FORECASTING THE TURKISH PRIVATE MANUFACTURING SECTOR PRICE INDEX: SEVERAL VAR MODELS VS SINGLE EQUATION MODELING

A THESIS PRESENTED BY A. HAKAN KARA
TO
THE INSTITUTE OF
ECONOMICS AND SOCIAL SCIENCES
IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS
FOR THE DEGREE OF MASTER OF
ECONOMICS

BILKENT UNIVERSITY
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Hakan Kara
tarafından bağışlanmıştır

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

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ABSTRACT

FORECASTING THE TURKISH PRIVATE MANUFACTURING SECTOR PRICE INDEX : SEVERAL VAR MODELS VS SINGLE EQUATION MODELING

A. Hakan KARA

M.A. In Economics

Supervisor : Asist. Prof. Dr. Kıvılcım Metin

September 1996

The purpose of this study is to forecast private manufacturing sector price index (WPI_{man}) in the period 1982(1)-1996(5) using the public sector wholesale price index (WPI_p), TL/Dollar Exchange Rate (E), M2Y and the private manufacturing sector production index (Q_{man}) as the explanatory variables. Time series properties of these variables are tested and cointegration relationships are determined. Several VAR models are introduced and at the end a single equation analysis is conducted which utilized the long-run properties of data. Forecast parameter constancy is used as the main design criterion where the special interest is on 1994 crisis.

Key Words : Unit root, Order of Integration, Seasonal Unit Root, Cointegration, Vector Autoregression, Equilibrium Correction.

ÖZ

TÜRK ÖZEL İMALAT SANAYİ FİYAT ENDEKSİ TAHMİNİ: ÇEŞİTLİ VEKTÖR OTOREGRESİF MODELLERİNE KARŞI TEK DENKLEM MODELLEMESİ

A. Hakan KARA

Yüksek Lisans Tezi

Tez Yöneticisi : Yrd. Doç.Dr. Kıvılcım Metin

Eylül 1996

Bu çalışmanın amacı 1982(1)-1996(5) dönemindeki Türk özel imalat sanayi fiyat endeksinin(WPI_{man}), kamu toptan eşya fiyat endeksi (WPI_p), TL/Dolar Döviz kuru (E), M2Y ve özel imalat sanayi endeksi (Q_{man}) değişkenleri kullanılarak tahmin edilmesidir. Değişkenlerin zaman serisi özellikleri test edilerek koentegrasyon ilişkileri tespit edilmektedir. Birçok farklı vektör otoregresif modeller sunulmakta ve son olarak uzun dönem ilişkilerinden faydalanarak elde edilen tek denklem modellemesi yapılmaktadır. Tahmin parametrelerinin değişmezliği temel tasarım kriteri olarak kullanılırken 1994 krizine ayrı bir önem verilmektedir.

Anahtar Kelimeler : Birim kök, entegrasyon derecesi,mevsimsel birim kök, koentegrasyon, vektor otoregresyon, denge düzeltme.

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CONTENTS

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Forecasting prices is an integral part of economic decision making. Price forecasts are useful for all decision making agents. Individuals may use forecasts to make money out of speculative activities, whereas they are needed by governments and firms to determine optimal government policies or to make business decisions. This explains why almost all major economic decision making agents in inflationary economies have their own models for inflation forecasting.

One such forecast model, used in Turkey was developed by the Central Bank of the Republic of Turkey. It is a first order Bayesian vector autoregression model and has been used to forecast the Turkish Private Sector Manufacturing Price Index every month. The liberalization efforts in the 1980's increased the importance of Turkish manufacturing industry. Coming to the 1990's it has an important share in the GNP which affects the price, investment and production decisions of the industry dynamically in the short run.

A potential problem for BVAR's is that in case of parameter non-constancies their ability to produce good forecasts may be temporary. Noting that the time series of the Turkish economy are non-stationary, and that the failure to capture these non-stationaries appropriately in a model can result in apparent parameter nonconstancies and this is a real problem. Recognizing this point, we used parameter constancy as the main design criterion for the models adopted in this thesis.

The Central Bank model fitted well until 1994 crisis but due to the sharp break in this period , it collapsed and never worked again. Being motivated with the fact that, the data were enough to model private manufacturing sector price index for the pre-crisis sample period, in this thesis, we will compare several models in terms of parameter constancy - focusing on the post-crisis period and develop a single equation stationary model that explains the crisis appeared in April 1994, using the Central Bank model data set.

Hendry (1996-a) has considered the partial removal of structural breaks in econometric systems using linear combinations of variables. He has formulated a reduced rank condition , analogous to cointegration - namely cobreaking. We are motivated with these results that if our data contains more than one variables subject to breaks, it may be possible that some linear combination of these variables at the same point in time do not depend on the break in 1994 even though the system as a whole is subject to structural break. Hendry states that this is analogous to check for if I(1) differences of I(2) variables may be required to obtain I(0) combinations (Johansen ,1992).

In this context rest of the thesis is organized as follows: Having considered the variables of interest of the Central Bank model, the subsections of the introductory chapter discuss the data set and developments in the Turkish economy during the sample period. Second chapter explains the concepts of stationarity, seasonal unit root and cointegration. In the third chapter, time series properties of the data is tested by using Augmented Dickey Fuller approach and the seasonal unit root calculation technique developed by Frances (1991). Next, evidence on the cointegration properties of a vector of variables are obtained by conducting an analysis in a system of I(1) using the maximum likelihood cointegration test developed by Johansen and Juselius (1990). The fourth chapter seeks for a model that achieves forecast parameter constancy in 1994 crisis. Several VAR approaches are tested in terms of their forecasting reliability and performances. At the end, utilizing the equilibrium correction mechanisms obtained from the cointegration results, a single equation modeling is conducted. Chapter five concludes.

1.2 DATA SET

Our data set consists of five different monthly series from 1982:1 to 1996:5 all obtained from the research department of Central Bank of Republic of Turkey. The variables in the data set are described below.

M2Y is currency in circulation plus demand deposits plus time deposits plus foreign currency demand and time deposits in domestic economy. E is the US dollar Turkish lira exchange rate (Monthly average). Public sector wholesale price index (WPI_p) consisted of the weighted average of the price index of the agricultural sector, the Turkish private manufacturing industry price index, mining and energy sector price indices which have negligible shares in the total index. Agricultural prices are highly dependent on seasonal effects while public sector manufacturing industry prices are influenced by the political cyclical movements. The Turkish private manufacturing industry whole sale price index is denoted by WPI_{man}. Finally, manufacturing industry price production index is shown by Q_{man}. Manufacturing industry general price index some 70 percent shares in the total wholesale price index while private sector manufacturing price index has some 49 percent share in it. That is why the manufacturing industry production index and private sector manufacturing industry wholesale price index are used in the model. Exchange rate has an important determinant of the general price level and also of the export and import prices. The variation in the public sector price level, possibly will affect the manufacturing industry prices by way of input to the production of this sector. Therefore, public sector general wholesale price index has been considered in the model. None of the series is seasonally adjusted.

1.3 THE SETTINGS

The stabilization program which was introduced on January 24,1980, began to show its effects starting from 1982. The implementation of tight monetary policy to control the inflation and efforts spent to form conditions for free market economy were successful . The annual average rate of increase in the wholesale prices which was 107.2 % in 1980 fell down to 36.7 % in 1981 and 25 % in 1982. The value of industrial production increased by 5.4 % in real terms in 1982. Currency in circulation, narrow money supply (M1) and broad money supply (M2) increased by 48.7 % , 39.3 % and 57 % respectively.

In 1983, although stabilization policies were still under implementation it was not possible to reach the targeted rate of inflation and balance of current account. General index of wholesale price index increased by 40.9 %. M1 and M2 increased by 42% and 26% respectively. The value of industrial production increased by 6.9 percent in real terms.

The policy measures of late 1983 were aimed at shifting the emphasis from domestic to external demand. Controlling inflation once again became a policy objective. The wholesale price index, one of the parameters of inflation increased by 52 % at annual averages in 1984. Growth rate of industrial production was 7.6 in real terms. M1 and M2 increased by 13.1 % and 56.1%, respectively. It was presumed that inflation rate could be brought down and excessive appreciation of dollar would halt therefore the Turkish Lira was appreciated. Effective from December 17, 1984, importation of gold of international standards has been started and selling and buying of gold by the Istanbul Foreign Exchange Branch, initiated with the purpose of stabilizing the prices of gold and foreign exchange in the markets.

In the period 1981-1985, the growth rate of industry was almost 1.6 times the GNP growth . The rising share of the manufactured goods in the exports made the industry more prone to influences transmitted from the world economy. In 1985 a number of steps were taken to ensure that the SEEs operate in a more competitive environment. Broad money (M2) strongly expanded in 1985.

1986 marked the beginning of a transition period in the implementation of monetary policy. This new policy shifted the emphasis from direct interference in private and public sector portfolios to the determination of money and credit expansion through control of the total reserves of the banking system. M2 rose by 40 %. Inflation rate was reduced from 38.0 % in 1985 to 25.8 % in 1986. The share of industrial sector rose from the preceding year's 31.6 % to 33.4 %, due to production increases in the manufacturing industry. Real interest rates regained high positive levels and the real depreciation of the Turkish lira accelerated.

The period of rapid growth which started in mid 1985 continued in 1987 with significant production increase in the industrial sector. The growth rate of the industrial sector, in real terms, stepped up to 9.1 in 1987, reaching a 32 % share in the GNP. The average wholesale price index became 51.7 % in 1987 and rate of increase of M2Y (which is calculated by adding the foreign exchange deposit accounts of the residents in Turkey to M2) was around 50.1 %.

From 1982 to 1987 Turkey faced an inflation of around %35-40, but starting from the last month of 1987, in 1988 Turkish economy moved into a higher inflationary path due to the increasing budget deficits. This may be regarded as the first break in the sample period. The most prominent features of the period were the stagnation in the manufacturing industry and high inflation rate of 70 %. The US dollar appreciated by 81.1 % in 1988 and M2Y grew by 54.7 .

In 1989 due to several macroeconomic developments, such as the decrease of the interest rates on credits, the tendency of the exchange rate to be below the rate of inflation, the annual rate of price increases in the private manufacturing industry, which reached 73 % in June 1989, fell gradually down from this level down to 52 %. The overall industrial production increased by 3.4 %. Wholesale price index of the manufacturing industry calculated by SIS increased by 65 %. .

Before 1990, monetary policy was essentially accommodating and base money was used to finance any residual gap of the fiscal deficit. In 1990, the monetary authorities announced and implemented a contractionary monetary program, reducing the rate of M2Y growth from 74.4 % in 1989 to below 47.8 in 1990. GNP at constant prices increased by 9.2 %, which was the highest real growth rate of the last 20 years. Manufacturing industry increased by 10 %. The reduction in the average rate of inflation in the private manufacturing sector was 20 %, whereas the decrease in the public manufacturing sector's average inflation was 8 %. Exchange rate movements were similar to those of 1989.

1991 was a year of uncertainty stemming from the Gulf crisis. The annual rate of industrial production growth was 2.9 %. The whole sale price index increase became 59.2 % and M2Y growth was 78 %. With the effect of the net short term capital outflow, the Turkish lira lost value in real terms.

In 1992, a rise in industrial production was observed due to the expansion of domestic demand which was stimulated by the increase of private consumption. Foreign exchange deposits increased sharply leading a high growth of M2Y compared to M1 and M2. The WPI increased 62 %.

Consumer price increases have remained around 65 % since 1989, and continued to move around the same level in 1993 also. A similar event was experienced between 1981-1987 as can be seen above. In that time period, despite the fluctuations, consumer price increases did not fall below 30 %. However in the last month of 1987, consumer prices shifted dramatically from 30 % to 65 % as a result of a public price increase shock.

In 1993 the growth rate in the manufacturing sector was 12.3 %. The real appreciation of Turkish lira was 2.3 % against the US dollar and M2Y declined in real terms. During the last months of 1993, the instability in the financial markets and oscillations in the foreign exchange rate gave rise to pessimistic expectations and as a result, uncertainties about the economy increased.

In the first quarter of 1994, the Turkish economy was on the verge of a crisis, which required a stabilization policy including permanent measures for the adjustment of the economy. The crisis started from the financial sector and spread into the real sector in a short time. Behind the crisis, there were two interrelated factor: Constantly increasing public deficits since 1980 and stimulation of economic growth by a rise in demand, especially in consumer expenditures. Also slow reaction of the government to the developments in the external and internal markets in the pre-crisis period was effective. April 5 Stabilization Program caused a contraction in domestic demand and an increase in import prices. In the second quarter manufacturing industry production index decreased by 15.4 percent. Whole sale price index increase reached 149.6 percent at the end of the year. The Turkish lira had depreciated by 167.6 percent against the US dollar by the end of 1994.

In 1995, the stabilization policies caused the domestic demand to retreat. Production in public sector manufacturing decreased by 0.3 % in the first quarter and then increased by 32.8 %, 29.9 % and 18.3 % in the second, third and fourth quarters of 1995, respectively. At end of the year, the Turkish lira depreciated 60.1 percent against the foreign exchange basket composed of 1.5 German mark and 1 US dollar. The wholesale price index, on the other hand, increased by 64.9 %.

CHAPTER 2

METHODOLOGY ON TIME SERIES PROPERTIES AND COINTEGRATION

2.1 STATIONARITY AND INTEGRATED PROCESSES

A stochastic process y_t is said to be stationary if :

$E(y_t)$ = constant = μ ;

$Var(y_t)$ = constant = σ^2 ; and:

$Cov(y_t y_{t+j}) = \sigma_j$.

Thus the means and variances of the process are constant over time while the value of the covariance between two periods depends only on the gap between the periods, and not the actual time at which this covariance is considered. If one or more of the conditions above are not fulfilled, the process is nonstationary.

Consider the following time series:

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

where ε_t is the uncorrelated disturbance term with zero mean and constant variance. In such a model, if α is less than 1 in absolute value, the observations fluctuate around zero. Such series in econometrics is said to be stationary. On the other hand if the absolute value of α is greater than 1, the model is explosive.

Random walk process is an important type of nonstationary stochastic process. It is characterized by the equation:

$y_t = y_{t-1} + \varepsilon_t$, where,

$E(\varepsilon_t) = \mu,$

$E(\varepsilon_t^2) = \sigma^2,$

$E(\varepsilon_t \varepsilon_p) = 0 \quad t \neq p.$

The main assumption is that, every current observation consists of its own previous value plus a random disturbance term and disturbance terms are identically distributed independent random variables.

In economics, the form of nonstationarity in a time series may be well evident from an examination of series. If the form of nonstationarity is a propensity of the series to move in one direction, we will call this tendency a *trend*.

A series may drift slowly upwards or downwards purely as a result of the effects of stochastic or random shocks. This is true for the random walk process. The variance of this process increases over time. These results imply that there may be long periods in which the process takes values well away from its mean value. Such series is called a time series with a stochastic trend.

Another example of a developing tendency in a nonstationary stochastic process is where the mean of the processs is itself a specific function of time. If such a function is linear, then the process can be described as :

$y_t = \mu_t + \varepsilon_t$, where:

$\mu_t = \alpha + \beta t.$

In this case it is said the process has a deterministic trend. A mixed stochastic-deterministic trend process is also possible. That is the process can be described as :

$y_t = \alpha + \beta_t + y_{t-1} + \varepsilon_t.$

Nonstationarity of time series has always been regarded as a problem of economic analysis. Regression analysis makes sense only for data which are not subject to a trend. Since almost all all economic series contains trends, it follows that these series have to be detrended before any sensible regression analysis can be performed. A convenient way of getting rid of trends in a series is by using first differences. Sometimes it is necessary to difference a series more than one in order to achieve stationarity. Following Engle and Granger (1987) we may define such series as follows :

Definition : A nonstationary series which can be transformed to a stationary series by differencing d times is said to be *integrated of order d.* A series x_t integrated of order d is conventionally denoted as:

$x_t \sim I\ (d).$

2.2 TESTING FOR THE ORDER OF INTEGRATION

Suppose we wish to test the hypothesis that a variable y_t is integrated of order one, that is $\alpha = 1$ in the equation :

$$y_t = \alpha y_{t-1} + \varepsilon_t \qquad (2.1)$$

where ε_t represents a series of identically distributed stationary variables with zero means. Actually determining whether α is equal to one or not is important since the effect of any shock is permanent in the unit root (α=1) case while the shock fades away in the other case (α<1) .

An appropriate and simple method of the above mentioned test is proposed by Dickey and Fuller (1979), hereafter called the DF test. The DF test is a test of the hypothesis that in (2.1) $\alpha = 1$, the so called unit root test. Rewriting equation (4.1) as

$$\Delta y_t = \delta y_{t-1} + \varepsilon_t, \qquad (2.2)$$

where

$$\alpha = 1 + \delta,$$

the test becomes simply testing $\delta = 0$ or $\delta < 0$. Rejection of the null hypothesis $\delta = 0$ in favor of the alternative $\delta < 0$ implies that y_t is integrated of order zero.

Because of the unit root, for equation (2.2), natural Student-t ratio does not have the familiar Student-t distribution. Therefore, the simulated DF critical values are used for comparison.

In case of the rejection of the null hypothesis, the variable y_t might be integrated of order higher than zero, or might not be integrated at all. Consequently the next step would be to test the null hypothesis of the order of integration is one. Hence, the test will be repeated for :

$$\Delta\Delta y_t = \delta\Delta y_{t-1} + \varepsilon_t,$$

and again our interest is in testing the negativity of δ. If the null hypothesis is rejected and the alternative $\delta < 0$ can be accepted, the series Δy_t is stationary and $y_t \sim I(1)$. We can continue the process until we establish an order of integration for y_t, or until we realize that y_t cannot be made stationary by differencing.

A weakness of the DF test is that it does not take into account of possible autocorrelation in the error process. If ε_t is autocorrelated, then the ordinary least squares estimation of equation (2.2) are not efficient. a simple solution advocated by Dickey and Fuller (1981), is to use lagged left hand side variables as additional explanotary variables to approximate the autocorrelation. This test is called Augmented Dickey-Fuller test. The ADF tests involve estimating the equation:

$$\Delta y_t = \delta y_{t-1} + \Sigma^{k}_{i=1} \delta_i \Delta y_{t-i} + \varepsilon_t .$$

The value of k must be small enough to save the degrees of freedom, but large enough to capture the autocorrelation in the error process. The testing procedure is the same as DF, with an examination of the Student t-ratio for δ and the critical values are the same as for the DF test.

2.3 SEASONALLY INTEGRATED SERIES

The entire problem of enquiry into stationarity becomes more complex in the case where the series x_t is subject to stationarity. For a series measured s times per annum, if the series has a seasonal pattern then the differencing which removes seasonality should be s rather than one. That is a Δs filter is required to achieve stationarity. Often, s differencing also removes trend, but where the trend is nonlinear, first differencing of the s-differences may be also necessary in order to make the series stationary. The definition of seasonally integrated series is the following.

Definition:A seasonal time series x_t is said to be integrated of order (d,D), denoted $I\ (d,D)$, if it can be transformed to a stationary series by applying s-differences D times and then differencing the resulting series d times using first differences.

2.4 TESTING FOR SEASONAL UNIT ROOTS

A method has been developed for testing for seasonal units roots proposed by Hyllberg et al. (1990) for quarterly data and by Frances (1991) for monthly data. In the case of monthly data, the differencing operator Δ_{12} assumes the presence of 12 roots on the unit circle, which becomes clear from noting that

$$1 - B^{12} = (1-B)\ (1+B)\ (1- iB)\ (1+ iB)\ [1+(\sqrt{3}+i)B/2]\ [1+(\sqrt{3}-i)B/2]\ [1-(\sqrt{3}+i\ )\ B/2]$$
$$[1-(\sqrt{3}-i)B/2]\ [1+(i\sqrt{3}+1)B/2]\ [1-(i\sqrt{3}-1)B/2][1-(i\sqrt{3}+1)B/2]\ [1+(i\sqrt{3}-1)B/2]\ .$$

where all terms other than $(1 - B)$ correspond to seasonal unit roots.

Testing for seasonal unit roots in monthly time series is equivalent to testing for the significance of the parameters in the auxilary regression

$$\varphi^*\ (\ B\ )y_{8,t} = \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-1} + \pi_4 y_{3,t-2} + \pi_5 y_{4,t-1} + \pi_6 y_{4,t-2} + \pi_7 y_{5,t-1}$$
$$+ \pi_8 y_{5,t-2} + \pi_9 y_{6,t-1} + \pi_{10} y_{6,t-2} + \pi_{11} y_{7,t-1} + \pi_{12} y_{7,t-2} + \mu_t + \varepsilon_t, \qquad (2.3)$$

where $\varphi^*\ (\ B\ )$ is some polynomial function of B and where

$y_{1,t} = (1+B)(1+B^2)(1+B^4+B^8)\, y_t$,

$y_{2,t} = -(1-B)(1+B^2)(1+B^4+B^8)\, y_t$,

$y_{3,t} = -(1-B^2)(1+B^4+B^8)\, y_t$,

$y_{4,t} = -(1-B^4)(1-\sqrt{3}B+B^2)(1+B^2+B^4)\, y_t$,

$y_{5,t} =- -(1-B^4)(1+\sqrt{3}B+B^2)(1+B^2+B^4)\, y_t$,

$y_{6,t} = -(1-B^4)(1-B^2+B^4)(1-B+B^2)\, y_t$,

$y_{7,t} = -(1-B^4)(1-B^2+B^4)(1+B+B^2)\, y_t$, $y_{8,t} = (1-B^{12})\, y_t$,

Furthermore, the μ_t in eq. (2.3) covers the deterministic part and might consist of a constant, seasonal dummies or a trend. This depends on the hypothesized alternative to the null hypothesis of 12 unit roots.

Applying ordinary least squares to eq. (2.3) gives estimates of the π_i. In case there are (seasonal) unit roots, the corresponding π_i are zero. Due to the fact that pairs of complex unit roots are conjugates, it should be noted that these roots are only present when pairs π's are equal to zero simultaneously, for example the roots i and $-i$ are only present when π_3 and π_4 are equal to zero (Frances 1990). There will be no seasonal unit roots if π_2 through π_{12} are significantly different from zero. If $\pi_1 = 0$, then the presence of root 1 can not be rejected. When $\pi_1 = 0$, π_2 through π_{12} are unequal to zero, then seasonality can be modeled with seasonal dummies (deterministic seasonality). In the case of $\pi_1 = \pi_2 = \ldots = \pi_{12} = 0$, $(1-B^{12})$ filtering requires to eliminate some seasonal unit roots.

2.5 COINTEGRATION ANALYSIS

Time series x_t and y_t are said to be *cointegrated* of order d,b where $d \geq b \geq 0$, written as. $x_t, y_t \sim \mathrm{CI}\,(d,b)$, if :

i. both series are integrated of order d,

ii. there exists a linear combination of these variables, say $\alpha_1 x_t + \alpha_2 y_t$ which is integrated of order $d - b$. The vector $[\alpha_1, \alpha_2]$ is called a *cointegrating vector.*

Above definition can be generalized as follows. If x_t denotes an n x 1 vector of series and:

i. each of them is I (d),

ii. there exists an n x 1 vector β such that $x'_t\beta \sim$ I ($d - b$), then: $x'_t\beta \sim$ CI(d,b). The vector β is called the *cointegrating vector.*

If x_t has n components, there may more than one cointegrating vector β. It is assumed that there are r independent cointegrating vectors ($r \leq n$-1) which constructs the rank of β and is called *the cointegrating rank* (Granger 1981).

The most widely used test for cointegration analysis is the *maximum likelihood procedure* suggested by Johansen (1988). This procedure analysis multicointegration directly investigating cointegration in the vector autoregression, VAR, model. We will assume throughout the analysis that all the variables in z_t are integrated of the same order, and that this order of integration is either zero or one. The VAR model can be represented, ignoring the deterministic part (intercepts, deterministic trends, seasonals, etc.), in the form :

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k} + \varepsilon_t, \qquad (2.4)$$

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

$$\Pi = -(I - A_1 - \ldots - A_k)$$

and ε_t are independent n dimensional Gaussian variables with zero mean and variance Σ and stationary. Since there are n variables which constitute the vector z_t, the dimension of Π is n x n and its rank can be at most equal to n. If the matrix of Π is equal to $r < n$, there exists a representation of Π such that :

$$\Pi = \alpha\beta',$$

where α and β are both $n \times r$ matrices. Matrix β is called the cointegrating matrix and has the property that $\beta' z_t \sim I(0)$, while $z_t \sim I(1)$. The columns of β contain the coefficients in the r cointegrating vectors. The α is called the adjustments or the loadings matrix, which measure the speed of adjustment of particular variables with respect to a disturbance in the equilibrium relation.

