) \quad (0.49)$$

(20) Akçay (1992) results for Turkish data (for the period from 1980.I to 1990.II) are (t-values in parentheses);

However, Mankiw (1987) and Akçay (1992) searched only for a positive relationship, and did not search for cointegration properties. The proper approach would be to test for the existence of cointegration between the nonstationary variables as defined by Granger (1986) and Engle and Granger (1987).

Grilli (1989) tested unit root and cointegration implications of a model which is similar to the that of Mankiw (1987). Grilli (1987), however, by assuming a quadratic utility function (which was critised by Dornbusch (1989) as being ad-hoc), looked for the cointegration between total seigniorage and total taxes. His results on optimal seigniorage were supportive for France, Ireland, Italy, Germany, and Greece; but not for Belgium, Denmark, the Netherlands, Spain, and UK.

When the velocity is not assumed to be constant, but the assumption of time-invarient welfare costs is sustained, the equation (19) becomes;

(20) $\ln\tau_t = a_o + (\Gamma/\alpha)\pi_t + (1/\alpha)[\ln y_t - \ln m_{t-1}]$

Poterba and Rotemberg (1990) estimated an equation like (20) by OLS and find a positive relationship between tax rates and inflation for the US, but the results for Japan, Germany, France, and UK were not supportive. Their findings, however, suffer from the similar econometric problems as those of Mankiw (1987).

The evidence on optimal seigniorage for developing countries are scarce, Edwards and Tabellini (1991) being the exception. They looked for the existence of unit roots in inflation and tax rates for a group of developing countries, but employ Mankiw (1987)'s OLS approach to test the implication of the theory. Their results reject the theory for a large group of countries.

$\Delta INF = -0.0067 - 0.669\ \Delta TAX$
$\quad\quad\quad(-0.72)\quad(-1.65)$

II.III. EMPIRICAL RESULTS

In this section, we will test the empirical implications of the optimal seigniorage theory. We will first test the stationarities of inflation rate and log of tax rate utilizing ADF (Augmented Dickey Fuller) test procedure(21). As equations (17) and (18) of the last section suggested inflation and log of the tax rate should be nonstationary series, i.e. they must be integrated of an order higher than zero. Moreover, the two rates, as equation (16) implied, are expected to move in the same direction and not to drift apart since both are expected to react to the government's revenue needs. If both inflation and log of tax rate turn to be nonstationary series, the next step is to test if they are cointegrated, that is to see if there exists a longrun relationship which do not allow the two series to drift apart. However, the cointegration between inflation and the log of tax rate (equation 16) depends on the assumptions that velocity is constant and distortionary costs are time-invarient functions. While the use of post-1980 data can justify the second assumption (since the time-varient cost functions were though to capture the institutional changes); the first assumption does not seem to be consistent with the Turkish data. Therefore, following equation (20), we will investigate the cointegration between log of tax rate, inflation, and log of the velocity (the velocity of reserve money, since the reserve money constitutes the proper base of inflation tax in Turkey). This necessitates testing the degree of integration of the log of the velocity, as well.

II.III.a. Testing The Stationarity of the Data

The results of the ADF (Augmented Dickey Fuller) test for the log of price level (for consumer price index) are reported in Table I (in the regressions below for stationarity and seasonality MICROFIT 3.0 econometric package is employed).

(21) For the ADF test procedure and for the other tests carried out in this section see Appendix.

TABLE I
ADF Test for Unit Roots in Log of Price Level (CPI)

$H_o: \alpha_2=0$	$H_o: \alpha_1=0$	$H_o: \alpha_1=\alpha_2=0$ (Φ_3)	n	LM(4)[a]
		Levels[b]		
-0.75[c]	0.48		0	4.32
		First Differences[d]		
-3.61(*)	3.35(*)	6.78(*)	3	5.11

The estimation period is 1980Q2 to 1993Q4 in the levels and from 1981Q1 to 1993Q4 in the first differences.
(a) Lagrange multiplier test for the fourth order serial correlation (Godfrey 1978).
(b) The results are from the regression;
$\Delta INF_t = \alpha_0 + \alpha_1 TIME + \alpha_2 INF_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta INF_{t-i} + e_t$
The null hypothesis is that $\alpha_2=0$, that is the series is nonstationary. The significant negativity of α_2 indicates the stationarity of the series. INF is the inflation rate and TIME is a time trend.
(c) The 5% critical T-value for H_o is -3.5 (Fuller,1976, Table 8.5.2). The 5% critical F-value for Φ_3 is 6.73 (Dickey and Fuller, 1981, Table VI). The 5% critical Chi-square value for LM(4) is 9.49.
(d) The results are from the regression;
$\Delta\Delta INF_t = \alpha_0 + \alpha_1 TIME + \alpha_3 \Delta INF_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta\Delta INF_{t-i} + e_t$.
(*) Indicates the significance at 5% level.

The results in the Table I show that the log of price level is a nonstationary series (we fail to reject the null hypothesis that the series is nonstationary), while its first difference (inflation rate) is a stationary, I(0), series, during this period (see also the Figures A.1. and A.2. in the Appendix). This is in contrast with the implications of the equation (18), and Turkish data on CPI inflation do not support this prediction of the optimal seigniorage theory.

Before testing the stationarities of logs of the tax rate and the velocity, an investigation of the graphs of these series and the autocorrelation functions of their differences (see Figures A.3 through A.6. in the Appendix) indicates that two series show significant seasonal patterns. Therefore, we have to test for the existence of seasonal integration in these two series. This is carried out by DHF (Dickey, Hazsa, Fuller) test for seasonal integration. The results of the DHF test for logs of the tax rate and for velocity are shown in the Table II.

TABLE II
DHF Test[a] for Seasonal Integration

	$H_o: \alpha_0 = 0$
LTR_t (Log of tax rate)	-0.85[b]
LV_t (Log of Velocity)	-0.48[b]

The estimation period is 198012 to 1993Q4.

(a) The results are from the regression;

$\Delta_s Y_t = \alpha_0 Z_{t-s} + \Sigma_{i=1}^{k} \alpha_i \Delta_s Y_{t-i} + e_t$ where

$\Delta_s Y_t = Y_t - Y_{t-4}$ is the seasonal differencing for quarterly data, and Y_t represents the relevant variable, and Z_t is a variable as defined in DHF test procedure.

The null hypothesis is that $\alpha_0 = 0$, that is the series show seasonality. The significant negativity of α_0 indicates nonseasonality.

(b) The 5% critical value for H_o is -4.21 (Dickey, Hazsa, Fuller, 1984, Table 7).

As the results of the Table II suggest, we can not reject the null hypothesis that two series are seasonally integrated, and seasonal differencing is necessary to make two series stationary. In order to test if seasonal differencing is sufficient to make them stationary, i.e. to test if the series are $SI_4(0,1)$, we will apply ADF test for the seasonally differenced series. ADF test results for log of the tax rate and log of velocity series, after they have been seasonally differenced, are shown in Table III.

TABLE III
ADF Tests for the Seasonally Differenced Data

variable	H_o: $\alpha_2=0$	H_o: $\alpha_1=0$	Ho: $\alpha_1=\alpha_2=0$ (Φ_3)	n	LM(4)
			Levels[a]		
$\Delta_s LTR_t$	-2.60[b]	1.35	3.43	4	7.02
$\Delta_s LV_t$	-2.24	0.42	2.66	4	2.89
			First Differences[c]		
$\Delta\Delta_s LTR_t$	-4.45(*)	0.14	10.12(*)	4	6.36
$\Delta\Delta_s LV_t$	-4.50(*)	-0.74	6.83(*)	4	5.79

The estimation period is 1981Q2 to 1993Q4.

(a) The results are from the regression;
$\Delta\Delta_s Y_t = \alpha_0 + \alpha_1 TIME + \alpha_2 \Delta_s Y_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta\Delta_s Y_{t-i}$ where Y_t represent the variable. The testing procedure is same as in Table I.

(b) The critical values are same as in Table I.

(c) The results are from the regression;
$\Delta\Delta\Delta_s Y_t = \alpha_0 + \alpha_1 TIME + \alpha_2 \Delta\Delta_s Y_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta\Delta\Delta_s Y_{t-i}$.

The results of the Table III show that the two series become stationary after differencing them one time seasonally and applying the resulting series ordinary differencing (see Figures A.7 and A.8. in the Appendix), that is the both series are $SI_4(1, 1)$.

Our empirical findings as a whole show that the Turkish data do not support the predictions of the optimal seigniorage theory: While we were able to show that the tax rate is a nonstationary series, we failed to demonstrate that the inflation rate is nonstationary. Therefore, the two rates can not be cointegrated since they are not integrated of same order.

The short period of our data, however, lowers the power of our test results. In order to investigate further if the inflation rate is indeed stationary and if we can terminate our testing procedure, we increased the number of observations backward for the CPI inflation and applied ADF testing procedure to the new series. Extending our series until the first quarter of 1977 did not alter our conclusions on the stationarity of the CPI inflation, and the results were similar to those in Table I.

We next employed wholesale price index (WPI) as an alternative inflation measure and analyzed its stationarity. The results of the ADF test for the log of WPI are shown in Table IV.

TABLE IV
ADF Test for Unit Roots in Log of Price Level (WPI)

H_o: $\alpha_2=0$	H_o: $\alpha_1=0$	H_o: $\alpha_1=\alpha_2=0$ (Φ_3)	n	LM(4)
		Levels[a]		
-2.64[b]	2.64	3.50	3	2.90
		First Differences[c]		
-2.70	0.56	3.66	2	7.00
		Second Differences[d]		
-12.15	-0.22	73.98(*)	1	2.65

The estimation period is 1977Q1 to 1993Q4 in the levels, from 1978Q1 to 1993Q4 in the first and second differences.

(a) The results are from the regression;

$\Delta INF_t = \alpha_0 + \alpha_1 TIME + \alpha_2 INF_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta INF_{t-i} + e_t$

Testing procedure is same as in Table I.

(b) The critical values are same as in Table I.

(c) The results are from the regression;

$\Delta\Delta INF_t = \alpha_0 + \alpha_1 TIME + \alpha_2 INF_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta\Delta INF_{t-i} + e_t$

(d) The results are from the regression;

$\Delta\Delta\Delta INF_t = \alpha_0 + \alpha_1 TIME + \alpha_2 INF_{t-1} + \Sigma_{i=1}^{n} \delta_i \Delta\Delta\Delta INF_{t-i} + e_t$

(*) Indicates the significance at 5% level.

The results of the Table IV shows that WPI inflation (the difference of log of price level) is a nonstationary series, while its first difference (the second difference of log of price level) is stationary. Concluding that WPI inflation is an I(1) series (see the Figures A.9 through A.11 in the Appendix), we can test the existence of cointegration between the seasonally differenced log of tax rate, WPI inflation and the seasonally differenced log of velocity, since all of these series are I(1).

There are two procedures in the literature for testing the existence of a cointegration relationship between a group of nonstationary variables. The two-step testing procedure, proposed by Engle and Granger (1987) investigates the stationarity of the OLS residuals obtained from the proposed longrun relationship. Since the cointegrated series are expected to move together, the residuals are expected to be stationary if the proposed cointegration relationship is correct. As pointed out by Johansen (1988), however, this two-step procedure is not appropriate and can lead to contradictory results for the cases with more than two I(1) series. An alternative approach for the cases with more than two I(1) variables is the maximum likelihood method developed by Johansen (1988) and Johansen and Juselius (1990).

