The Behavior of Stock Returns in Turkey:

1986 - 1988

A Thesis
Submitted to the Department of Management
and the Graduate School of Business Administration
of Bilkent University
in Partial Fulfillment of the Requirements
for the Degree of
Master of Business Administration

by

ERDEM BASCI

September, 1989

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A B S T R A C T

The Behavior of Stock Returns in Turkey:

1986 - 1988

ERDEM BASCI

MBA in Management

Supervisor: Assist.Prof. Kursat Aydogan

September 1989, 120 pages

This study investigates distributional and time series behavior of common stock returns in Istanbul Stock Exchange (ISE) for the period 1986-1988. The distributions of weekly price returns deviate from normality with sharp peaks, heavy tails and positive skewness. These observations are similar to those of United States stock markets but ISE returns have higher means and higher variances. The first order serial dependence is insignificant for most stocks and Box-Jenkins linear forecasting models shows a poor performance. So, published past price information cannot be used to obtain better forecasts of future prices by this model. This observation is in line with the random walk behavior as expected from a weak form efficient market. Applicability of Box-Jenkins models may be questioned however, since variance of returns is not stationary due to a second order dependence. This type of dependence is not against weak form efficiency and is seen in US stock returns as well. To detect any longer term dependence, the test of variance-time function is employed. The results indicate significant long term dependence for most stocks and this is against weak form efficiency. The weekly change in trading volume series turns out to be forecastable by univariate Box- Jenkins models and it seems to explain some of the variation in stock price returns.

Keywords: Market efficiency, random walk behavior, Box-Jenkins ARIMA models, stationarity, test of variance time function.

Ö Z E T

Türkiye'de Hisse Senedi Getirilerinin Davranışı:

1986 - 1988

ERDEM BAŞÇI

Yüksek Lisans Tezi, İşletme Enstitüsü

Tez Yöneticisi: Yd.Doç.Dr. Kürşat Aydoğan

Eylül 1989, 120 sayfa

Bu çalışma İstanbul Menkul Kıymetler Borsası'ndaki hisse senedi getirilerinin olasılık dağılımları ve zaman içindeki davranışlarını incelemektedir. Haftalık getirilerin dağılımı sivrilik ve çarpıklık açılarından normal dağılımdan farklılık göstermektedir. Bu gözlem gelişmiş hisse senedi piyasalarındakilere benzemektedir ancak İMKB getirilerinin ortalama ve varyansları daha yüksektir. İncelenen senetlerin çoğu için birinci derece dizisel bağımlılık anlamlı bulunmamış, ve Box-Jenkins doğrusal kestirim modelleri başarılı olamamıştır. Dolayısıyla yayınlanmış geçmiş fiyat bilgisi gelecekteki fiyatların bu modelle tahmininde bir iyileşme sağlayamaz. Bu gözlem zayıf tür etkin bir piyasadan beklenen rassal yürüyüş davranışıyla tutarlıdır. Ancak Box-Jenkins modellerinin bu dizilere uygunluğu sorgulanabilir, çünkü getirilerin varyansı ikinci derece bir bağımlılık dolayısıyla durağan değildir. İkinci derece bağımlılık, zayıf etkinliğe aykırı olmayıp gelişmiş piyasalarda da görülmektedir. Daha uzun dönemli bir bağımlılığın varlığı ise varyans-zaman testi ile sınanmıştır. Sonuçlar senetlerin bir kısmı için anlamlı bir uzun dönem bağımlılığın varlığını göstermektedir ve bu rassal yürüyüş modeline aykırıdır. haftalık toplam işlem hacmindeki değişim oranı dizisi Box-Jenkins modelleri ile kestirilebilir bulunmuştur ve bu değişkenin fiyat değişimlerini bir ölçüde açıkladığı gözlenmiştir.

Anahtar Kelimeler: Pazar etkinliği, rassal yürüyüş modeli, Box-Jenkins ARIMA modelleri, durağanlık, varyans-zaman testi.

ACKNOWLEDGEMENTS

I would like to express my gratitute to Dr. Kürşat Aydoğan for his invaluable supervision during the development of this thesis. I also would like to express my thanks to the Management Department of Bilkent University for providing me with the necessary background through the MBA programme. Special thanks go to Professor Subidey Togan for his enthusiastic encouragement and to Dr. Ümit Erol for useful comments and suggestions on methodology and interpretation of results. I would like to thank to the Research Department of the Capital Market Board and especially to Mr. Abdullah Akyüz and Mr. Güven Sak for very informative discussions. Also I express my gratitute to the National Productivity Center for the financial support they provided for the project.

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I. INTRODUCTION

The market for common stocks constitutes an important part of the capital market. Besides being the basic source of long term equity financing for corporations, it can provide even very short term investment opportunities for individual investors. Two basic properties are to be expected from an effectively operating stock market. First, it should be developed enough so that any individual investor can purchase "large" amount of securities in a short time without affecting prices, and any firm can raise the necessary funds in a short time from the market. Secondly, the market should be efficient.

Efficiency basicly is related to the health of prices generated in the market. If the price of a security at any time instant can be used as the best estimate of its value, given the set of available relevant information, pricing or external efficiency is said to exist. Operational efficiency on the other hand is used to describe the efficiency of intermediaries in the market. Allocational efficiency is the term used to describe the market that has both pricing and operational efficiency.[1] In an allocationally efficient market, the price signals of common

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[1] The definitions are from Tınıç & West chapter 5 [25].

stocks will reflect the performance of firms and the health of investment decisions, so resource flow to new investments will be healthy.

As an attempt to promote the development of capital markets in Turkey, Istanbul Securities Exchange has been founded and has started its operations on January 1986. There has been a few studies in an attempt to test the Capital Asset Pricing Model (CAPM) in this market[2]. CAPM basicly assumes existance of arbitrage activity (i.e. buy the underpriced, sell the overpriced) between stocks so as to generate "rational" relative prices eliminating the profit opportunity. Pricing efficiency on the other hand, assumes arbitrage activity through time (i.e. buy when cheap, sell when dear type of behavior) to eliminate the systematic profit opportunity. The purpose of this study is to perform some statistical tests as insights to the degree of pricing efficiency in I.S.E. common stock market while providing some description of the price and return generating process for the three year period from January 1986 to December 1988.

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[2] For example see Unvan, Hayal (1989) and Albayrak, Cemil (1989)

Considering published past price behavior as the only relevant information, Random Walk Theory provides the basic model for the price process. It has two axioms; (1) price changes come from some common probability distribution and (2) each price change is independent from the past changes. The statistical tests of Random Walk Theory are known as Weak Form Efficiency tests in the literature[3]. The basic reasoning behind this type of price behavior can be the following. There are sufficient number of speculators to make use of any persistent dependence structures so that such structures fade and only explanation for price changes is changes in "value" due to arrival of new information. So, the only valid tests of weak form efficiency can be statistical ones to detect persistent dependence structures.

In part II of this study, the relevant literature is summarized. In part III, some descriptive analysis of 15 I.S.E. common stock data and I.S.E. index is conducted. First the distribution of price returns and deviations from normality is investigated. The weak form efficiency test of the variance-time function [27] is performed. Box-Jenkins' time series analysis [8] is also conducted including autocorrelation, partial autocorrelation analyses, model fitting and diagnostic checking

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[3] For example see Fama (1965)

for appropriate series. Observations about heteroscedasticity and its implications are stated. Trading volume series is also analyzed both as a univariate series and as an explanatory variable in a dynamic regression model to affect the price index. Results and conclusions are presented in part IV.

II. A REVIEW OF LITERATURE ✓

A.UNCONDITIONAL DISTRIBUTION OF STOCK RETURNS

The possible probability distribution of common stock returns has attracted many researchers to the field. Fama [14,p.41] gives three reasons for the importance of knowing the distribution of stock returns. These are,

- To give an idea of riskiness to the investor,
- To provide descriptive information about the process generating price changes,
- To justify the validity of using statistics like mean and variance as descriptive tools.

Traditionally, a normal distribution for stock returns has been assumed, basicly due to the ease of computations and theoretical justification from the Central Limit Theorem. "If transactions within a time interval are fairly uniformly spread over time and price changes between transactions are independent and identically distributed with finite variance, the only distribution for price change over that interval is "normal"" [14,p44]. Fama, in his 1965 paper, recognizing the fat tails in distribution of daily returns of stocks in Dow Jones Index, proposed a non-normal stable distribution. Stable Paretian, a general class of stable symmetric distribution, has infinite variance and exhibits fat tails for $\alpha<2$ where α is the characteristic exponent. If $\alpha=2$ the Stable Paretian reduces to normal and for $\alpha=1$, it becomes Cauchy distribution.

Blattbery & Gonedes in 1974 report that α is not constant over time [5]. They propose a continous mixture of normal (Gaussian) distributions where variance itself is taken as a random variable. As a specific case, if variance is distributed as inverted Gamma, the posterior distribution reduces to Students-t. They have compared symmetric Stable and Students-t distributions based on Likelihood ratio test which favor Students-t. Also sums of returns (taken by Monte Carlo methods) appear to converge to normality. This is consistent with "Student" whereas not consistent for "stable" type distributions. So, they conclude that Student model has greater descriptive validity than the symmetric stable model proposed by Fama.

A discrete mixture of Gaussian distributions was proposed by Kon in 1984 [18]. Although it seems to fit the data better, his suggestion has some undesired features. The number of distributions that enter the mixture is introduced as an additional parameter and that number vary with selection of stocks.

A generalized beta distribution of the second kind (GB2) for individual stock returns were introduced and proposed by Bookstraber and McDonald (1987) [7]. A large number of distributions can be obtained as special cases of GB2. Therefore, it can be seen as an unrestricted model and tests based on Maximum Likelihood comparisons of specific models are facilitated by the introduction of this distribution. They have tried to fit the distribution to stock return data and they report moderate success.

Regardless of the study, all authors have reported that observed distributions are leptokurtic, that is they have heavy tails and sharp peaks. Also, nonzero skewness was observed. To model skewness, lognormal distribution [10] and to model fat tails, stable Paretian family were considered. Badrinath and Chatterjee propose g, h, and (gxh) distributions [4]. g is a skewed distribution, h an alonged one and gxh, obtained by multiplying the two, has both skewness and elongation. they claim their method to be of more practical use, since calculations in the estimation process are easier. Hence they recommend the use of gxh distribution in three moment Capital Asset Price Models (CAPM) and the development of four or higher moment criteria CAPM models.

All the above studies were concerned mainly on the unconditional distributions of returns and the sequence of the series were not important. The results, however, are important since they guide selection of appropriate statistics for testing hypothesis, give an idea of the shape of observed distribution, and lead to the separation the concepts of serial independence and serial uncorrelatedness of stock returns due to the non-normality of distributions. Also the fat tails have implications for existence of autocorrelation in the time series data.

B. TIME SERIES BEHAVIOR AND SERIAL CORRELATION

The basic motivation in investigation of stock market returns as time series has arisen from the debate on Efficient Market Hypothesis. Before 1970's a random walk model was seen as a necessary condition for weak form efficiency.[4] That is the returns were required to be independent and identically distributed. So, tests of serial autocorrelation in return processes were used as indicators to degree of independence. And for some stocks, the first order serial autocorrelation was found to be significant [14]

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[4] The discussion is from Fama's 1970 paper.

In his 1970 paper [15], however, Fama recognizes that independent and identical distribution is not necessary for "fair game" efficiency. The process X(t) will be a fair game, and there will be fair game efficiency in P(t) if

$$E(X_{j,t+1} | \theta_t) = 0$$

where

$$X_{j,t+1} = P_{j,t+1} - E(P_{j,t+1} | \theta_t)$$

and θ_t: all the information about the history.

A special case would be

$$E(P_{j,t+1} | \theta_t) \geq P_{jt}$$

which is called a submartingale (Martingale, if equality holds). So, a martingale process would imply efficiency and any systematic trade rule would not overperform simple buy and hold. Similarly, a "fair game" process, which does not necessiate zero autocorrelation would imply efficiency. Considering the above points, and the low magnitudes of autocorrelation, Fama, concludes that no point against efficiency can be made out of that.

But still, some nonlinear dependence may yield existence of profitable trading rules whose existence is shown by Akgiray (1988) [1] on absolute value of R and R^2 where R denotes the daily return series.

Very recently, Conrad and Kaul [11] in line with the "fair game" efficiency model argument of Fama, fit an AR(1) process to expected returns which reduce to an ARMA(1,1) process in terms of observed returns. The data is weekly returns of 10 equal weighted portfolios of NewYork and American Stock Exchange common stocks for the period 1962 to 1985. As a result they obtained values of Φ varying from .087 to .589. They conclude that $\Phi < .6$ implies rapidly decaying time variation in expected returns. So that a shock in expected returns would dissipate after a month. Although they start with the assumption of market efficiency, using their model, an arbitrager would easily overperform simple buy and hold of course neglecting transaction costs.

Oldfield & Jarrow (1977) [19] have proposed an autoregressive jump process for common stock returns, the time intervals between jumps being distributed Gamma. In Perry's 1982 paper, the null hypothesis of stationary and "independent" increments is rejected [20].