By regressing Δz_t and z_{t-k} on $\Delta z_{t-1}, \Delta z_{t-2}, \ldots, \Delta z_{t-k+1}$ we obtain residuals R_{0t} and R_{kt}. The residual product moment matrices are,

$$S_{ij} = T^{-1}\Sigma^{T}_{t=1} R_{it} R'_{jt}, \quad i,j = 0, k. \ (T = \text{sample size})$$

Solving the eigenvalue problem,

$$| \mu S_{kk} - S_{ko} S^{-1}_{00} S_{ok} | = 0, \tag{2.5}$$

yields the eigenvalues $\mu_1 > \mu_2 > \ldots > \mu_n$ (ordered from largest to the smallest) and associated eigenvectors u_i which may be arranged into the matrix $V = [\, u_1\ u_2 \ldots u_n]$. The eigenvectors are normalized such that $V' S_{kk} V = I$. If the cointegrating matrix β is of rank $r < n$, the first r eigenvectors are the cointegrating vectors, that is they are the columns of matrix β. Using the above eigenvalues, the hypothesis that there are at most r cointegrating vectors can be tested by calculating the loglikelihood ratio test statistics :

$$LR = -T \sum^{n}_{i=r+1} \ln(1 - \mu_i),$$

This is called the trace statistics (Johansen and Juselius 1990). Normally testing starts from $r = 0$, that is from the hypothesis that there are no cointegrating vectors in a VAR model. If this cannot be rejected, it is possible to examine sequentially the hypothesis that $r \leq 1$, $r \leq 2$, and so on.

There is also a likelihood ratio test known as the maximum eigenvalue test in which the null hypothesis of r cointegrating vectors is tested against the alternative of $r + 1$ cointegrating vectors. The corresponding test statistics is :

$$LR = -T \ln(1 - \mu_r).$$

These tests are asymptotically distributed as a $(n-r)$ dimensional Brownian motion with covarience matrix I (Johansen 1992). The critical values of these tests are tabulated by Johansen and Juselius(1990).

CHAPTER 3

EMPIRICAL RESULTS ON COINTEGRATION

3.1 ORDER OF INTEGRATION

It is clear at first sight from the graphical representation that the series are not stationary (Graphs 1-5) . Unit root test is necessary in order to identify the order of integration for our modeling purposes. The order of integration of each individual series is tested using the Augmented Dickey Fuller testing procedure which is based on Dickey- Fuller (1981) and the results are reported in table 6. The effect of structural breaks/regime shifts on tests for the order of integration is not taken into consideration not to loose any information.

Results of the ADF test show that the manufacturing sector production index, which is I(1), is stationary in the first differences. All the remaining variables require an I(2) analysis. It can be safely assumed that the process are not I(3).

3.2 SEASONAL UNIT ROOTS

Results of the seasonal unit roots tests, which is conducted using the above explained method developed by Frances (1991), are reported in table 7 through table11. All monthly series are in log levels. The t statistic on π_1 is indicative of a strong unit root at the nonseasonal frequency at 5 % level for all series. This is in accordance with the ADF test results explained above. All the series reject the null hypothesis (π_2 through π_{12} is zero) at 5 % significant level but there is strong evidence of stochastic seasonality in private sector manufacturing price index (Q_{man}) since the *t* test accepts the presence of unit roots at all seasonal frequencies except for π_2 and π_6 . It can be concluded that applying a Δ_{12} filter may be appropriate in order to remove seasonality and nonstationary in this variable, but also a Δ filter may be enough for sationarity if the result of the joint F-test is regarded as our main criteria.

The general results about the time series WPI_{man} , WPI_p , M2Y, E is that the regularly applied Δ_{12} filter is certainly not appropriate and it will imply overdifferencing. Taking into account the ADF tests conducted above, in this case, Δ^2 filter is sufficient to remove non-stationarity. Therefore seasonality in these series can be modeled by using eleven seasonal dummies.

3.3 LONG RUN ANALYSIS

The aim of this subsection is to determine the long run relationships among the variables of interest using cointegration analysis. Parameter non-constancies may impede the determination of cointegration vectors. It is clear from the plots of the first differenced variables (Graphs 6-9) that there is a parallel break in some of the series and there may have been a break in the whole system. At least three of the variables - namely WPI_{man}, WPI_p and E are immediately seen to co-break at 1994:1 to 1994:6.

The first step in this empirical study is to apply the appropriate filters so that we could introduce an I(1) analysis. This is achieved easily since one of the variables are already I(1) and the others become I(1) after first differencing. So the list of variables which enter the cointegration analysis are $\Delta LWPI_p$, ΔLM2Y, ΔLE, $\Delta LWPI_{man}$ and LQ_{man}. Second step, which is selecting the optimal lag length is conducted through the appropriate system reduction. Using Schwarz criteria we ended up with an VAR (2) analysis. Utilizing the seasonal unit root test results above, we assume that the stochastic seasonality can be approximated by deterministic seasonality and that the variables are integrated of order one conditionally on the presence of an intercept term and seasonal dummy variables in the nonstochastic part of the VAR model. In fact , such a procedure was used in practice in VAR cointegration analysis in models estimated by Johansen and Juselius (1990) and by Hendry, Muellbauer and Murphy (1990). The VAR(2) model is :

$$Z_t = A_0 D_t + \sum_{i=1}^{2} A_i Z_{t-i} + \varepsilon_t ,$$

where $D_t = [$ intercept, $Q1_t, Q2_t, \ldots, Q11_t]$

and $Zt = [\Delta LWPI_p, \Delta LM2Y, \Delta LE, \Delta LWPI_{man}, LQ_{man}]$

where L denotes for logarithm and Δ is the first difference filter.

In order to test for cointegration, the above mentioned maximum likelihood procedure developed in Johansen (1988) and Johansen and Juselius (1990) is used. Test statistics are reported in Table 12. Looking at both the trace and maximum eigenvalue statistics leads us to accept definitely four cointegrating relationships (this is not a surprising fact if we reconsider the parallel movement of our variables).

Interpreting the evidence, from the first row of the standardized eigenvectors, the two different monthly inflation variables $\Delta LWPI_p$ and $\Delta LWPI_{man}$ seem to be cointegrated with the vector (1 , -1). Testing the restriction that $\Delta LWPI_p$ - $\Delta LWPI_{man}$ is nonstationary in the long-run rejects with a $Chi^2(1)$ of 0.624. We conclude that the cointegration vector (1, 0, 0, -1, 0) lies in the cointegration space . The adjustment coefficients α show that the main effect of this cointegration vector is on $\Delta LWPI_p$.

The second cointegration relationship can be interpreted as a long run relationship between the public sector wholesale price index and money. Standardized loadings strongly indicate that the effect of this cointegration vector is on $\Delta LM2Y$ and the variables ΔLE, $\Delta LWPI_{man}$ and LQ_{man} are weakly exogenous. So we end up with the equation $\Delta LM2Y = 0.25\Delta LWPI_p$ which can be explained by the fact that the increase of money by 1% raises the price of government products by 0.25%.

The third row of the standardized eigenvectors seems to be a representation of increasing purchasing power of the Turkish Lira against US $ since 1982 : $\Delta LE = 0.84\Delta LWPI_{man}$. In order to check the validity of this equation we calculated the ratio of US $ exchange rate increase to private sector manufacturing price index increase between the period 1982:1 to 1996:05. The result 0.81 is very close to the coefficient obtained from the cointegration test. The adjustments coefficients α suggest that the main effect of this cointegration vector is on ΔLE.

Interpreting the evidence from the fourth row of the standardized eigenvectors, the last cointegration relationship may be a general equation on the determination of private manufacturing sector price index. The standardized loadings of fourth column indicates no weak exogeneity and the main effect is on ΔLE and $\Delta LWPI_{man}$. The equation can be written as:

$$\Delta LWPI_{man} = 0.15\Delta LWPI_{p} - 0.02\Delta LM2Y + 0.22L\ \Delta E + 0.02LQ_{man}\ .$$

Overall, it seems from the results above that, in the Turkish economy, manufacturing sector price index can be explained by our variables of interest.

3.4 RESTRICTIONS ON THE COINTEGRATION VECTORS:

Looking at the standardized β eigenvectors and α coefficients we notice some insignificant parameters. Loadings indicate that first cointegration vector has no effect on LQ_{man}; second cointegration vector has no effect on ΔLE, $\Delta LWPI_{man}$ and LQ_{man}; the main effect of third cointegration vector is on ΔLE and LQ_{man} and the last cointegration vector affects $\Delta LWPI_{p}$, ΔLE, $\Delta LWPI_{man}$. Testing these restrictions (corresponding α s are zero) jointly fails to reject the null with a χ^2 ($\approx$2) value of 1.676. Also testing the weak exogeneity of $\Delta M2Y$ and Q_{man} in the remaining cointegration vectors accepts $\chi^2(\approx 3) = 2.831$.

We omitted some parameters while constructing the cointegration vectors above. In order to preserve reliability of the cointegration relationships, it is important that one should test for these restrictions . A joint test for all the restrictions on β (corresponding β's are zero) fails to reject the null with a χ^2 ($\approx$0) = 0.625. So we conclude that statistically, there shouldn't be any objections related to the omission of the variables from the cointegration vectors above.

CHAPTER 4

MODELING AND ESTIMATION

4.1 VECTOR AUTOREGRESSION (VAR) :

VAR consists of regressing each current (non-lagged) variable in the model on all the variables in the model lagged a certain number of times. Often, particular equations in a general VAR model are completed by an additional set of deterministic components, such as intercept terms, deterministic trends and seasonal dummy variables. Also the existence of stochastic trends may be accommodated by allowing variables integrated of a given order to enter the VAR model after appropriate differencing. Harvey (1989, pp.469-470), however, points out some difficulties with this if different series have different orders of integration.

One straightforward application of an unrestricted VAR model is for forecasting. A VAR forecaster does not worry about the economic theory underlying a VAR model and, more importantly, does not need to make any assumptions about the values of exogenous variables in the forecasting period.

4.2 VAR MODELS

Our basic model is an unrestricted VAR model in levels with deterministic component D_t, namely:

$$Zt = A_0 D_t + \sum_{i=1}^{k} A_i Z_{t-i} + \varepsilon_t , \qquad (4.1)$$

where Z_t = [$LWPI_{man}$,$LWPI_p$,LE,LM2Y,LQ_{man}] and the deterministic component D_t = [intercept, trend ,11 seasonal dummies]. L denotes the logarithm of each variables. Since the model is to be used for an *ad hoc* mechanistic forecast, no adjustment to the data has been made, though from the results of Chapter 3 we know that the data are nonstationary. To establish the optimum lag length in a VAR model, starting with a five lag, a sequential reduction process is applied. The optimal lag length (the order of the VAR process) was found to be two (so that k=2) according to the Schwarz criteria. The model is estimated by multivariate least squares. One step ahead forecasts are used. This type of forecasts are conditional on the observed values of lagged variables, e.i. values for the periods up to and including period t are used for making predictions for period t + 1.

We have used several alternative VAR models which incorporate five order vector autoregressive process for the variables of interest. Our first model is exactly the same as the basic model explained above.

As the second and a rival model for the first one , we again introduce a VAR in level but this time the intercept term is divided into three parts. This can be regarded as some kind of intercept correction which assumes two structural breaks in the intercept during the sample period : The first break point is 1988:1 in which inflation shifted into a higher path and the second is 1994:4, after the April 5 economic measures. The model is same as above except that s_1, s_2 and s_3 exist instead of the intercept term where,

$s_1 = 1$ from 1982:1 to 1987:12

$= 0$ otherwise;

$s_2 = 1$ from 1988:1 to 1994:3

$= 0$ otherwise;

$s_3 = 1$ from 1994:4 to 1996:5 .

Our third model is a first differenced VAR, except for the LQ_{man} is kept in level so that the system is I(1) with a deterministic part of an intercept and 11 seasonal dummies. So, the vector Z_t in eq. 4.1 includes the variables $\Delta LWPI_p$, $\Delta LM2Y$, ΔLE, $\Delta LWPI_{man}$ and LQ_{man}.

As a fourth model, the data is mapped to I(0) series by differencing the LQ_{man} once and the others twice. The variables of the VAR equation are $\Delta^2 LWPI_p$, $\Delta^2 LM2Y$, $\Delta^2 LE$, $\Delta^2 LWPI_{man}$ and ΔLQ_{man} with a deterministic part of a constant and seasonal dummies. A rival of this model is introduced as the fifth model which assumes stochastic seasonality on all of the variables. In this case the variables which enter the VAR process is $\Delta\Delta_{12}LWPI_p$, $\Delta\Delta_{12}LM2Y$, $\Delta\Delta_{12}LE$, $\Delta\Delta_{12}LWPI_{man}$ and $\Delta_{12}LQ_{man}$ and the deterministic part consists of only a constant.

4.3 SINGLE EQUATION ANALYSIS

In order to conduct a reliable single equation analysis, weak exogeneity of the variables $\Delta LWPI_p$, $\Delta LM2Y$, ΔLE, and LQ_{man} should be tested. A necessary condition for these variables to be weakly exogenous for the parameters in the $\Delta LWPI_{man}$ equation is that the corresponding α coefficients are zero. Although the cointegration analysis in section 3.4 which is summarized in table 12 indicates that weighting coefficients of ΔLE and $\Delta LWPI_p$ appear to be significantly different from zero, the joint zero restriction test on the loading coefficients of these four variables in the equation for monthly growth rate of private manufacturing sector price index fails to reject the null ($\Delta LWPI_p$, $\Delta LM2Y$, ΔLE and LQ_{man} are weakly exogenous in the $\Delta LWPI_{man}$ equation) with a LR-test of $\chi 2$ ($\approx$ 1) = 0.179. Besides, lack of weak exogeneity for the cointegration vector does not necessarily imply a simultaneous equations model. Rather, it means that inference about the cointegration vector is more efficiently (and easily) performed at the system level. Having estimated the cointegration vectors above, we will proceed by single equation modeling , treating the estimated cointegration coefficients as given.

Single equation modeling starts with an unrestricted autoregressive distributed lag (ADL) of order 2 (to match the lag length k=2 for the VAR) for the private manufacturing sector inflation growth combined with the first lag of cointegration residuals. At the beginning of the reduction process we have the following variables as regressors:

$\Delta^2 LWPI_{man,t-1}$, $\Delta^2 LWPI_{man,t-2}$, $\Delta^2 LWPI_{p,t}$,$\Delta^2 LWPI_{p,t-1}$, $\Delta^2 LWPI_{p,t-2}$, $\Delta^2 LE_t$, $\Delta^2 LE_{t-1}$, $\Delta^2 LE_{t-2}$,$\Delta^2 LM2Y_t$,$\Delta^2 LM2Y_{t-1}$,$\Delta^2 LM2Y_{t-2}$,$\Delta LQ_{man,t}$,$\Delta LQ_{man,t-1}$,$\Delta LQ_{man,t-2}$,$CI_{1,t-1}$,$CI_{2,t-1}$ + $CI_{3,t-1}$ +$CI_{4,t-1}$

The model is simplified via a sequential reduction procedure which is conducted by eliminating the terms that have insignificant t-values. The final model simplifies to :

$$\Delta^2 LWPI_{man,t} = \alpha_0 + \beta_0 \Delta^2 LWPI_{p,t} + \beta_1 \Delta^2 LE_t + \beta_2 CI_{1,t-1} + \beta_3 CI_{3,t-1} + \beta_4 CI_{4,t-1} \qquad (4.2)$$

where CI_i denotes the i'th *equilibrium correction mechanism* obtained from the cointegration analysis as the cointegration residuals. Coefficient estimates of the simplified model is reported in table 13. Writing the cointegration residuals in expanded form and substituting in (4.2) we obtain:

$$\Delta^2 LWPI_{man,t} = \alpha_0 + \beta_0 \Delta^2 LWPI_{p,t} + \beta_1 \Delta^2 LE_t + \beta_2(\Delta LWPI_p - \Delta LWPI_{man})_{t-1} + \beta_3 (\Delta LE - 0.84\Delta LWPI_{man})_{t-1} + \beta_4(\Delta LWPI_{man} - 0.15\Delta LWPI_p - 0.02\Delta LM2Y - 0.22\Delta LE + 0.02 LQ_{man})_{t-1} \quad (4.3)$$

Through the reduction from the beginning model to eq. (4.3), Schwarz criterion (SC) decreases from - 8.508 to -8.774. Standard error remains the same and the complete reduction appears valid, with F(11,155) = 0.973[0.4732].

4.4 PARAMETER CONSTANCY AND FORECAST STATISTICS

All the five models including the single equation model are estimated using monthly data from 1982(1) to 1996(5). One step ahead forecasts are made for 1, 3,6,12 and 24 month horizons. The three types of parameter constancy tests are reported, in each case a F (nH, T -k) for n equations and H forecasts :

1. Using Ω : This is an index of numerical parameter constancy, ignoring both parameter uncertainty and intercorrelation between forecast errors at different time periods.

2. Using V[e] : This test is similar to (a) but takes parameter uncertainty into account.

3. Using V[E] : Here V[E] is the full variance matrix of all forecast errors E, which takes both parameter uncertainty and inter-correlations between forecast errors into account.

Graphic evaluation of the forecasts efficiently summarize the large volume of statistical output. We will use the following graphs for the forecast statistics :

1. Actual and fitted values of the dependent variable overtime, including the forecast period.

2. Residuals scaled by estimated error standard deviation, plotted over t = 1, . . . ,T + H, where T is the estimation period and T is the forecast period.

3. Forecasts and outcomes. The one step forecasts are plotted in a graph over time T +1,. . ., T+H with error bars of ± 2 S.E.

Constancy is a crucial statistical property in econometric models. We will use recursive least squares statistics which provide clear and decisive tools for investigating constancy. Recursive methods estimate the model at each t for t = M-1, . . . ,T. RLS initialize the process by estimation over 1,. . . , M-1 which is followed by recursive updating over M, . . . ,T. The output generated by the recursive procedures is most easily studied graphically.

It will be useful to consider the stability of the parameters in the sample period, and to be able to identify specific points within the sample period where a structural break in the Central Bank model may have occurred. The first guide to parameter constancy in our model is provided by plotting the residuals for the last period in the sample used for the recursion against time. This residual is termed as one-step residual. The plot also includes error bands of $\pm$ 2 $S.E._t$ around zero. Values of one step residuals which lie outside these bands are suggestive either outlier values for the variable or of some alteration in the structural parameters of the model.

Another useful test for investigating stability is break-point F-test (N↓ - step Chow test) which are F(T- t +1, t - k - 1) for t = M, . . . , T, and are called decreasing horizon Chow test because the number of forecasts goes from N = T - M +1 to 1.

4.5 EMPIRICAL RESULTS ON ESTIMATION

Having characterized our models now we can compare the related recursive estimates and forecast statistics. Three types of forecast constancy statistics, which are reported in each case as F(nH, T-k) for n equations and H forecasts which are reported in table 14-16 show that for all of the models, the null hypothesis of all parameters are unchanged between the sample and post sample periods is accepted in the short horizons of 1, 3, 6 and 12 months. But if we extend the forecast period to 24 months so that it overlaps with the 1994 crisis (forecast period starts from 1994(6)), parameter constancy is rejected for all the VAR models outlined above. The only exception is the single equation model which accepts the parameter constancy for two year horizon and behaves well at the crisis period .

The first specification is a VAR model in levels with a deterministic component of constant, trend and 11 seasonal dummies. Recursive graphics of this model (Graph 11) show that there is two possible structural breaks in the sample period: One is in 1988(1) and the other in 1994(1-6). Intercept corrected version of this model (Model 2) remedies the estimation failure in the first break. However, 1994 crisis period still remains to be a problem . If the early post crisis period is excluded, intercept correction seems to improve the forecasts.

One step residuals and break point Chow tests reveal parameter nonconstancy and a large increase in residual variance during the period 1994(1)-1994(6) for all the five VAR models. The sharp break in the one step residual gets smoother as the model gets into a lower integrated dimension - from I(2) to I(1). But even mapping the data to I(0) (Models 4 and 5) fails to conduct a model that accounts for the break in this period. For the single equation modeling, one step residual graphics are within the bands of ± 2 Standard Errors except for a few slight breaks. The sharp break in 1994 no longer appears to be a problem in the plots. Also the breakpoint chow test shows the constancy of the system and the model fits perfectly well at the crisis period. Above results are illustrated through the graphs 12-31.

The coefficients of single equation modeling, which are reported in table 13 indicate that $\Delta^2 LWPI_p$ and $\Delta^2 LE$ are highly significant in determining the private manufacturing sector inflation growth. Also the coefficients of CI_1 and CI_3 are positive and highly significant. CI_4 acts as an error correction mechanism with a dominant coefficient of -0.445.

CHAPTER5

SUMMARY AND CONCLUSIONS

The main aim of this thesis was to derive a model that would explain the private manufacturing sector wholesale price index during the sample period 1982(1)-1996(5) especially focusing on the sharp break of 1994 crisis .

Graphical inspection indicates that recursive estimates of the VAR models point to two break points in the sample period. One is at the beginning of 1988 and the other is through the first six months of 1996. The break in 1988 is related with the inflationary shift in the economy within this period and may need an intercept correction, but 1994 crisis is a much more difficult case to deal with the tools of econometrics.

All of the VAR models failed to explain the sharp rise in the private manufacturing sector price index in the first six months of 1994. Constancy is violated in case the forecast period is extended to 24 months - from 1994(6) to 1996(5) - so that it overlaps with the crisis period. Hence, unrestricted vector autoregression models cannot explain the sharp movement in this period. But these models regain stability in the post-crisis period which means that crisis does not seem to cause a regime shift for the post crisis period.

We obtained several long run relationships among the variables with the tools from the cointegration analysis. Two notable features were a unit long run homogeneity restriction on the public and private manufacturing sector inflation and increasing purchase power of Turkish Lira during the sample period. Since cointegration implies Granger causality in at least one direction, it is not a property of series that just happen to be correlated but entails a more fundamental link.

Graphical interpretations suggest that a genuine relationship exists between the two inflation variables and the exchange rate since they not only move together in the long run but also co-break in the crisis period.

Having detected the parallel break in the three variables, namely inflation in the private manufacturing sector and the public sector and the exchange rate, we evaluated a single equation modeling of Turkish private manufacturing sector price index which utilized the equilibrium correction mechanisms that is obtained from the cointegration analysis . The resulting model fitted perfect in the crisis period.

One noticeable part of this model is the lack of money and production index variables in the left side of the equation. This may be due to the fact that the sharp rise of interest rates increased the velocity of money in the crisis period so the appropriately defined money growth could not track the inflation rate in the short run and the inflation rate has diverged from the trend rate of money growth. Also the production index has failed to show an immediate reaction (in the opposite direction) to the jump of inflation in the private manufacturing sector in the crisis period which can be explained by the fact that the crisis started from the financial sector and it took a while to spread into the real sector. That means inflation caused the production index to decline - not the opposite case which we are interested in.

Equally notable were the equilibrium correction mechanisms which consist of the difference between the most recent actual value for the series and the long run model's forecast of that value, e.i. deviations from the long-run equilibrium. In the single equation model, the ratio of the inflation of public and private manufacturing sectors has been found to affect the private manufacturing sector inflation growth via the equilibrium correction mechanism obtained from the first cointegration vector. Inflation in the private sector accelerates with the increase of this ratio. Also falls in the purchasing power of Turkish Lira in the long run lead to more private manufacturing sector inflation. The dominating component which influence the private manufacturing sector inflation is the equilibrium correction mechanism, representing deviations of its own value from its long run path.

Two most important determinants of inflation in the private manufacturing sector appears as the exchange rate and the public sector inflation. From the supply side, the effect of exchange rate on prices may-be explained by the theory that an appreciation in the exchange rate raises the manufacturing sector prices due to an increase in the import prices of inputs. Nonexistence of the lagged components of these two variables as the determinants of the private sector inflation is indicative of the quick adjustment of the manufacturing sector prices during the crisis period.

When economic systems are subject to shocks, conventional models need not forecast satisfactorily. Predictive failure of the VAR models in forecasting seems to be associated with the break in 1994, but single equation modeling based on the equilibrium correction mechanisms succeeds to remedy this failure partially and provides a stable solution. This may be due to the fact that cointegrated series also co-break during the crisis period although there may be thought to be an apparent contradiction between long run constancy and breaks in the levels.