Johansen estimation method is based on the error correction representation of a vector autoregressive system (VAR) with Gaussian residuals:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots\dots\dots + \Gamma_k \Delta X_{t-k+1} + \pi X_{t-k} + DZ_t + e_t$$

where X_t is an n x 1 vector of I(1) variables, Z_t is an s x 1 vector of I(0) variables, Γ_1, Γ_2, $\Gamma_3, \dots, \Gamma_{p-1}$, π are n x n matrices of unknown parameters, D is n x s matrix. Since there are n variables that constitute the vector X_t, π is an n x n matrix and its rank can be at most n. Johansen (1988) shows that if π has a reduced rank of $r < n$, π can be represented as $\pi = \pi B'$. This reduced rank condition also implies that X_t is nonstationary, ΔX_t is stationary, linear combinations $B'X_t$ are stationary, and relations $B'X_t$ are the cointegrating relations. Johansen (1988) proposed two statistics for testing the rank of π: maximum eigenvalue statistics and trace statistics which can be computed by Microfit 3.0. It is also possible to obtain the B matrix, the parameters of the long run relationship by using Microfit 3.0.

Before going into the Johansen procedure, however, it is necessary to determine the order of VAR model. This is carried out by a testing down procedure: The VAR model is estimated starting from a 5-lag model and the reduction of the lags are tested using likelihood ratio (LR) statistics. If the reduction is rejected at some point, previous lag is used. When the order of the VAR model is determined, the residuals of each equation in the VAR model is also tested for autocorrelation, autoregressive conditional heteroscedaticity (ARCH) and normality. When the model fails in these diagnostic tests the order of the VAR increased by one and the residuals of the new model is tested. The calculations for the LR test are carried out in RATS 3.10, the diagnostic tests of residuals are also done in RATS 3.10 following Juselius (1991). The results of these diagnostic tests are shown in Table V.

TABLE V
Diagnostic Tests for the Order of VAR System in Johansen Test for Cointegration

	Likelihood Ratio Statistics[a]
5 lags vs. 4 lags	$CHI^2(9) = 11.94$
4 lags vs. 3 lags	$CHI^2(9) = 15.63$
3 lags vs. 2 lags	$CHI^2(9) = 20.94$(*)

Residual Misspecification Tests (3 lags)

	BP(9)[b]	ARCH(3)[c]	JB(3)[d]
DLWPI	12.50	6.37	0.03
SDLTR	8.32	5.06	9.70(*)
SDLRV	16.97(*)	3.18	1.66

(a) LR test for the significance of the proposed lag against the alternative reduction in the lag. A significant CHI^2 indicates that the reduction of the lags is rejected. The 5% $CHI^2(9)$ critical value is 16.92.
(b) Box and Pierce (1970) test for q^{th} order autocorrelation. A significant CHI^2 indicates the existence of autocorrelation. The 5% $CHI^2(9)$ critical value is 16.92.
(c) Engle (1982) test for q^{th} order ARCH. A significant CHI^2 indicates the existence of ARCH. The 5% $CHI^2(3)$ critical value is 7.82.
(d) Jarque and Berra (1981) test for normality of residuals. A significant CHI^2 indicates the non-normality of the residuals. The 5% $CHI^2(3)$ critical value is 7.82.
(*) Indicates the significance at 5% level.

Following the results of the Table V, we concluded that the appropriate order of our VAR model is 3. Although there exist problems with the desired properties of the residuals, the alternative 4-lag model produced similar problems. Following Özatay (1994), however, we employed the lower of these two lags in the estimations. The results of Johansen tests for the existence of cointegration are shown in Table VI.

TABLE VI
Johansen Test Statistics for the Number of Cointegrating Vector

Maximal Eigenvalue Statistics[a]

Number of Cointegrating Vectors (r)		Statistics	95% Critical Value
Null	Alternative		
r=0	r=1	19.513	20.96
r<=1	r=2	11.04	14.06
r<=2	r=3	4.47	3.76

Eigenvalue Trace Statistics[a]

Number of Cointegrating Vectors (r)		Statistics	95% Critical Value
Null	Alternative		
r=0	r=1	35.34(*)	29.68
r<=1	r=2	15.83(*)	15.41
r<=2	r=3	4.78(*)	3.76

(a) Both test are to determine the rank of π matrix, r. A significant statistics indicates the acceptance of the null hypothesis about the number of different cointegration relations between the variables. Critical values are provided by the Microfit 3.0.

The results of the Table VI are mixed: while according to the maximal eigenvalue statistics there is no cointegration relation between these three variables, the trace test indicates the existence of three alternative longrun relations between them. However, the existence of three alternative cointegrating vector in a three variable model indicates that there is no meaning in cointegration and these variables can not have long run relationship. Hence, although we have showed that WPI inflation is an I(1) series, it is not cointegrated with the tax rate and velocity.

Considering Özatay (1994)'s results on the solvency assumption and our results on the longrun relationship between the tax rates and inflation, we can conclude that Turkish data is in contrast with the predictions of the optimal seigniorage theory about the inflationary process in Turkey.

Our conclusions on the suboptimality of government's policies, however, must be taken with care. Given the institutional and political environment, the negative relationship between tax rate and inflation as demonstrated by Akçay (1992) or the lack of a longrun relationship between these two series as shown by our results above can be optimal from a different perspective for the government. If government is unable to increase τ_t beyond a certain limit due to the institutional and political factors government will be faced with a different optimization problem. In this case, inflation tax can be a substitute for ordinary taxes, and as we will try to discuss below government can be in its optimal path.

III. THE ALTERNATIVE MODEL

III.I. PRELIMINARIES

III.I.a. Different View of Government and Inflation

The empirical evidence of the last section was inconsistent with the predictions of the optimal seigniorage theory. This result indicates that we should model our government's behavior differently. In what follows we will present a simple deficit oriented approach to government behavior. We will no more assume that government uses inflation as an efficient (in terms of its welfare effects) financing tool. Instead, inflation tax is used by the government as a residual revenue to finance the part of the deficit which can not be financed in noninflationary ways. Hence, inflation is dictated by the government's inability to finance its deficits in a noninflationary manner rather than being its conscious optimal policy. We have in this model a weak government instead of an optimizing one.

Note, however, that this particular government behavior might be optimal for the society as a whole or for some of its segments if the benefits of deficits (services provided by the government) are valued higher than the costs of inflation in their utility functions. The inability of government to increase the noninflationary ways of raising revenue (mainly taxation) might be an optimal behavior for the government as well if the higher taxes can lower the possibility of its reappointment. Hence, our government might be a different kind of optimizer which optimizes his utility function which does not only include the welfare effects of inflation and taxation, but also the benefits of higher deficits and costs of raising ordinary taxes. Than it might be optimal for the government to inflate in order to finance the deficits without trying to lower the deficits which creates benefits for some segments of the society (if not for the whole), or without trying to raise the taxes which will reduce its popularity(22).

(22) The present crisis in Turkey can be analyzed in the light of these arguments. The ongoing PSBR which about 16% of GNP means that the society as whole must give up the services provided by the government or must pay for it. As long as the services provided by the government are considered more valuable than the macroeconomic instability created by the deficits, people will react the any adjustment unless the cost of

To investigate if the inflationary process in Turkey is consistent with the picture of the government that we have outlined above and to see if the inflation is determined by the fiscal fundamentals we will use a model developed in the works of Bruno (1989), and Bruno and Fischer (1986 and 1990). Rodrik (1991) employed a similar framework to explain the inflationary process in Turkey. Gottlieb (1992) modified some parts of Bruno (1989) model and provided valuable insights to the problem. These models are based on the fundamental relations among the following key macroeconomic variables: budget deficit, ratios of high-powered money, domestic and foreign debts to GNP and growth rate.

From these very basic relations the model obtains an inflation rate which is dictated by the fundamentals (so-called steady state inflation). This steady state inflation indicates the extent of fiscal deterioration. If our conjecture about the behavior the government policy is consistent with the Turkish experience, this steady state inflation is expected to capture the movements of actual inflation and the important turning points.

III.I.b. Orthodoxy vs. Heterodoxy Debate

Before presenting the model, we should also mention the orthodoxy vs. heterodoxy debate in the inflation stabilization literature. The orthodox view of stabilization claims that once fiscal situation is restored, and fundamentals are set in order, inflation will decline. A clear and credible indication of change in the rules of the game, a regime change as labelled by Sargent (1982) will be the necessary and the sufficient policy action to stop inflation. The famous and well documented examples of such stabilization experiences are the hyperinflation countries of Europe after first and second World Wars. Bolivia constitute a recent example where inflation ended suddenly(23). The heterodox policies, on the other hand , consider the correction of fundamentals as the necessary but not the sufficient condition for the reduction of

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instability become very severe as probably happening in Turkey.

(23) For the analysis of these old and new hyperinflations see Dornbush, Sturzenegger, and Wolf (1990), Kiguel and Liviatan (1992) among others.

inflation. Kiguel and Liviatan (1992) makes a distinction between the classical hyperinflations and the new ones experienced by Latin American countries and Israel. These new hyperinflations have been the final and explosive stages of a long history of inflation. This long history, which was laking in the classical hyperinflations, creates an inflationary inertia, and inflation gains its own momentum. The long history also shapes people's expectations and creates a deep-rooted belief in the resurgence of inflation. In such an inertial environment, it becomes almost impossible to stop inflation by correcting fundamentals since people do not believe the regime-shifts. It becomes then necessary to support the fiscal corrections with incomes policies (wage-price-exchange rate freezes) in order to break the inflationary expectations and to create a period of stability.

In this study we will not go into an analysis of inflationary expectations in Turkey. We nevertheless believe that heterodox policies are not very relevant for Turkey. One point is the institutional problems which make any wage-price-exchange rate freeze a very difficult task. Another point is rather short history of inflation in Turkey and consequent lack of formal indexation. The most important point is the fact that a heterodox program without the necessary orthodox component produces a worse situation, Brazil being the typical example, where freezes are followed by new waves of inflations and new freezes. One can never predict the degree and persistence of inertia in the economy and successful heterodox programs (in Israel and Mexico) were implemented only after a long and remarkable process of fiscal adjustment that did not affect the inflation in the country and called for the policies based on freezes[24]. Hence it is very crucial to determine to what extent fiscal fundamentals determine the inflationary process and if governments have the necessary room of manoeuvre for a successful stabilization program by correction of fundamentals.

(24) For the cases of Israel and Mexico see Bruno and et. al. (1988 and 1991).

III.II. THE MODEL AND ITS RESULTS

III.II.a. The Model

After discussing the alternative view of the government and the inflationary process, we can present our model and its results for Turkey. As in the theory of optimal seigniorage consider first a basic government budget constraint;

(1) $G\text{-}T = \Delta H/P + \Delta B + \Delta FE/P$ where;

G-T: real budget deficit,
H: nominal high powered money,
B: stock of real government bonds,
F: stock of nominal foreign debt,
E: exchange rate,
P: price level,
Δ: change in a variable.

In the steady state (note that steady state in this model is not in the strict sense of the word, therefore dictated inflation is used interchaneably with this term), the H/PY and B/Y ratios (where Y is the real GNP) are considered to be constant, and the growth of the high powered money, Θ, $\Delta H/H$, is equal to inflation rate (π) plus the growth rate of output (n). Similarly, the growth rate of government bonds, $\Delta B/B$, must be equal to the growth rate of Y, (n).