C. VOLATILITY IN DAILY RETURNS AND CONDITIONAL HETEROSCEDASTIC MODELS

Although the serial correlation can be modelled by Box Jenkins models, it has been observed that there is second order dependence in residuals which cannot be removed by simple AR transformations.[5] This is due to the nonnormal characteristics of return distributions and of residuals. The AR transformation

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[5] Akgiray (1989)

eliminates serial correlation in residuals but, the high degrees of autocorrelation observed in absolute and squared residuals even at long lags cannot be eliminated. This is an implication of nonlinearity of the process. That is it cannot be represented as a linear combination of independent and identically distributed (white noise) processes and its second moments are not constant over time which indicates nonstationarity [6].

The Autoregressive conditional Heteroscedasticity, ARCH, model introduced by Engle [13] in 1982 and its natural extention Generalized ARCH (GARCH) model introduced by Bollerslev [6] in 1986, are good approximations to type of nonlinearity indicated above. Domowitz has succesfully applied the ARCH model in exchange markets to determine risk premium based on the conditional variance of market forecast errors [12].

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[6] For definitions of nonlinearity and nonstationarity see Priestley [23] p.106 and p.816.

A GARCH process of orders p and q denoted as GARCH(p,q), can be described as follows:

$$X_t | \Omega_{t-1} \sim F(\mu_t, \nu_t)$$

$$\mu_t = \Phi_0 + \Phi_1 X_{t-1}$$

$$\nu_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i e^2_{t-i} + \sum_{j=1}^{q} \beta_j \nu_{t-j}$$

$$e_t = X_t - \Phi_0 - \Phi_1 X_{t-1}$$

where $p>0$ and $q>0$ are the orders of the process, and the parameters satisfying conditions $\alpha_0 > 0$, $\alpha_i, \beta_i \geq 0$. Ω_{t-1} is the set of all information available at time t $(X_{t-1}, X_{t-2}, \ldots)$. When q=0, the process reduces to ARCH(p).

Akgiray [1], applied both ARCH and GARCH models to daily stock returns data obtained from CRSP tapes for the period 1963 to 1986. The results obtained were as follows: test statistics supported the use of the models. And the best fit was obtained from a GARCH(1,1) process.

The basic descriptive implication of the models is that large price changes tend to follow large ones and small changes tend to follow small ones. The models can easily be used to forecast volatility and are shown to simulate the ex post (in sample) behavior of stock returns very closely [1]. They can also be used to obtain ex ante measures of variance which can be used for both theoretical and practical purposes.

As long as the deviations from expected returns have zero mean, which is the case for GARCH models, the "fair game efficiency" as introduced by Fama (1970) holds. However, the existence of AR(1) coefficient Φ_1 will be against submartingale behavior. And simple buy and hold strategy will not necessarily be optimal.

D.LONGER TERM BEHAVIOR AND THE TEST OF VARIANCE TIME FUNCTION

Looking at the stock returns of longer durations, it is seen that there is a dramatic intertemporal variation. Shiller (1981) [24] questions the validity of EMH. He has calculated the ex-post discounted values of future real dividends to determine a rational price value at a given point in time. Such price series follow a surprisingly smooth path as compared to that of actual price series.

"One is struck by the smoothness and stability of the ex post rational price series P_t' when compared with the actual price series".[7]

Such a long term dependence even if it exists might escape from the independence tests based on autocorrelation function or number of runs in the same direction. For that reason, different specific tests for long term dependences have been developed and used. Aydogan and Booth [3] for example have used the so called

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[7] Shiller [24] ,p.421

R/S analysis to detect any long cycles in stock prices from July 1962 to December 1980. They report that long term dependence is either not prevalent or too small to be measured by R/S analysis. Their test statistics, indicate that if long dependence exists, it is positive in the sense that variability at low frequencies is higher than in the high frequencies.

Young [27] has developed a different test based on the variance-time function. The basic idea is that if the returns are strictly independent, the variance of sum of m daily returns should be m times the variance of daily returns. If the variance of the sum is smaller, a negative dependence and if greater, a positive dependence is said to exist. The basic observation of the study is that, for short intervals, for example for m=2,3 and 4, random walk hypothesis of independence cannot be rejected, while for larger values of m, significant deviations from independence mostly negative in direction take place. This dependence leading to price reversals may be the result of the accumulation of weak dependences that are not significant in a short time interval but may accumulate within a longer interval and become more significant. Young notes that this is not completely against the efficient market hypothesis since transaction costs may be the reason for the persistance of such non-random price behaviors.

No.of days	No of Stocks	% Share in Total Stocks
21	10	20
16 - 20	22	44
11 - 15	9	18
6 - 10	2	4
1 - 5	4	8
0	3	6

Table 2 Frequency of trading for First Market stocks of IMKB on January 1989

developed stock market. The trading volume should be high enough to enable any individual investor to buy or sell large amount of securities in a very short time period without much affecting prices. For that, trade volume must be large and pricing efficiency must exist. The development of monthly TL trading volume can be seen on figure 1. Although there is a decline in real trading volume in 1988, number of shares traded has increased. As it can be seen from the below table, trading volume has increased by 43.6% while number of shares increased by 115.6%. This is basicly due to the general fall in stock prices

YEAR:	1986	1987	1988
Number of shares traded (Millions):	3.2	14.7	31.7
Trading Volume (Billions of TL) :	8.7	105.4	149.0

Table 3: Developments in trading activity of ISE
(Source ISE Annual Bulletins)

after 1987 October. The index calculated and published by ISE, namely the IMKB-index, has fallen from 1140 in July 1987 down to 374 in 1988 end. The plot of IMKB-index for the 3 years is given on figure 2. As it can be seen, up to August 1987, there has been a sharp rise and after August, a decline has taken place up to 1988 end.

The index is calculated according to the formula[10]

$$I_t = \frac{1}{40} \sum_{i=1}^{40} \frac{P_{it} * Q_{it}}{P_{io} * Q_{io}} * 100 \qquad \text{where,}$$

P_{io} = Base period price of i^{th} stock

Q_{io} = Base period number of shares outstanding of i^{th} stock

P_{it} = Price of i^{th} stock at period t

Q_{it} = Number of shares outstanding of i^{th} stock

So, $I_{it} = \frac{P_{it} * Q_{it}}{P_{io} * Q_{io}}$ is an indicator of the change in total market value of a common stock relative to the base period value.

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[10] Istanbul Stock Exchange Weekly Bulletin, January 9, 1987

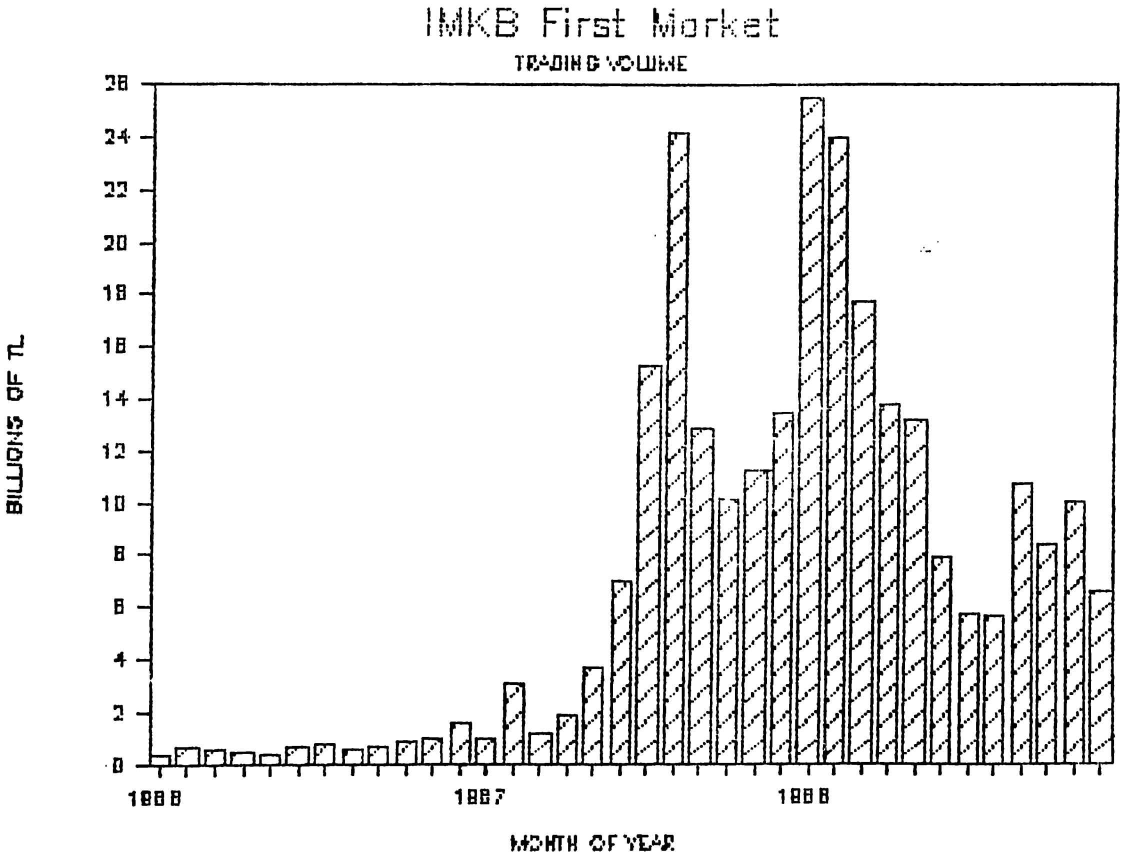

Figure 1 Monthly Trading volume (Billion TL)

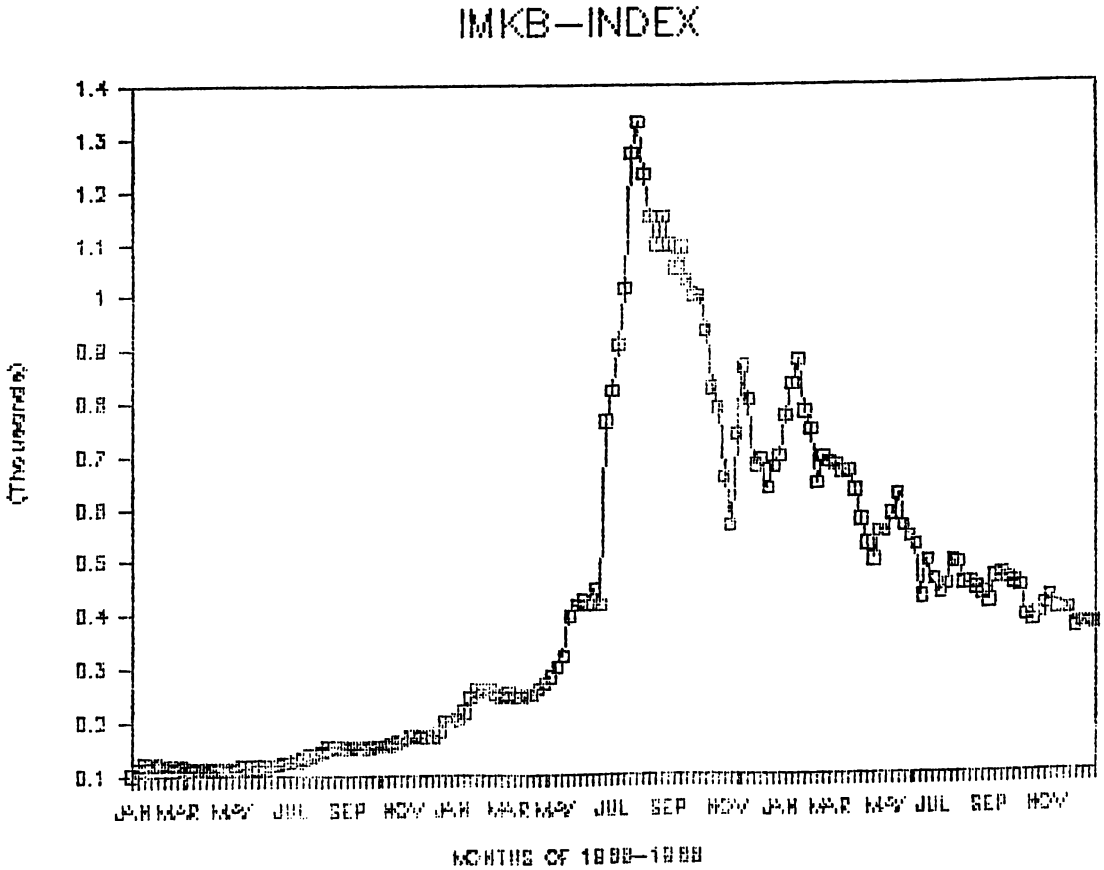

Figure 2 Plot of weekly IMKB index for the 3 year period 1986-88

This index at the same time, is a measure of value for an equally weighted portfolio of 40 stocks formed at the base period. The base period value of each stock is taken as a weighted average of January 1986 prices of that stock. Stock splits are also accounted for by this formula. In the following sections, statistical behaviour of the IMKB-index together with 15 selected stocks will be examined.

B. THE DATA

The data basicly consists of weekly Friday closing prices of 15 stocks and IMKB index. To avoid any problems due to missing observations, the selected stocks are those that have been continuously traded within the 3 year period. In addition, weekly trading volume values are compiled.