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APPENDIX A

Table 1

Data for Private Manufacturing Sector Price Index, Monthly

1982/1 - 1996/5

WPI_{man}

82-1	16.2	86-1	62.3	90-1	356.2	94-1	2121.2
82-2	16.7	86-2	63.8	90-2	363.4	94-2	2363.7
82-3	17.0	86-3	65.3	90-3	374.9	94-3	2585.1
82-4	17.5	86-4	67.4	90-4	386.0	94-4	3442.1
82-5	17.5	86-5	69.2	90-5	397.2	94-5	3866.6
82-6	18.1	86-6	70.6	90-6	403.6	94-6	3961.3
82-7	18.5	86-7	72.0	90-7	414.2	94-7	4018.2
82-8	18.9	86-8	73.4	90-8	433.5	94-8	4132.6
82-9	19.3	86-9	75.1	90-9	454.4	94-9	4326.0
82-10	19.5	86-10	77.3	90-10	472.9	94-10	4600.4
82-11	19.6	86-11	78.9	90-11	488.3	94-11	4898.8
82-12	19.6	86-12	80.3	90-12	499.5	94-12	5183.9
83-1	21.3	87-1	84.4	91-1	519.7	95-1	5625.7
83-2	21.6	87-2	86.3	91-2	533.7	95-2	5879.4
83-3	22.0	87-3	88.5	91-3	560.0	95-3	6106.5
83-4	22.6	87-4	91.6	91-4	588.0	95-4	6325.1
83-5	23.0	87-5	94.3	91-5	618.1	95-5	6515.7
83-6	23.9	87-6	96.3	91-6	634.2	95-6	6720.0
83-7	24.3	87-7	99.8	91-7	655.8	95-7	7009.0
83-8	24.9	87-8	102.6	91-8	675.1	95-8	7295.6
83-9	25.8	87-9	105.5	91-9	704.3	95-9	7553.7
83-10	26.4	87-10	110.3	91-10	731.8	95-10	7826.8
83-11	27.2	87-11	115.6	91-11	752.9	95-11	8106.1
83-12	28.4	87-12	124.8	91-12	782.8	95-12	8469.5
84-1	29.7	88-1	139.0	92-1	834.5	96-1	9033.6
84-2	30.6	88-2	147.9	92-2	854.4	96-2	9351.8
84-3	30.9	88-3	157.6	92-3	878.6	96-3	9807.2
84-4	33.2	88-4	165.9	92-4	912.5	96-4	10421.3
84-5	34.8	88-5	171.8	92-5	953.5	96-5	11015.7
84-6	36.2	88-6	177.8	92-6	999.2		
84-7	37.2	88-7	183.6	92-7	1034.0		
84-8	38.7	88-8	191.8	92-8	1077.8		
84-9	40.3	88-9	202.3	92-9	1137.5		
84-10	41.4	88-10	211.9	92-10	1197.1		
84-11	42.5	88-11	220.9	92-11	1239.5		
84-12	43.3	88-12	227.3	92-12	1283.2		
85-1	45.0	89-1	242.0	93-1	1342.7		
85-2	46.1	89-2	250.2	93-2	1390.5		
85-3	47.8	89-3	259.0	93-3	1438.3		
85-4	49.4	89-4	270.9	93-4	1480.4		
85-5	50.7	89-5	282.7	93-5	1544.3		
85-6	51.9	89-6	293.3	93-6	1594.1		
85-7	53.1	89-7	305.0	93-7	1649.1		
85-8	54.6	89-8	312.5	93-8	1708.8		
85-9	55.8	89-9	319.4	93-9	1778.9		
85-10	57.8	89-10	326.1	93-10	1846.8		
85-11	59.1	89-11	333.3	93-11	1954.2		
85-12	60.0	89-12	341.9	93-12	2013.1		

Table 2

Data for Public Sector Whole Sale Price Index, Monthly

1982/1 - 1996/5

WPI$_p$

82-1	18.7	86-1	76.2	90-1	362.7	94-1	2322.3
82-2	19.5	86-2	78.4	90-2	369.7	94-2	2479.3
82-3	20.1	86-3	78.4	90-3	384.7	94-3	2568.9
82-4	20.2	86-4	79.3	90-4	394.8	94-4	3985.8
82-5	20.4	86-5	79.4	90-5	397.8	94-5	4197.7
82-6	20.5	86-6	80.0	90-6	405.8	94-6	4208.5
82-7	20.8	86-7	81.0	90-7	411.3	94-7	4303.0
82-8	21.5	86-8	81.0	90-8	436.1	94-8	4477.8
82-9	21.6	86-9	81.9	90-9	488.4	94-9	4568.6
82-10	21.7	86-10	85.5	90-10	528.1	94-10	4696.8
82-11	21.9	86-11	86.4	90-11	535.5	94-11	4891.4
82-12	22.1	86-12	86.9	90-12	542.6	94-12	5486.1
83-1	24.0	87-1	88.4	91-1	571.9	95-1	5850.2
83-2	24.7	87-2	91.5	91-2	597.1	95-2	6205.8
83-3	24.9	87-3	92.9	91-3	612.5	95-3	6474.9
83-4	25.1	87-4	94.9	91-4	631.8	95-4	6733.5
83-5	25.3	87-5	95.4	91-5	669.9	95-5	6933.0
83-6	26.1	87-6	96.5	91-6	682.0	95-6	7118.3
83-7	26.3	87-7	100.1	91-7	704.1	95-7	7292.5
83-8	27.2	87-8	101.6	91-8	768.1	95-8	7395.6
83-9	27.5	87-9	102.6	91-9	788.1	95-9	7555.9
83-10	27.7	87-10	103.3	91-10	798.8	95-10	7689.9
83-11	29.2	87-11	104.8	91-11	808.9	95-11	7905.7
83-12	30.3	87-12	128.1	91-12	849.5	95-12	8133.0
84-1	32.9	88-1	137.8	92-1	977.9	96-1	8964.5
84-2	33.4	88-2	143.0	92-2	989.6	96-2	9550.9
84-3	33.7	88-3	153.2	92-3	1004.1	96-3	10629.3
84-4	35.6	88-4	162.4	92-4	1029.2	96-4	12012.4
84-5	36.8	88-5	164.0	92-5	1073.0	96-5	12504.8
84-6	39.6	88-6	165.7	92-6	1106.9		
84-7	40.5	88-7	170.7	92-7	1164.9		
84-8	42.1	88-8	176.7	92-8	1227.0		
84-9	43.7	88-9	181.2	92-9	1290.7		
84-10	44.3	88-10	191.0	92-10	1351.7		
84-11	47.7	88-11	195.6	92-11	1382.6		
84-12	48.8	88-12	202.6	92-12	1417.4		
85-1	51.2	89-1	225.4	93-1	1471.1		
85-2	54.3	89-2	227.4	93-2	1512.0		
85-3	55.0	89-3	233.7	93-3	1537.3		
85-4	57.4	89-4	243.6	93-4	1556.3		
85-5	63.5	89-5	255.0	93-5	1657.3		
85-6	64.4	89-6	266.9	93-6	1756.2		
85-7	65.8	89-7	295.9	93-7	1831.9		
85-8	66.5	89-8	299.7	93-8	1910.8		
85-9	67.0	89-9	307.5	93-9	2007.3		
85-10	68.4	89-10	314.2	93-10	2063.1		
85-11	70.1	89-11	331.3	93-11	2150.3		
85-12	73.2	89-12	355.4	93-12	2200.0		

Table 3

Data for Exchange Rate, Monthly

1982/1 - 1996/5

E

82-1	139.0
82-2	145.6
82-3	147.2
82-4	150.2
82-5	151.7
82-6	161.8
82-7	168.7
82-8	174.1
82-9	177.3
82-10	180.0
82-11	185.1
82-12	188.7
83-1	190.9
83-2	196.7
83-3	201.7
83-4	210.0
83-5	214.4
83-6	221.4
83-7	227.9
83-8	238.6
83-9	246.7
83-10	250.5
83-11	261.7
83-12	279.1
84-1	305.5
84-2	313.2
84-3	317.0
84-4	331.6
84-5	353.2
84-6	364.2
84-7	378.3
84-8	388.0
84-9	404.5
84-10	416.1
84-11	418.8
84-12	436.4
85-1	453.9
85-2	470.6
85-3	495.4
85-4	503.7
85-5	526.0
85-6	535.7
85-7	535.2
85-8	537.1
85-9	554.2
85-10	551.6
85-11	560.7
85-12	573.6

86-1	589.2
86-2	598.0
86-3	639.7
86-4	674.1
86-5	678.1
86-6	688.6
86-7	685.4
86-8	686.5
86-9	699.7
86-10	713.7
86-11	749.4
86-12	758.8
87-1	754.2
87-2	762.4
87-3	777.7
87-4	791.5
87-5	807.5
87-6	837.8
87-7	869.3
87-8	892.5
87-9	914.6
87-10	948.4
87-11	960.0
87-12	996.0
88-1	1082.3
88-2	1157.9
88-3	1205.6
88-4	1252.2
88-5	1298.8
88-6	1354.0
88-7	1421.1
88-8	1503.2
88-9	1589.6
88-10	1725.9
88-11	1727.4
88-12	1800.0
89-1	1853.4
89-2	1912.6
89-3	1982.7
89-4	2059.7
89-5	2075.0
89-6	2121.1
89-7	2145.3
89-8	2187.5
89-9	2244.5
89-10	2281.1
89-11	2316.6
89-12	2314.5

90-1	2334.1
90-2	2381.8
90-3	2458.8
90-4	2502.9
90-5	2552.6
90-6	2633.0
90-7	2669.9
90-8	2682.1
90-9	2722.0
90-10	2744.6
90-11	2777.5
90-12	2876.9
91-1	2996.5
91-2	3143.2
91-3	3550.5
91-4	3801.0
91-5	3985.4
91-6	4227.8
91-7	4384.0
91-8	4516.6
91-9	4654.1
91-10	4841.1
91-11	4958.1
91-12	5059.4
92-1	5322.6
92-2	5684.2
92-3	6101.3
92-4	6426.6
92-5	6718.0
92-6	6889.4
92-7	6952.3
92-8	7101.7
92-9	7280.5
92-10	7567.5
92-11	8123.2
92-12	8360.0
93-1	8711.8
93-2	9049.7
93-3	9380.3
93-4	9563.1
93-5	9980.7
93-6	10484.9
93-7	11186.6
93-8	11646.4
93-9	11882.3
93-10	12508.5
93-11	13377.5
93-12	14061.7

94-1	15194.6
94-2	17740.4
94-3	20628.1
94-4	32222.8
94-5	33948.2
94-6	31746.0
94-7	31031.9
94-8	31727.5
94-9	33984.5
94-10	34952.1
94-11	36331.0
94-12	37477.8
95-1	40237.4
95-2	41109.0
95-3	41880.5
95-4	42411.6
95-5	43054.2
95-6	43293.5
95-7	44570.8
95-8	46735.8
95-9	46735.1
95-10	47892.7
95-11	50125.1
95-12	52517.5
96-1	56872.0
96-2	60594.3
96-3	64214.4
96-4	68447.5
96-5	72725.1

Table 4

Money, monthly

1982/1 - 1996/5

M2Y

82-1	1599
82-2	1669
82-3	1662
82-4	1654
82-5	1772
82-6	1798
82-7	1845
82-8	2056
82-9	2056
82-10	2138
82-11	2232
82-12	2267
83-1	2602
83-2	2422
83-3	2448
83-4	2485
83-5	2554
83-6	2573
83-7	2625
83-8	2721
83-9	2733
83-10	2736
83-11	2893
83-12	2967
84-1	3308
84-2	3167
84-3	3314
84-4	3635
84-5	3663
84-6	3787
84-7	4091
84-8	4135
84-9	4434
84-10	4445
84-11	4701
84-12	5121
85-1	5698
85-2	5574
85-3	5857
85-4	6051
85-5	6380
85-6	6851
85-7	5962
85-8	7556
85-9	7604
85-10	7820
85-11	8054
85-12	8945
86-1	8512
86-2	8790
86-3	9244
86-4	9601
86-5	9826
86-6	10289
86-7	10435
86-8	10750
86-9	11125
86-10	11408
86-11	11771
86-12	12219
87-1	12812
87-2	13010
87-3	13403
87-4	13754
87-5	14171
87-6	14608
87-7	15164
87-8	15980
87-9	16648
87-10	17379
87-11	17829
87-12	18827
88-1	19649
88-2	19701
88-3	20268
88-4	20741
88-5	21205
88-6	21558
88-7	22511
88-8	23857
88-9	25404
88-10	27434
88-11	28804
88-12	31319
89-1	33725
89-2	35668
89-3	37783
89-4	39456
89-5	40631
89-6	41723
89-7	43992
89-8	45644
89-9	47830
89-10	50997
89-11	54224
89-12	57359
90-1	60300
90-2	61446
90-3	63082
90-4	65975
90-5	68057
90-6	70311
90-7	73546
90-8	76367
90-9	78308
90-10	81478
90-11	84951
90-12	87482
91-1	88435
91-2	90890
91-3	96801
91-4	100438
91-5	104430
91-6	111409
91-7	115529
91-8	123857
91-9	132700
91-10	141394
91-11	148074
91-12	156548
92-1	167763
92-2	177983
92-3	187481
92-4	196230
92-5	207493
92-6	222461
92-7	231604
92-8	246094
92-9	259271
92-10	268448
92-11	276675
92-12	284831
93-1	303336
93-2	318652
93-3	344127
93-4	356520
93-5	369170
93-6	380041
93-7	395186
93-8	414263
93-9	436125
93-10	461772
93-11	482339
93-12	506678
94-1	549142
94-2	585262
94-3	625928
94-4	726972
94-5	802631
94-6	846501
94-7	934268
94-8	997552
94-9	1062651
94-10	1109406
94-11	1147313
94-12	1203905
95-1	1286115
95-2	1364534
95-3	1481744
95-4	1577784
95-5	1659285
95-6	1710298
95-7	1826569
95-8	1927839
95-9	2019070
95-10	2087163
95-11	2196962
95-12	2415069
96-1	2541852
96-2	2708340
96-3	2867160
96-4	3085890
96-5	3275999

Table 5

Manufacturing Industry Production Index, monthly

1982/1 - 1996/5

Q_{man}

82-1	83.562	86-1	107.705	90-1	137.698	94-1	180.650
82-2	78.120	86-2	91.015	90-2	132.163	94-2	152.533
82-3	87.647	86-3	106.165	90-3	152.720	94-3	160.998
82-4	79.844	86-4	102.734	90-4	128.293	94-4	158.543
82-5	82.879	86-5	107.744	90-5	145.785	94-5	155.856
82-6	81.080	86-6	99.821	90-6	146.424	94-6	149.139
82-7	81.880	86-7	113.486	90-7	128.296	94-7	152.425
82-8	92.085	86-8	105.685	90-8	143.572	94-8	156.752
82-9	87.843	86-9	117.043	90-9	157.712	94-9	172.307
82-10	95.174	86-10	126.466	90-10	164.460	94-10	173.128
82-11	100.142	86-11	119.234	90-11	166.003	94-11	178.016
82-12	101.788	86-12	116.745	90-12	152.148	94-12	178.273
83-1	87.796	87-1	112.780	91-1	113.962	95-1	164.054
83-2	84.024	87-2	106.908	91-2	136.750	95-2	146.963
83-3	91.108	87-3	113.036	91-3	161.292	95-3	161.563
83-4	82.083	87-4	118.190	91-4	135.715	95-4	173.969
83-5	83.428	87-5	110.403	91-5	170.762	95-5	171.035
83-6	91.631	87-6	122.240	91-6	140.416	95-6	183.455
83-7	83.524	87-7	114.653	91-7	157.196	95-7	180.457
83-8	93.336	87-8	113.230	91-8	146.310	95-8	181.101
83-9	91.530	87-9	135.131	91-9	161.324	95-9	192.140
83-10	97.547	87-10	144.739	91-10	173.355	95-10	184.928
83-11	100.084	87-11	140.635	91-11	160.671	95-11	185.496
83-12	106.030	87-12	137.354	91-12	160.658	95-12	191.895
84-1	98.451	88-1	124.947	92-1	153.100	96-1	177.994
84-2	93.790	88-2	125.291	92-2	143.790	96-2	148.995
84-3	97.432	88-3	128.541	92-3	157.325	96-3	164.323
84-4	90.897	88-4	131.642	92-4	145.990	96-4	166.368
84-5	95.320	88-5	124.006	92-5	166.175	96-5	192.422
84-6	90.186	88-6	126.790	92-6	150.380		
84-7	93.612	88-7	120.077	92-7	165.676		
84-8	102.211	88-8	124.768	92-8	151.013		
84-9	95.661	88-9	131.961	92-9	175.068		
84-10	115.208	88-10	135.932	92-10	182.891		
84-11	112.396	88-11	128.395	92-11	176.779		
84-12	114.832	88-12	134.587	92-12	175.502		
85-1	103.397	89-1	124.532	93-1	166.903		
85-2	89.361	89-2	119.577	93-2	153.346		
85-3	98.077	89-3	131.650	93-3	159.389		
85-4	101.080	89-4	111.995	93-4	179.246		
85-5	112.715	89-5	110.893	93-5	180.434		
85-6	91.606	89-6	121.634	93-6	170.520		
85-7	95.894	89-7	111.577	93-7	185.756		
85-8	94.958	89-8	123.155	93-8	157.286		
85-9	105.085	89-9	132.980	93-9	190.478		
85-10	118.457	89-10	138.620	93-10	193.718		
85-11	114.551	89-11	144.029	93-11	189.041		
85-12	115.522	89-12	143.033	93-12	200.971		

Table 6 Augmented Dickey-Fuller Test Statistics

Variable	ADF statistics**	Lag length
$LWPI_p$	2.654	6
LM2Y	3.326	7
LE	1.403	10
$LWPI_{man}$	2.178	13
LQ_{man}	-0.940	12
$\Delta LWPI_p$	-3.051	9
$\Delta LM2Y$	-2.371	11
ΔLE	-3.220	8
$\Delta LWPI_{man}$	-2.958	12
ΔLQ_{man}	-4.068 *	11
$\Delta^2 LWPI_p$	-7.827 *	8
$\Delta^2 LM2Y$	-6.376 *	10
$\Delta^2 LE$	-7.943 *	7
$\Delta^2 LWPI_{man}$	-7.635 *	7

* significant at 1% .
** all the ADF regressions contain a constant term except for the Q_{man} which also include seasonal dummies.The sample is 1982(1)-1996(5).

Table 7
Seasonal Frequency Calculation Results for

WPI_{man} *(1/82 - 5/96)*

	without lag		with 12 lags	
	C+S+T	C+S	C+S+T	C+S
t:π_1	-0.850 **	1.618 **	-0.255	2.048
t:π_2	-3.939 **	-3.929 **	-2.194	-2.193
t:π_3	-5.745 **	-5.820 **	-3.783 **	-3.830 **
t:π_4	-0.340 *	-0.278 *	-0.637	-0.606
t:π_5	-4.943 **	-4.943 **	-3.274 *	-3.280 *
t:π_6	-4.896 **	-4.886 **	-3.114	-3.112
t:π_7	-2.291 **	-2.572 **	-1.407 **	-1.497 **
t:π_8	-0.377 *	-0.157	-0.369 *	-0.298 *
t:π_9	-4.172 **	-4.168 **	-2.731 *	-2.723 *
t:π_{10}	-4.683 **	-4.659 **	-3.225 *	-3.213 *
t:π_{11}	-4.751 **	-4.867 **	-3.346 **	-3.411 **
t:π_{12}	0.601 **	0.689 **	0.531	0.572
F:π_3&π_4	16.588 **	16.993 **	7.431 **	7.578 **
F:π_5&π_6	13.152 **	13.126 **	5.554 *	5.567 *
F:π_7&π_8	14.926 **	15.215 **	6.389 **	6.439 **
F:π_9&π_{10}	13.747 **	13.648 **	6.125 **	6.088 **
F:π_{11}&π_{12}	13.153 **	13.588 **	6.463 **	6.206 **
F:π_3..π_{12}	68.791 **	68.944 **	10.710 **	10.778 **

* significant at 10% level

** significant at 5% level

C+S, auxilary regression contains constant and 12 seasonal dummies.

C+S+T, auxilary regression contains constant and 12 seasonal dummies and trend.

Table 8
Seasonal Frequency Calculation Results for

$\mathbf{WPI}_p$ *(1/82 - 5/96)*

	without lag		with 12 lags	
	C+S+T	C+S	C+S+T	C+S
t:π_1	-0.787	1.728	0.275	2.279
t:π_2	-3.177 **	-3.177 **	-2.714 **	-2.724 **
t:π_3	-3.962 **	-3.997 **	-2.605	-2.617
t:π_4	-3.423 **	-3.382 **	-2.550	-2.560
t:π_5	-5.511 **	-5.507 **	-3.354 **	-3.368 **
t:π_6	-4.735 **	-4.719 **	-3.075	-3.088
t:π_7	0.271	0.123	0.938	0.940
t:π_8	-2.365	2.254	-1.987	-1.995
t:π_9	-5.163 **	-5.169 **	-3.056 **	-3.068 **
t:π_{10}	-4.932 **	-4.905 **	-3.298 *	-3.313 *
t:π_{11}	-2.484 **	-2.558 **	-1.136 **	-1.142 **
t:π_{12}	-2.564	-2.514	-2.156	-2.164
F:π_3&π_4	15.200 **	15.176 **	7.049 **	7.108 **
F:π_5&π_6	15.268 **	15.238 **	5.722 *	5.770 *
F:π_7&π_8	12.182 **	12.239 **	3.455	3.482
F:π_9&π_{10}	18.184 **	18.109 **	6.934 **	6.995 **
F:π_{11}&π_{12}	14.850 **	14.945 **	6.098 **	6.149 **
F:π_3..π_{12}	59.521 **	59.676 **	8.233 **	8.338 **

* significant at 10% level

** significant at 5% level

C+S, auxilary regression contains constant and 12 seasonal dummies.

C+S+T, auxilary regression contains constant and 12 seasonal dummies and trend.

Table 9
Seasonal Frequency Calculation Results for

E *(1/82 - 5/96)*

	without lag		with 12 lags	
	C+S+T	C+S	C+S+T	C+S
t:π_1	-0.970	1.377	-0.128	1.971
t:π_2	-4.021 **	-4.003 **	-2.611 *	-2.609 *
t:π_3	-5.451 **	-5.528 **	-3.285 **	-3.340 **
t:π_4	-0.471	-0.399 *	-0.432 *	-0.407 *
t:π_5	-5.108 **	-5.097 **	-3.426 **	-3.422 **
t:π_6	-4.977 **	-4.951 **	-3.314 *	-3.305 *
t:π_7	-1.901 **	-2.214 **	-0.659 **	-0.727 **
t:π_8	-0.867	-0.617	-1.033	-0.978
t:π_9	-4.131 **	-4.142 **	-2.662 *	-2.667 *
t:π_{10}	-3.678 **	-3.648 **	-2.529	-2.519
t:π_{11}	-4.350 **	-4.477 **	-2.429 **	-2.486 **
t:π_{12}	-0.817	-0.696	-1.217	-1.175
F:π_3&π_4	15.011 **	15.389 **	5.513 *	5.676 *
F:π_5&π_6	13.867 **	13.774 **	6.166 **	6.147 **
F:π_7&π_8	16.933 **	17.045 **	6.363 **	6.329 **
F:π_9&π_{10}	10.707 **	10.670 **	4.599	4.593
F:π_{11}&π_{12}	16.236 **	16.434 **	7.753 **	7.768 **
F:π_3..π_{12}	57.529 **	57.400 **	8.736 **	8.812 **

* significant at 10% level

** significant at 5% level

C+S, auxilary regression contains constant and 12 seasonal dummies.

C+S+T, auxilary regression contains constant and 12 seasonal dummies and trend.