By dividing the budget constraint (1) by output and rewriting, we get;

(2) $G\text{-}T/Y = (\Delta H/H)(H/PY) + (\Delta B/B)(B/Y) + (\Delta F/F)(FE/PY)$

Using the above mentioned steady state conditions we achieve,

(3) $d = (\pi + n)h + nb + n1^*f$, and rewriting it;

(4) $d1 = d - n1^*f = \pi h + n(h+b)$, where

d1: budget deficit after foreign finance
d: budget deficits
$n1 = \Delta F/F$
$f = FE/PY$
$h = H/PY$
$b = B/Y$

Deriving the rate of inflation, π, from (4) we get;

(5) $\pi = (d1-n^*v)/h$, where

$v = h + b$ (ratio of net wealth to GNP)

The equation (4) puts together the basic determinants of the inflation:

a) The ratio n^*v indicates the part of deficit that can be financed in a noninflationary way. As h and b increases, the steady state inflation declines. With rising inflation, h is expected to decline while b is expected to rise, partly balancing their effects. That makes the growth rate, n, an important determinant of the inflation, as growth rate declines the steady state inflation rises.

b) It is obvious that as budget deficits, d, increases the steady state inflation rises.

c) Finally, as the ratio of monetary base to GNP, h, declines (as flight from money takes place), inflation rises. Moreover, the decline in h, which is in the denominator of the equation (4), strengthens the inflationary effects of a rise in the deficit or a decline in the growth rate.

All of these factors were present in the Israeli case: The growth rate declined from 6.5% in 1968-1977 period to 2.6% between 1978 and the second quarter of 1985 (the onset of stabilization program). During the same period the h (ratio of the monetary base to GNP) declined from 11.6% to 3.3 %. The budget deficits were 7.95% and 7.7% respectively in the same period. In Israel, the acceleration of dictated inflation preceded the jumps of actual inflation into the new plateaus until its explosion in 1984. It is interesting to note that between 1975 and 1984 the gap between the steady state and actual inflation rates widened: the steady sate inflation being about 80% points higher than the actual one in 1981-83 period(25).

III.II.b. Turkish Evidence

The results of the equation (5), π = (d1 - n*v)/h, for Turkey are shown in the Table VI and the calculated values of dictated inflation together with the actual values are shown in Figure I.

An examination of the results show that the developments in the fundamentals (d, n, and h) can capture the inflationary dynamics in the Turkey to a large extent. As Table I indicates there has not been a major shock in h, i.e. the decline in h (the flight from money) have been gradual. Although the figures derived from the equation (4) are the results of fundamental relations and must be interpreted in the light of short term developments and deviations, the movements in the inflation (both the dictated and the actual ones) seem to be shaped by the fluctuations in the budget deficit and the growth rate, together with the gradual decline in the monetary base. The major jumps in steady state inflation (in 1984, 1988, and 1991) are characterized by a decline in the growth rate and/or a rise in the budget deficit.

Rodrik (1991) uses a similar model to explain the inflationary process in Turkey. From a simple budget constraint where the deficits are purely financed by money creation, Rodrik obtains an identity for (the dictated) inflation as π = (d/m) - μn (where π is

(25) For the relevant figures see Bruno (1989).

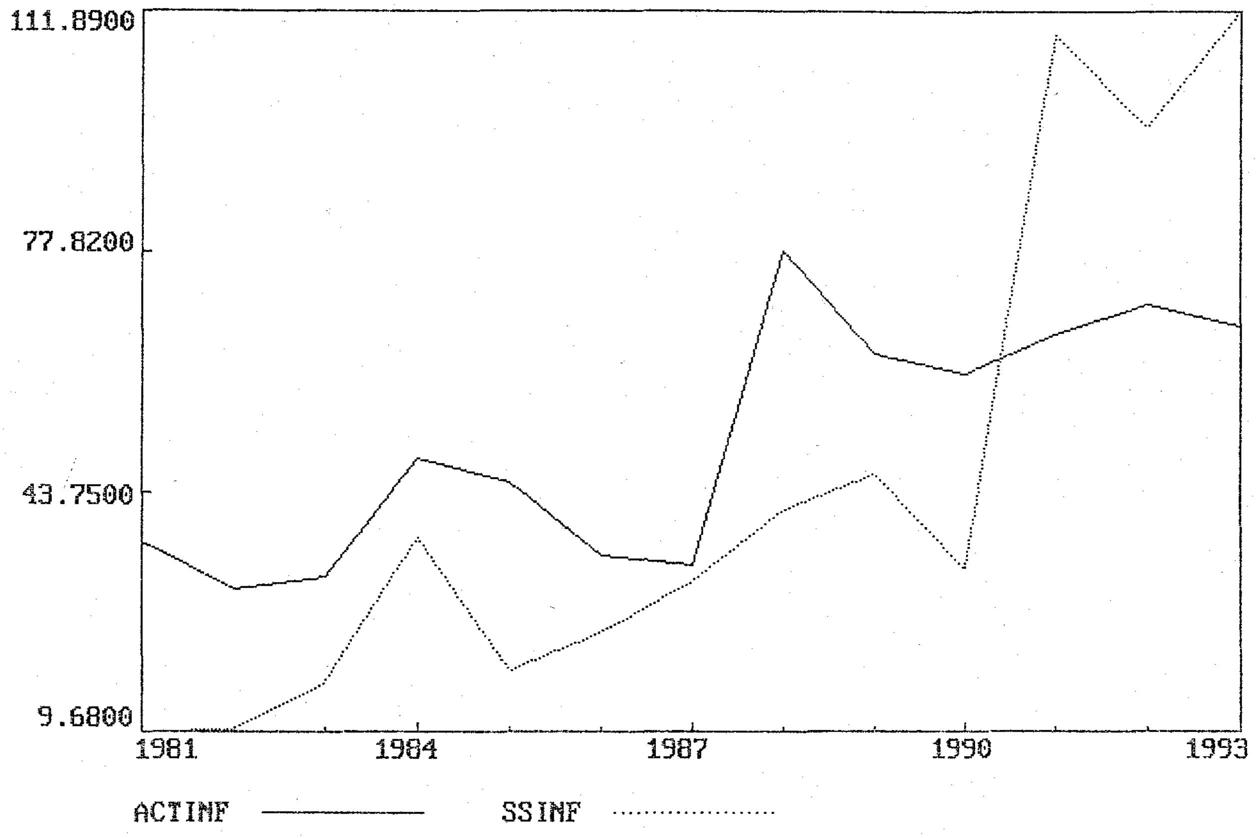
TABLE VII

Actual and Steady State Inflations

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
d ((G-T)/Y)	1.54	1.47	2.22	4.31	2.19	2.70	3.42	2.95	3.22	3.02	5.38	5.50	6.71
b (B/Y)	0.03	0.03	0.03	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.07	0.11	0.14
f (F*E/Y)	0.24	0.27	0.30	0.35	0.37	0.41	0.45	0.44	0.38	0.39	0.34	0.36	0.36
h (H/Y)	0.083	0.088	0.091	0.083	0.077	0.068	0.065	0.060	0.059	0.052	0.048	0.045	0.046
n	5.30	3.70	4.60	7.80	4.50	7.50	9.30	1.40	2.30	9.20	0.50	5.90	6.80
n1	0.56	0.51	0.45	0.87	0.70	0.60	0.63	0.68	0.53	0.74	0.37	0.81	0.71
h+b	0.11	0.12	0.12	0.12	0.12	0.11	0.12	0.12	0.12	0.11	0.12	0.15	0.19
n*(h+b)	0.60	0.44	0.56	0.94	0.53	0.85	1.13	0.16	0.28	1.04	0.06	0.91	1.30
n1*f	0.13	0.14	0.13	0.30	0.26	0.24	0.29	0.30	0.20	0.29	0.12	0.29	0.25
-steady state	9.68	10.02	16.70	37.02	18.24	23.61	30.98	41.12	46.20	32.78	108.49	95.50	111.89
-actual	36.60	29.80	31.40	48.40	45.00	34.60	33.10	77.70	63.30	60.30	66.00	70.10	67.10

Sources: Financial statistics are from The Undersecretariat of Treasury and Foreign Trade, the growth rate and inflation are from the State Planning Organization, and monetary statistics are from Central Bank of the Republic of Turkey.

Figure I. Actual and Steady State Inflations



inflation, d and m are the shares of the budget deficit and base money in GNP, μ is the income elasticity of demand for base money, and n is the real growth rate). Rodrik (1991), however, run several regressions for the different values of μ and interprets his R-squares as the part of the inflation explained by the "fiscal view". Wijnbergen (1991) criticized Rodrik (1991) for using OLS for his identity since the results of such public-finance approach must be considered as evidence for the problem of sustainability, rather than as a way of explaining the behavior of inflation from one quarter to the other. Following Bruno (1989), and considering Wijnbergen (1991), we did not try to estimate any regression for our steady-state inflation identity, but try to evaluate the result as the indications for the problems of long term sustainability and fragility.

Our facts are better presented when we look at the data in subperiods. This is done in Table V, where the data obtained in Table IV are presented for subperiod averages. The periodization, which is always arbitrary to a certain extent, depends on the major breaks in the steady state inflation rate. It, nevertheless, coincides with the actual shocks: with the adjustment of public prices in December 1987 and with the Gulf Crises in 1991.

TABLE VIII
Actual and Steady State Inflation

	1981-87	1988	1989-90	1991-93
d	2.5	2.9	3.1	5.8
n	6.1	1.4	5.7	4.4
h	7.9	6.0	5.5	4.6
π (steady state)	20.9	41.1	39.5	105.3
π (actual)	36.9	77.8	61.8	67.7

The numbers until the 1991 are easier to interpret: with a fall in the growth rate, the public prices shock of December 1987 brought the inflation into a new plateau, despite the comparable budget deficit numbers. The similar magnitudes of the jumps in the steady state inflation and the actual inflation in 1988 are noticeable. Both rates of inflation declined in the next period, yet the magnitudes being different. The rise in the growth rate and the budget deficit have produced a neutral effect on the steady state inflation, but inflation have been reinforced by the gradual decline in the monetary base.

The two rates diverge, however, after 1991: while with further decline in h, and with a lower growth rate (mainly due to the bad performance of 1991), the sharp rise in the budget deficit increases the steady state inflation to 100% level, the actual inflation has remained stable at its higher plateau. With such a high steady state inflation, the actual inflation can be expected to shift to a new and higher plateau after a possible shock (internal or external); or to reach the higher levels gradually without a shock in the next period.

Given these facts, the continuation of the high growth rates of the last years, the reversal or slowdown of the flight from money (i.e. dollarization), and most importantly the correction of fiscal situation (the reduction of the budget deficits by a combination of expense cuts, including a privatization program; and revenue increasing tax reforms) are three fundamental areas where there is need for immediate action.

The recent evidence of flight from money in Turkey is a dangerous development in this respect. The coefficient of dollarization (the share of foreign exchange deposits in total deposits) reached 44% in the last ten months of 1993, while the same figures for 1992 (again the last ten months), 1991 and 1990 were 39.7%, 31% and 19% respectively. The velocity of M1 (the ratio of GNP to M1), also increased from 8.2 in 1980 to 11.6 in 1988 and 13.7 in 1993.