The focus of attention will be on the series $R_t = \ln(P_t / P_{t-1})$, where P_t is the price of the security at week t end. This corresponds to continuously compounded price return during period t. It is approximately equal to the arithmetic rate of return $a_t = (P_t - P_{t-1})/P_t$ for small vaues of R_t[11]. Since stock splits and right offerings are frequent and at high proportions in Turkey, the adjustment

$$R_{t+1} = \ln(k*P_{t+1} - W_t) - \ln(P_t)$$

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[11] First order Taylor series approximation.

where k is the stock split ratio, and W is the net payment per share to obtain the new shares is to be performed [14,p.46]. But it would be the same to adjust the prices for splits and payments first and then perform the log-difference transformation on the adjusted prices. So, all the ex-split prices are multiplied by the split ratio and the net payment is subtracted . The effect of dividends is not considered because dividends are distributed on quite a wide time period and it is not possible to identify the exact ex-dividend price. However, this is not likely to alter the results much since the magnitudes are small compared to market prices and its effect would be seen only on 3 out of 156 observations.

C. UNCONDITIONAL DISTRIBUTIONS OF STOCK RETURNS

The summary statistics for weekly price returns of 15 stocks and the market index are presented on Tables 4 - 9. First thing to note is that all the average weekly returns are positive and quite high. The minimum average return was of Celikhalat, by 0.789% weekly, which corresponds to a 41% annual continuously compounded rate and the maximum average return was of Cukurova Elektrik by 1.877% weekly, which corresponds to a 97.6% annual continuously compounded rate. The average for index was 0.85% weekly and 44.2% annual. The next observation is the large variance and standard deviation estimates. Minimum standard deviation is 9.9% weekly (Kocyatirim) and the maximum is 15% (Sisecam). The IMKB index has a standard deviation estimate of 8.36% weekly. So, 10% weekly price changes are not very surprising. The smallest of minimum returns is 61% fall (Cukurova Elektrik) and largest of maximum returns is 98.7% rise (Rabak) in a week. So, the price of one stock has more than doubled in one week in the investigated period. Comparing these figures with the means and variances of stock returns of United

Variable:	Akcimento	Bagfas	Celikhalat
Sample size	152	152	155
Average	9.24108E-3	0.0114294	7.89046E-3
Median	0	0	0
Mode	0	0	0
Variance	0.0167133	0.0162115	0.0100751
Standard deviation	0.12928	0.127324	0.100375
Standard error	0.010486	0.0103274	8.06228E-3
Minimum	-0.424883	-0.306374	-0.30673
Maximum	0.569095	0.531234	0.4378
Range	0.993978	0.837609	0.744531
Lower quartile	-0.0542259	-0.050488	-0.0311552
Upper quartile	0.0559752	0.0706501	0.041243
Interquartile range	0.110201	0.121138	0.0723981
Skewness	1.10163	0.709738	0.58763
Standardized skewness	5.54477	3.57227	2.98672
Kurtosis	4.6719	2.82199	4.37379
Standardized kurtosis	11.7574	7.10184	11.1152

Table 4 Summary statistics for weekly returns

Variable:	Cukurova Elk.	Erdemir	Kartonsan
Sample size	155	154	155
Average	0.0187751	0.0121998	8.96224E-3
Median	7.11747E-3	0	0
Mode	0	0	0
Variance	0.0183364	0.0132905	0.010438
Standard deviation	0.135412	0.115285	0.102167
Standard error	0.0108766	9.28989E-3	8.20623E-3
Minimum	-0.614104	-0.482426	-0.421904
Maximum	0.563132	0.706846	0.431782
Range	1.17724	1.18927	0.853686
Lower quartile	-0.0363676	-0.0250013	-0.041243
Upper quartile	0.0771896	0.0473461	0.0512933
Interquartile range	0.113557	0.0723474	0.0925363
Skewness	0.144904	1.14146	0.556878
Standardized skewness	0.736497	5.78289	2.83041
Kurtosis	4.54818	10.572	4.26139
Standardized kurtosis	11.5584	26.78	10.8296

Table 5 Summary statistics for weekly returns (cont'd)

Variable:	Kocyatirim	Kordsa	Koruma Tarim
Sample size	155	155	155
Average	0.010228	9.90431E-3	0.0109343
Median	0	5.493E-4	0
Mode	0	0	0
Variance	9.90616E-3	0.0120686	0.0125135
Standard deviation	0.0995297	0.109857	0.111864
Standard error	7.99442E-3	8.82393E-3	8.98511E-3
Minimum	-0.325422	-0.310155	-0.273041
Maximum	0.504436	0.463573	0.563791
Range	0.829858	0.773728	0.836832
Lower quartile	-0.0289846	-0.0387145	-0.0357181
Upper quartile	0.0448477	0.0519597	0.0416314
Interquartile range	0.0738323	0.0906743	0.0773495
Skewness	1.09211	0.929463	1.18379
Standardized skewness	5.55082	4.72413	6.0168
Kurtosis	5.79192	3.91841	5.2321
Standardized kurtosis	14.7192	9.95796	13.2965

Table 6 Summary Statistics of weekly returns (cont'd)

Variable:	Lassa	Otosan	Rabak
Sample size	155	154	155
Average	0.0118231	0.0135027	0.0111021
Median	0	0	0
Mode	0	0	0
Variance	0.0148439	0.0164492	0.0193646
Standard deviation	0.121836	0.128254	0.139157
Standard error	9.78608E-3	0.010335	0.0111773
Minimum	-0.373426	-0.384412	-0.603343
Maximum	0.519409	0.584933	0.987563
Range	0.892835	0.969345	1.59091
Lower quartile	-0.0426894	-0.0425594	-0.0456105
Upper quartile	0.0689929	0.0408218	0.0531098
Interquartile range	0.111682	0.0833811	0.0987204
Skewness	0.833469	1.3457	1.99667
Standardized skewness	4.23623	6.81763	10.1484
Kurtosis	3.7637	6.00076	17.5373
Standardized kurtosis	9.56478	15.2006	44.568

Table 7 Summary statistics for weekly returns (cont'd)

Variable:	Sarkuysan	Sisecam	Turkdemirdokum
Sample size	155	154	155
Average	9.72091E-3	8.0724E-3	0.0144562
Median	8.36825E-3	0	0
Mode	0	0	0
Variance	0.0141421	0.022614	0.0106824
Standard deviation	0.11892	0.15038	0.103355
Standard error	9.55192E-3	0.0121179	8.30171E-3
Minimum	-0.454736	-0.56453	-0.277632
Maximum	0.619039	0.834226	0.385056
Range	1.07378	1.39876	0.662688
Lower quartile	-0.0327898	-0.0384661	-0.0500104
Upper quartile	0.0512933	0.0425595	0.0707366
Interquartile range	0.0840831	0.0810255	0.120747
Skewness	1.09337	0.859732	0.591371
Standardized skewness	5.55722	4.3556	3.00573
Kurtosis	7.65564	7.90151	1.0597
Standardized kurtosis	19.4555	20.0154	2.69305

Table 8 Summary statistics for weekly returns (cont'd)

Variable:	IMKB-index
Sample size	155
Average	8.50902E-3
Median	2.69941E-3
Mode	-0.0465395
Variance	7.00092E-3
Standard deviation	0.0836715
Standard error	6.72066E-3
Minimum	-0.206855
Maximum	0.600904
Range	0.807759
Lower quartile	-0.0242533
Upper quartile	0.0360329
Interquartile range	0.0602862
Skewness	2.37098
Standardized skewness	12.0509
Kurtosis	16.3596
Standardized kurtosis	41.575

Table 9 Summary statistics for weekly returns (cont'd)

States stock markets, one sees that the ISE is much more volatile, hence risky but its average returns are larger as well. Akgiray [1] reports the sample average return of daily CRSP[12] value weighted series for 1963-86 as 0.0422% and the daily variance estimate for the same period as 0.602E-3 The corresponding weekly means and standard deviations are presented on table 10 together with those values of IMKB index just for a comparison.[13]

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[12] Center for Research of Security Prices. These indices contain all the stocks of NYSE and AMEX markets.

[13] The figures are not adjusted for inflation differentials

INDEX:	IMKB	CRSP
MEAN ESTIMATE :	0.85%	0.21%
STANDARD DEV. EST.:	8.36%	5.48%

Table 10 A comparison of weekly return mean and standard deviations for Turkish and American Stock Markets.[14]

The next observation from the summary statistics is that for all series with no exception, median and mode estimates are below the mean estimates. This is an implication for positive skewness of the distribution. The standardized skewness statistics[15] justify this argument. At 95% confidence level, 14 out of 15 stocks and the index are positively skewed (skewed to the right). For the single remaining stock Cukurova Elektrik, median is

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[14]For the CRSP, weekly mean estimate is five times daily mean estimate and the standard deviation estimate σ_w is calculated from $\sigma_w^2 = 5 * \sigma_d^2$ where σ_d^2 is the daily variance. This is only approximation. It holds exactly if daily returns are independent.

[15]Both standardized skewness and kurtosis estimates are distributed approximately Student's t with degrees of freedom greater than 100.

closer to mean but is still smaller. On the other hand, with no exception, all the 15 stocks and the index turned out to be leptokurtic at 95% confidence level. So they all have sharp peaks and heavy tails as compared to normal distributions. The least leptokutic stock, Turk Demirdokum has a standardized kurtosis measure of 2.69.

To test for normality, Kolmogorov-Smirnov one sample test is employed. This test statistic measures the maximum difference of the observed cummulative distribution from the best fit cummulative normal distribution. If the difference is significant, then the distribution is rejected. The results of the test are presented at appendix A. At 5% significance level, normality is rejected for 14 out of 15 weekly stock returns and at 1% significance level, normality is rejected for 8 out of 15 weekly stock returns.

The distribution of monthly rates of change in IMKB index is also investigated. The summary statistics given at appendix B indicates no skewness and kurtosis at 95% confidence level, and quite interestingly Kolmogorov-Smirnov test fails to reject normality at all significance levels up to 99%. So, although weekly returns are far from normal, monthly returns can be taken as normal quite confidently. This fact makes the suitability of symmetric stable distribution questionable. Sums of returns should also be nonnormal stable under stable laws, which does not seem to be the case here.

This last observation brings quite a relief since although normality cannot be claimed to exist, means and variances are still defined and can be used as descriptive tools in further analysis.

D. INTERTEMPORAL DEPENDENCE OF STOCK RETURNS

In a stock market in which prices move as predicted by the random walk theory, the stock return series should be independent and identically distributed. This implies that the theoretical autocorrelation function values ρ_k should be zero.[16] If the distribution of returns is normal, the sample autocorrelation estimates r_k are approximately normally distributed with mean zero and variance $1/T$ [17] where T is the number of observations. So if the absolute value of a sample autocorrelation estimate r_k exceeds $2/\sqrt{T}$, then with 96% confidence, ρ_k is different from zero and is said to be significant. This confidence band is an underestimate for deviations from normality in the form of leptokurtosis.

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[16] The autocorrelation of a stationary series x_t at lag k is defined as $\rho_k = E(x_t x_{t-k})$ and estimates are calculated as $r_k = 1/T*\sum x_t x_{t-k}$

[17] Bartlett's approximation for the case when the series is completely random [8, p.35].

The sample autocorrelation coefficient plots up to lag 40 together with 2σ confidence bands and coefficient values up to lag 32 with standard errors of estimates are presented at appendix C. The significant spikes are tabulated for the 15 stocks and the index. As it can be seen, for 4 stocks and the index, there are no significant spikes. Only for 2

Name of Series:	Significant Spike at Lag:
Akcimento	None
Bagfas	6, 25
Celikhalat	6, 18
Cukurova Elektrik	12, 25
Erdemir	5, 12
Kartonsan	6
Kocyatirim	9
Kordsa	1, 7, 12, 13, 26
Koruma Tarim	None
Lassa	1
Otosan	7, 12
Rabak	6
Sarkuysan	None
Sisecam	6, 21
Turkdemirdokum	None
IMKB-index	None

Table 11 Lags of significant sample autocorrelation values for 15 stocks and the IMKB-index

stocks first lag coefficient is significant. For 5 stocks lag 6 coefficient is significant.

Provided that the assumptions of stationarity[18] and normality are close approximations, the significant spikes are either

[18] Used here in the meaning of identical unconditional distributions.

spurious[19] or they indicate a univariate serial dependence. In the case that the dependence structure is linear, Box-Jenkins univariate ARMA models[20] [8] can be employed for forecasting purposes. Among the 11 stocks with any significant autocorrelation coefficient, 5 stocks with relatively large coefficient values are selected for ARMA model fitting. The identification, estimation, diagnostic checking and model selection phases are presented at appendix E. The summary of the results are given on table 12 below. Constant term is estimated for each model and all are insignificant at 5% level. The Q

Series	Model Tried	R^2	Q(20)	Selected?	Reason
Celikhalat	MA(6)	9.1%	14.49	NO	
	SMA(6)	10.1%	16.57	YES	Parsimony
Kordsa	AR(1),SAR(7)	9.1%	22.41	NO	
	AR(1),SAR(13)	10.2%	18.34	NO	
	AR(7)	7.8%	18.39	NO	
	AR(7),SAR(13)	12.4%	9.51	YES	High R^2, Low Q
Lassa	MA(1)	4.8%	19.41	YES	High R^2, Low Q
	AR(1)	3.6%	20.92	NO	
Otosan	SMA(7)	3.9%	20.38	YES	Parsimony
Rabak	SMA(6)	8.5%	11.82	YES	High R^2, Low Q
	SAR(6)	7.3%	13.19	NO	

TABLE 12 Diagnostic Checks of ARMA models

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[19] That means they are realized by chance and have no implication of a dependence structure in the series.