Table 10
Seasonal Frequency Calculation Results for

M2Y *(1/82 - 5/96)*

	without lag		with 12 lags	
	C+S+T	C+S	C+S+T	C+S
$t:\pi_1$	-0.201	2.832	1.783	2.971
$t:\pi_2$	-3.604 **	-3.606 **	-2.798 **	-2.828 **
$t:\pi_3$	-0.516	-0.512	-0.099	-0.177
$t:\pi_4$	-4.886 **	-4.891 **	-2.582	-2.615
$t:\pi_5$	-5.055 **	-5.059 **	-2.688	-2.719
$t:\pi_6$	-5.788 **	-5.798 **	-3.324 *	-3.339 *
$t:\pi_7$	-2.676 **	-2.815 **	-1.277 **	-1.174 **
$t:\pi_8$	0.153	0.253	-0.024	-0.123
$t:\pi_9$	-3.022 **	-3.032 **	-2.150	-2.208
$t:\pi_{10}$	-5.254 **	-5.257 **	-4.172 **	-4.233 **
$t:\pi_{11}$	-1.725 **	-1.751 **	-0.767 *	-0.919 *
$t:\pi_{12}$	-3.320 *	-3.301 *	-2.510	-2.492
$F:\pi_3\&\pi_4$	12.112 **	12.137 **	3.339	3.435
$F:\pi_5\&\pi_6$	16.757 **	16.813 **	5.598 *	5.633 *
$F:\pi_7\&\pi_8$	13.191 **	13.435 **	3.417	3.316
$F:\pi_9\&\pi_{10}$	13.922 **	13.943 **	8.701 **	8.962 **
$F:\pi_{11}\&\pi_{12}$	15.643 **	15.641 **	6.199 **	6.619 **
$F:\pi_3..\pi_{12}$	92.130 **	92.645 **	7.353 **	7.653 **

* significant at 10% level

** significant at 5% level

C+S, auxilary regression contains constant and 12 seasonal dummies.

C+S+T, auxilary regression contains constant and 12 seasonal dummies and trend.

Table 11
Seasonal Frequency Calculation Results for

Q_{man} *(1/82 - 5/96)*

	without lag		with 12 lags	
	C+S+T	C+S	C+S+T	C+S
$t{:}\pi_1$	-2.167	-0.796	-1.615	-1.295
$t{:}\pi_2$	-3.395 **	-3.340 **	-2.926 **	-2.869 **
$t{:}\pi_3$	-1.679	-1.691	-0.674	-0.648
$t{:}\pi_4$	-3.891 **	-3.758 **	-1.954	-1.844
$t{:}\pi_5$	-3.352 **	-3.302 **	-3.084 *	-2.997 *
$t{:}\pi_6$	-4.138 **	-4.089 **	-4.488 **	-4.415 **
$t{:}\pi_7$	1.134	0.799	1.227	1.255
$t{:}\pi_8$	-3.231 *	-2.860	-2.193	-2.083
$t{:}\pi_9$	-0.446	-0.410	0.403	0.487
$t{:}\pi_{10}$	-3.368 **	-3.355 *	-3.239 *	-3.227 *
$t{:}\pi_{11}$	-0.021	-0.097	0.354	0.388
$t{:}\pi_{12}$	-3.433 **	-3.289 *	-2.858	-2.765
$F{:}\pi_3\&\pi_4$	9.281 **	8.779 **	2.138	1.913
$F{:}\pi_5\&\pi_6$	8.701 **	8.504 **	12.271 **	12.049 **
$F{:}\pi_7\&\pi_8$	15.001 **	13.507 **	3.522	2.974
$F{:}\pi_9\&\pi_{10}$	6.935 **	6.947 **	8.701 **	8.927 **
$F{:}\pi_{11}\&\pi_{12}$	8.495 **	7.990 **	4.970 *	4.599
$F{:}\pi_3..\pi_{12}$	16.537 **	15.787 **	7.498 **	7.242 **

* significant at 10% level

** significant at 5% level

C+S, auxilary regression contains constant and 12 seasonal dummies.

C+S+T, auxilary regression contains constant and 12 seasonal dummies and trend.

Table 12 A Cointegration Analysis of Data*
$\{\Delta LWPI_p, \Delta LM2Y, \Delta LE, \Delta LWPI_{man}, LQ_{man}\}$

Eigenvalues	0.433	0.422	0.333	0.207	0.008
Hypotheses	$r = 0$	$r \leq 1$	$r \leq 2$	$r \leq 3$	$r \leq 4$
λ_{max}	96.5	93.2	69.0	39.5	1.4
λ^{df}_{max}	90.8	87.7	64.9	37.2	1.4
95%critical value	33.5	27.1	21.0	14.1	3.8
λ_{trace}	299.7	203.2	110.0	40.9	1.4
λ^{df}_{trace}	282.0	191.2	103.5	38.5	1.4
95%critical value	68.5	47.2	29.7	15.4	3.8

Standardized eigenvectors β'

Variable	$\Delta LWPI_p$	$\Delta LM2Y$	ΔLE	$\Delta LWPI_{man}$	LQ_{man}
	1.00	0.18	0.0	-1.04	-0.01
	-0.25	1.00	-0.05	-0.03	-0.02
	-0.06	-0.06	1.00	-0.84	0.00
	-0.15	0.02	-0.22	1.00	-0.02

Standardized adjustment coefficients α

$\Delta LWPI_p$	-1.57	0.35	-0.05	-0.60
$\Delta LM2Y$	-0.44	-1.27	0.09	-0.18
ΔLE	-0.69	-0.08	-0.76	-1.02
$\Delta LWPI_{man}$	-0.41	0.06	0.00	-0.75
LQ_{man}	0.16	0.15	-0.41	-0.12

* The order of VAR is 2, included a constant and 11 seasonal dummies.

Table 13 - Modeling the Turkish Private Manufacturing Sector Inflation Growth by OLS, 1982(1) - 1996(5)

Dependent Variable is $\Delta^2 LWPI_{man}$

Variable	Coefficient	Std. Error	t-value
Constant	-0.033	0.005	-6.509
$\Delta^2 LE$	0.259	0.031	8.354
$\Delta^2 LWPI_p$	0.271	0.028	9.680
$CI1_{-1}$	0.228	0.045	5.120
$CI3_{-1}$	0.219	0.039	5.558
$CI4_{-1}$	-0.445	0.067	-6.645
R^2	0.824		
σ	0.011		
$F_{d.f.}$	$154.79_{(5,165)}$		
DW	2.05		
AR_{1-7}, $F_{d.f.}$	$0.564_{(7,158)}$		
$ARCH_7$, $F_{d.f.}$	$0.605_{(7,151)}$		
RESET, $F_{d.f.}$	$6.685_{(1,164)}$		

Notes: $F_{ARi\text{-}j}$ is a test for *i*th or *j*th order autocorrelation suggested by Harvey (1981),$F_{ARCHi\text{-}j}$ is the ARCH test (AutoRegressive Conditional Heteroscedasticity due to Engle (1982). F_{RESET} is Ramsey's (1969) test.

Table 14 Forecast Statistics - Var in Levels

Forecast Horizons	Test Statistics	Model 1	Model 2[a]
Less 1 forcasts	Forecast F test		
	Using Ω	F(5,147)=0.877[0.497]	F(5,145)=0.925[0.466]
	Using V[e]	F(5,147)=0.743[0.591]	F(5,145)=0.784[0.562]
	Using V[E]	F(5,147)=0.743[0.591]	F(5,145)=0.784[0.562]
Less 3 forcasts	Forecast F test		
	Using Ω	F(15,145)=1.531[0.101]	F(15,143)=1.476[0.121]
	Using V[e]	F(15,145)=1.257[0.236]	F(15,143)=1.208[0.271]
	Using V[E]	F(15,145)=1.250[0.241]	F(15,143)=1.206[0.273]
Less 6 forcasts	Forecast F test		
	Using Ω	F(30,142)=1.568[0.043]	F(30,140)=1.408[0.096]
	Using V[e]	F(30,142)=1.274[0.174]	F(30,140)=1.127[0.313]
	Using V[E]	F(30,142)=1.216[0.222]	F(30,140)=1.091[0.355]
Less 12 forcasts	Forecast F test		
	Using Ω	F(60,136)=1.110[0.305]	F(60,134)=0.932[0.612]
	Using V[e]	F(60,136)=0.885[0.698]	F(60,134)=0.723[0.920]
	Using V[E]	F(60,136)=0.882[0.704]	F(60,134)=0.787[0.850]
Less 24 forcasts	Forecast F test		
	Using Ω	F(120,124)=3.229[0] *	F(120,122)=6.479[0] *
	Using V[e]	F(120,124)=1.849[0] *	F(120,122)=3.208[0] *
	Using V[E]	F(120,124)=0.934[0.64]	F(120,122)=1.054[0.38]

a Model 2 is intercept corrected version of Model 1
* Significant at 1%

Table 15
Forcast Statistics for Δ and Δ^2 Filtered Deterministic Seasonality Models

Forecast Horizons	Test Statistics	Model 3	Model 4
Less 1 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(5,147)=1.497[0.194] F(5,147)=1.274[0.277] F(5,147)=1.274[0.277]	 F(5,135)=2.414[0.039] F(5,135)=2.181[0.059] F(5,135)=2.181[0.059]
Less 3 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(15,145)=2.104[0.012] F(15,145)=1.808[0.038] F(15,145)=1.758[0.046]	 F(15,133)=1.605[0.080] F(15,133)=1.424[0.144] F(15,133)=1.425[0.144]
Less 6 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(30,142)=1.532[0.051] F(30,142)=1.334[0.134] F(30,142)=1.311[0.149]	 F(30,130)=1.193[0.246] F(30,130)=1.062[0.393] F(30,130)=1.072[0.380]
Less 12 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(60,136)=1.021[0.450] F(60,136)=0.892[0.685] F(60,136)=0.875[0.715]	 F(60,124)=0.944[0.590] F(60,124)=0.840[0.771] F(60,124)=0.836[0.778]
Less 24 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(120,124)=2.718[0] * F(120,124)=1.199[0.16] F(120,124)=1.093[0.31]	 F(120,112)=5.353[0] * F(120,112)=1.857[0] * F(120,112)=1.791[0] *

* Significant at 1%

Table 16

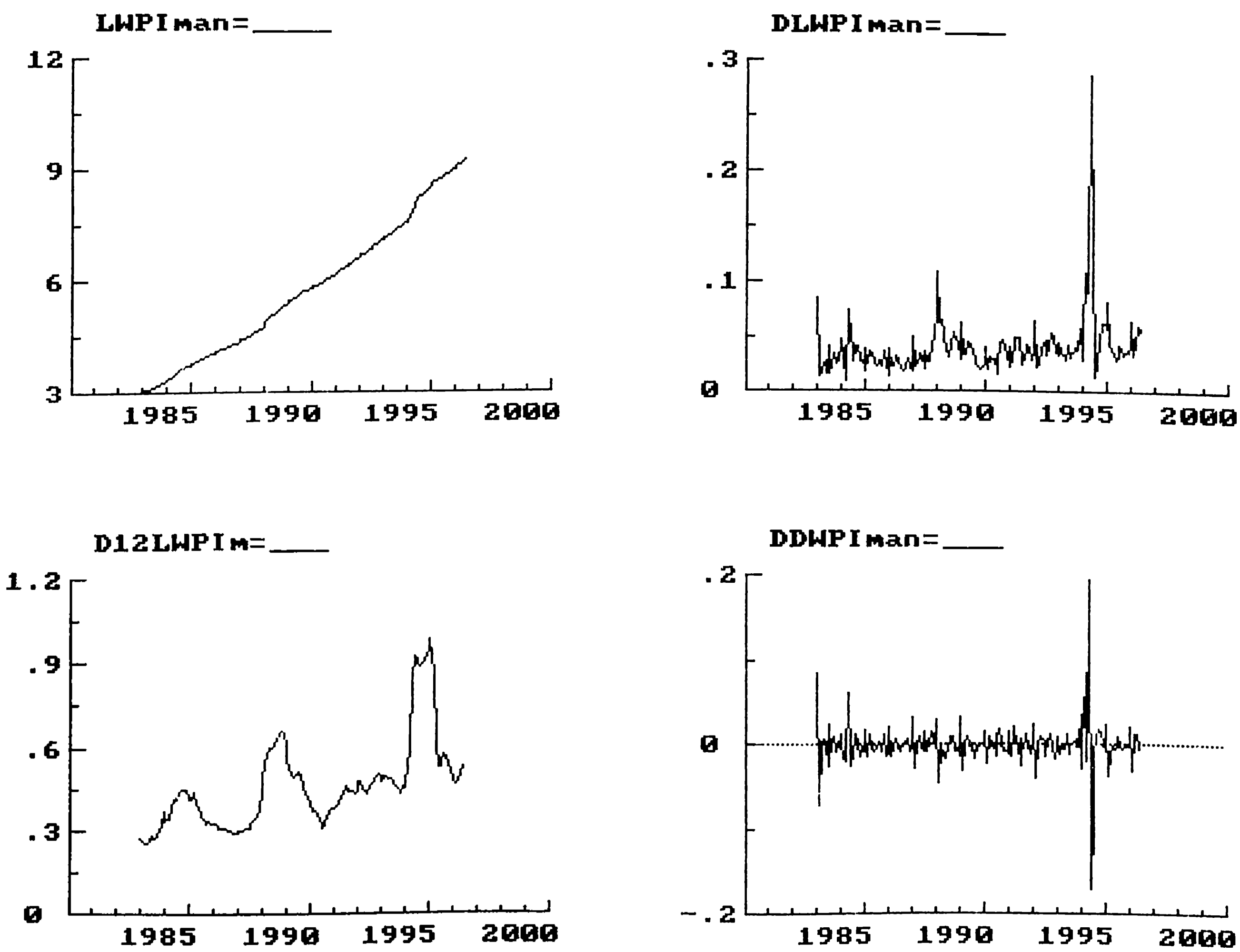
Forecast Statistics of $\Delta\Delta_{12}$ Filtered Stochastic Seasonality Model and Single Equation Model

Forecast Horizons	Test Statistics	Model 5	Model 6
Less 1 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(5,146)=0.774[0.569] F(5,146)=0.732[0.599] F(5,146)=0.732[0.599]	 F(1,151)=0.032[0.856] F(1,151)=0.031[0.562] F(1,151)=0.784[0.562]
Less 3 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(15,144)=1.130[0.334] F(15,144)=1.073[0.386] F(15,144)=1.049[0.409]	 F(3,149)=1.110[0.346] F(3,149)=1.046[0.373] F(3,149)=1.206[0.393]
Less 6 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(30,141)=1.026[0.439] F(30,141)=0.970[0.516] F(30,141)=0.973[0.513]	 F(6,146)=1.845[0.094] F(6,146)=1.785[0.105] F(6,146)=1.699[0.125]
Less 12 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(60,135)=0.902[0.668] F(60,135)=0.808[0.821] F(60,135)=0.800[0.834]	 F(12,140)=1.031[0.423] F(12,140)=1.000[0.451] F(12,140)=0.958[0.491]
Less 24 forcasts	Forecast F test Using Ω Using V[e] Using V[E]	 F(120,123)=3.714[0] * F(120,123)=1.989[0] * F(120,123)=0.801[0] *	 F(24,128)=1.017[0.45] F(24,128)=0.976[0.501] F(24,128)=0.961[0.521]

* Significant at 1%

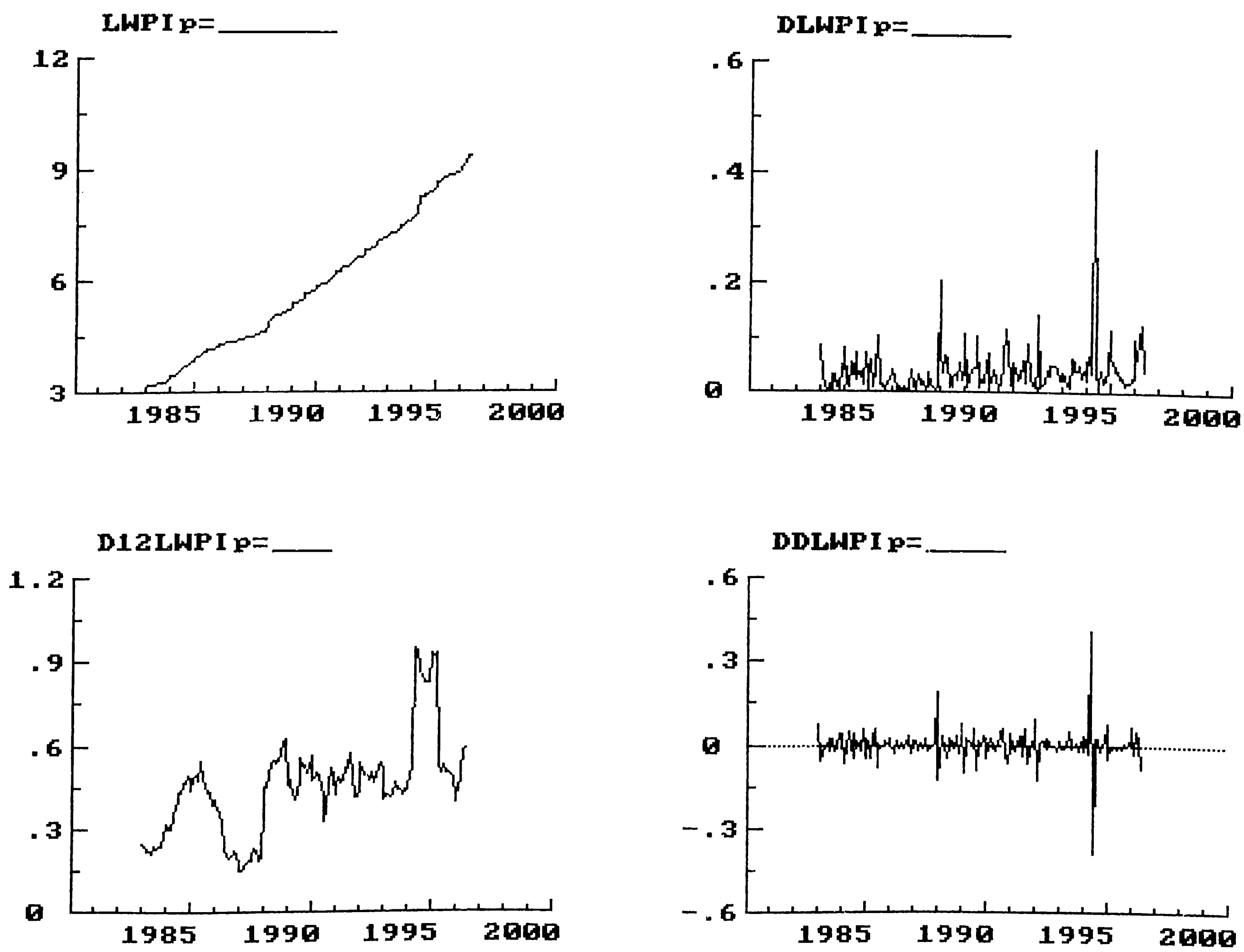
APPENDIX B

Graph 1 Private Manufacturing Industry Wholesale Price Index



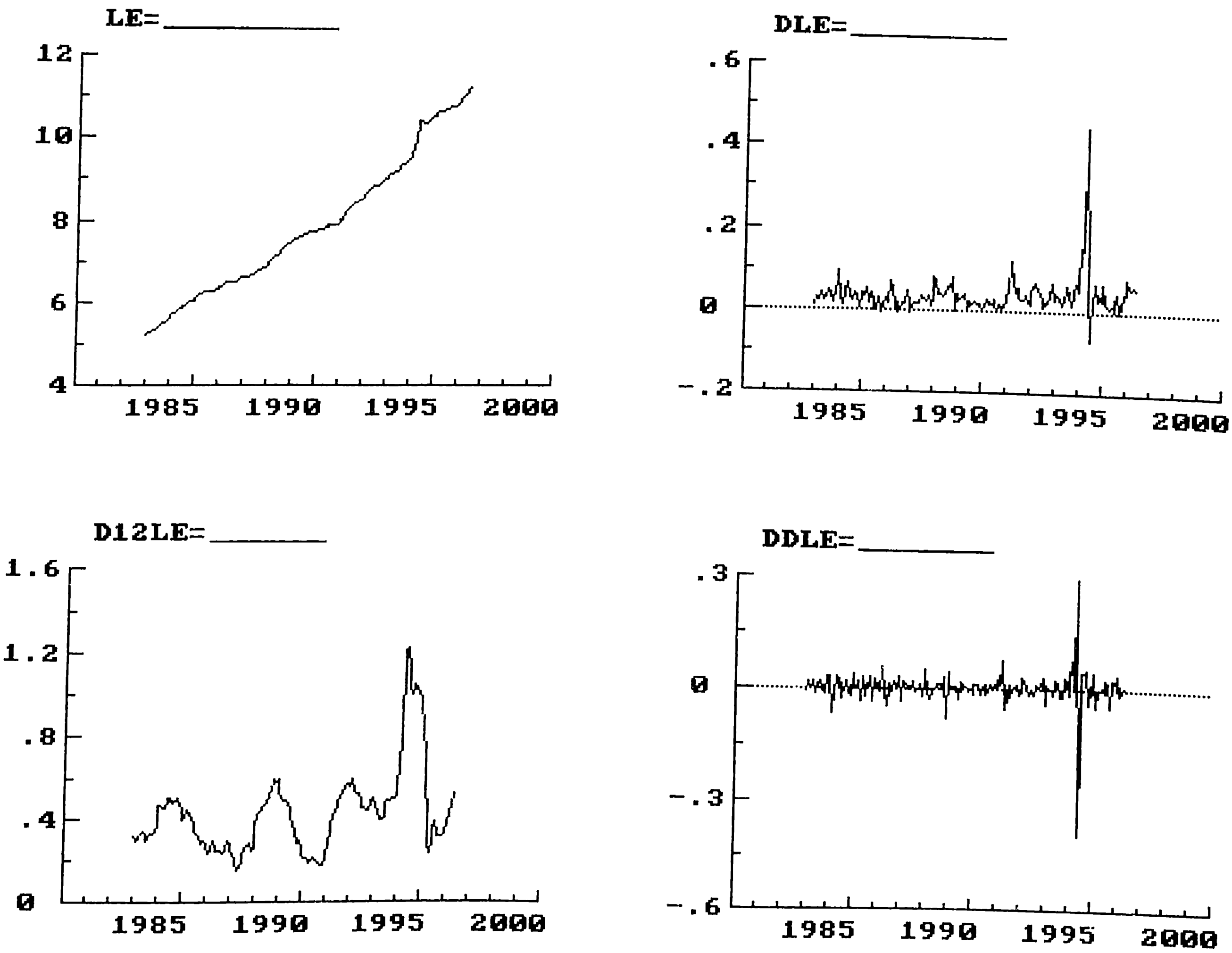
Sample Period 1982(1)-1996(5)

Graph 2 Public Sector Wholesale Price Index



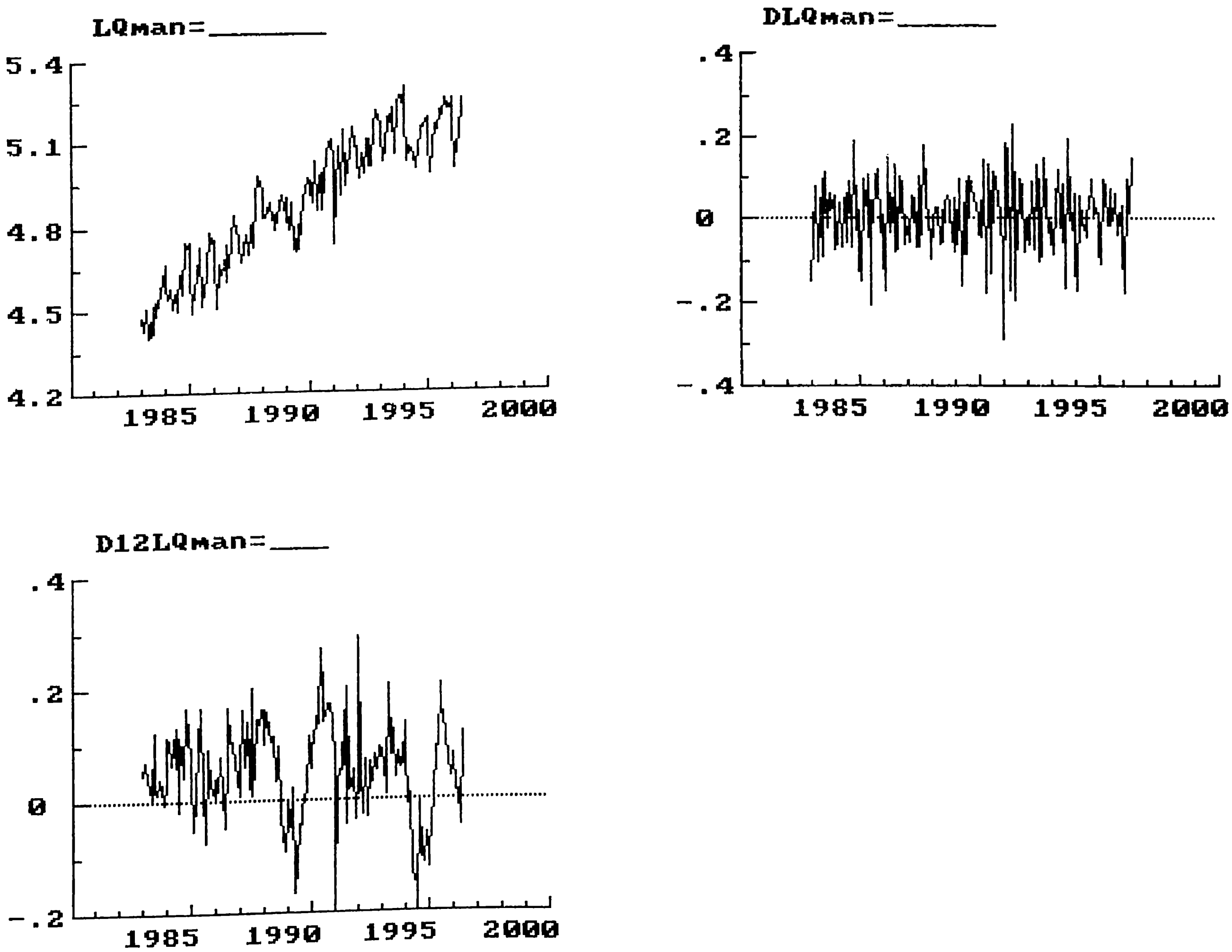
Sample Period 1982(1) 1996(5)