The important problem facing Turkish economy is whether the flight from the narrow money will be matched by financial innovations that will produce inflation-protected instruments; or the flight will result in further dollarization, an uncertain yet widely available way of protection against inflation. Both of these developments seem to take place in Turkey. The decline of the velocity of M2, and the rise of the M2-GNP ratio until 1988 are indicators of financial adaptation, yet the high level of dollarization coefficient and decline in the M2-GNP ratio in recent years represent the forces in other direction. As flight from money continues, a given budget deficit represents a larger share of money stock, a development increasing the fragility of the economy and the possibilities of higher inflation.

What we have presented so far is the only the half of the model by Bruno and Fischer. The full model considers the nonlinear nature of the equation (5), once the expectations are introduced to the model. In order to explain the sudden rise of the inflation in Israel without the accompanying fiscal deterioration after 1983, they show that the equation (5) is consistent with two inflation rates for a given fiscal situation and once the expectations began to play the determining role, the economy can jump suddenly to what they call the high inflation trap. We did not try to include the role of expectations in this study: one important reason is the lack of formal indexation in Turkey which prevent the calculations of the inertia in the same way as Bruno (1989). Our other reason is the belief, which is supported by our data, that the role of fiscal fundamentals are more important than the inertial factors in inflation.

IV. CONCLUSIONS

In this study, we tried to investigate some aspects of the interaction between government behavior and inflation. The theory of optimal seigniorage states that if the government's aim is to minimize the expected present value of the excess burden of taxation and seigniorage and if the monetary and fiscal sections cooperate to do so, it might be optimal for government to inflate and use inflation alongside with the ordinary taxation. This particular view of the government, which models a benevolent government caring only about the welfare consequences of its actions and nothing else, produces testable restrictions on the data. We have demonstrated that both tax rate and inflation series must be nonstationary as the result of the government's revenue smoothing considerations. Furthermore, these two nonstationary series must be cointegrated and imply a long run relationship. We have tested these restrictions for Turkey using post-1980 data. Our results demonstrated that while the tax rate is a nonstationary series, CPI inflation rate is not. Therefore, there can not exist a long run relationship between taxes and CPI inflation and two series can not be cointegrated. As an alternative measure of inflation, we investigated the time series properties of WPI inflation. WPI inflation is a nonstationary series and it is possible to investigate the longrun relation between the tax rate, WPI inflation, and the velocity. We could not find, however, a cointegration relationship between WPI inflation, tax rate, and velocity. These results suggest that the revenue smoothing and welfare considerations were not the dominant elements in the evaluation of seigniorage and inflation in post-1980 Turkey within our optimization problem. Our next concern was to see if we can investigate the inflationary process and government's behavior in Turkey in a different framework. We investigated if we can explain the inflationary process in Turkey using a deficit-oriented approach, and looked for the connections between fiscal fundamentals and inflation. Our results suggested that fiscal fundamentals dictated inflation to the government (which is unable to correct the fundamentals). We also argued that such a government behavior can be optimal for the politicians and for the society, when we redefined the utility function of the government. The results indicated the degree of fragility in the system and the need for the correction of fundamentals. The correction of the fundamentals, on the other hand, necessitates the redefinitions of the rules of the game between the government and the society.

APPENDIX

The Integration and Cointegration Analysis: Basic Definitions and Test Procedures.

Most of the definitions and the notations in this section are taken from Charemza and Deadman (1992), which contains a clear introduction to the analysis of integration and cointegration. Campbell and Perron (1991) and Benerjee and Others (1993) are advanced texts which provide the formal definitions of the concepts and the testing procedures.

Stationarity: A time series, y_t, is said to be stationary (weak or covariance stationary) if:

$E(y_t) = \text{constant} = \mu$; $Var(y_t) = \text{constant} = \sigma^2$; and $Cov(y_t, y_{t+j}) = \sigma_j$

If one or more of these conditions are not fulfilled, the series is said to be nonstationary.

Random Walk: When a time series, y_t, can be characterized as:

$y_t = y_{t-1} + e_t$ where e_t is a white noise residual,

it is said to follow a random walk.

If a time series follows a random walk, it is nonstationary, because the second condition of the stationarity is violated:

$$y_t = y_{t-1} + e_t$$

$$y_{t+1} = y_t + e_t$$

$$y_{t+2} = y_{t+1} + e_t = y_t + 2e_t$$

$$y_{t+n} = y_t + ne_t$$

$$E(y_{t+n}) = E(y_t)$$

$Var(y_{t+n}) = Var(y_t) + n^2\sigma^2$

Trend: If the nonstationarity of a series is in the form of propensity to move in one direction, this propensity or tendency is called a trend. A trend can be stochastic, $y_t = y_{t-1} + e_t$, or deterministic, $y_t = \alpha_0 + \alpha_1 T$, where T denotes time.

Spurious Regressions: If two nonstationary (trended) series are regressed on each other using OLS, one is likely to end up with a model with significant results, although there is no meaning in the regression. Moreover, when the series are nonstationary statistical properties of the regression and the usual t-statistics are not valid (Granger and Newbold, 1974, and Phillips, 1986).

Integration: A nonstationary series, y_t, that can be transformed to a stationary series by differencing d times is said to be integrated of order d, and denoted as I(d). If a series is I(1), for example, it is nonstationary in its levels but stationary in its first differences.

Unit Roots: When a series is nonstationary in its levels but stationary in its first differences, that is the series is I(1), it is said to contain a unit root.

Seasonal Integration: A nonstationary series is said to be seasonally integrated of order (d,D), if it can be transformed to a stationary series by applying seasonal differences D times and then differencing the resulting series d times using first differences. Seasonally integrated series are denoted as $SI_s(d,D)$, where s denotes the frequency of the data. An $SI_4(1,1)$ series, for example, turns to be stationary after applying quarterly differencing to the series and first differencing to the resulting series.

Cointegration: The nonstationarity is a problem for empirical econometrics. However, if there exists a long run relationship between two variables they can not drift apart, and their deviations from a long run path are expected to be stationary (Granger, 1986, Engle and Granger, 1987).

Two time series x_t and y_t are said to be cointegrated of order d,b, where $d \geq b \geq 0$ if:

1. both series are integrated of order d,

2. there exists a linear combination of these variables $\alpha x_t + \alpha y_t$ which is integrated of order d-b.

In empirical work the interesting case is where d = b, that is where the linear combination of the two series is I(0).

If two series are I(1) for example and there is assumed to exist a long run relationship between them as $y_t = \alpha x_t$. Then the series $y_t - \alpha x_t$ (indeed the residual from the regressing x_t on y_t) must be stationary, I(0), series.

ADF (Augmented Dickey Fuller) Test for Integration: This is the most commonly used test procedure to test the order of integration of a time series. If a series y_t is nonstationary;

$$y_t = \alpha y_{t-1} + e_t$$

α must be equal to one in this regression. ADF test is based on testing if $\alpha = 1$ against the alternative $|\alpha| < 1$. Rewriting this equation as:

$$\Delta y_t = \Theta\, y_{t-1} + e_t$$

If Θ in this equation is negative, then α in the above equation turns to be less than one, implying the stationarity of the data.

ADF test uses a generalization of this procedure and looks at the results of the following regression;

$$\Delta y_t = \alpha_0 + \alpha_1 \mathrm{TIME} + \alpha_2 y_{t-1} + \Sigma_{i=1}^{k} \Delta y_{t-i} + e_t$$

The lags of dependent variables up to k are included in order to avoid the problem of autocorrelation. The null hypothesis is that the series is nonstationary (H_0: $\alpha_2 = 0$). and the significant negativity of α_2 indicates the stationarity of the data (non-conventional t-values for testing this is provided by Fuller, 1976). It is also possible, using Lagrange Multiplier test, to test jointly the absence of a stochastic trend ($\alpha_2 < 0$) and the existence of a deterministic trend ($\alpha_2 = 0$) or the existence of a drift, stochastic trend, and the deterministic trend (non-conventional F-values provided by Dickey and Fuller,1981).

DHF (Dickey, Hasza, Fuller) Test for Seasonal Integration:

This test defined in Dickey, Hasza, and Fuller (1984) is a two step procedure to test seasonal integration. First, the seasonality of the data is tested and it is decided if seasonal differencing is necessary; then the stationarity of the seasonally differenced data is tested in order to determine if further first differencing is needed. DHF test is based on the following regression;

$$\Delta_s y_t = \alpha_0 Z_{t-s} + \Sigma_{i=1}^{k} \alpha_1 \Delta_s y_{t-i} + e_t$$

The original DHF procedure used $\Delta_s Z_t$ as the dependent variable, we used $\Delta_s y_t$ as the dependent variable following Osborn and et. al. (1988). The significant negativity of α_0 in this regression indicates the nonseasonality of the series. The critical t-values for the null hypothesis that the series show seasonality (H0: $\alpha_0 = 0$) are provided in Dickey, Hasza, and Fuller (1984).

Z_t is a variable which is constructed as follows;

$$\Delta_s y_t = \Sigma_{i=1}^{k} \mu_i \Delta_s y_{t-i} + e_t$$

$$Z_t = y_t - \Sigma_{i=1}^{k} \mu_i y_{t-i}$$

Johansen Test for Cointegration:

This test is (both computationally as well as conceptually) more complicated than the other tests we have outlined above. Therefore we will not explain all of the computational details of this procedure, and will only summarize its logic. (For a more detailed analysis see the papers by Johansen (1988) and Johansen and Juselius (1990), as well as the relevant sections of Charemza and Deadman (1992) and Pesaran and Pesaran (1991).

Consider an unrestricted VAR model:

$$X_t = \Sigma_{i=1}^{k} A_i X_{t-i} + e_t$$

where X_t consists of n variables in the model and e_t is a vector of random variables. Assume that all of the variables in X_t is integrated of same order higher than zero, in particular assume that they are I(1). This VAR model can also be written as:

$$\Delta X_t = \Sigma_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \pi X_{t-k} + e_t$$

where;

$\Gamma_i = -I + A_1 + A_2 + \ldots\ldots + A_i$ (I is a unit matrix)

$\pi = -(I - A_1 - A_2 + \ldots\ldots + A_k)$

Since there are n variables constituting π matrix, the rank of π can be at most n. Johansen (1988) shows that:

(I) If the rank of matrix π is equal to n, vector process X^t is stationary.

(II) If the rank of matrix π is equal to r < n, there exists a representation of π such that $\pi = \alpha B'$, where α and B are n x r matrices.

Johansen testing procedure estimates two statistics, maximal eigen value statistics and trace statistics, for testing the existence of cointegration between a set of variables, that is for determining the rank of π matrix. If the existence of cointegration is not rejected, that is if π tun to be reduced matrix, it is also possible to obtain the cointegrating vector, B, which provides the parameters of longrun relationship.