[20] The model representation for ARMA models is given at appendix D.

statistics are calculated as the sum of squares of the first 20 autocorrelation estimates of the residual series. Under the hypothesis of uncorrelated residuals, Q is distributed χ^2 with 20 degrees of freedom. All of the given Q statistics are insignificant at 10% level. So independence of residuals cannot be rejected. The R^2 values are mean adjusted and the maximum is 12.4% for the AR(7)SAR(13) model of Kordsa. It should be noted that this number is obtained at the expense of parsimony principle.

The diagnostic checks that are tabulated indicate that although not very accurate, the selected models can be used for forecasting purposes. It is interesting however, to note that the models selected for the five series are not similar to each other, while 11 of the 16 series did not require modelling at all. So, it would be wise to see the forecasting performance of the models to check for validity and usefulness. For this purpose, an in sample forecasting was conducted. For each series, the selected ARIMA model forecast errors are compared with the naive forecasts of the martingale model for the last 36 weeks of 1988.[21] The comparison is made by the ratio of root mean squared ARIMA model forecast errors to the root mean squared

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[21] The reestimation period for ARIMA model parameters is 12 weeks

naive forecast errors. This measure is presented in the last column on table 13 for the 5 stocks. As it can be seen for 3 of the stocks including Kordsa with 12.4% R^2, naive forecasts of the random walk theory turned out to be better. For the remaining 2 stocks the ratio is close to 1, which means little improvement.

Series	Model Used	U value
Celikhalat	SMA(6)	1.078
Kordsa	AR(7),SAR(13)	1.039
Lassa	MA(1)	1.010
Otosan	SMA(7)	0.989
Rabak	SMA(6)	0.954

Table 13 A comparison of forecasting performances of naive and ARIMA models

All the above arguments question the usefulness of ARIMA models in forecasting stock prices in IMKB. This may be either due to the nonlinearity of the dependence structure, or due to the nonstationarity of the series. If the nonlinearity is in the form of a second order dependence as reported by Akgiray [1], then the variance is not stationary and the autocorrelation analysis may become meaningless.

In order to have an idea about stationarity, the equality of distributions of IMKB-index returns for the three years 1986, 1987 and 1988 is tested by the nonparametric Kolmogorov Smirnov two sample test based on the differences in the cummulative density functions. At 90% confidence level, paired equality of distributions for the three years is rejected. As a more detailed analysis of the source of possible non-stationarity, equality of means and variances are compared by the Kolmogorov-Smirnov (K-S) two sample analysis. The results are summarized on table 14 for the IMKB index series and the most problematic series Kordsa. For the both the index return series and Kordsa return series, the hypothesis of equal means could not be rejected at 1% significance level. However the hypothesis of equal variances can safely be rejected for all three years with 99% confidence for the index, and it can be rejected for 1986-1987 and 1986-1988 comparisons for Kordsa series. So, one can conclude that the stock return series are not variance stationary. To see how this effects the usefulness of the autocorrelation analysis, the autocorrelation estimates for the three years are plotted seperately for both series at appendix F. The differences between years are remarkable. More interestingly all autocorrelation coefficients are within the confidence band for Kordsa as well as the index. So the huge variance in 1986 has pushed some irrelevant spikes out of the band for the 1986-1988 period.

Given the evidence on nonstationarity of the variance, existence of nonlinear dependence is suspected. To check for any second order dependence, the autocorrelation of absolute and squared returns are plotted and presented at appendix G. For all the series and the index, there is significant first lag positive autocorrelation at the absolute returns. For 14 out of 16 series, there is at least one significant positive spike up to the fifth lag. This is a strong indication of positive second order dependence. It means large price changes tend to follow large ones and small changes tend to come after small ones.

SERIES	HYPOTHESIS*	AT SIGNIFICANCE LEVEL 5%	1%
KORDSA	$\mu_{1986} = \mu_{1987}$	Not rejected	Not rejected
KORDSA	$\mu_{1987} = \mu_{1988}$	Not rejected	Not rejected
KORDSA	$\mu_{1986} = \mu_{1988}$	Not rejected	Not rejected
KORDSA	$\sigma^2_{1986} = \sigma^2_{1987}$	Rejected	Rejected
KORDSA	$\sigma^2_{1987} = \sigma^2_{1988}$	Not rejected	Not rejected
KORDSA	$\sigma^2_{1986} = \sigma^2_{1988}$	Rejected	Rejected
INDEX	$\mu_{1986} = \mu_{1987}$	Not rejected	Not rejected
INDEX	$\mu_{1987} = \mu_{1988}$	Not rejected	Not rejected
INDEX	$\mu_{1986} = \mu_{1988}$	Rejected	Not rejected
INDEX	$\sigma^2_{1986} = \sigma^2_{1987}$	Rejected	Rejected
INDEX	$\sigma^2_{1987} = \sigma^2_{1988}$	Rejected	Rejected
INDEX	$\sigma^2_{1986} = \sigma^2_{1988}$	Rejected	Rejected

* Two sided tests based on confidence interval for difference of means including zero and conf. interval for ratio of variances including unity.

Table 14 Were the means and variances equal for three years

It is shown by the above analysis that there is no short term linear dependence structure in weekly returns. The existence of a longer term dependence is checked by the test of variance-time function developed by Young. As discussed in part II-D, if there is no serial dependence, variance of sums of m consequtive returns, should be m times variance of the return series. If the ratio is larger than m, positive, otherwise negative long term dependence is said to exist. To test for the existance of such a phenomena two sample series are necessary for each stock. One is the original return series and the other is the m-sum series. The m-sum series is contructed as a T-m+1 number of overlapping sums of the return series [27,p.806]. Due to its construction, the m-sum series is correlated with the return series. By making use of this property, a test statistic for testing the hypothesis $\sigma_s^2 = m\sigma_r^2$ where r subscript denotes the one period return series and s subscript denotes the m-sum or m period return series. If the hypothesized relation holds, the transformation

(1) $u = s + mr$,

(2) $v = s - mr$;

should generate uncorrelated u and v. So, $\rho_{uv}=0$ can be used as an equivalent hypothesis [27,p.805].

The above procedure is used for the IMKB data. The m values used are { 2,3,4,5,6,12,26,52}. Disregarding significance of observations, table 15 gives the number of series for which observed variance for the m sum series are greater or less than the estimated return series variance for all the 15 stocks. For

	Interval (m)							
	2	3	4	5	6	13	26	52
Less	6	8	8	8	8	4	7	5
Greater	9	7	7	7	7	11	8	10

Table 15 Number of stocks for which observed variance of the m sum series (S^2_m) was greater or less than the estimated random walk variance (mS^2_1).

the IMKB-index, the m sum variance was greater than expected for all m values. Up to m=13, the results do not seem to be against the random walk model. At and after m=13 however, the differences seem to be in favor of a positive dependence. Still, all that figure might be a coincidence. To be able to talk more strongly, the statistic ρ_{uv} mentioned above is calculated for each series. The number of significant ρ values at 1% and 5% significance levels are presented on table 16 together with the implied direction of dependence. The first observation is that up to m=13 weeks there are only 3 stocks (1 stock only at 1%) which exhibit a long term dependence. For m=13,26 and 52, at least 6 stocks at 5% (4 stocks at 1%) exhibit significant long term dependence. The interesting point is the change in sign of dependence with the value of m. For m=52,

Level	Type	Interval (m)							
		2	3	4	5	6	13	26	52
Five per cent	Negative	0	0	0	2	2	0	3	4
	Positive	1	1	1	1	1	6	5	3
One per cent	Negative	0	0	0	0	0	0	1	4
	Positive	0	1	1	1	1	4	4	2

Table 16 Number of stocks out of 15 with significant negative or positive serial long term dependence at the 5% and 1% level as indicated by $\sigma_{\varepsilon}^2 \neq m\sigma_r^2$ for m=2,3,4,5,6,13,26,52 week holding period returns.

negative dependence is seen more while for m=13, all the significant dependences are positive. This might imply the existance of local trends which last almost for 13 weeks and then reverse in direction. Still this is not a very reliable conclusion due to heteroscedasticity. If such a single phenomena has taken place during the high volatility periods, it could cause this observation. But anyway, the statistics do tell the more likely existance of long term dependence as compared to no significant short term dependence.

E. TRADING VOLUME AND ITS EFFECTS ON RETURN SERIES

The weekly total TL trading volume series might have a systematic effect on the prices. Before questioning the existance of such an effect it would be a good starting point to investigate the univariate behavior of trading volume series. Steps of the complete Box-Jenkins methodology applied to this series is given at appendix I. The original series is not stationary. A log-difference operation is sufficient for stationarity. In this form, v_t stands for the approximate percentage change in trading volume. The significant first lag partial autocorrelation coefficient and the dying down autocorrelation function pattern suggests the use of an MA(1) model. The estimate of Θ_1 turns out to be 0.703 (t= 12.2). If it were 1, then the original series would be almost a mean plus random error model. $\Theta_1 < 1$ indicates that some change takes place on that mean value due to each disturbance[22]. Therefore the log trade volume is much better forecastable with an integrative moving average (IMA(1,1)) model as compared to a random walk model.

To see the effects of rate of changes in trade volume on rate

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[22] If $\Theta_1 = 0$, we have a random walk where each disturbance changes the mean value.

of changes in IMKB index, first the cross correlation estimates are investigated (Appendix J). Rate of change in trade volume seem to have a positive effect on rate of change in IMKB-index at a lag of one week. To see the extent at which volume changes can explain price changes, a few dynamic regression models are fit to the available data of 140 observations. The regression results are summarized on table 17. All the coefficients are significant. Model 3 which includes lags 0, 1 and 2 has an R^2 of 9.6% . But for forecasting purposes, the contemporeneus (lag 0) term is not available. So the model 2 with an R^2 of 6.2% is to be used. Model 1 is less useful than model 2.

The positive coefficient at lag zero is normally expected. Since TL volume is price times quantity, change in volume may be the result of a price change in the same direction. But the positive lag 1 and lag 2 coefficients require a further explanation.

Dependent Variable : RIND (Rate of change in IMKB-index)

Explanatory Variables: RVOL1 (First lag rate of change volume)
From 1986: 5: 2 until 1988:12:30
Observations: 139 Degrees of Freedom 138

R**2	.0408114	RBAR**2	.04081142
SSR	1.0121371	SEE	.08564068
Durbin-Watson	1.7557493		

LABEL	VAR	LAG	COEFFICIENT	STD.ERROR	T-STATISTIC
Beta1	RVOL1	1	.02210071	.00820002	2.695199

Table 17A Regression model 1

Dependent Variable :	RIND (Rate of change in IMKB-index)		
Explanatory Variables:	RVOL1 (First lag rate of change volume)		
	RVOL2 (Second " " " " ")		
From 1986: 5: 2 until 1988:12:30			
Observations:	139	Degrees of Freedom:	137
R**2	.06169437	RBAR**2	.05479506
SSR	.98971436	SEE	.08530715
Durbin-Watson	1.77459415		

LABEL	VAR	LAG	COEFFICIENT	STD.ERROR	T-STATISTIC
Beta1	RVOL1	1	.02827784	.0089186	3.170630
Beta2	RVOL2	2	.01531646	.0089202	1.717048

Table 17B Regression model 2

Dependent Variable :	RIND (Rate of change in IMKB-index)		
Explanatory Variables:	RVOL0 (Contemp. rate of change volume)		
	RVOL1 (First Lag " " " ")		
	RVOL2 (Second " " " " ")		
From 1986: 5: 2 until 1988:12:30			
Observations:	139	Degrees of Freedom	136
R**2	.0913609	RBAR**2	.07789959
SSR	.9584224	SEE	.08425808
Durbin-Watson	1.7960253		

LABEL	VAR	LAG	COEFFICIENT	STD.ERROR	T-STATISTIC
Beta0	RVOL0	0	.01946381	.00927093	2.099446
Beta1	RVOL1	1	.03852506	.01007084	3.825405
Beta2	RVOL2	2	.02132295	.00926437	2.302320

Table 17C Regression model 3

IV. RESULTS & CONCLUSIONS

The first observation of this study is the high average returns and high risk in Istanbul Stock Market as compared to United States stock markets. This is quite natural due to the uncertainities involved in the development of such a market being established the first time in a country that is closed to international financial markets. The market which has been small and thin initially, has developed remarkably in both respects in three years.

The distributions of price returns, similar to what has been observed in US stock markets, deviate from normality, due to sharp peaks and long tails (Leptokurtosis) and positive skewness. Monthly returns approach normality, and hence the variance is more likely to be finite.

The pure random walk hypothesis is to be rejected for the observed period since,

i. Identical distributions is rejected due to nonstationary variance and

ii. Independence is rejected due to the existence of a second order dependence.

However, fair game efficiency may not be rejected and due to uncorrelatedness of weekly returns, a submartingale model may still be appropriate. The second order dependence cannot directly be used to improve forecasting performance in a linear model to outperform the average returns. But it might be used to forecast variances of returns with the use of a GARCH model. This application may be a potential subject for future research.

Although weekly returns exhibit no significant serial correlation, there is statistical evidence on the existance of a long term dependence pointed out by the test of variance-time function. This dependence which is more positive for 13 week changes, becomes more negative for 52 week changes. To fit a forecasting model based on such a dependence structure may constitute a very interesting research area. Such a model, if developed, may give an idea about the existance, average duration and magnitude of trends.