Graph 3 TL/$ Exchange Rate



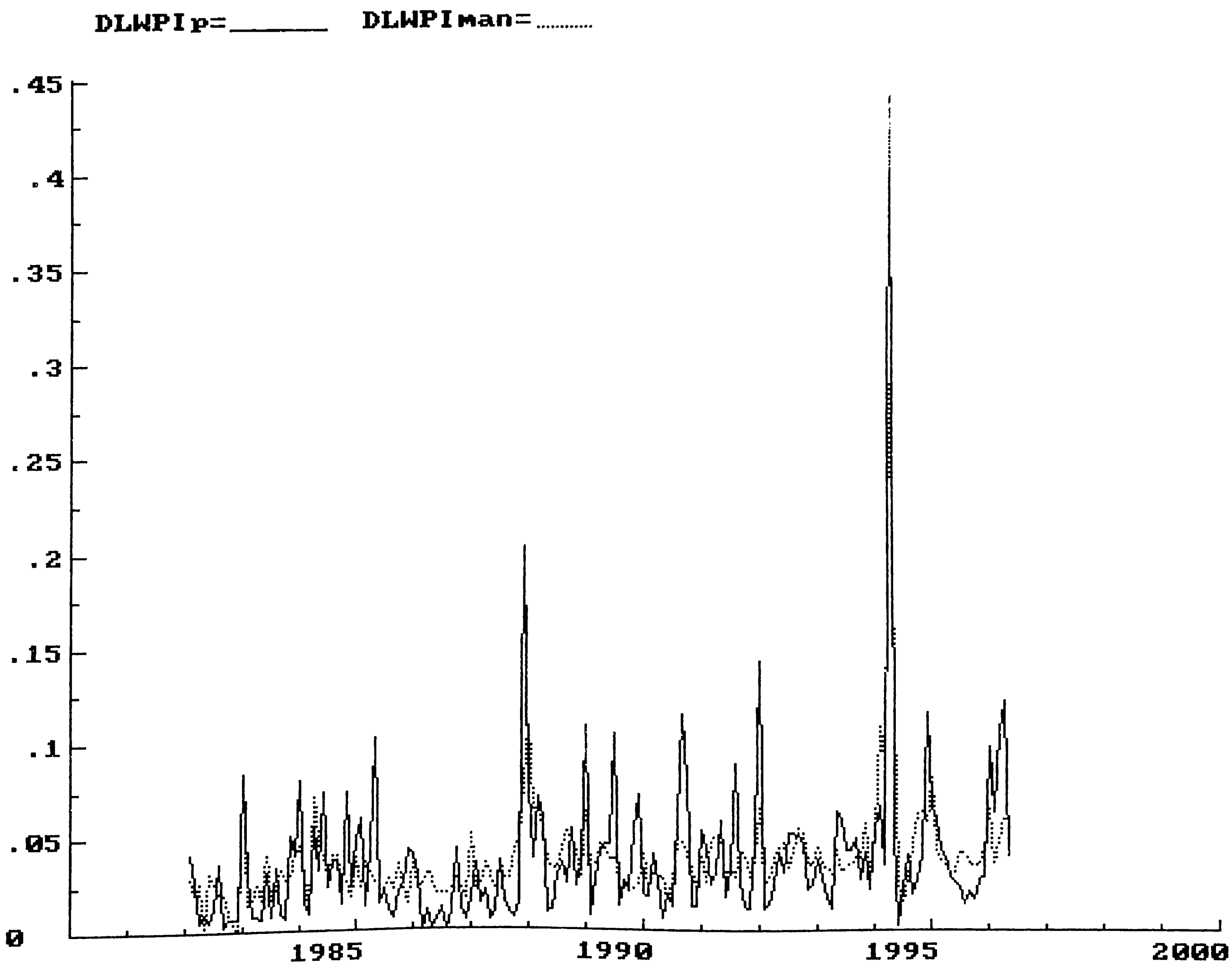
Sample Period 1982(1)-1995(6)

Graph 5 Manufacturing Industry Production Index



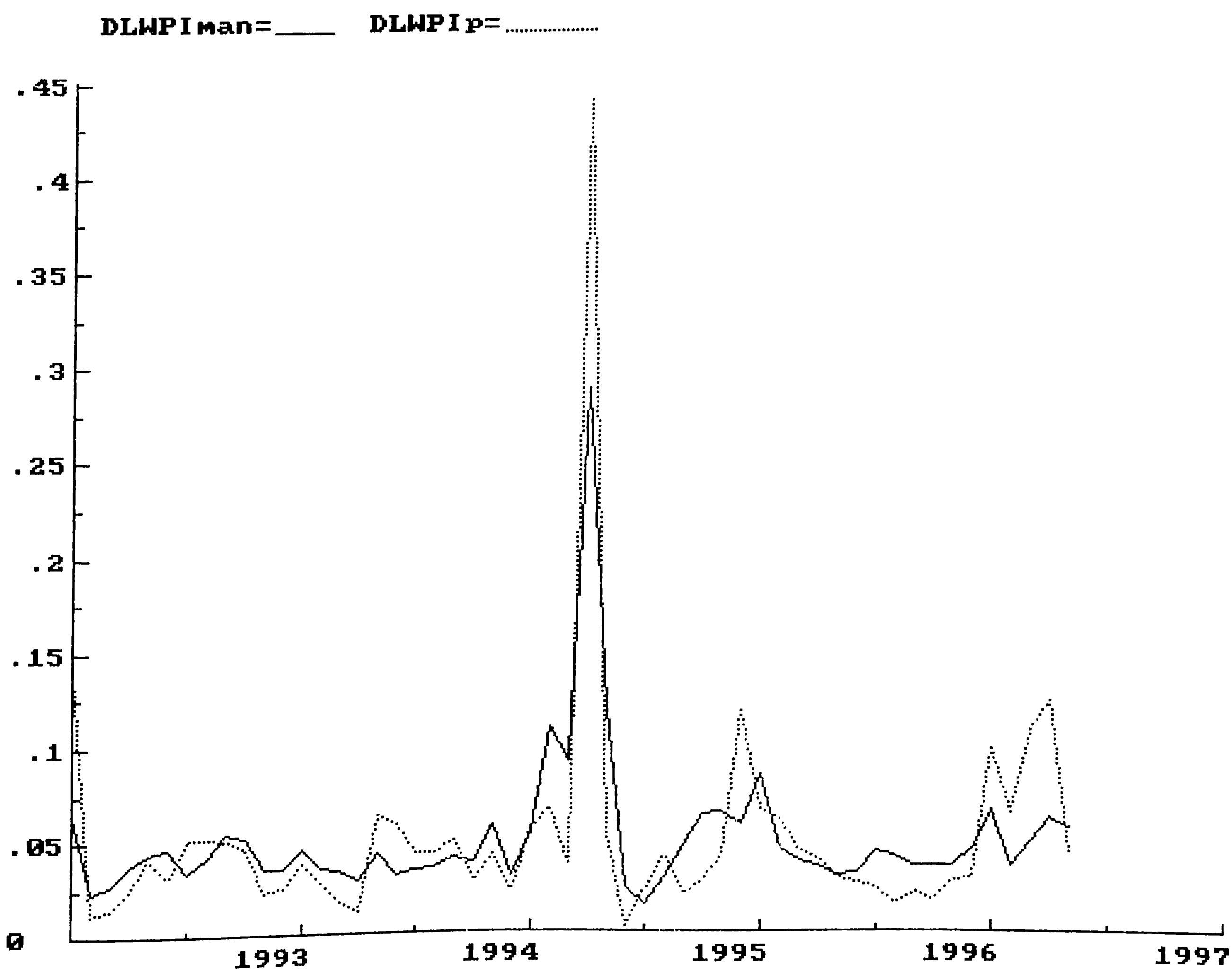
Sample Period 1982(1)-1996(5)

Graph 6 DWPIman and DWPIp



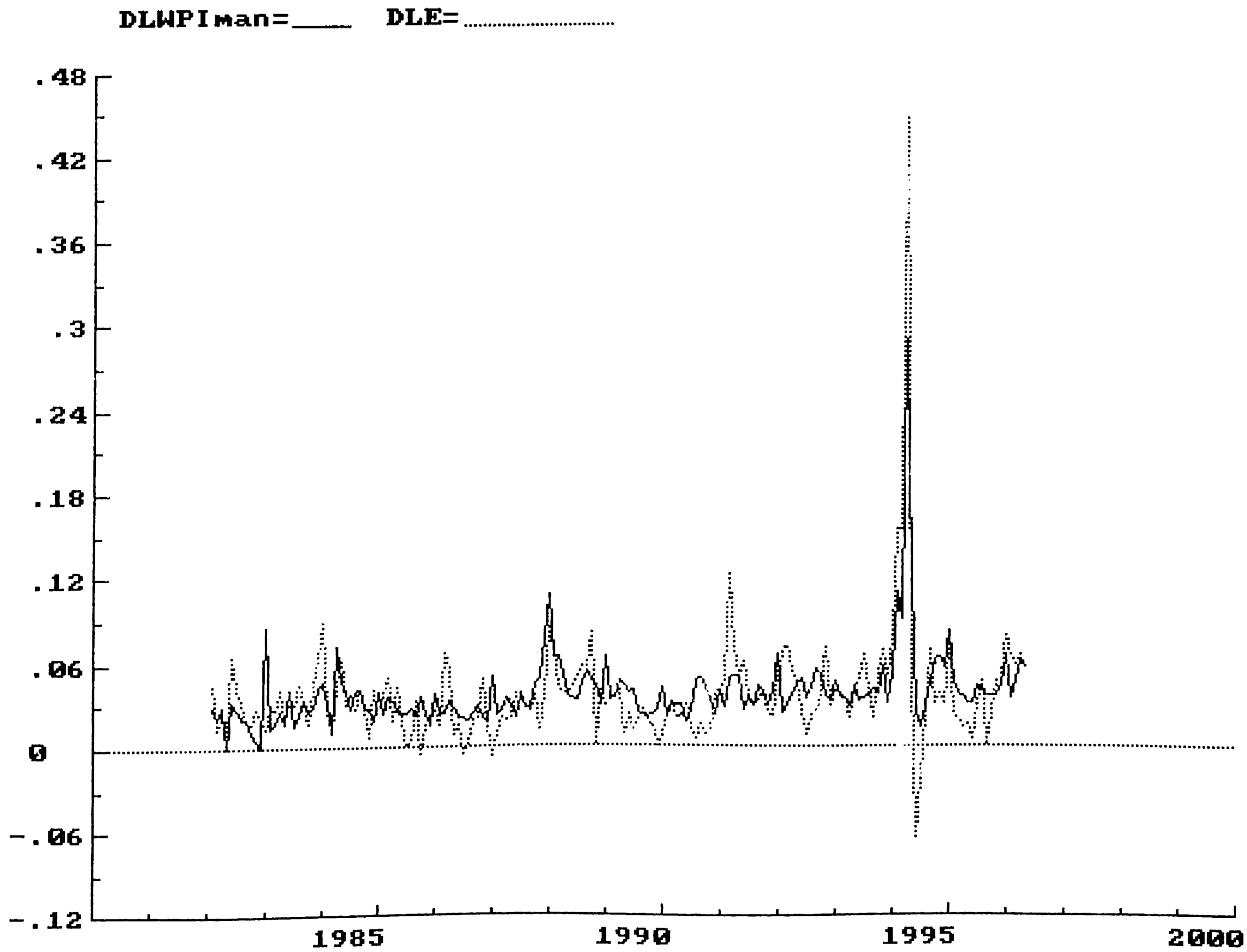
Sample Period 1982(1)-1996(5)

Graph 7 DWPIman & DWPIp



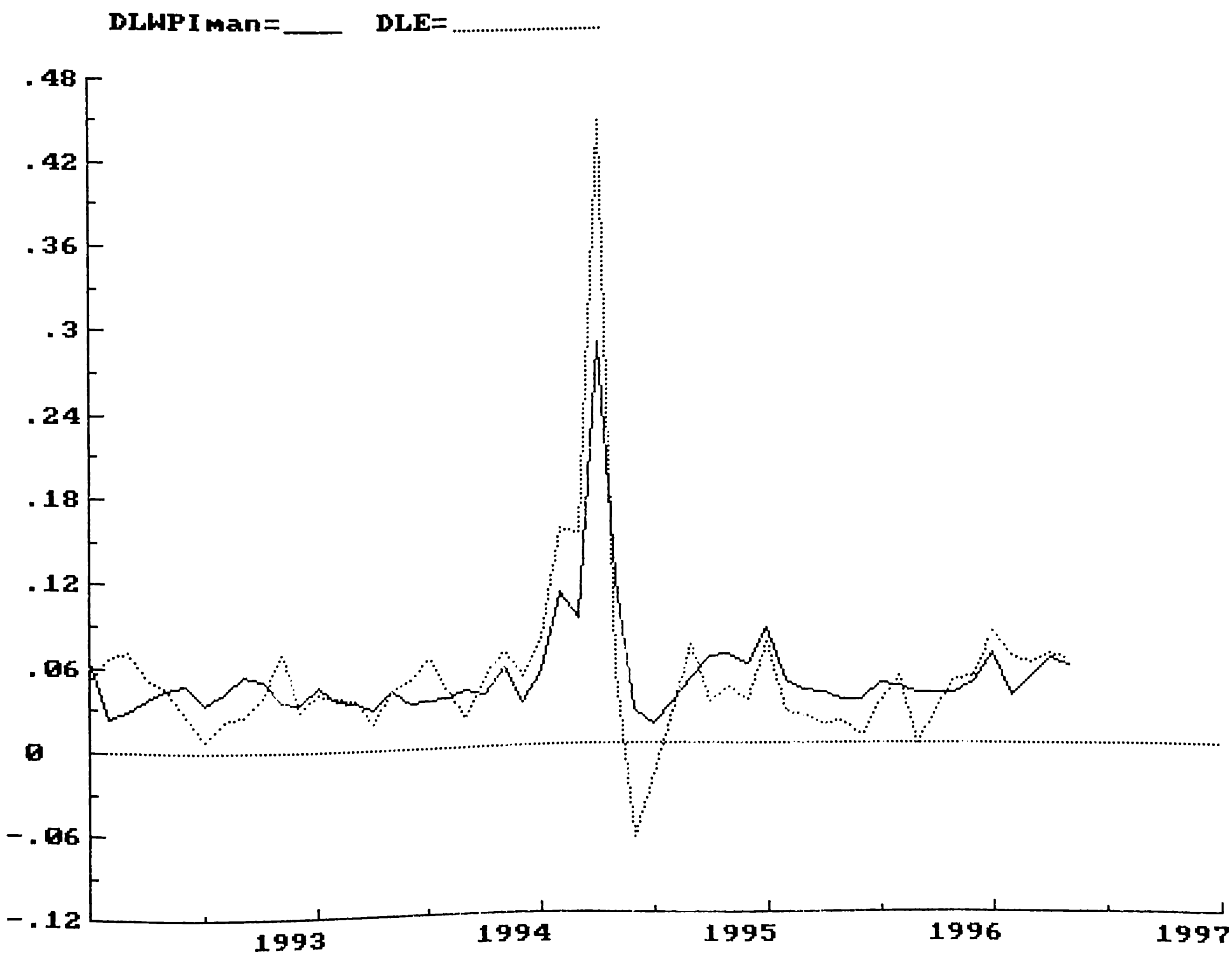
Sample Period 1992(1)-1996(5)

Graph 8 DWPIman & DE

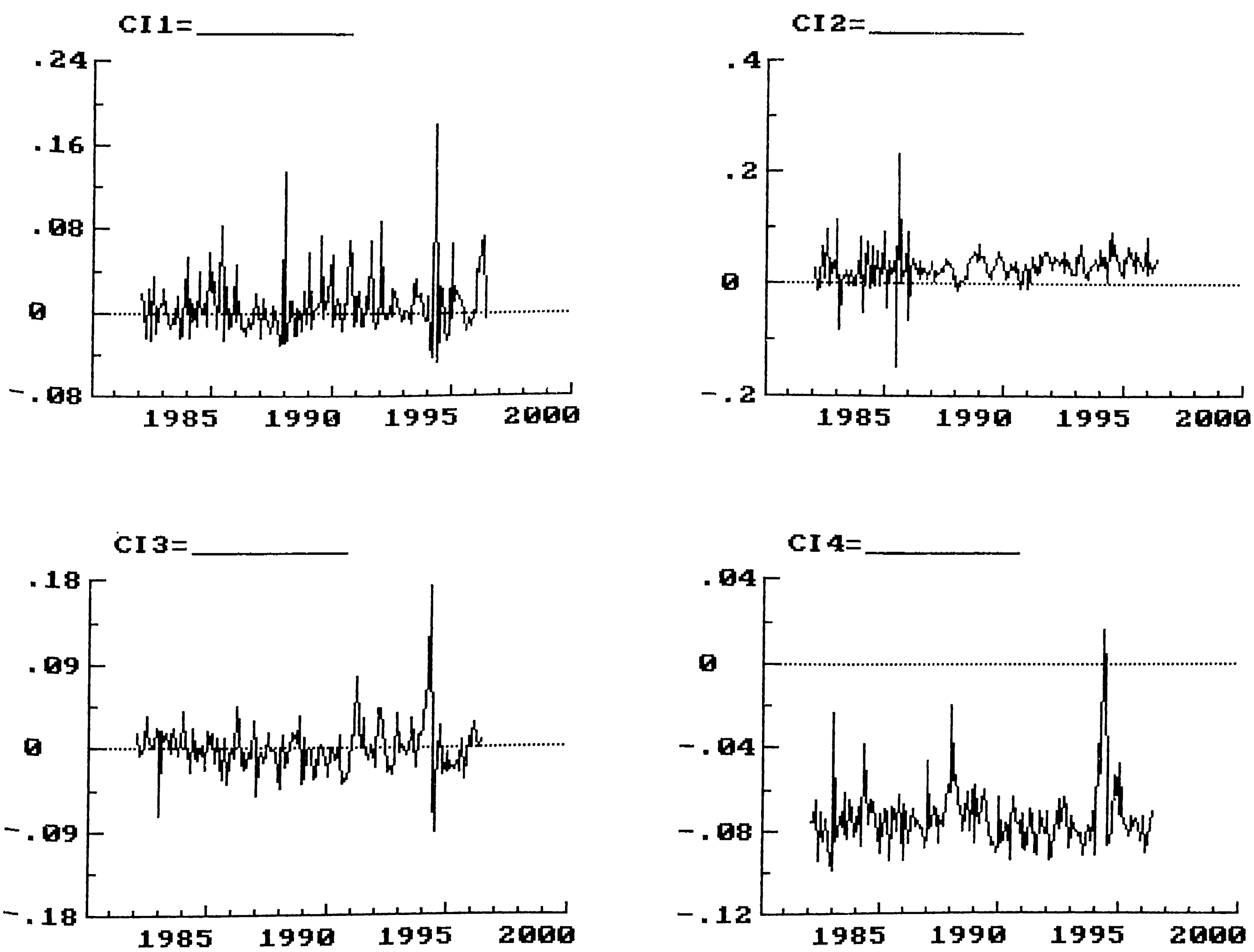


Sample Period 1982(1)-1996(5)