Figure A.1. Log of Price Level

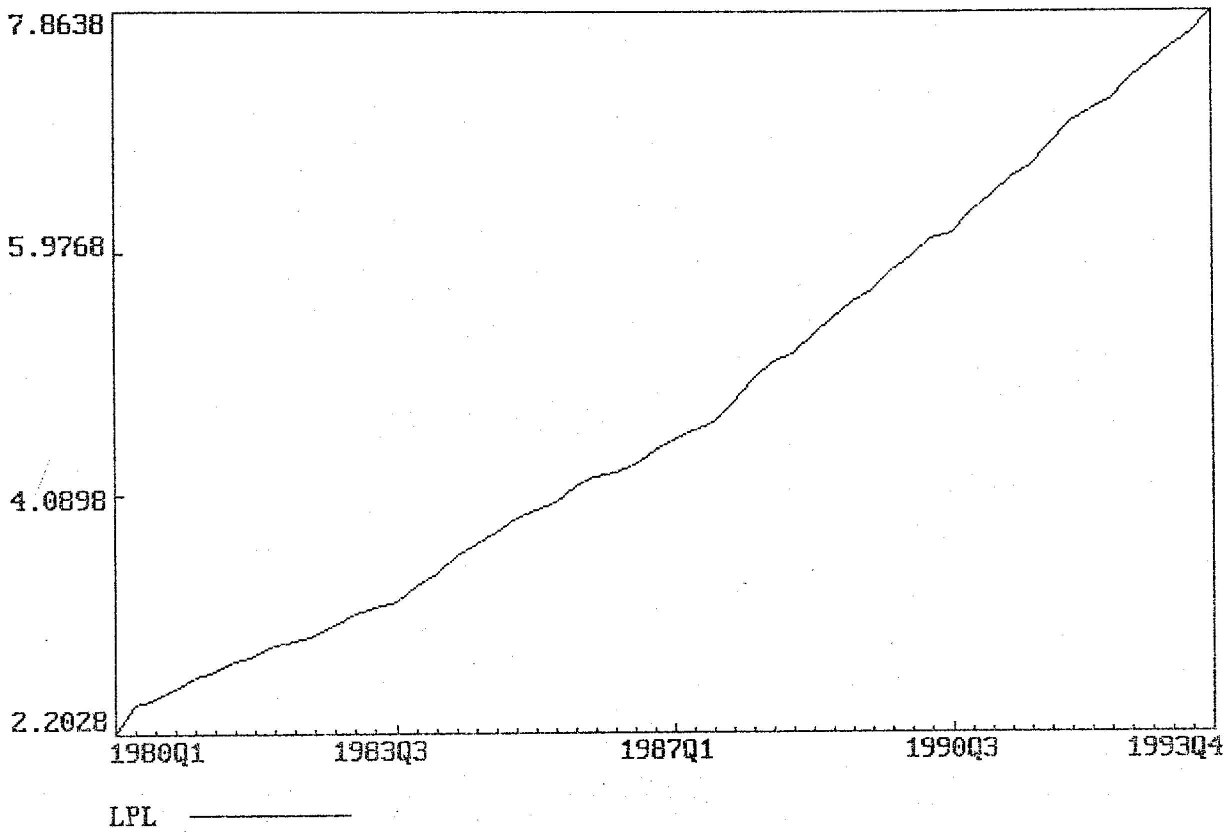


Figure A.2. The Difference of Log of Price Level

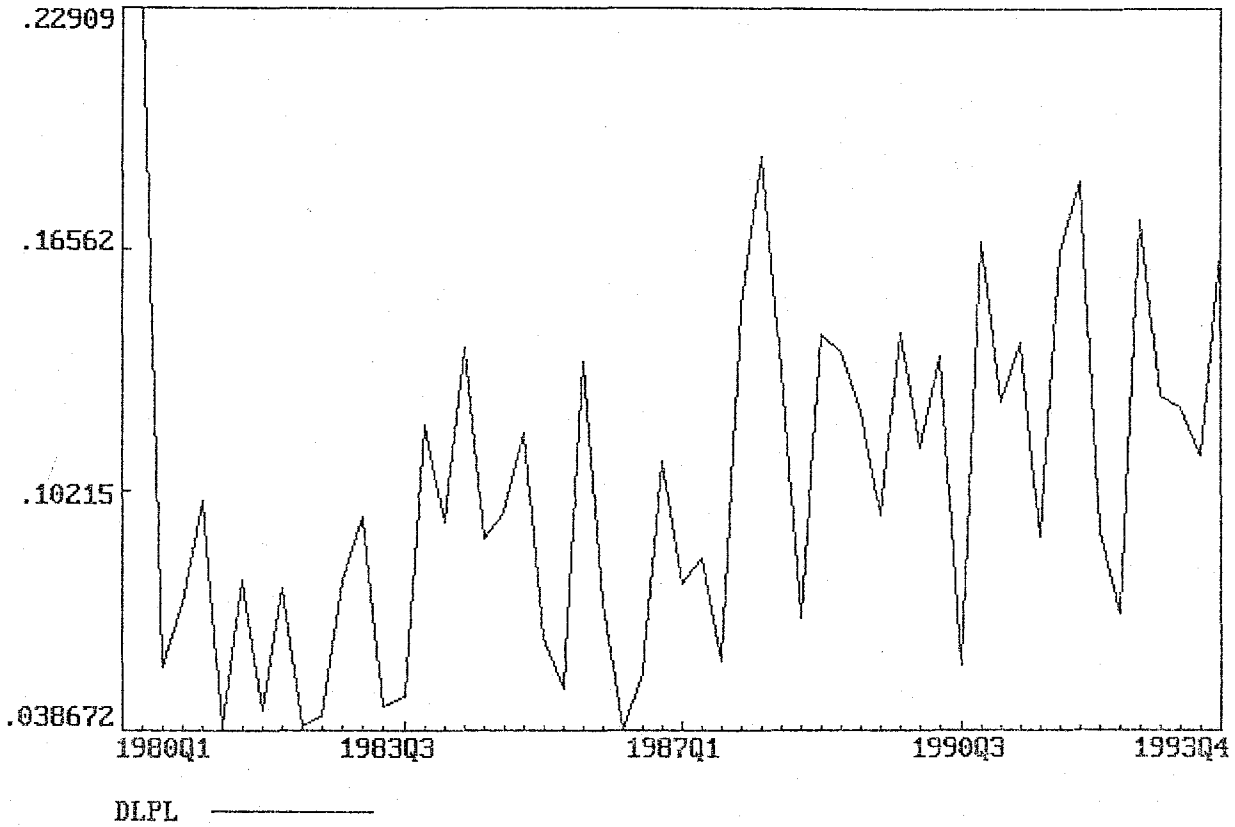


Figure A.3. Log of Tax Rate

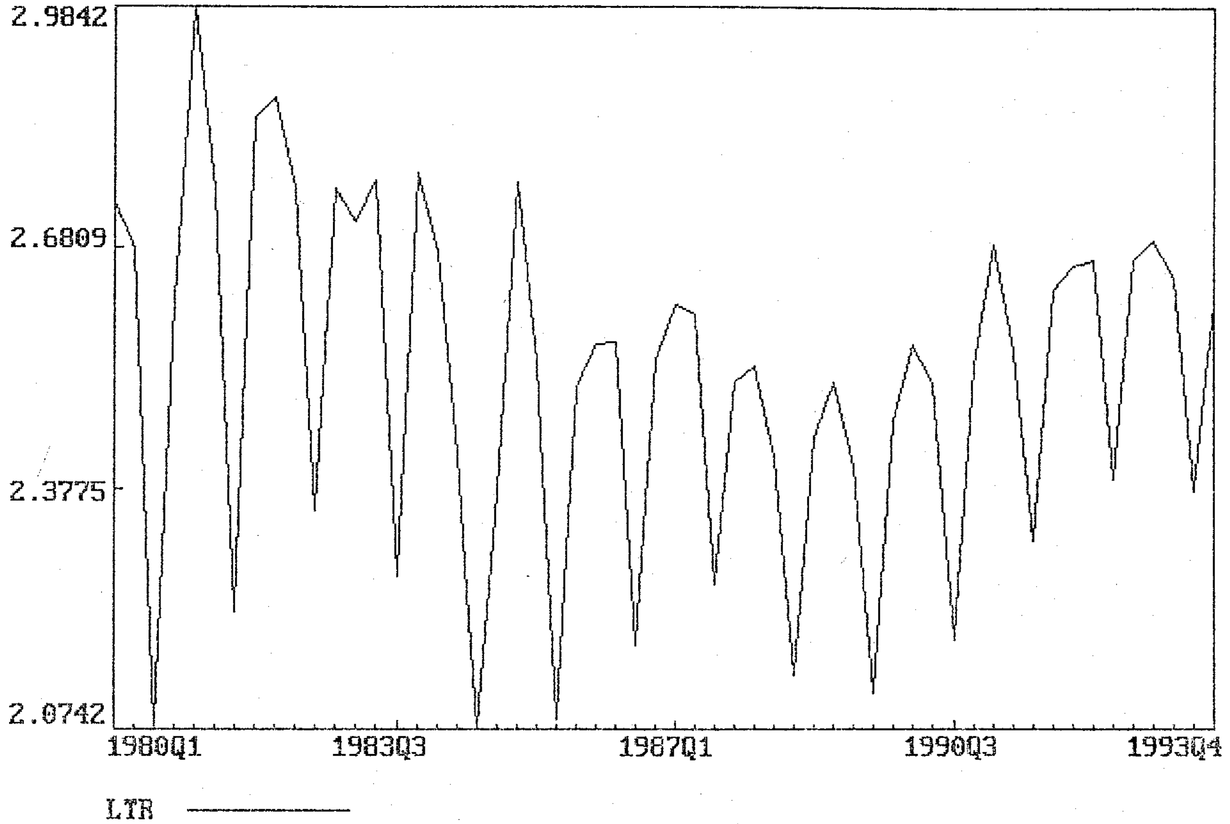


Figure A.4. Log of Velocity

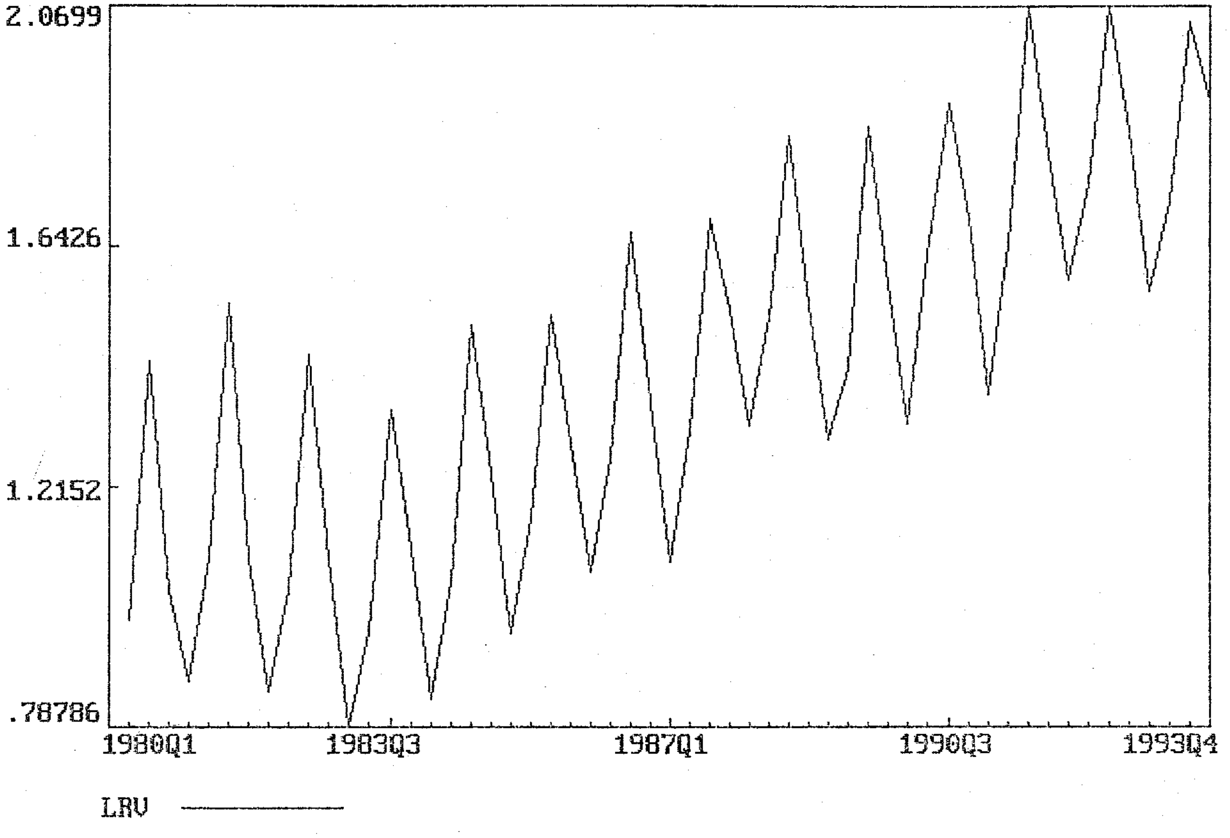