Another interesting observation is the near significant positive lag one autocorrelation estimate of the IMKB-index series. This value is higher than expected from a similarly formed portfolio of the 15 stocks analysed. Recent studies[23] show that differences in frequency of trading between securities in a portfolio will tend to induce spurious first lag autocorrelations. The IMKB-index also includes stocks that are

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[23]For example, Lo and Mackinlay April 1989, *An Econometric Analysis of Nonsynchronous-Trading*, Rodley L. White Center for Financial Research - The Wharton School of University of Pennsylvania.

traded very infrequently hence that have stale prices. So a general rise in the market will be underestimated by the index for the first period, but will seem to continue in further periods due to the adjustments in the stale prices.

The weekly trade volume can be represented better by an IMA(1,1) model than a random walk or constant mean model. So an unexpected rise or fall in trading volume is partially to be reversed (70%) but part of it represents a level change(30%).

There is a positive dependence between rate of change in index returns and simultaneous and lagged values of trading volume. The variance of changes in trading volume is very much larger (112 times) than that of index returns hence one can conclude that changes in trading volume in short term is mostly due to changes in quantity of stocks traded. Therefore the positive dependence means that prices tend to rise when trading activity increases and fall when falls. This also requires a theoretical explaination. A case where the sell orders (flow supply) tend to adjust slower than the buy orders (flow demand) to arrival of new information, such a case may take place. Any rise in flow demand would increase trading volume together with prices and any fall would decrease both. Supply would adjust to the new conditions after a week of delay. The delay in price change may become more pronounced due to the stale prices of the thin market index. Still, both the operation of the market can be investigated on daily data for such operating imperfections and more detailed techniques like transfer function modelling with feedback may be applied to the data.

This study, as a first step towards the investigation of distributional and time series properties of Istanbul Stock Exchange returns can lead to the conclusion that, both of these properties are similar to the well developed stock markets of the world. The only remaining development in IMKB now, is the continuing rise in real trading volume as a result of rising interest to the market from both the side of the corporations as a source of equity financing and the side of investors as a prospective medium for savings with liquidity and high returns.

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A P P E N D I X - A

Series	K-S Statistic DN	Approx.Sign Level	Conclusion At 1%	At 5%
Akcimento	0.127991	0.01374	NR**	R*
Bagfas	0.116432	0.03245	NR	R
Celikhalat	0.130709	0.01002	NR	R
Cukurova Elektrik	0.129749	0.01083	NR	R
Eregli Demir Celik	0.147060	0.00255	R	R
Kartonsan	0.111911	0.04120	NR	R
Kocyatırım	0.138878	0.00506	R	R
Kordsa	0.131443	0.00944	R	R
Koruma Tarım	0.152431	0.00148	R	R
Lassa (Brisa)	0.112849	0.03859	NR	R
Otosan	0.168905	0.00030	R	R
Rabak	0.159247	0.00077	R	R
Sarkuysan	0.144563	0.00307	R	R
Sisecam	0.174245	0.00017	R	R
Turk Demirdokum	0.083144	0.23421	NR	NR

* Rejected
** Not Rejected

Kolmogorov-Smirnov (K-S) test results for the null hypothesis of normality is presented on the above table. The test statistic DN is the maximum absolute deviation of observed cummulative density function from best fit hypothetical cummulative probability density function which is Gaussian (ie Normal) for this case. At 5% significance level, for 14 stock return series, normality is rejected. At 1% level for 8 series normality is rected.

A P P E N D I X - B

Variable:	Four Week Rate of Return on IMKB index	
Sample size	38	
Average	0.0589661	
Median	0.039375	
Mode	0.03475	
Variance	0.0604794	
Standard deviation	0.245926	
Standard error	0.0398944	
Minimum	-0.62248	
Maximum	0.69313	
Range	1.31561	
Lower quartile	-0.10821	
Upper quartile	0.19494	
Interquartile range	0.30315	
Skewness	0.211087	
Standardized skewness	0.531224	(Not significant at 5%)
Kurtosis	1.26305	
Standardized kurtosis	1.5893	(Not significant at 5%)

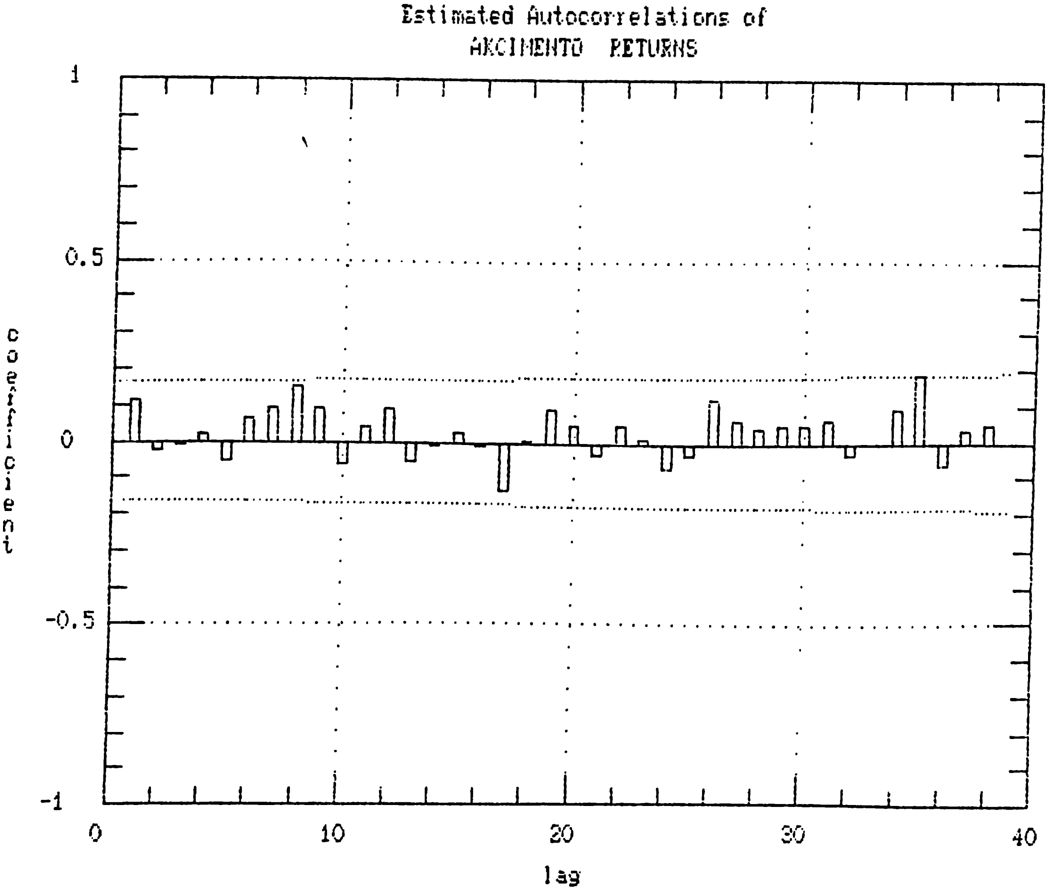
KOLMOGOROV- SMIRNOV TEST OF NORMALITY FOR
FOUR WEEK RATE OF RETURN ON iMKB INDEX

Estimated KOLMOGOROV statistic DPLUS = 0.104855
Estimated KOLMOGOROV statistic DMINUS = 0.0825177
Estimated overall statistic DN = 0.104855
Approximate significance level = 0.999971

So, at 99% confidence, the distribution is normal.

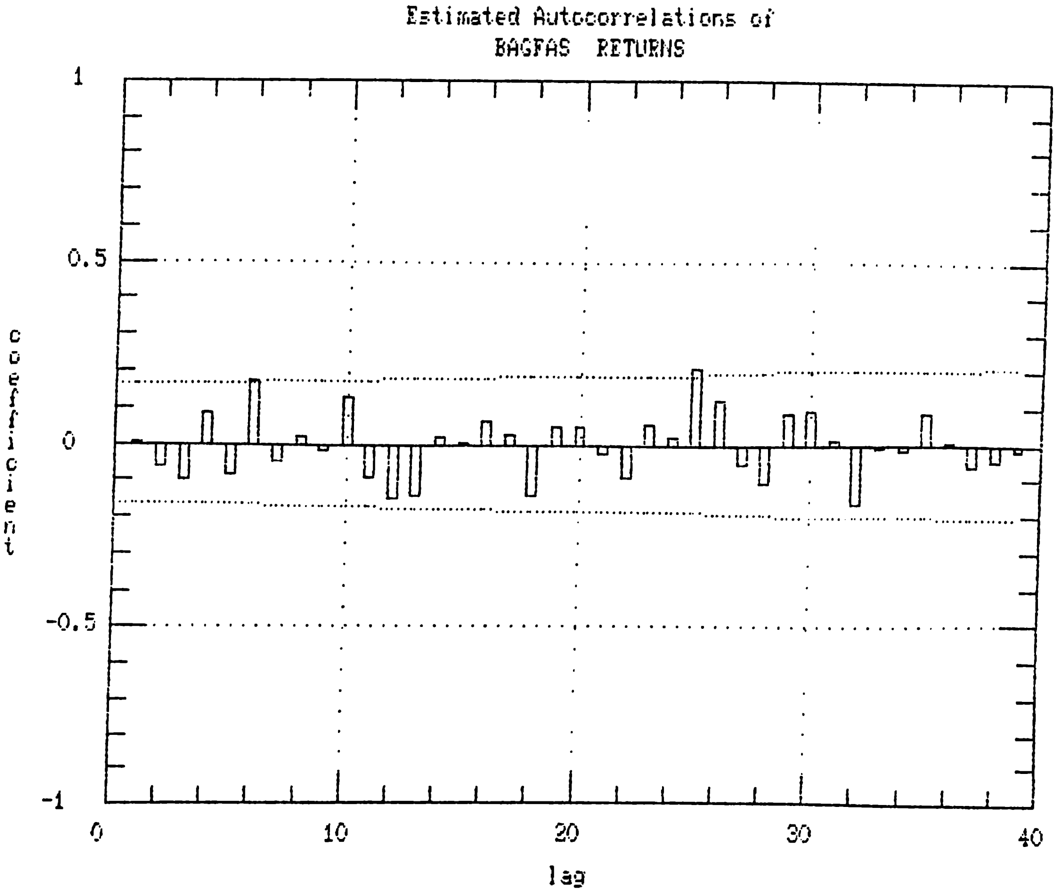
A P P E N D I X - C

Estimated Autocorrelation Functions for
Weekly Returns of 15 Common Stocks
Traded at ISE for the period
January 1986 - December 1988



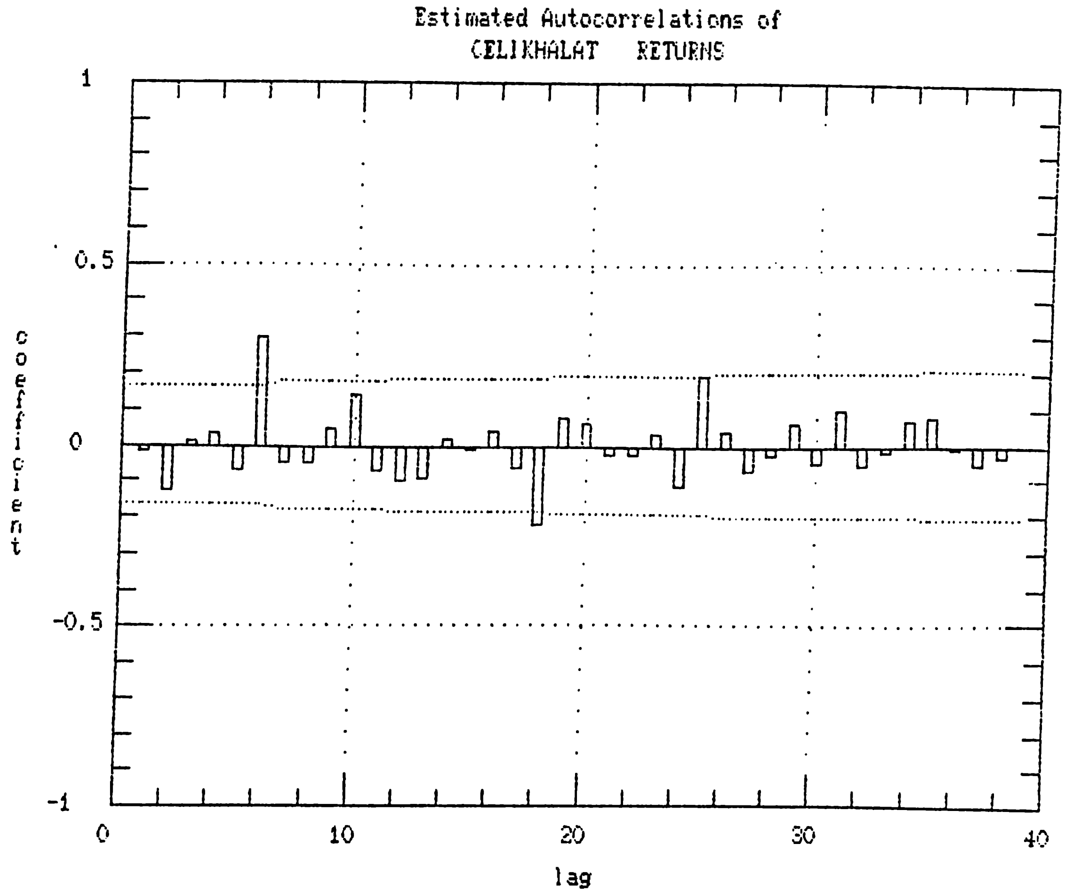
Estimated autocorrelations for D:AKCIM.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.11042	.08032	2	-.02563	.08130
3	-.01112	.08135	4	.01854	.08136
5	-.05706	.08138	6	.06305	.08164
7	.08814	.08196	8	.15084	.08257
9	.08995	.08432	10	-.06354	.08494
11	.03774	.08525	12	.09156	.08535
13	-.05723	.08599	14	-.00983	.08623
15	.02450	.08624	16	-.01074	.08628
17	-.13727	.08629	18	.00249	.08769
19	.08949	.08769	20	.05085	.08828
21	-.03342	.08847	22	.04780	.08855
23	.01086	.08871	24	-.06867	.08872
25	-.03000	.08906	26	.11892	.08913
27	.05834	.09015	28	.04248	.09039
29	.04663	.09052	30	.05066	.09067
31	.06101	.09086	32	-.03189	.09112