Graph 9 DWPIman and DE

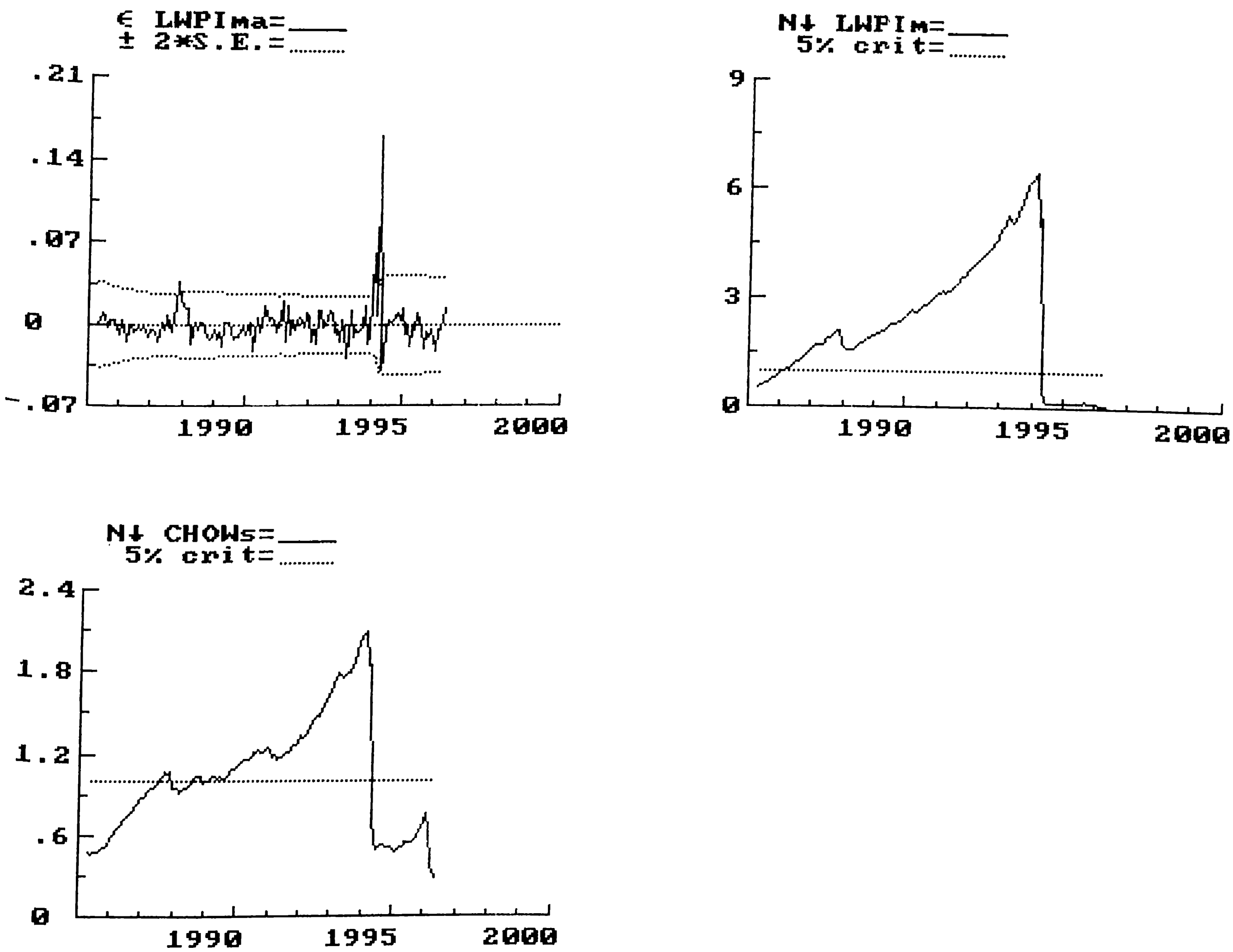


Graph 10 Cointegration Residuals



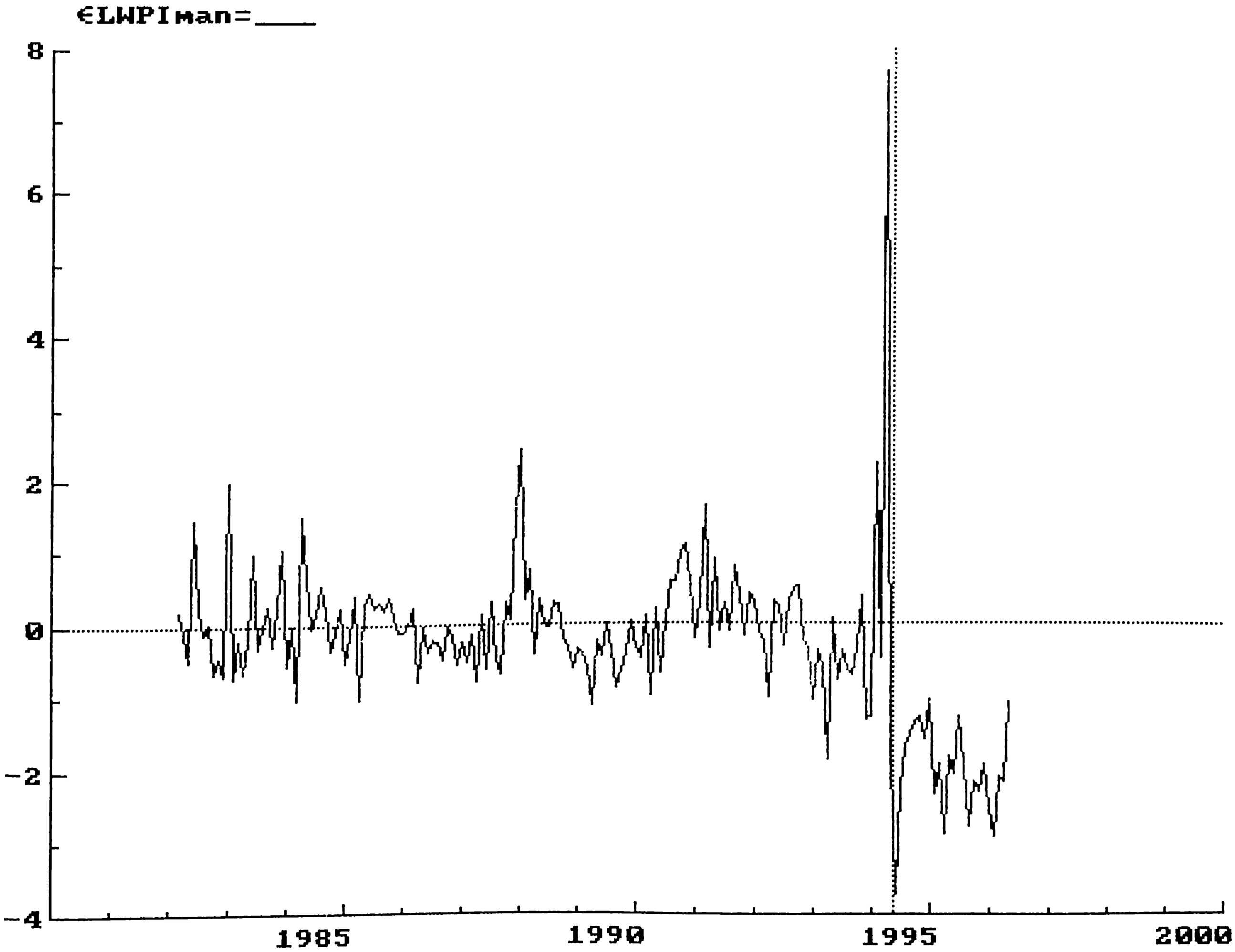
Sample Period 1982(1)-1996(5)

Graph 11 Recursive Estimates of Model1



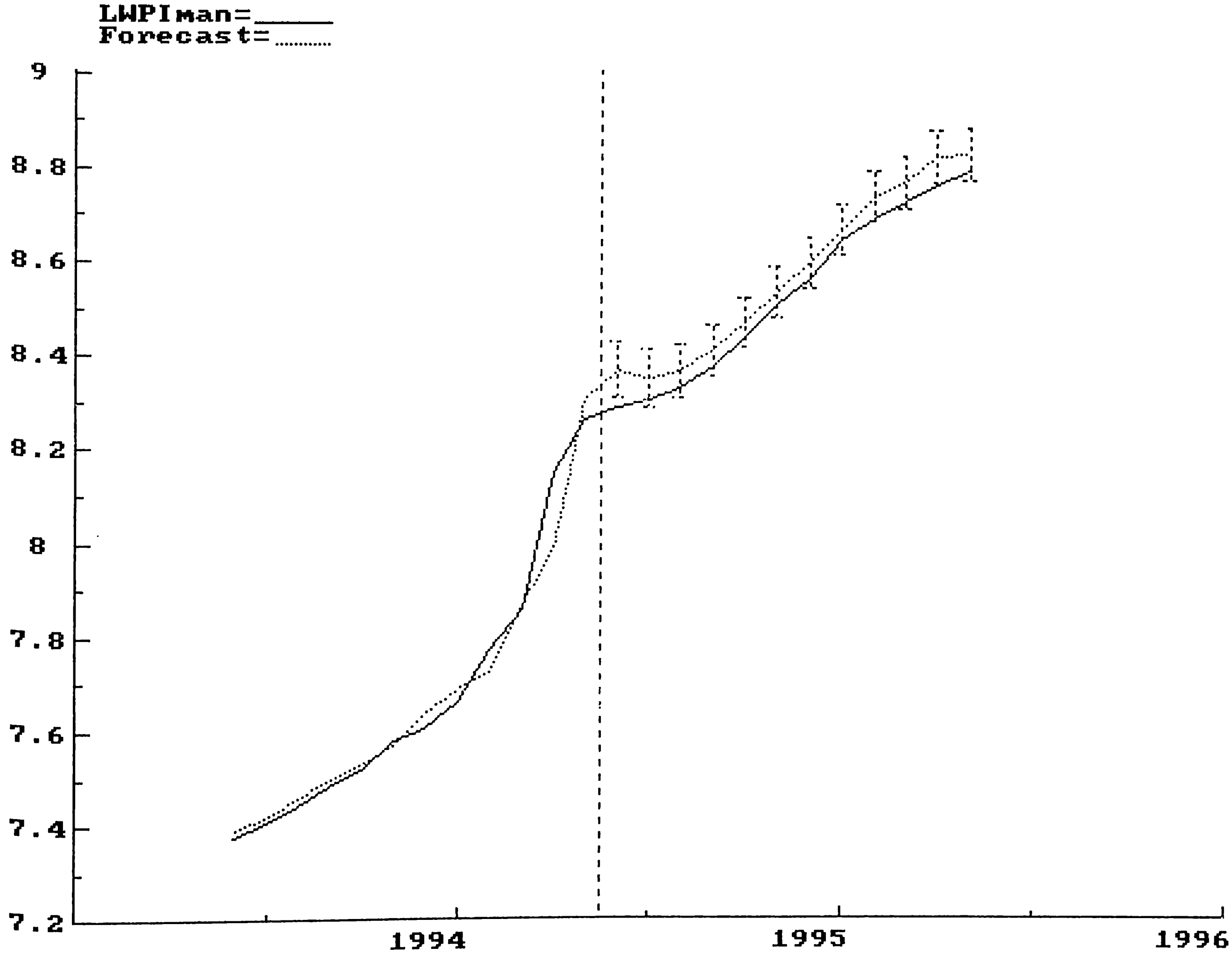
Estimation Period 1982(1)-1996(5)

Graph 12 Scaled Residuals of Model1



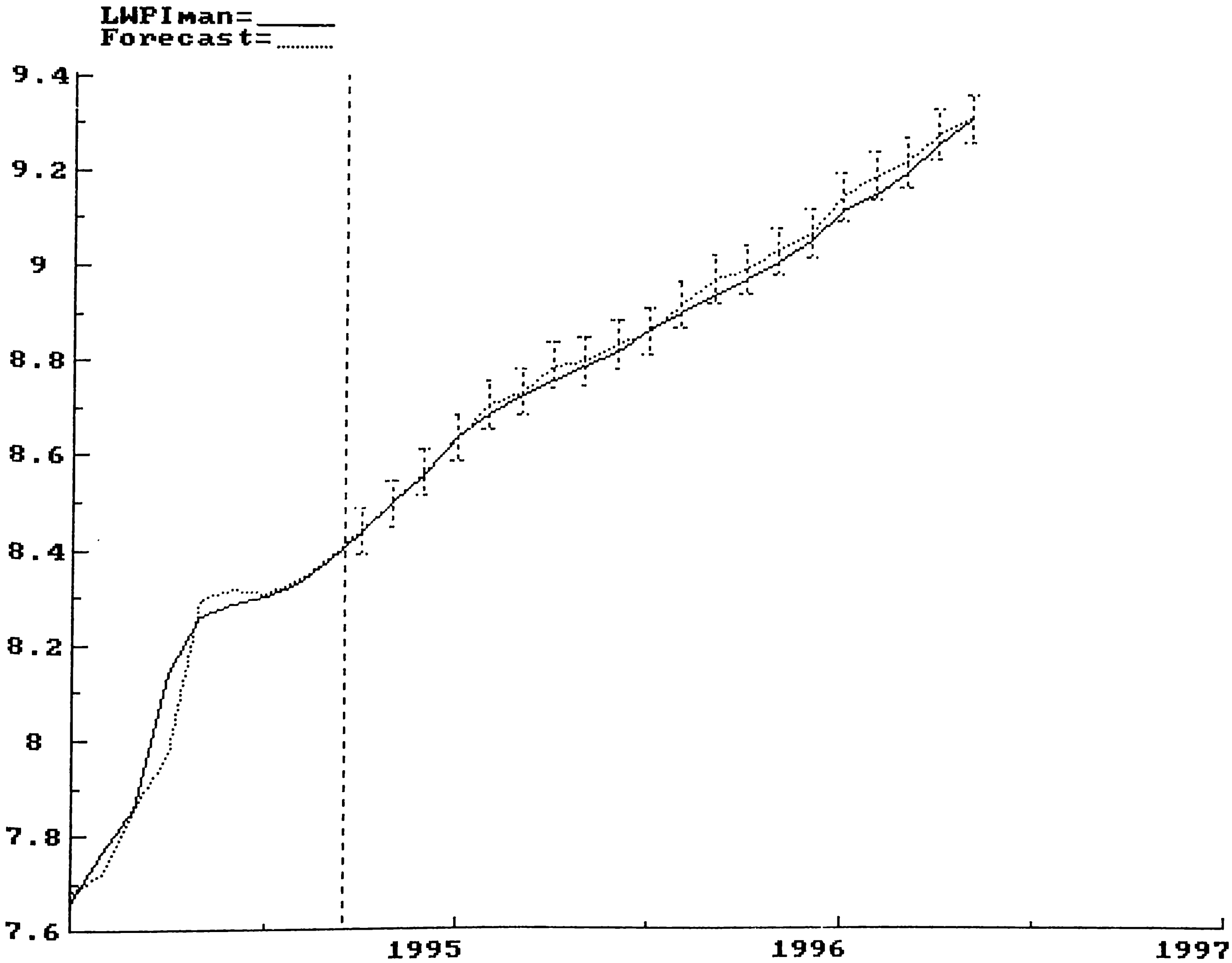
Estimation Period:1982(1)-1996(5) less 24 forecasts

Graph 13 1-step Forecasts and Outcomes of Model 1



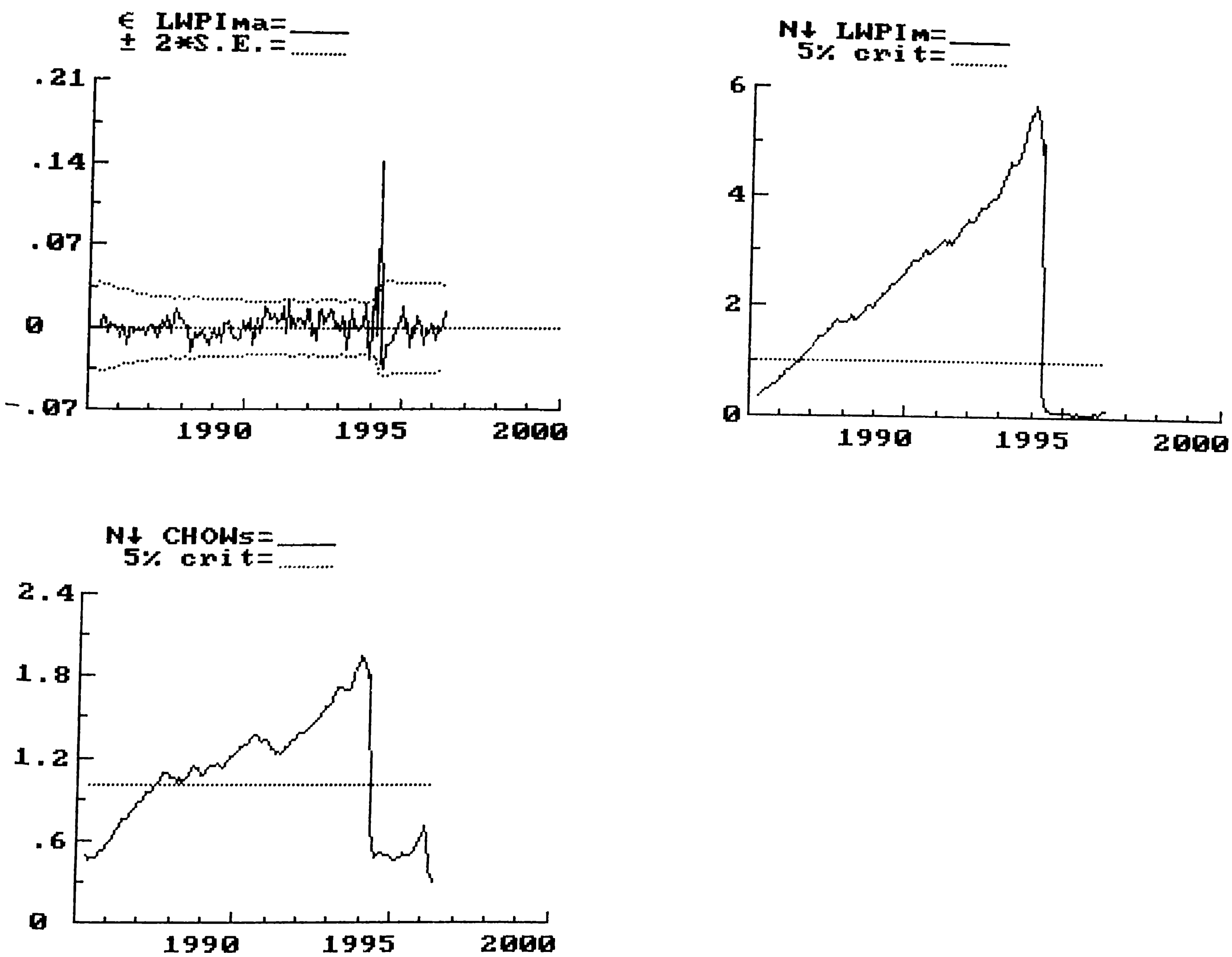
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 14 Forecasts and Outcomes of Model 1



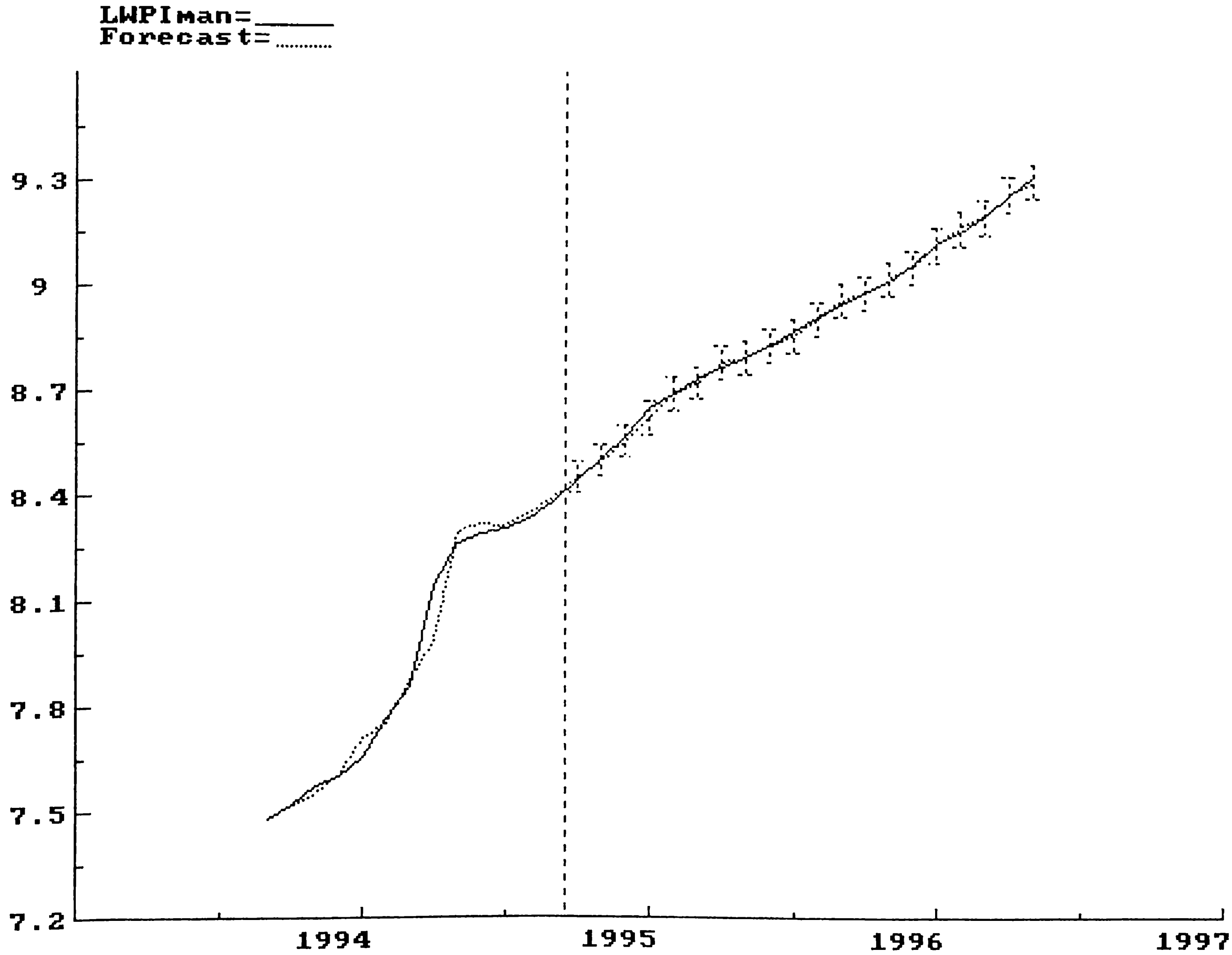
Estimatiom Period 1982(1)-1996(5) less 20 forecasts

Graph 15 Recursive Estimates of Model 2



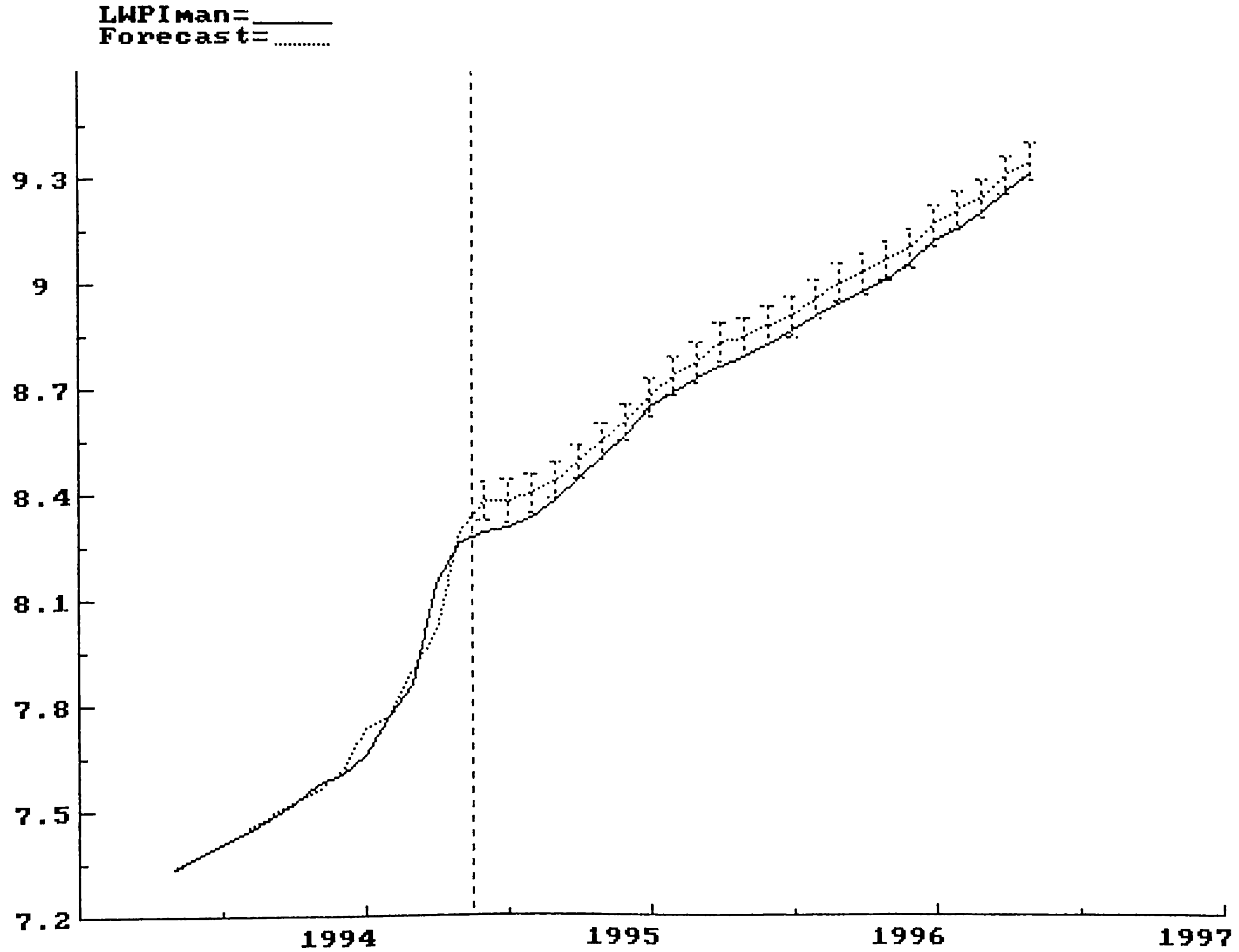
Estimation Period 1982(1)-1996(5)