Figure A.5. Autocorrelation Function of The Difference of Log of Tax Rate

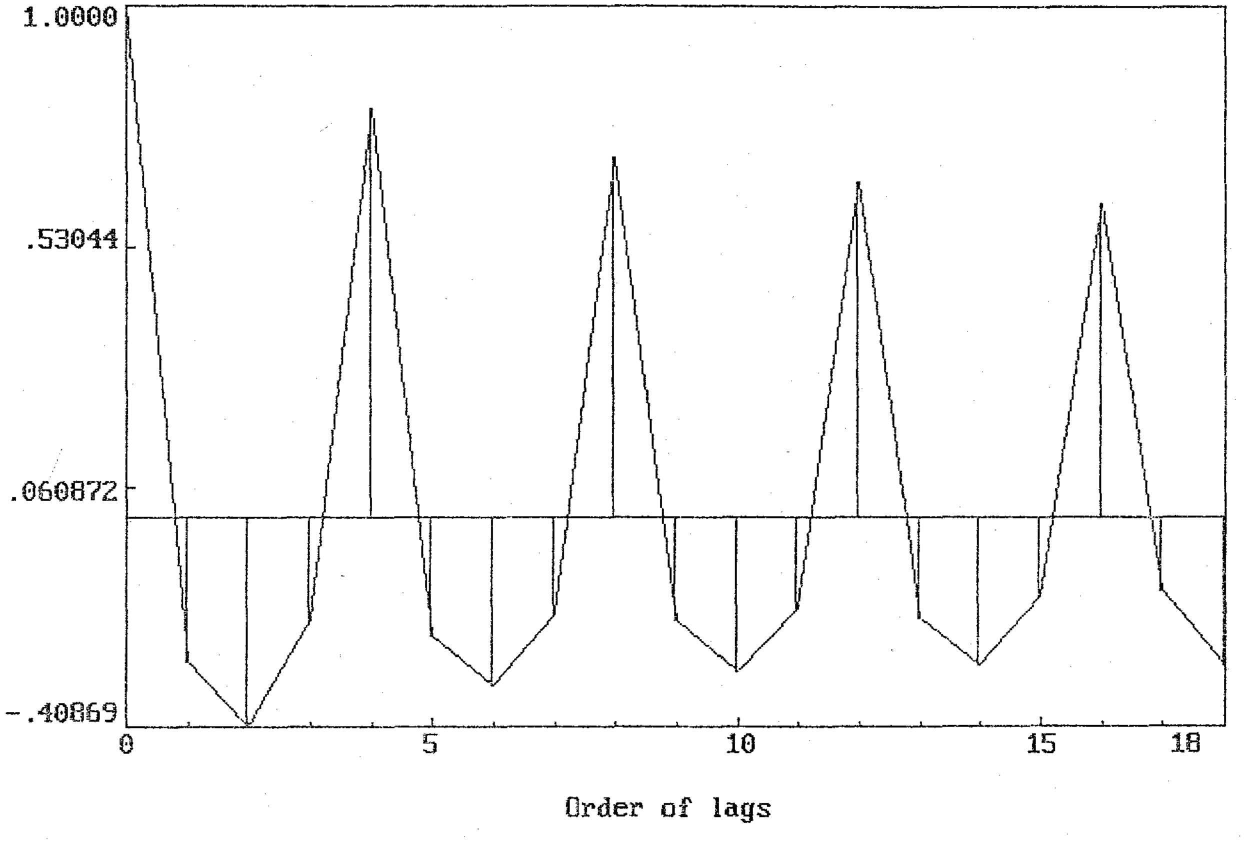


Figure A.6. Autocorrelation Function of The Difference of Log of Velocity

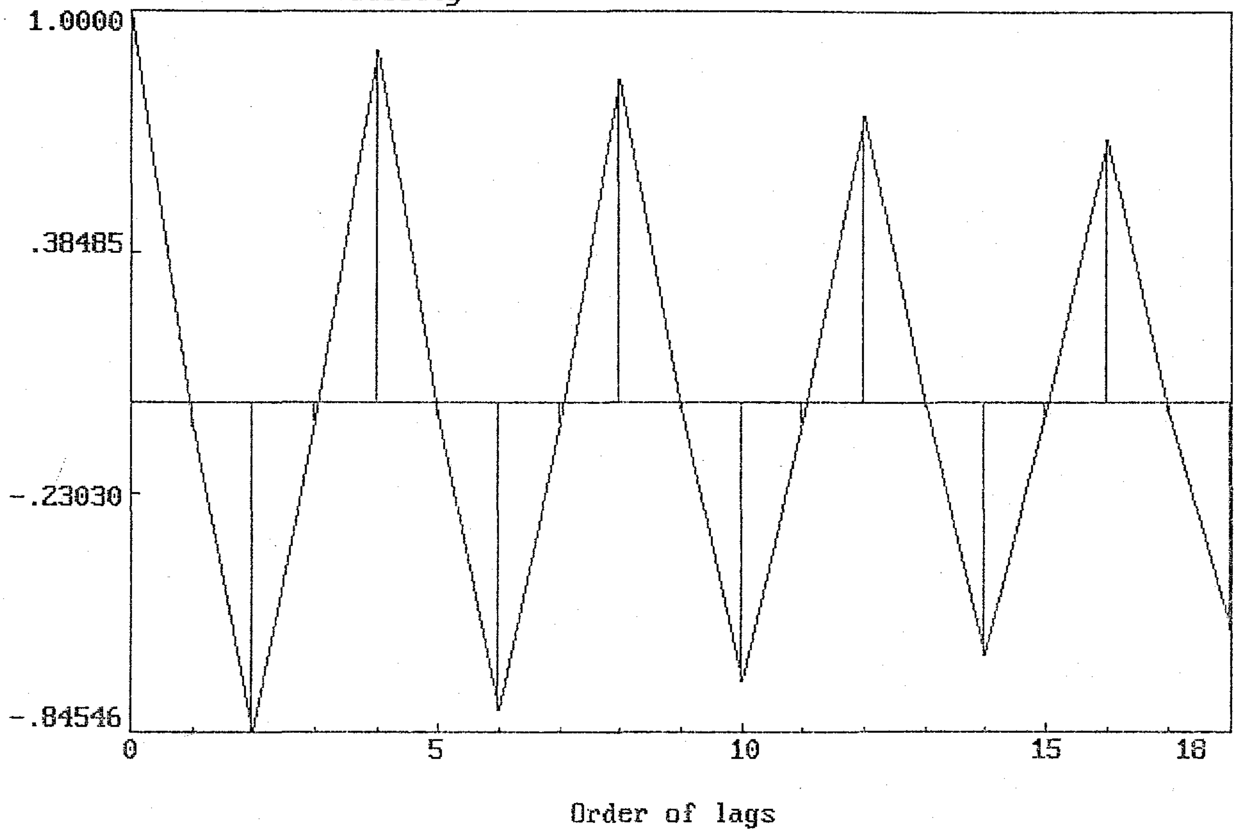


Figure A.7. The Difference of Seasonally Differenced Log of Tax Rate

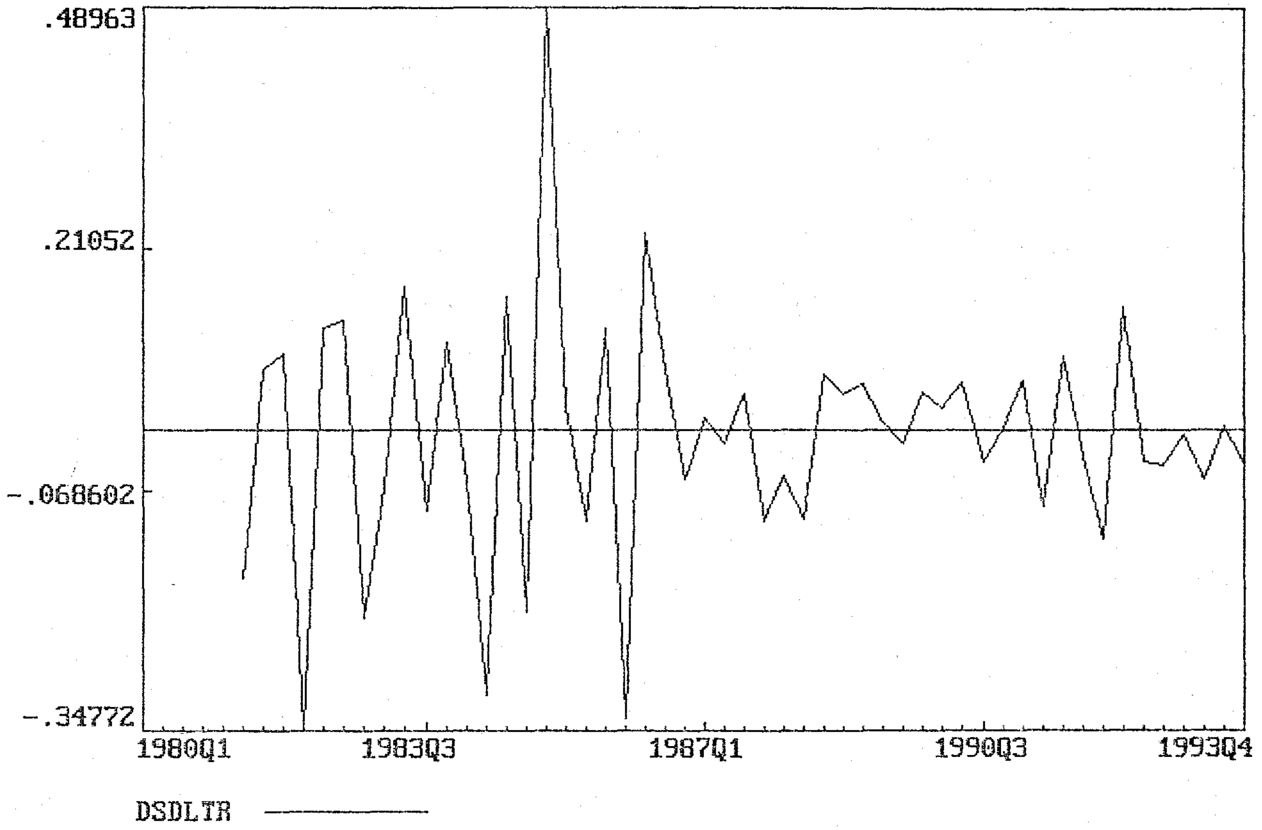