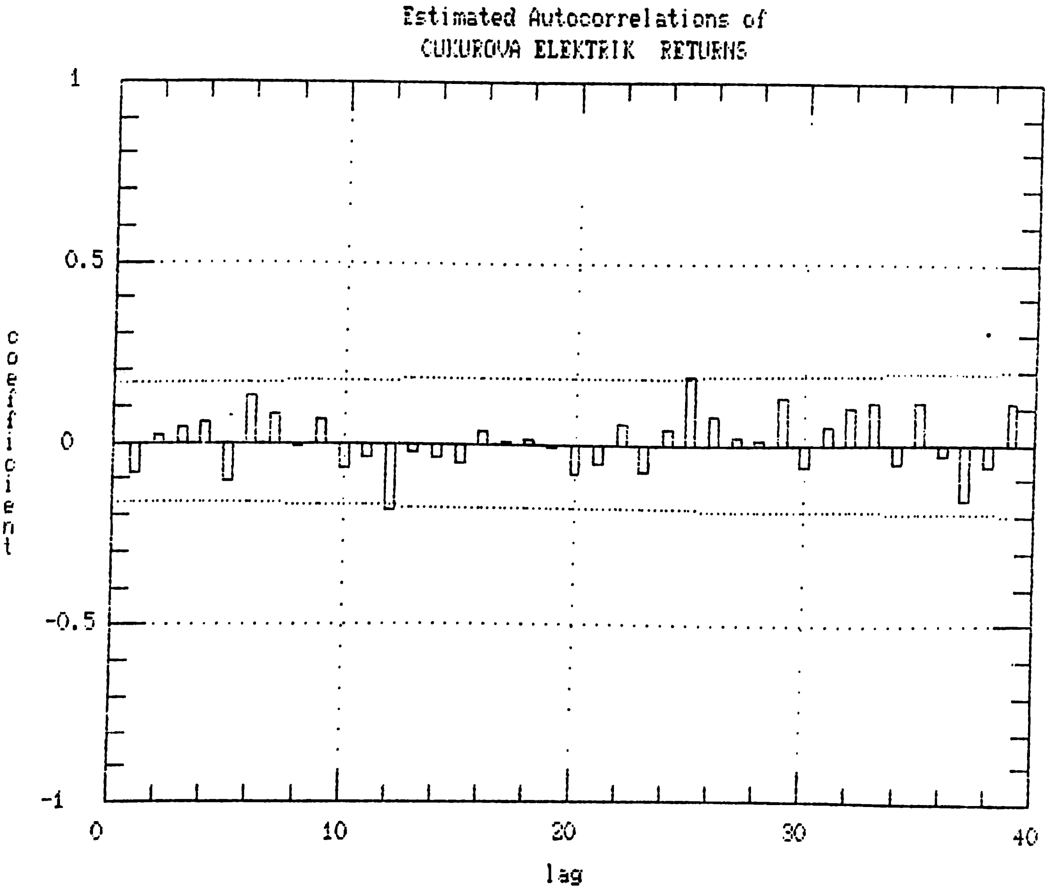
Estimated autocorrelations for D:BAGFAS.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.00643	.08111	2	-.05911	.08111
3	-.09868	.08140	4	.08011	.08218
5	-.08090	.08269	6	.16820	.08321
7	-.04808	.08542	8	.01821	.08560
9	-.01751	.08562	10	.12434	.08565
11	-.09055	.08683	12	-.15189	.08744
13	-.14433	.08916	14	.01985	.09069
15	.00232	.09072	16	.06106	.09072
17	.02590	.09099	18	-.13949	.09103
19	.04636	.09243	20	.04779	.09258
21	-.02750	.09275	22	-.08946	.09280
23	.05517	.09336	24	.01717	.09358
25	.20545	.09360	26	.11794	.09652
27	-.05545	.09746	28	-.10704	.09767
29	.08180	.09844	30	.08993	.09869
31	.01059	.09942	32	-.16393	.09943



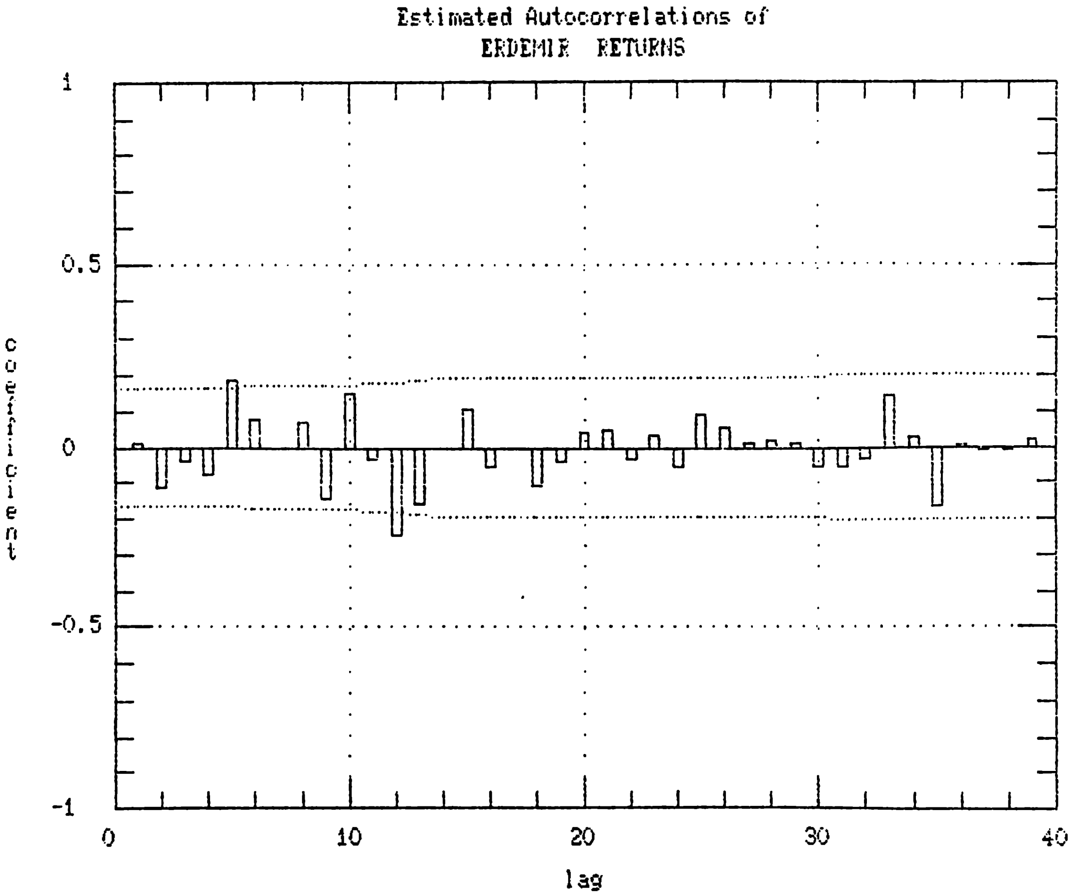
Estimated autocorrelations for D:CELIK.rate

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	-.01831	.08032	2	-.12741	.08035
3	.01074	.08164	4	.03414	.08165
5	-.06983	.08174	6	.29651	.08213
7	-.04815	.08877	8	-.04638	.08893
9	.04445	.08909	10	.14462	.08923
11	-.06657	.09073	12	-.09943	.09105
13	-.09032	.09174	14	.02033	.09232
15	-.01139	.09235	16	.04283	.09235
17	-.06029	.09248	18	-.21895	.09274
19	.07999	.09601	20	.06270	.09644
21	-.02698	.09670	22	-.02328	.09675
23	.03038	.09679	24	-.11176	.09685
25	.19071	.09768	26	.03900	.10005
27	-.06537	.10015	28	-.02701	.10043
29	.05936	.10047	30	-.04429	.10070
31	.09882	.10082	32	-.05498	.10145



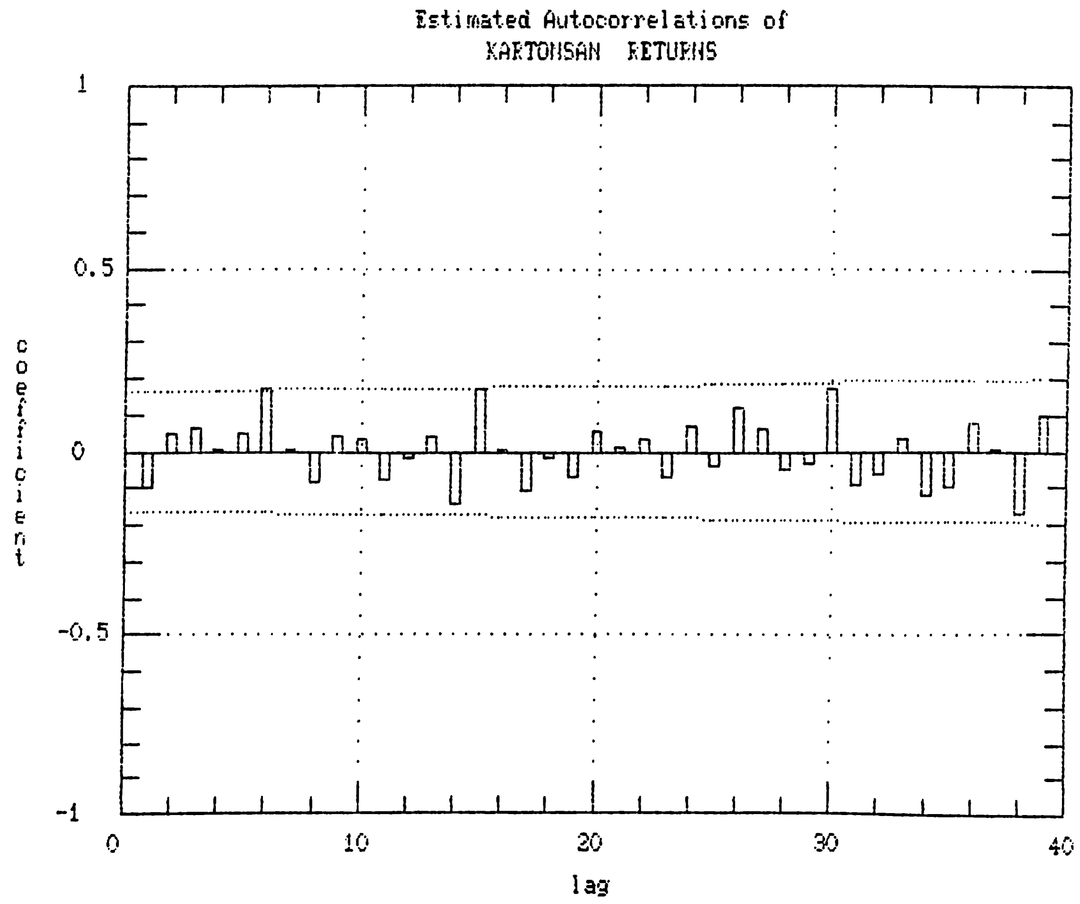
Estimated autocorrelations for D:CUKUR.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	-.08192	.08032	2	.02175	.08086
3	.04326	.08090	4	.05618	.08105
5	-.10470	.08130	6	.12467	.08216
7	.07916	.08337	8	-.01056	.08386
9	.06149	.08387	10	-.06863	.08416
11	-.04222	.08452	12	-.18681	.08465
13	-.02510	.08727	14	-.03896	.08732
15	-.05127	.08743	16	.03612	.08762
17	.00477	.08772	18	.00885	.08772
19	-.00749	.08773	20	-.08091	.08773
21	-.05728	.08821	22	.05449	.08845
23	-.07405	.08867	24	.04229	.08907
25	.18733	.08920	26	.07990	.09170
27	.01835	.09215	28	.00761	.09217
29	.12828	.09217	30	-.05909	.09332
31	.04449	.09356	32	.10054	.09370