Graph 16 Forecasts and Outcomes of Model 2



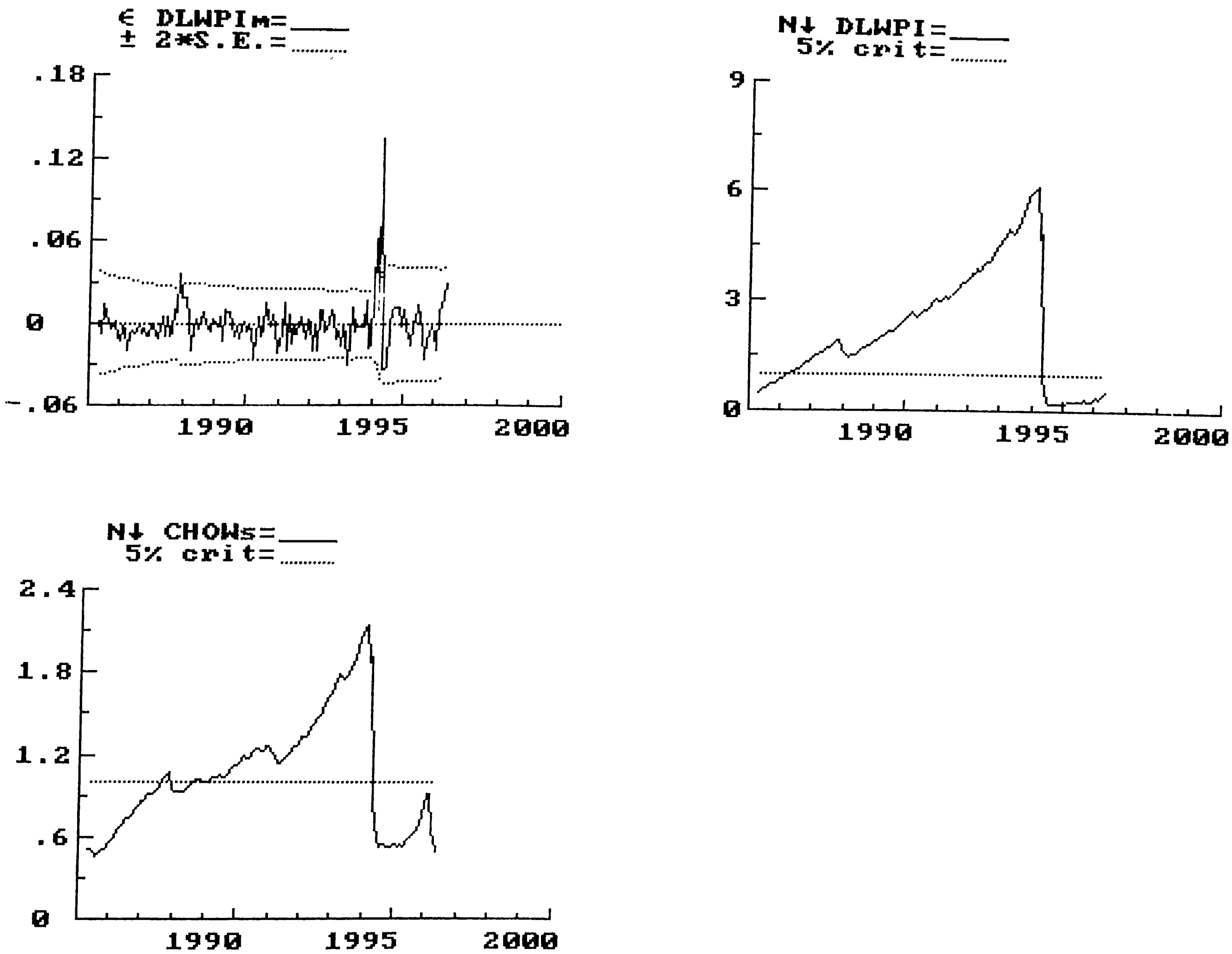
Estimation Period 1982(1)-1996(5) less 20 forecasts

Graph 17 Forecasts and Outcomes of Model 2



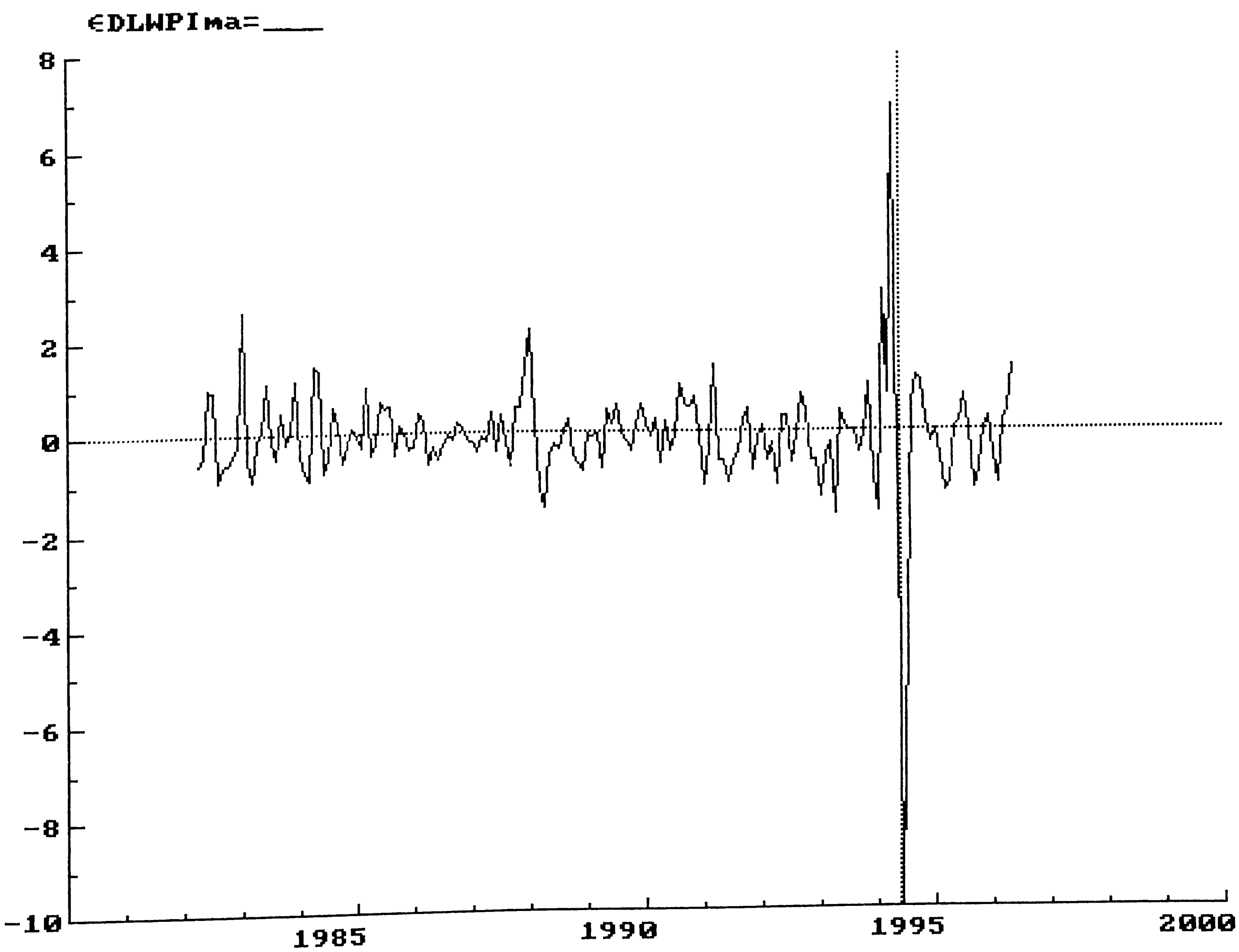
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 18 Recursive Estimates of Model 3



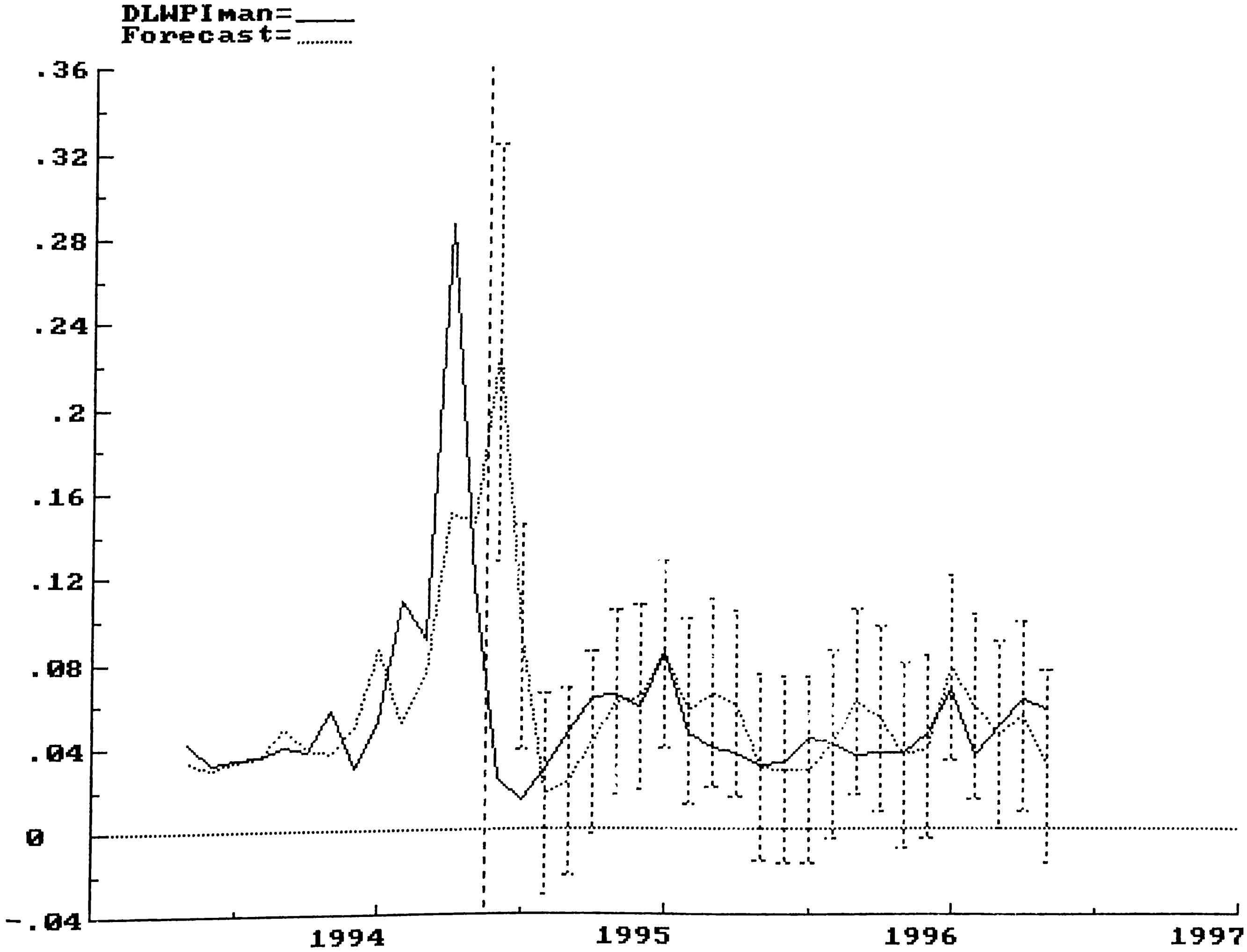
Estimation Period 1982(1)-1996(5)

Graph 19 Scaled Residuals of Model 3



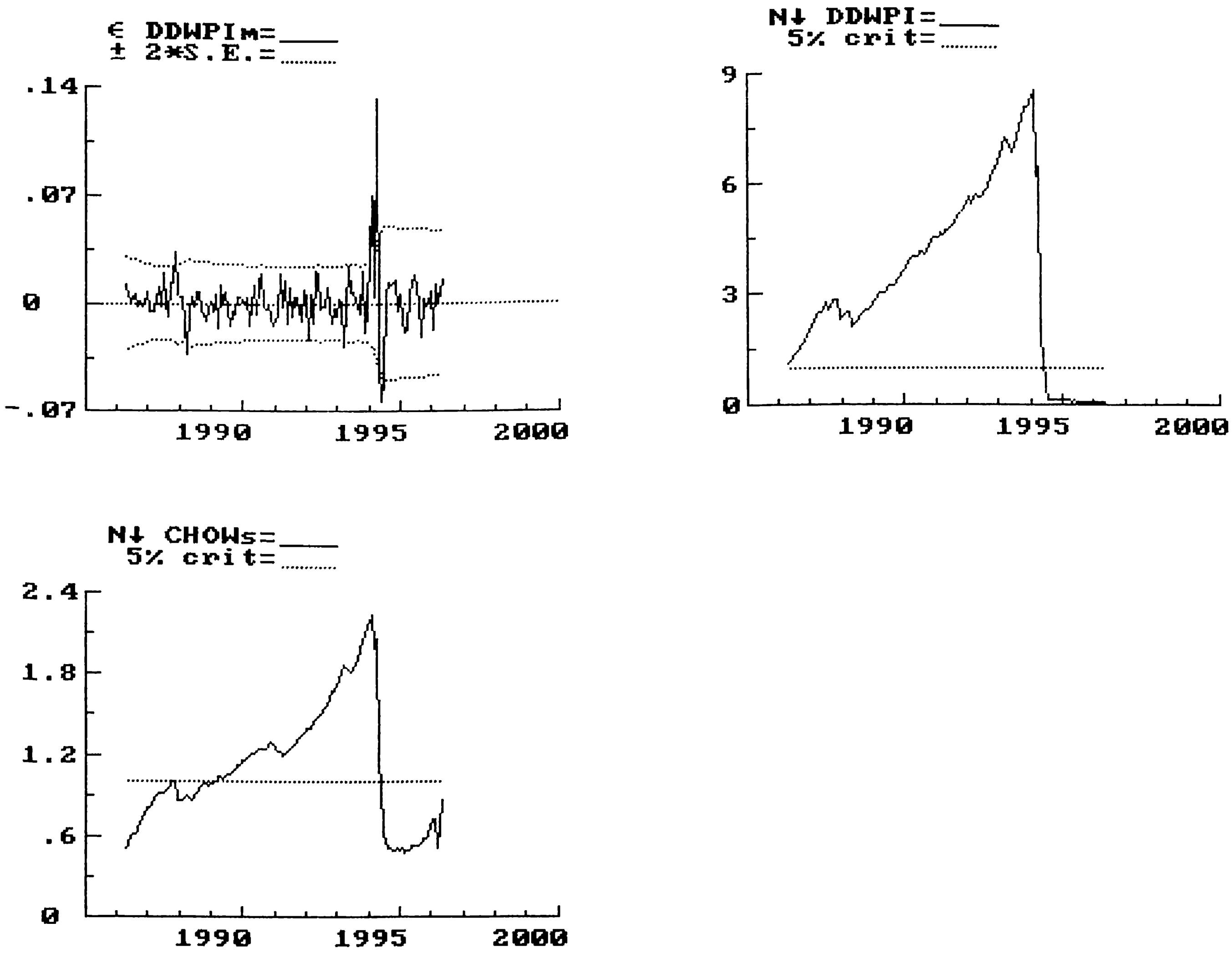
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 20 Forecasts and Outcomes of Model 3



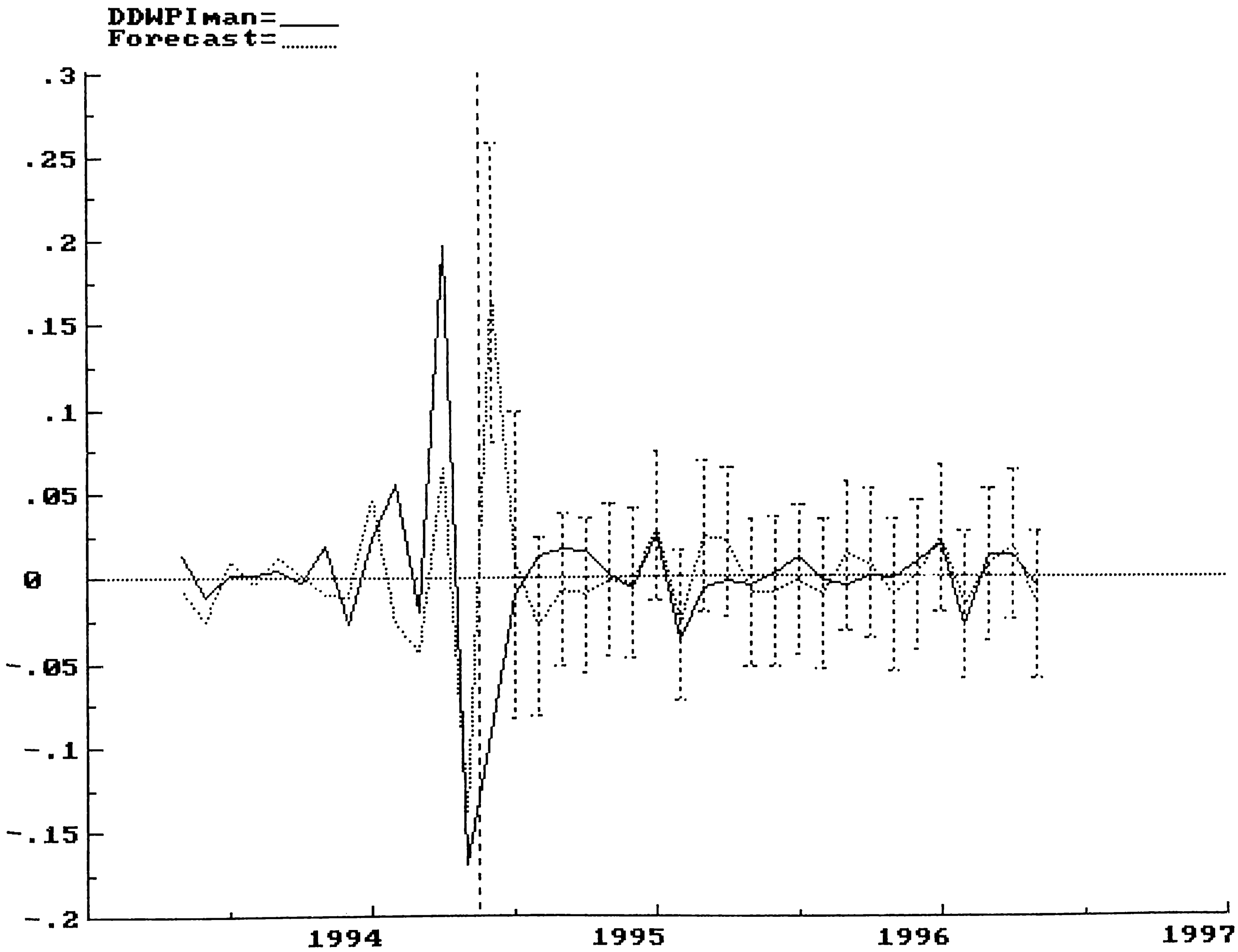
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 21 Recursive Estimates of Model 4



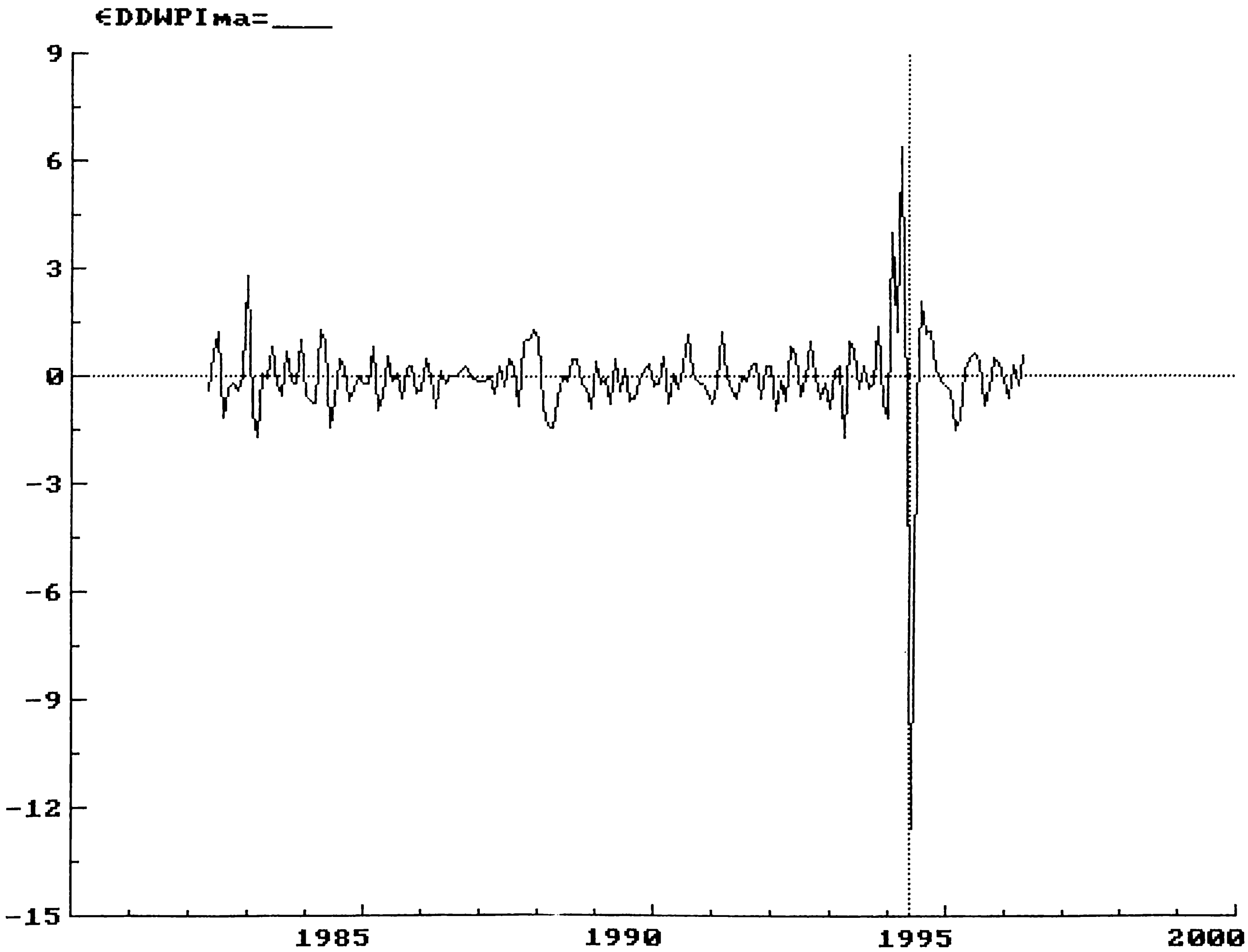
Estimation Period 1982(1)-1996(5)

Graph 22 Forecasts & Outcomes of Model 4



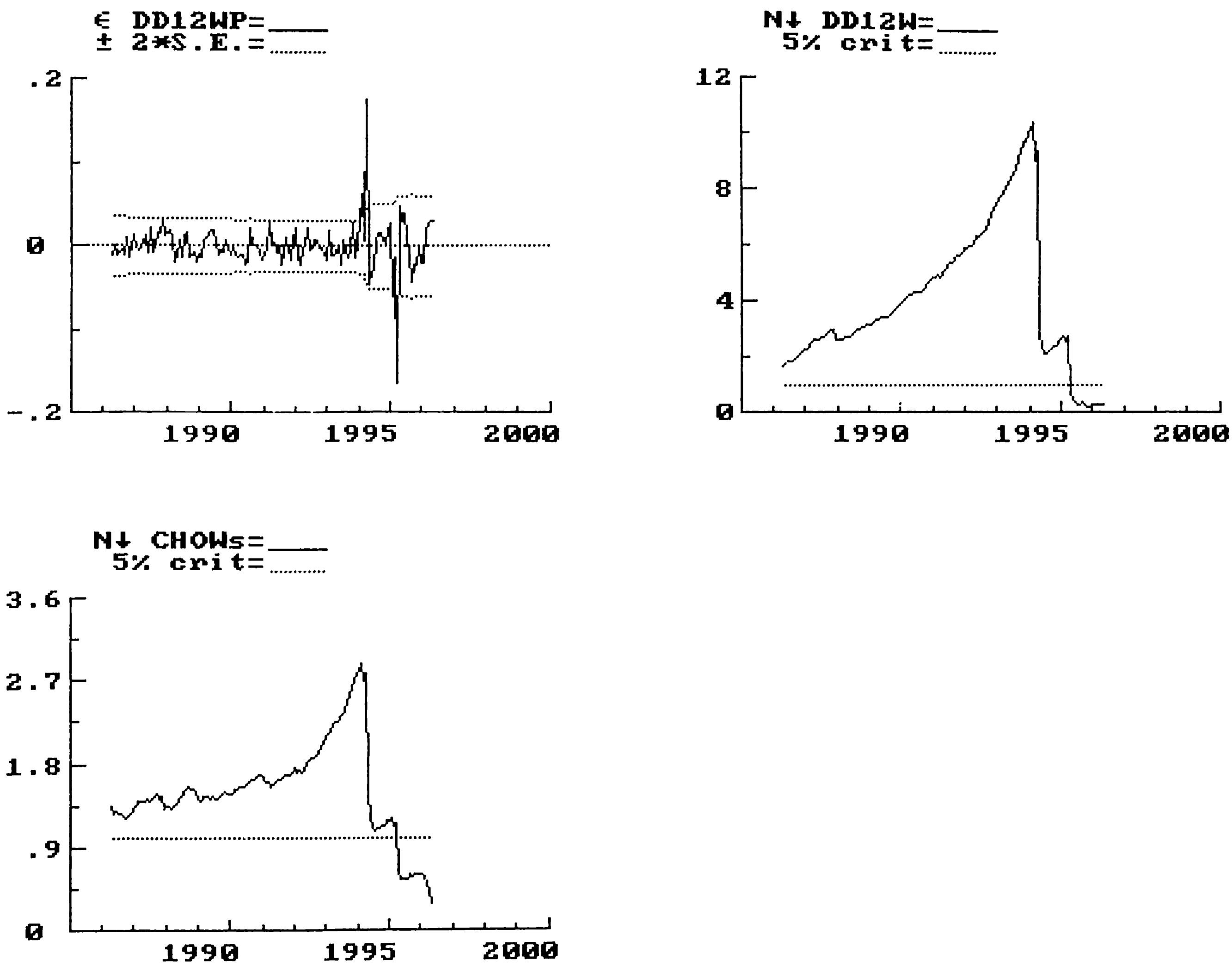
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 23 Scaled Residuals of Model 4



Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 24 Recursive estimates of Model 5

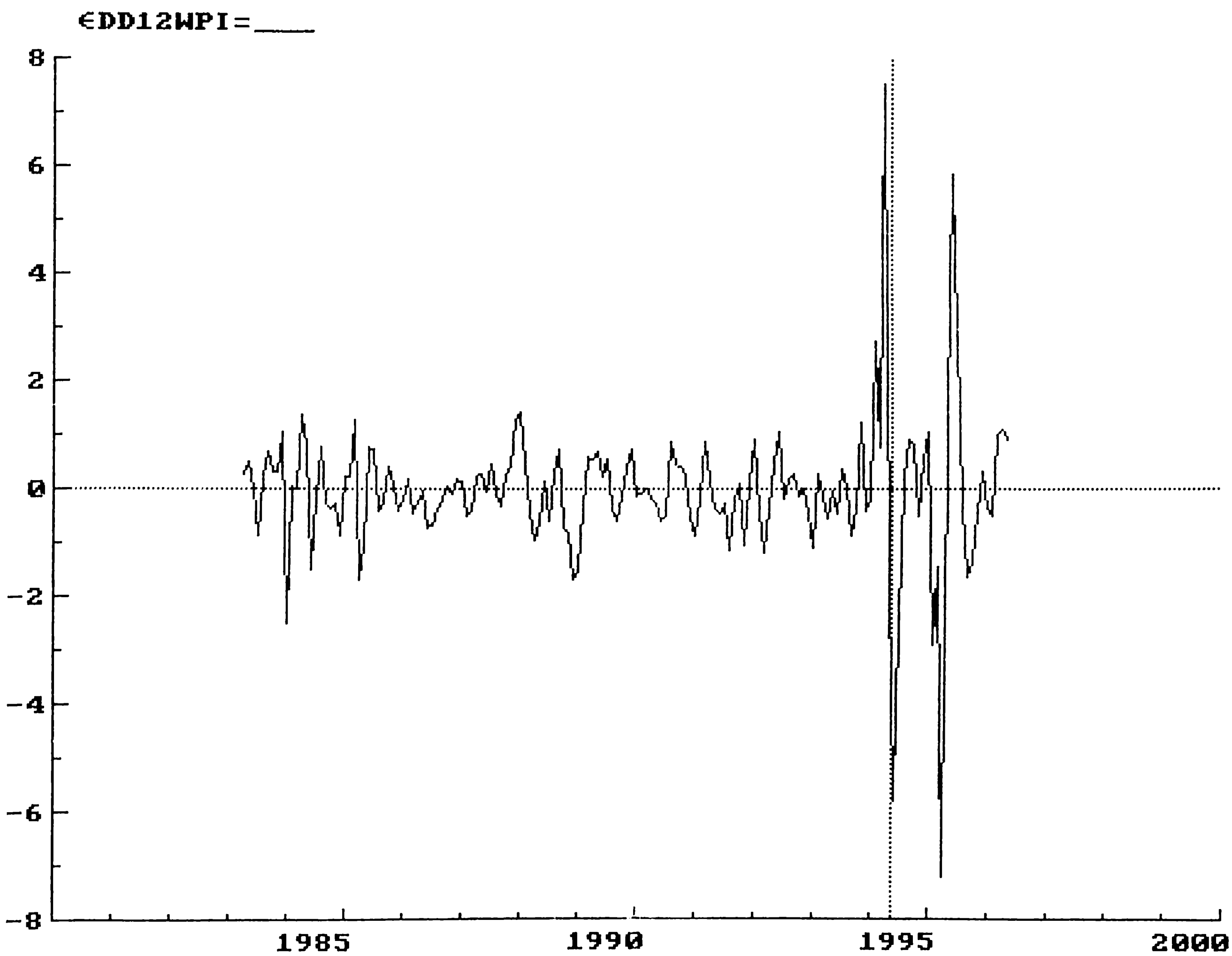


Sample Period 1982(1)-1996(5)

Graph 25 Forecasts & Outcomes of Model 5

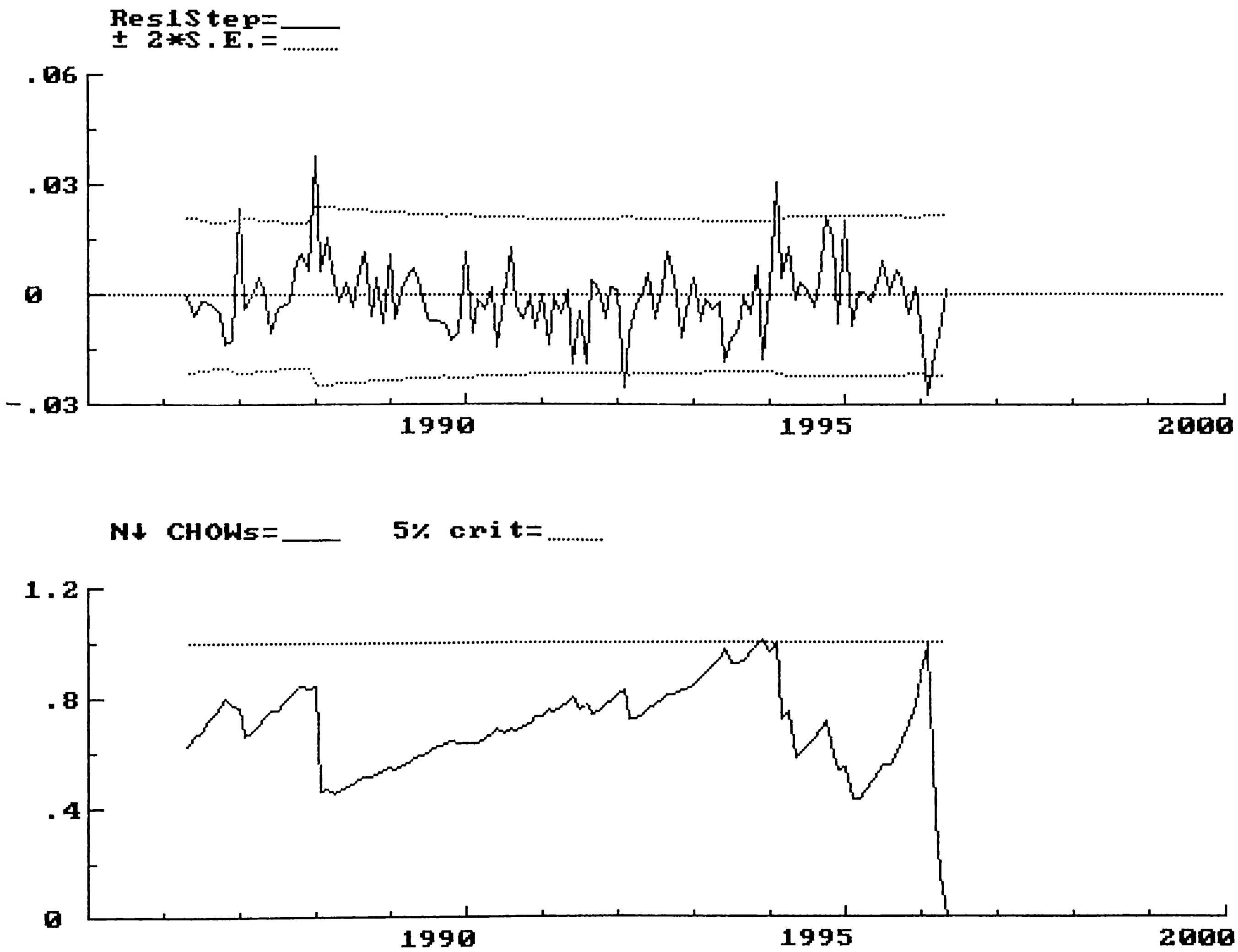
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 26 Scaled Residuals of Model 5



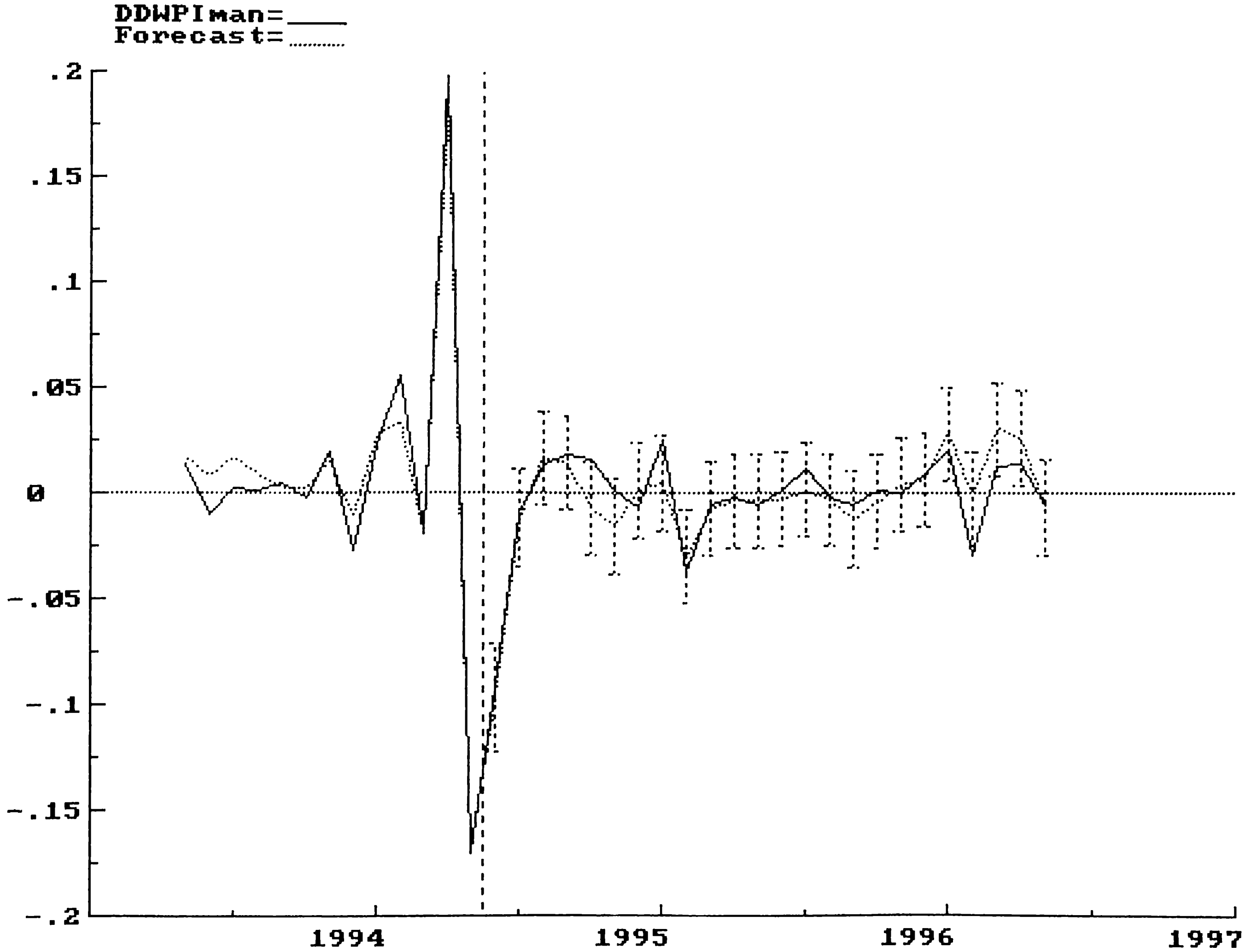
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 27 Recursive Estimates of Single Eq. Model



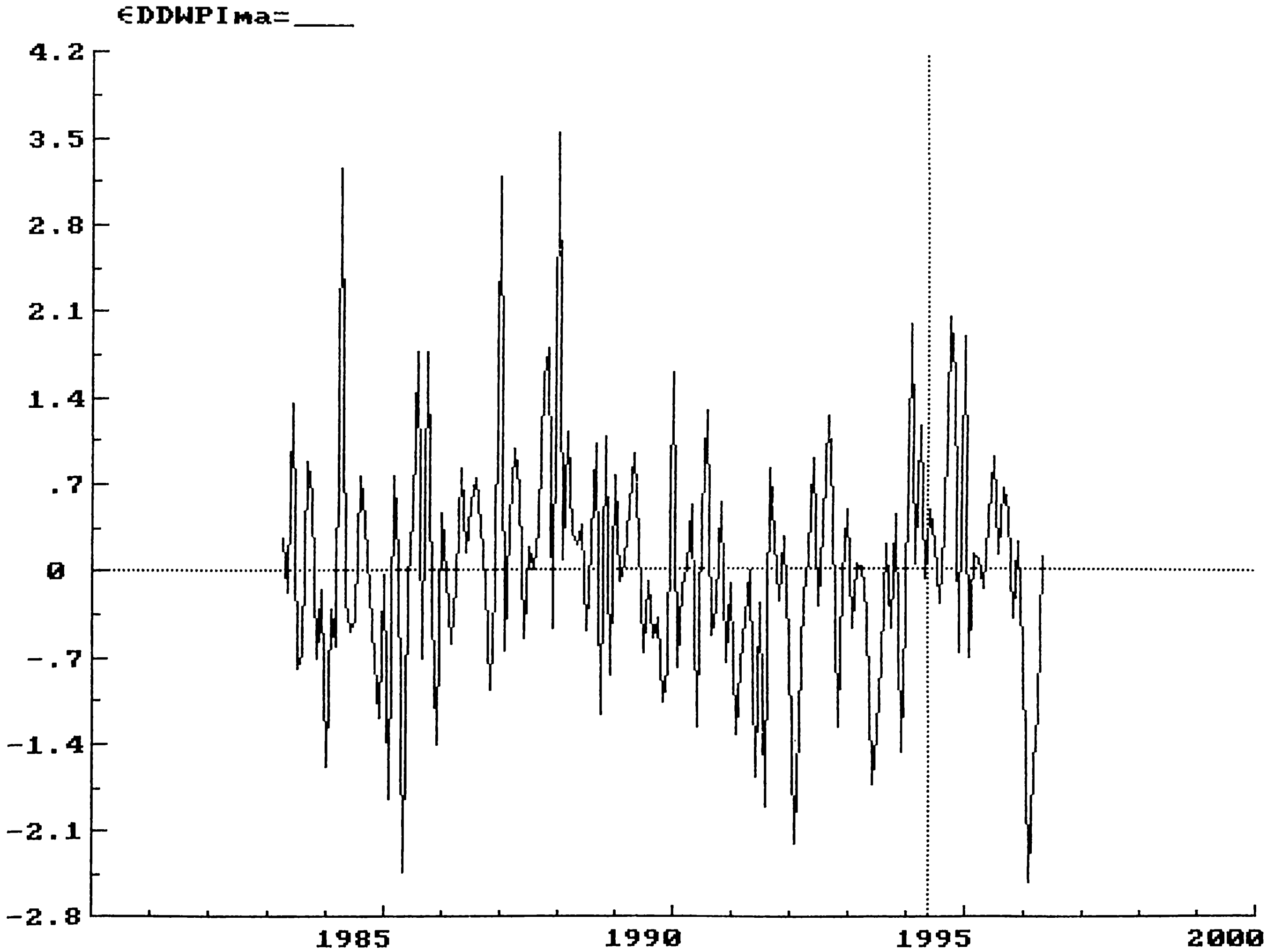
Estimation Period 1982(1)-1996(5)

Graph 28 Forecasts and Outcomes of Single Eq. Model



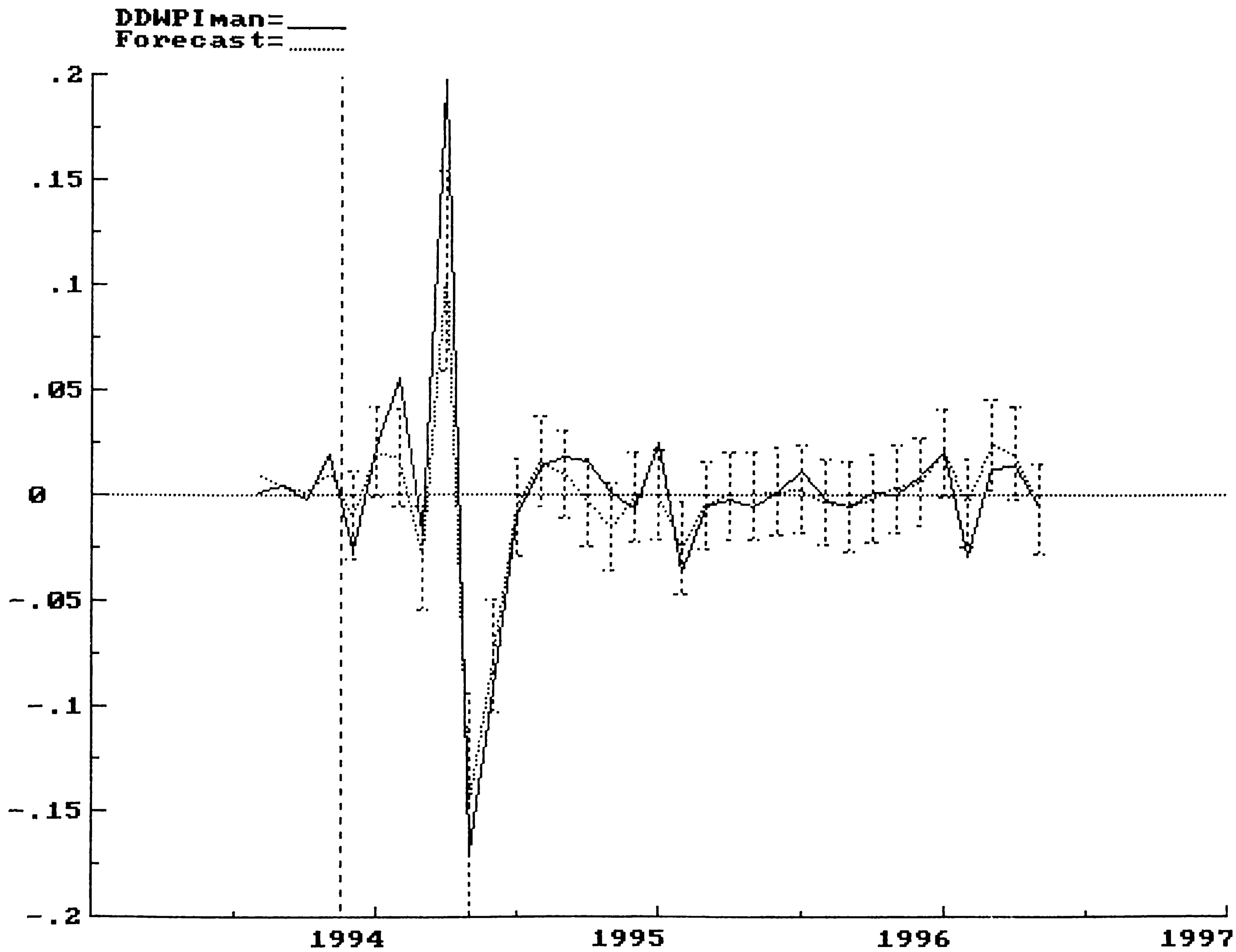
Estimation Period 1982(1)-1996(5) less 24 forecasts

Graph 29 Scaled Residuals of Single Eq. Model



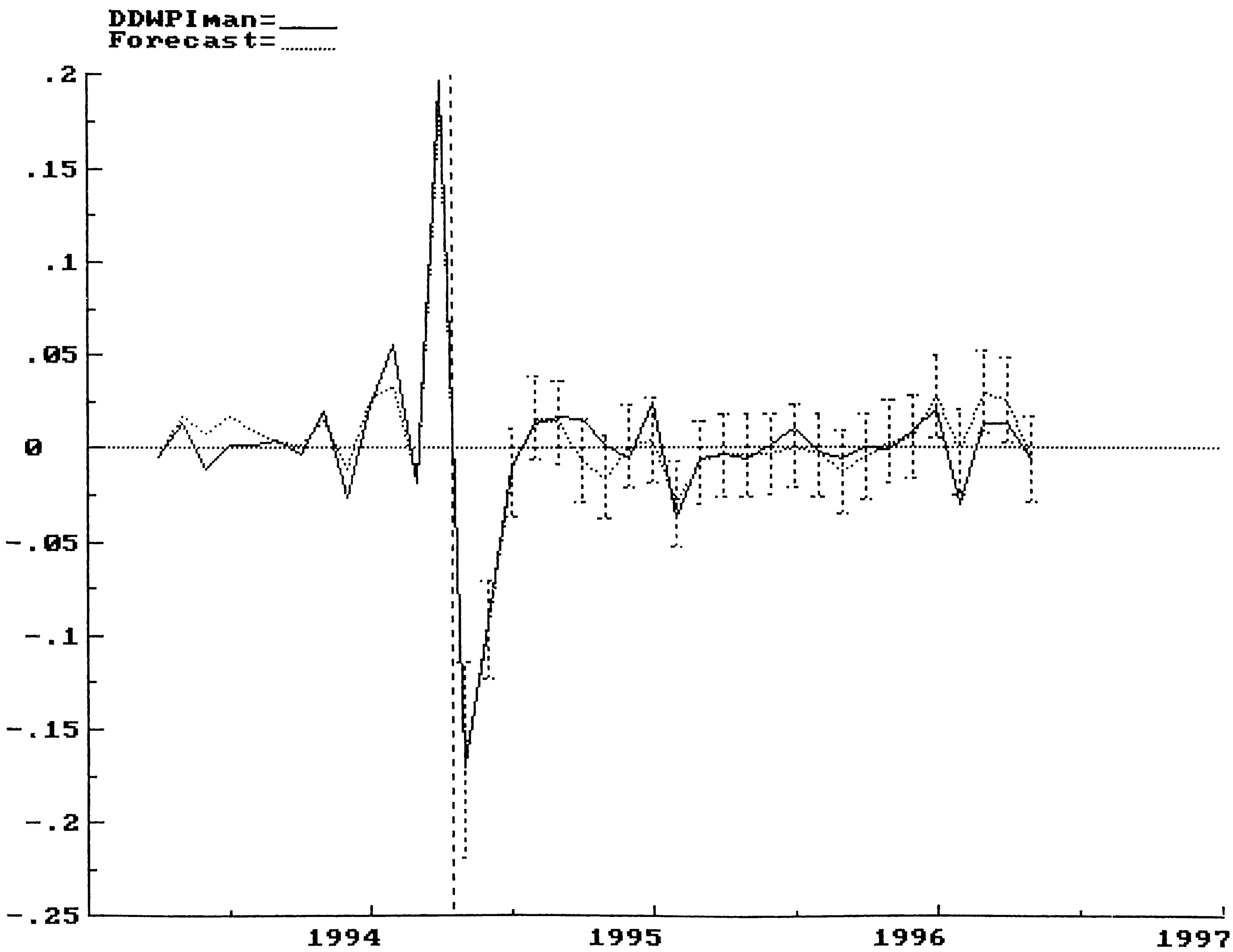
Sample Period 1982(1)-1996(5) less 24 forecasts

Graph 30 Forecasts and Outcomes of Single Eq. Model



Estimation Period 1982(1)-1996(5) less 30 forecasts

Graph 31 Forecasts and Outcomes of Single Eq. Model



Estimation Period 1982(1)-1996(5) less 26 forecasts