Figure A.8. The Difference of Seasonally Differenced Log of Velocity

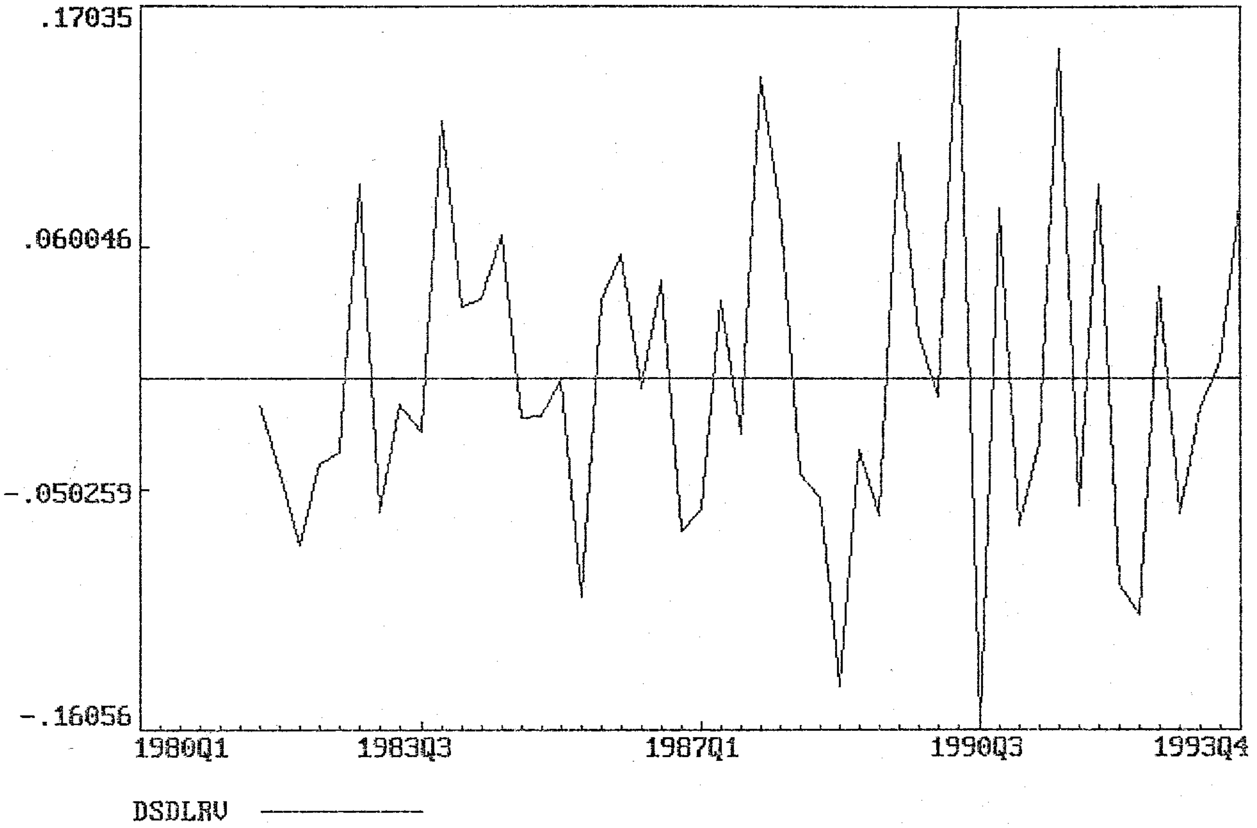


Figure A.9. Log of Price Level (WPI)

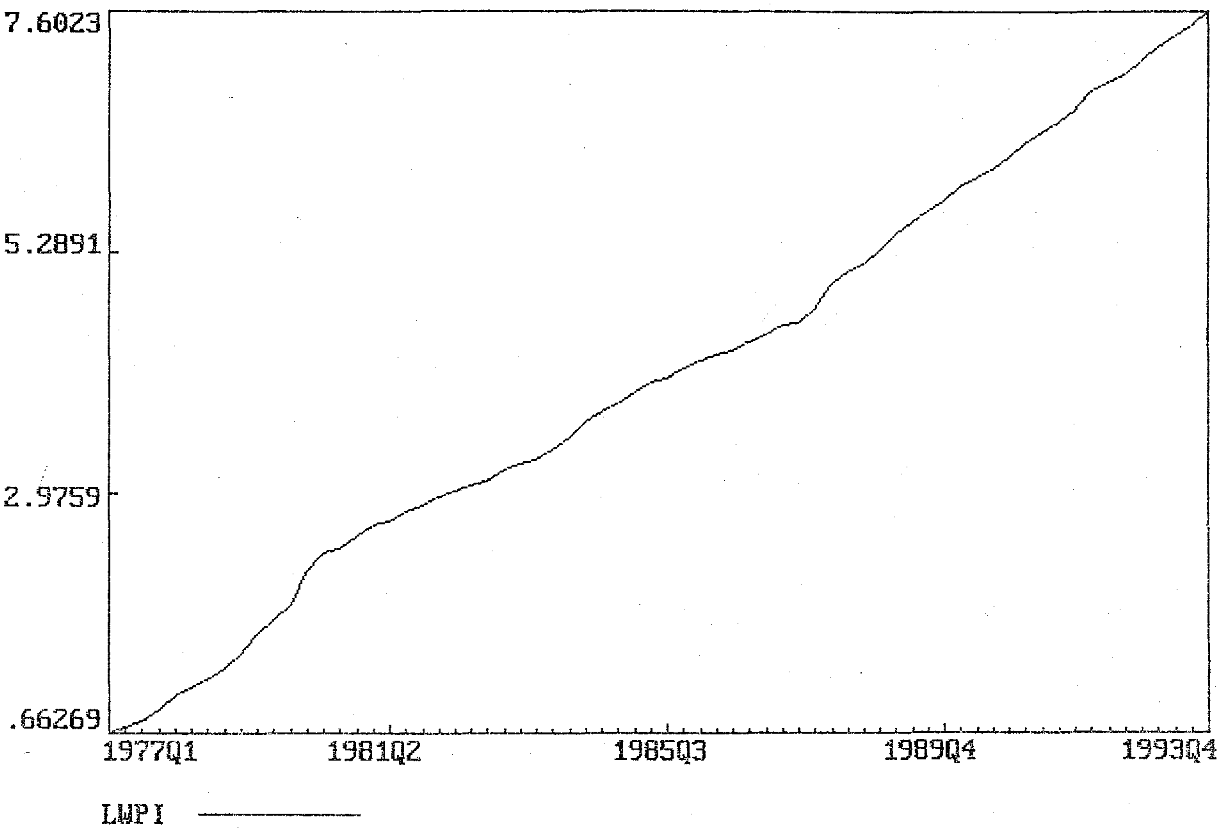


Figure A.10. The First Difference of Log Of Price Level (WPI)

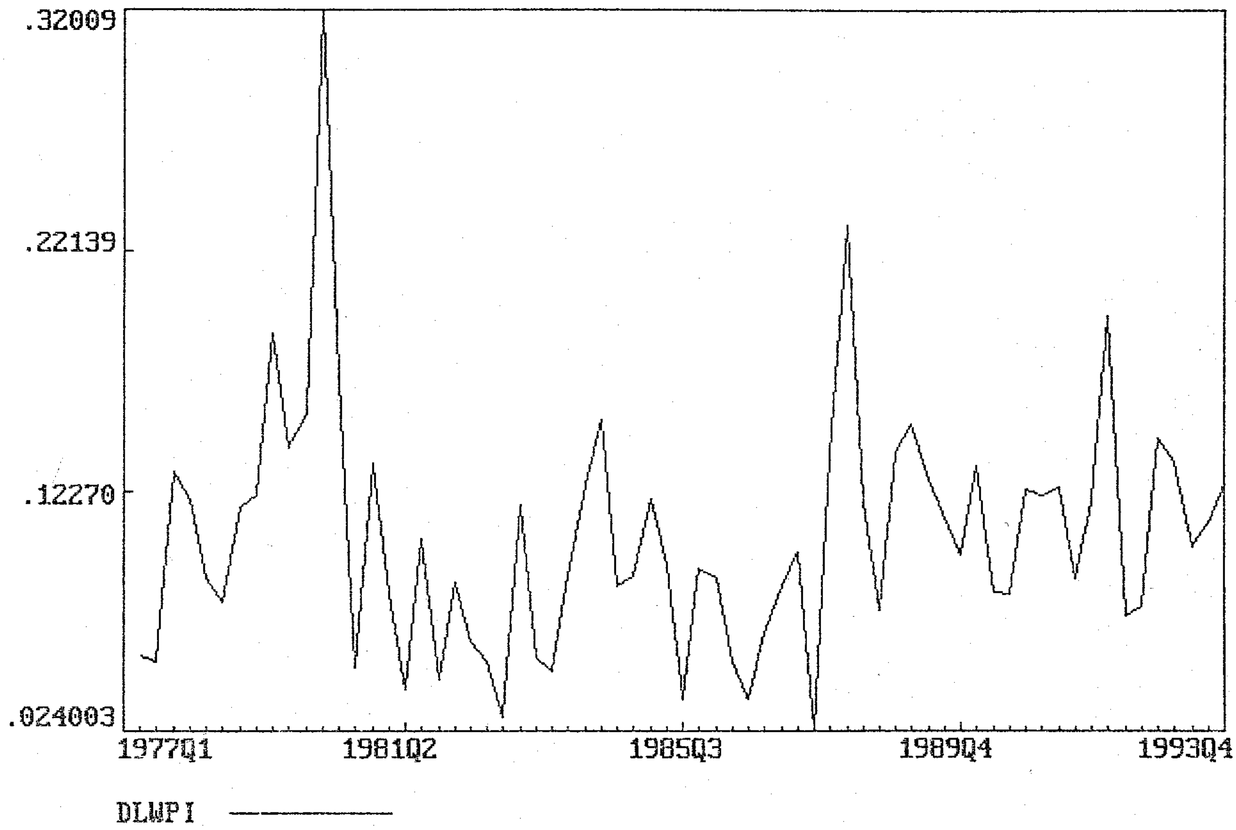
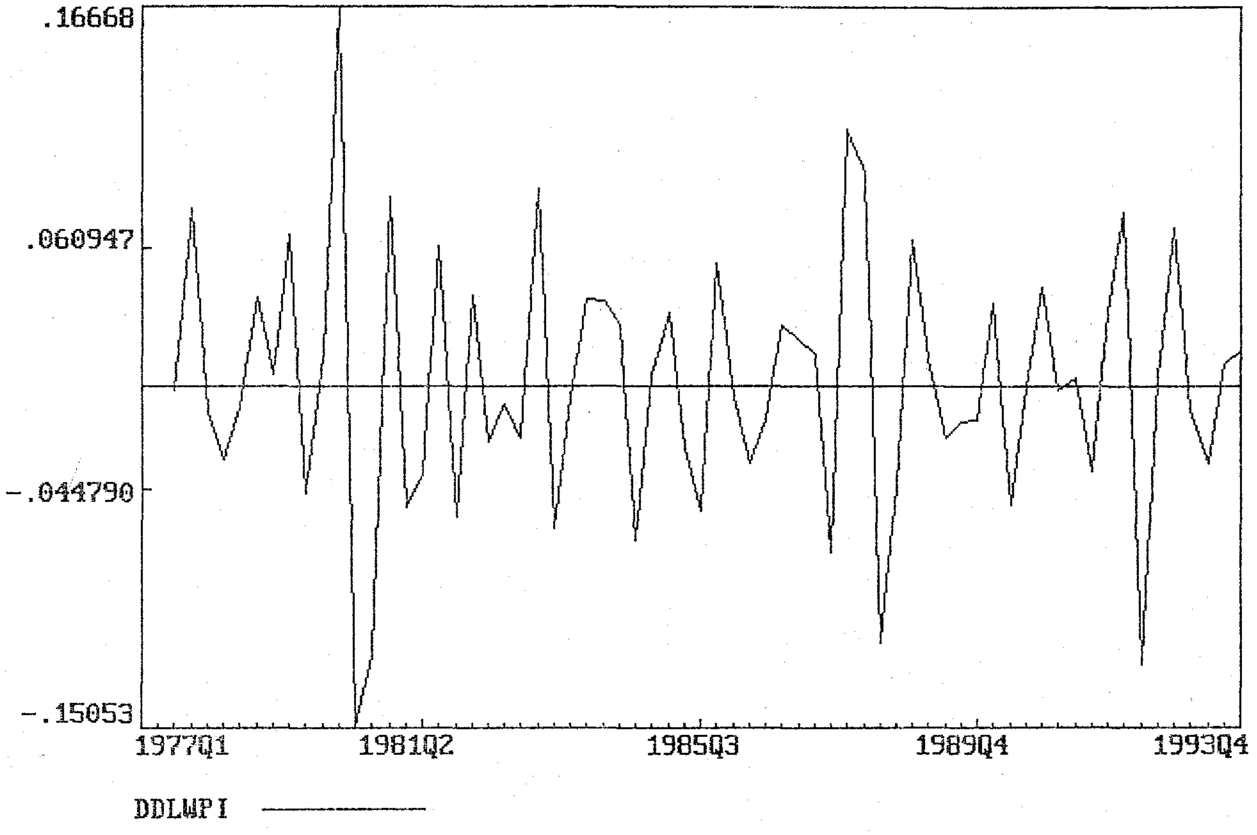