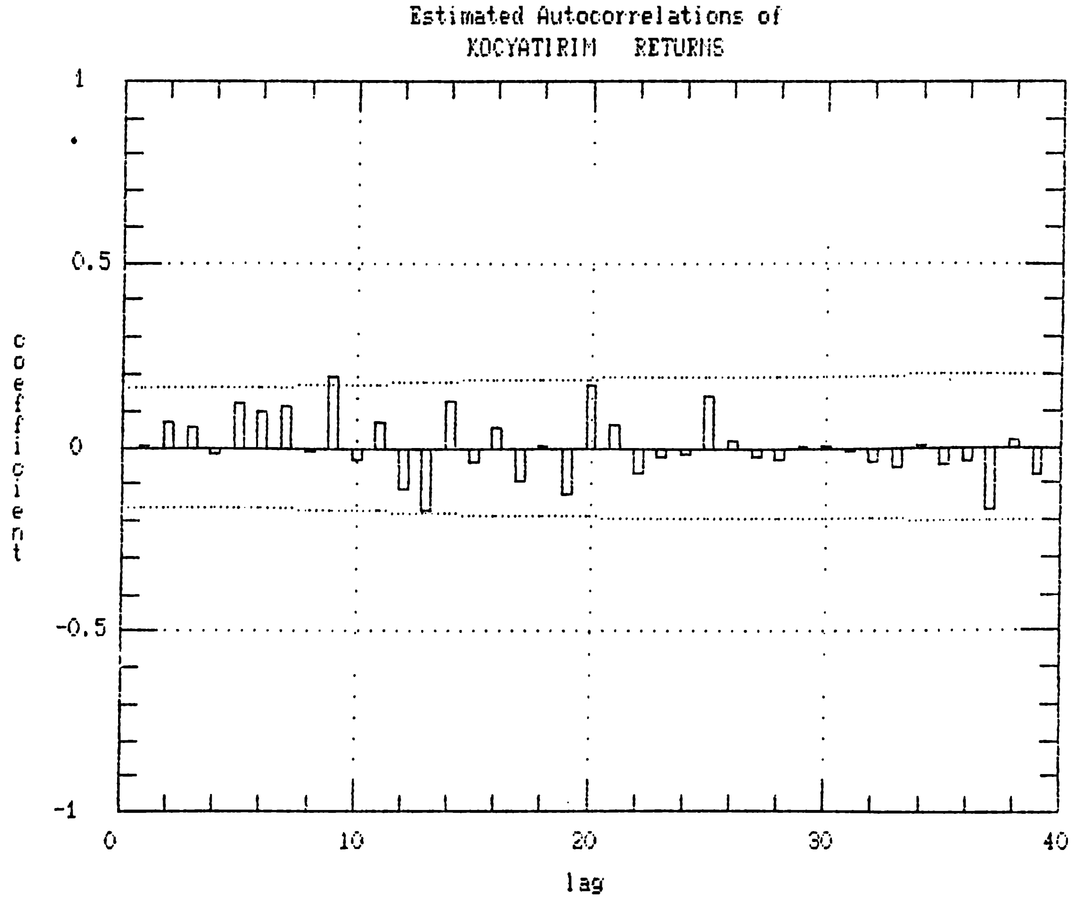
Estimated autocorrelations for D:DEMIR.rate

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.01284	.08058	2	-.11157	.08060
3	-.03678	.08159	4	-.07442	.08170
5	.18191	.08214	6	.07888	.08471
7	-.00198	.08519	8	.06749	.08519
9	-.14291	.08554	10	.14918	.08707
11	-.03521	.08872	12	-.24639	.08881
13	-.15329	.09314	14	-.00196	.09477
15	.10705	.09477	16	-.05226	.09555
17	-.00105	.09573	18	-.10204	.09573
19	-.03903	.09644	20	.04334	.09654
21	.04673	.09667	22	-.03185	.09681
23	.03158	.09688	24	-.05684	.09695
25	.09361	.09716	26	.05407	.09775
27	.01423	.09794	28	.01765	.09795
29	.01186	.09798	30	-.05705	.09798
31	-.05440	.09820	32	-.03555	.09840



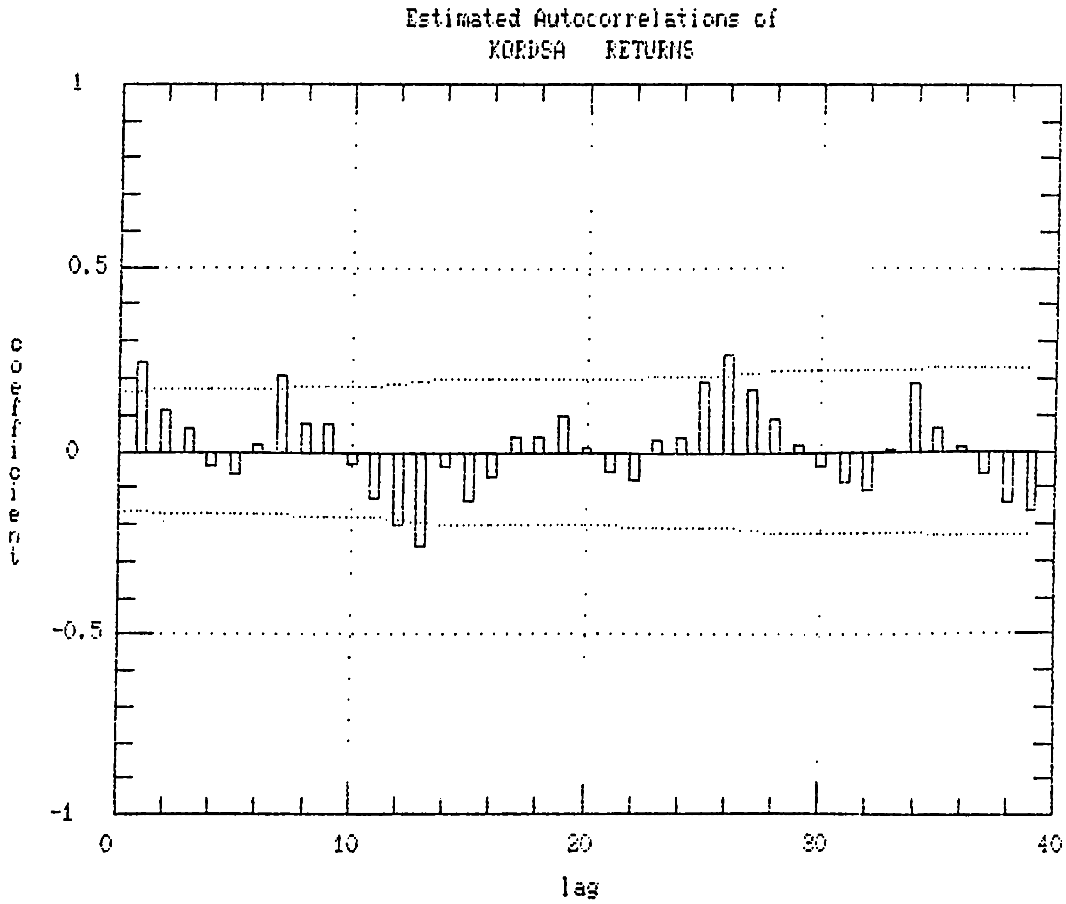
Estimated autocorrelations for D:KARTON.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	-.09854	.08032	2	.04712	.08110
3	.05909	.08127	4	.00681	.08155
5	.05023	.08155	6	.16957	.08175
7	.00468	.08399	8	-.08298	.08399
9	.03976	.08452	10	.02970	.08464
11	-.07428	.08471	12	-.02040	.08513
13	.03904	.08516	14	-.13877	.08528
15	.17141	.08672	16	.00247	.08888
17	-.10764	.08888	18	-.01707	.08972
19	-.07080	.08974	20	.05254	.09010
21	.00988	.09029	22	.03352	.09030
23	-.06536	.09038	24	.07217	.09069
25	-.04182	.09106	26	.11650	.09118
27	.06426	.09214	28	-.04682	.09242
29	-.02917	.09258	30	.16786	.09264
31	-.08942	.09458	32	-.06520	.09512



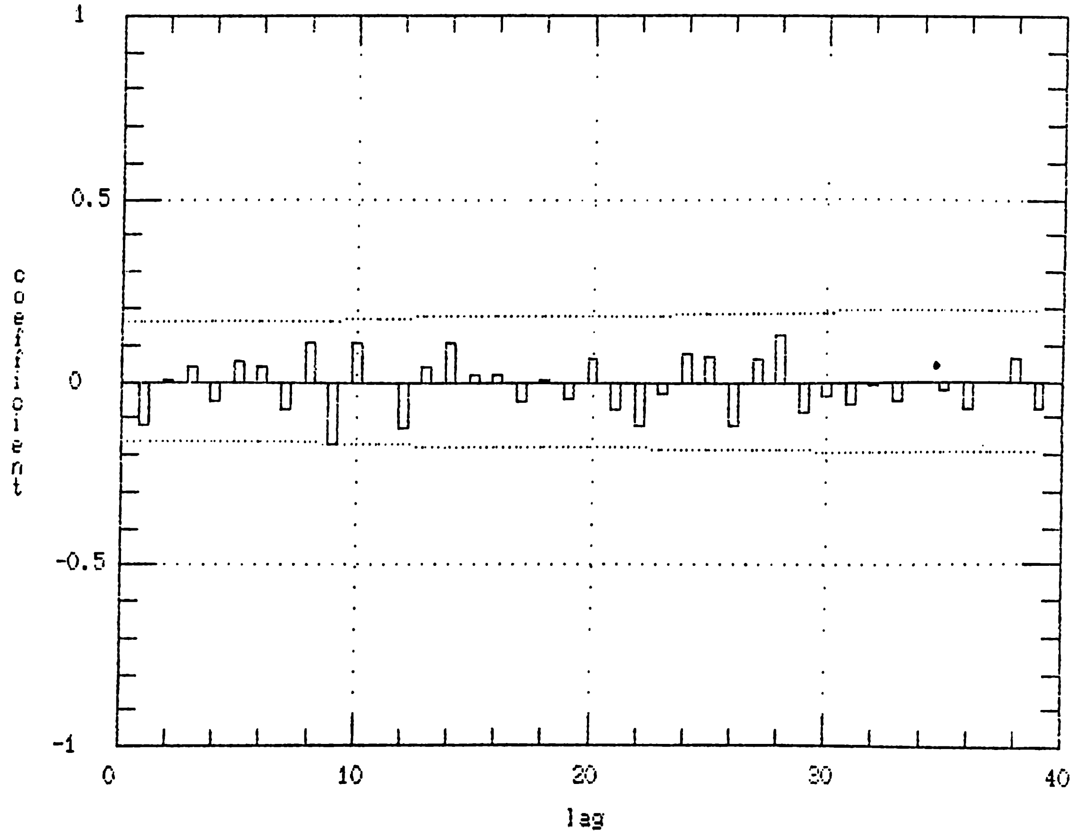
Estimated autocorrelations for D:AKOCYAT.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.00622	.08058	2	.07075	.08059
3	.05258	.08099	4	-.01584	.08121
5	.11944	.08123	6	.09745	.08236
7	.10924	.08311	8	-.00965	.08403
9	.19391	.08404	10	-.03209	.08690
11	.06869	.08698	12	-.11553	.08733
13	-.17014	.08831	14	.12792	.09042
15	-.04033	.09158	16	.05779	.09170
17	-.09152	.09194	18	.00305	.09253
19	-.12803	.09253	20	.17164	.09367
21	.06262	.09569	22	-.07251	.09596
23	-.02524	.09631	24	-.01582	.09635
25	.14080	.09637	26	.01520	.09770
27	-.02576	.09771	28	-.03358	.09776
29	.00020	.09783	30	.00647	.09783
31	-.00741	.09783	32	-.04343	.09784



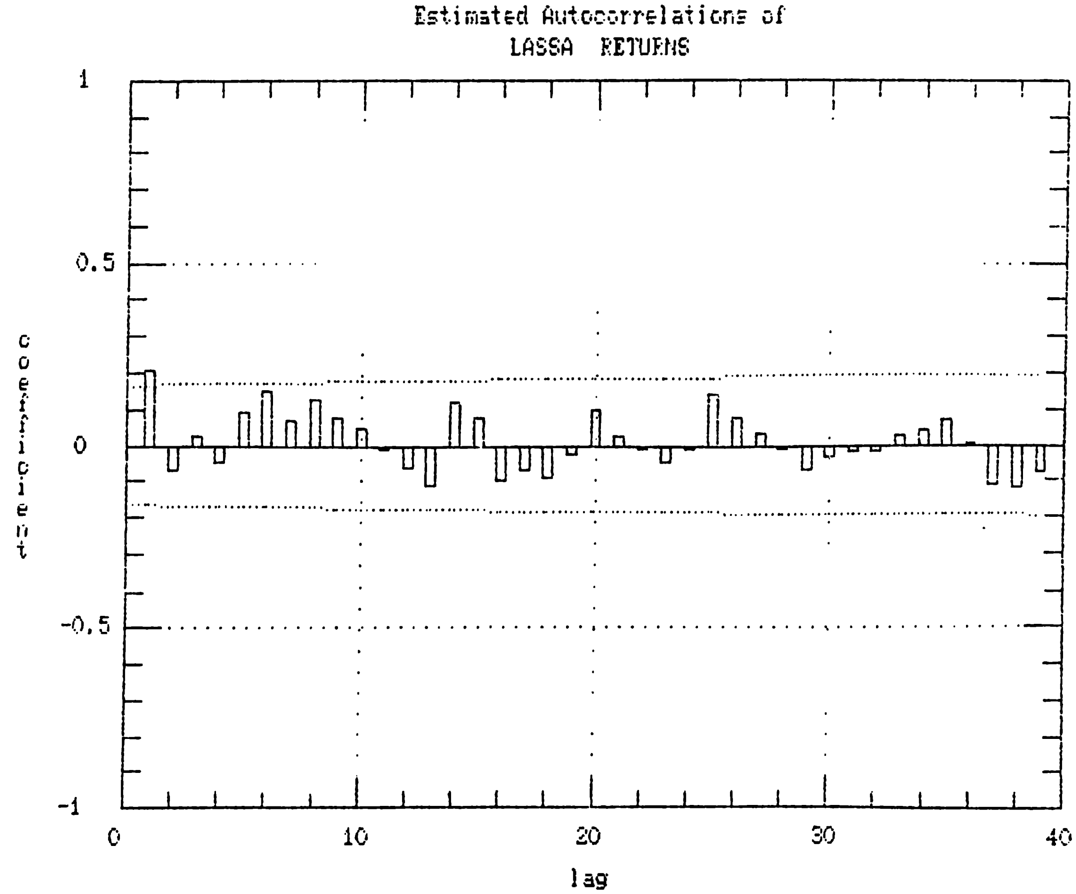
Estimated autocorrelations for D:KORDSA.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.24705	.08032	2	.11212	.08508
3	.06320	.08603	4	-.03974	.08633
5	-.06326	.08645	6	.01748	.08675
7	.20647	.08677	8	.07473	.08988
9	.07797	.09028	10	-.02915	.09072
11	-.12546	.09078	12	-.19629	.09189
13	-.26081	.09455	14	-.04341	.09909
15	-.13596	.09921	16	-.06659	.10041
17	.04237	.10069	18	.03886	.10080
19	.09864	.10090	20	.00996	.10152
21	-.05452	.10153	22	-.07711	.10172
23	.03579	.10209	24	.04328	.10217
25	.19328	.10229	26	.26306	.10462
27	.17286	.10881	28	.08909	.11056
29	.01594	.11103	30	-.04143	.11104
31	-.08034	.11114	32	-.10348	.11151