Figure A. 11. The Second Difference of Log of Price Level (WPI)



REFERENCES

Akçay, C. (1992), "Inflation Tax in a Post Financial Liberalization Environment: Evidence from Turkey, 1980-1990", Unpublished Ph.D. Dissertation, City University of New York.

Bailey, M. J. (1956), "The Welfare Cost of Inflationary Finance", Journal of Political Economy, vol.64, pp.93-110.

Barro, R. (1979), "On the Determination of the Public Debt", Journal of Political Economy, vol.87, pp.940-971.

(1989), "Modern Business Cycle Theory", Harvard University Press, Cambridge, Mass.

Box, G. E. P. and Pierce, D. A. (1970), "Distribution of Residual Autocorrelations in Autoregressive Integrated-Moving Average Time Series Models", Journal of American Statistical Association, vol.65, pp.1509-1529.

Bruno, M. (1989), "Econometrics and the Design of Economic Reform", Econometrica, vol.57, pp.275-306.

Bruno, M. and Fischer, S. (1986), "The Inflationary Process: Shocks and Accommodation", in The Israeli Economy: Maturing Through Crisis, Yoram Ben-Porath (ed.), Harvard University Press.

(1990), "Seigniorage, Operating Rules, and High Inflation Trap", Quarterly Journal of Economics, pp. 353-374.

Bruno, M. et. al. (eds.), (1988), "Inflation Stabilization: The experience of Israel, Argentina, Brazil, Bolivia, and Mexico", MIT Press, Cambridge, MA.

Bruno, M. et. al. (eds.), (1991), "Lessons of Economic Stabilization and Its Aftermath", MIT Press, MA.

Campbell, J. Y. and Perron, P. (1991), "Pitfalls and Opportunities: What Macroeconomists Should Know about Unit Roots", in NBER Macroeconomics Annual.

Charemza, W. W. and Deadman, D. (1992), "New Directions in Econometric Practice", Edward Elgar Publishing Company.

Dickey, D. and Fuller, W. (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", Journal of American Statistical Association, vol.74, pp.427-431.

(1981) "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", Econometrica, vol.49, pp.1057-1072.

Dickey, D. A., Hasza, D. P., and Fuller, W. A. (1984), "Testing for Unit Roots in Seasonal Time Series", Journal of American Statistical Association, vol.79, pp.355-367.

Doan, T. A. (1990), "RATS 3.10, User's Manual", VAR Econometrics Inc.

Dornbusch, R. (1989), "Discussion" on Grilli (1989) in "A European Central Bank?" ed. by De Cecco and Giovannini, Cambridge University Press, Cambridge.

Dornbusch, R., F. Sturzenegger, H. Wolf (1990), "Extreme Inflation: Dynamics and Stabilization", Brooking Papers on Economic Activity, 2, pp. 1-84.

Driffill, J., Mizon G., and Ulph A. (1990), "Costs of Inflation" , in Handbook of Monetary Economics, vol.2, ed. by B.M. Friedman and F.H: Hahn, Elsevier Science Publishers.

Edwards, S. and Tabellini, G. (1991), "Explaining Fiscal Policies and Inflation in Developing Countries", Journal of International Money and Finance, vol.10, pp.s16-s48.

Engle, R. F. (1982), "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom" Econometrica, vol.50, pp.987-1008.

Engle, R. F. and Granger, C. W. J. (1987) "Cointegration and Error Correction: Representation, Estimation, and Testing", Econometrica, vol.55, pp.251-276.

Fischer, S.(1981), "Towards an Understanding of the Costs Of Inflation: II", Carnegie-Rochester Conference Series on Public Policy, vol.15, pp. 5-42.

(1987), "New Classical Macroeconomics", in New Palgrave Dictionary of Economics.

Friedman, M. (1971), "Government Revenue from Inflation", Journal of Political Economy, vol.79, pp.846-856.

Fuller, W. A. (1976), "Introduction to Statistical Time Series", New York, John Wiley.

Godfrey, L. G. (1978), "Testing for Higher Order Serial Autocorrelation in Regression Equations When the Regressors Include Lagged Dependent Variables", Econometrica, vol.46, pp. 1303-10.

Gottlieb, D. (1992), "Inflation and Policy Response, The Israeli Case: 1970-1989", in Price Dynamics, H. Ersel (ed.), The Central Bank of The Republic of Turkey, Ankara.

Granger, C. W. J. (1986), "Developments in the Study of Cointegrated Economic Variables", Oxford Bulletin of Economics and Statistics, vol.48, pp.213-228.

Granger, C.W.J. and Newbold, P. (1974), "Spurious Regressions in Econometrics", Journal of Econometrics, vol.2, pp.111-120.

Grilli, V. (1989), "Seigniorage in Europe", in "A European Central Bank?" ed. by De Cecco and Giovannini, Cambridge University Press, Cambridge.

Gupta, K.L. (1992), "Optimal Taxation Policy: Evidence from Canada", Public Finance, vol.47, pp. 193-200.

Hall, R. (1978), "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence", Journal of Political Economy, vol.86, pp.971-987.

(198), "Consumption"in Barro (1989) pp.153-178.

Hoover, K.D. (1988), "The New Classical Macroeconomics", Basil Blackwell.

Jarque, C. M. and Berra, A. K. (1980), "Efficient Tests for Normality, Homescedasticity and Serial Independence of Regression Residuals", Economic Letters, vol.6, pp.255-259.

Johansen, S. (1988), "Statistical Analysis of Cointegration Vectors", Journal of Economic Dynamics and Control", vol. 12, pp. 231-254.

Johansen, S. and Juselius, K. (1990), "Maximum Likelihood Estimation and Inference on Cointegration with Application to Demand for Money", Oxford Bulletin of Economics and Statistics, vol. 52, 169-209.

Juselius, K. (1991), "Manual to Cointegration Analysis of Time Series: CATS in RATS", Institute of Economics, University of Copenhagen, mimeo.

Kiguel, M. A. and Liviatan, N. (1992), "Stopping Three Big Inflations: Argentina, Brazil, and Peru", The World Bank Policy Research Working Papers, WPS 999, Washington, D.C.

Küçüker, C., Kazdağlı, H., and Erdemir, C. (1993), "Seigniorage in Turkey", Undersecretariat of Treasury and Foreign Trade, Ankara.

Lambert, P. J. (1988), "Advanced Mathematics for Economists", Basil Blackwell.

Lucas, R. E. (1973), "Some International Evidence on Output-Inflation Tradeoffs", American Economic Review, vol.63, 326-334.

(1976), "Econometric Policy Evaluation: A Critique" Carnegie-Rochester Conference Series on Public Policy, vol.1.

Mankiw, N. G. (1987), "The Optimal Collection of Seigniorage" Journal of Monetary Economics, vol.20, pp.327-341.

Mankiw, N.G., Rotemberg, J.J., Summers, L.H., (1985), "Intertemporal Substitution in Macroeconomics", Quarterly Journal of Economics, February, pp.225-251.

Marty, A. L., "Growth and the Welfare Cost of Inflationary Finance", Journal of Political Economy, vol.69, pp.56-62.

Musgrave, R.A. and Musgrave, P.B. (1989), "Public Finance in Theory and Practice", McGraw-Hill Book Company.

Osborn, D. R., Chui, A. P. L., Smith, J. P., and Birchenhall, C. R. (1988), "Seasonality and the Order of Integration for Consumption", Oxford Bulletin of Economics and Statistics, vol.50, pp.361-377.

Öniş, Z. and Webb, S.B. (1992), "Political Economy of Policy Reform in Turkey in the 1980s", Policy Research Working Paper, WPS 1059, the World Bank.

Özatay, F.(1993), "The Sustainability of Public Sector Deficits:The case of Turkey", The Central Bank of the Republic of Turkey, Research Department, Ankara.

Pesaran, M. H. and Pesaran, B. (1991), "MICROFIT 3.0: An Interactive Econometric Software Package, User Manual", Oxford University Press.

Phelps, E. S. (1973), "Inflation in the Theory of Public Finance", Swedish Journal of Economics, vol.75, pp.67-82.

Phillips, P. C. B. (1986), "Understanding Spurious Regressions in Econometrics", Journal of Econometrics, vol. 33, pp. 311-340.

Poterba, J.M. and Rotemberg, J.J. (1990), "Inflation and Taxation with Optimizing Governments", Journal of Money, Credit and Banking, vol.22, pp.2-18.

Rodrik, D. (1991), "Premature Liberalization, Incomplete Stabilization: The Özal Decade in Turkey" in Lessons of Stabilization and its Aftermath, M. Bruno et.al.(eds.), MIT Press.

Sahasakul, C. (1986), "The US Evidence on Optimal Taxation Over Time", Journal of Monetary Economics, vol. 18, pp.251-275.

Sandmo, A. (1976), "Optimal Taxation: An Introduction to the Literature", Journal of Public Economics, vol.6, pp. 37-54.

Sargent , T.J. (1982), "The Ends of Four Big Inflations", in Inflation: Causes and Effects, R.E.Hall (ed.), Chicago University Press.

Spaventa, L. (1989), "Seigniorage: Old and New Policy Issues", European Economic Review, vol. 33, pp.557-563.

Stern, N.H. (1987), "Optimal Taxation" in The New Palgrave Dictionary of Economics.

Trehan, B. and Walsh, C.E. (1988), "Common Trends, Intertemporal Budget Balance, and Revenue Smoothing", Journal of Economic Dynamics and Control, vol.12, pp.425-444.

Trehan, B. and Walsh, C.E. (1990), "Seigniorage and Tax Smoothing in the United States", Journal of Monetary Economics, vol.25, pp.97-112.

Wijnbergen van, S. (1991), "Comments" on Rodrik, in Bruno and Others (eds.).