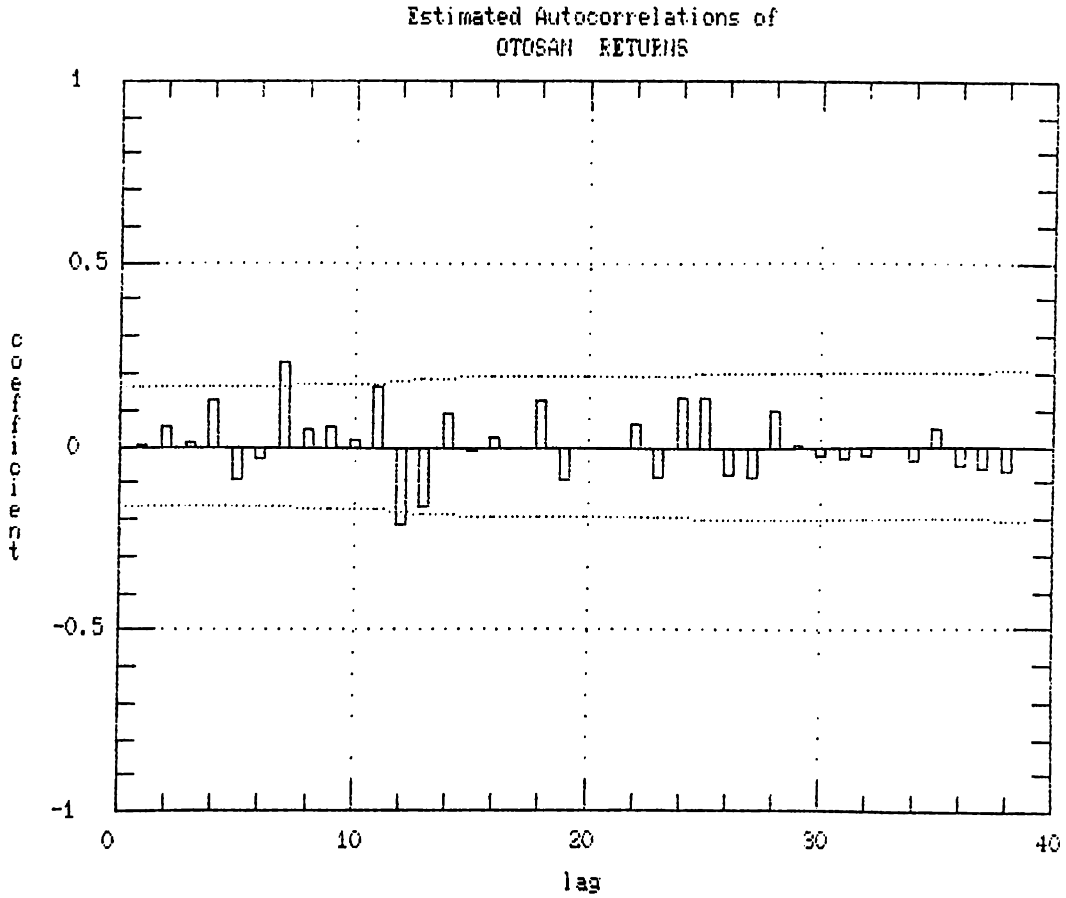
Estimated autocorrelations for D:KORUMA.rate

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	-.11891	.08032	2	.00290	.08145
3	.03861	.08145	4	-.05628	.08157
5	.05411	.08182	6	.03868	.08205
7	-.07545	.08217	8	.10770	.08261
9	-.16961	.08351	10	.10337	.08571
11	-.00146	.08651	12	-.12578	.08651
13	.04074	.08768	14	.10881	.08780
15	.01937	.08867	16	.01552	.08869
17	-.05572	.08871	18	.00706	.08894
19	-.05009	.08894	20	.06419	.08912
21	-.07622	.08942	22	-.12063	.08984
23	-.03624	.09088	24	.07886	.09097
25	.06610	.09141	26	-.11698	.09172
27	.05868	.09268	28	.12421	.09292
29	-.08284	.09398	30	-.04113	.09445
31	-.06527	.09457	32	-.01426	.09486



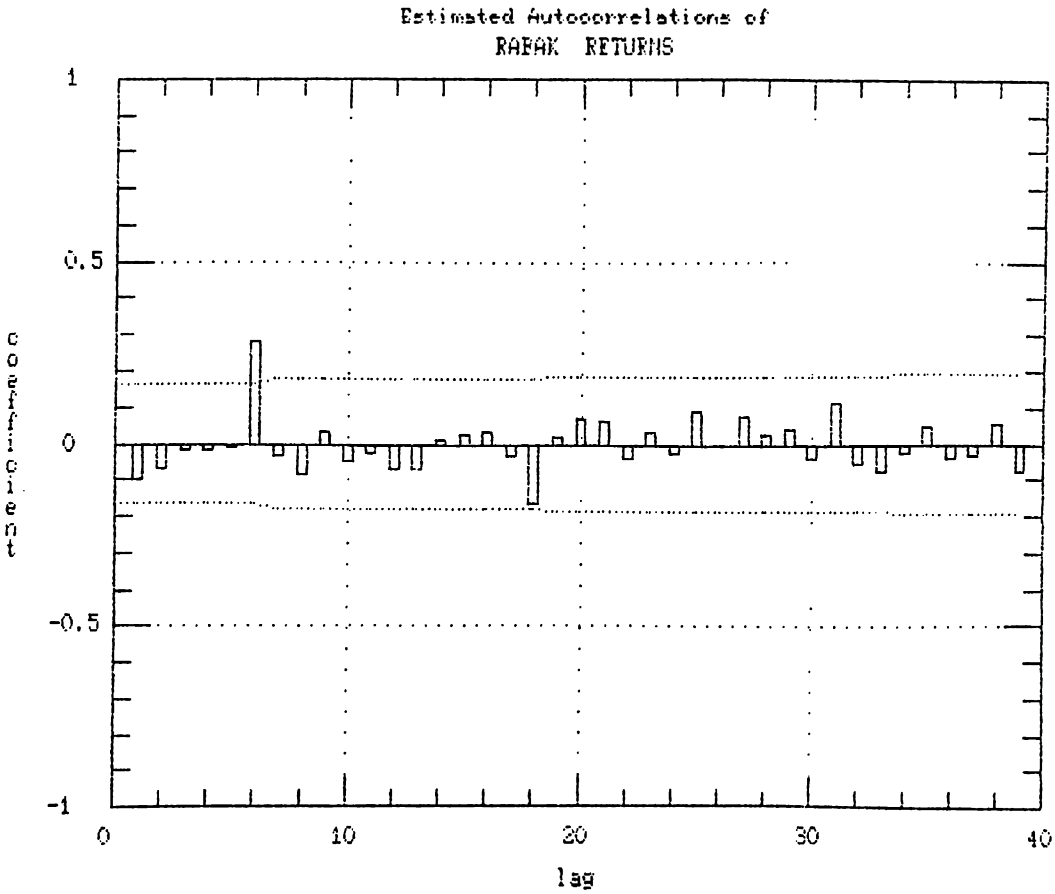
Estimated autocorrelations for D:LASSA.rate

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.20640	.08032	2	-.07209	.08367
3	.02326	.08407	4	-.04591	.08412
5	.09109	.08428	6	.14543	.08491
7	.06631	.08650	8	.12448	.08683
9	.07331	.08797	10	.04841	.08837
11	-.00805	.08854	12	-.05848	.08854
13	-.10988	.08879	14	.11763	.08966
15	.07640	.09065	16	-.09684	.09107
17	-.06976	.09173	18	-.08924	.09207
19	-.02513	.09263	20	.09542	.09267
21	.02666	.09330	22	-.01044	.09335
23	-.04928	.09336	24	-.01154	.09353
25	.14328	.09354	26	.07707	.09494
27	.03200	.09535	28	-.01154	.09541
29	-.07242	.09542	30	-.02987	.09578
31	-.01454	.09584	32	-.02038	.09585



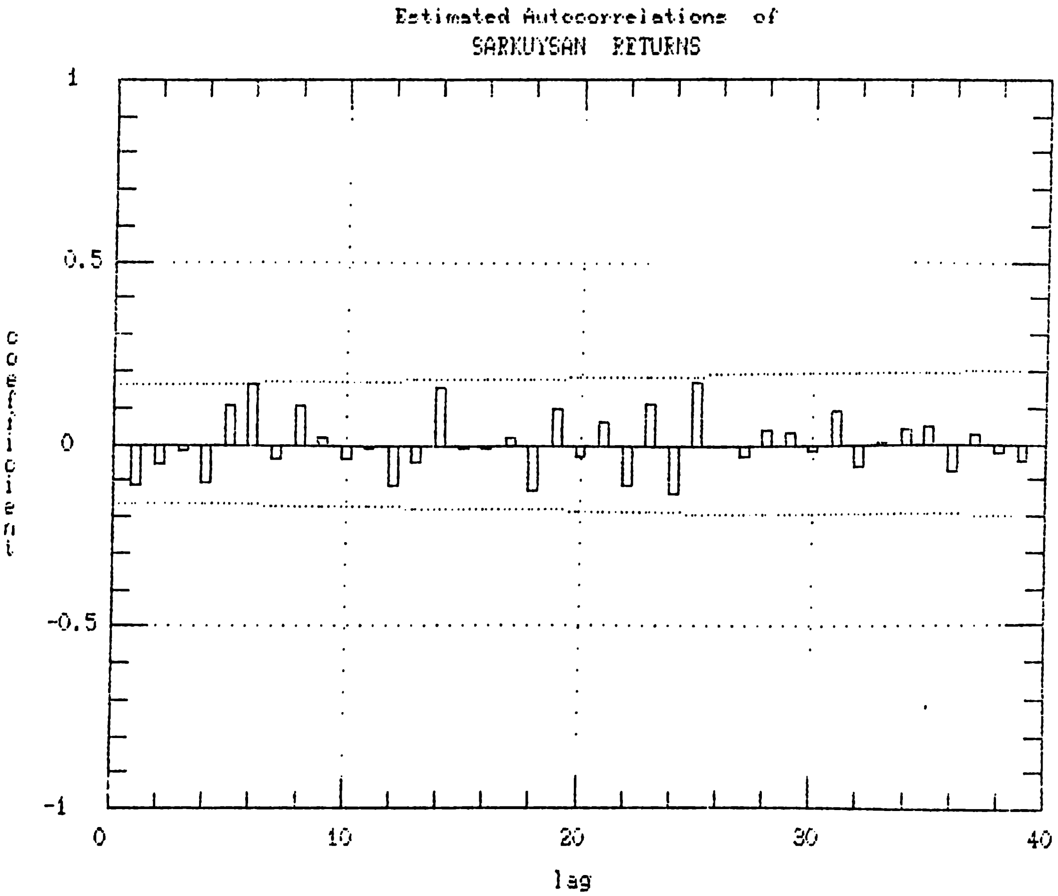
Estimated autocorrelations for D:OTOSAN.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.00453	.08058	2	.05178	.08058
3	.01121	.08080	4	.12490	.08081
5	-.08801	.08205	6	-.02926	.08266
7	.22848	.08273	8	.04805	.08673
9	.05352	.08691	10	.01978	.08712
11	.16239	.08715	12	-.21591	.08909
13	-.16376	.09243	14	.09307	.09429
15	-.01216	.09489	16	.02251	.09490
17	-.00285	.09493	18	.12563	.09493
19	-.09098	.09601	20	-.00390	.09656
21	-.00276	.09656	22	.06507	.09657
23	-.08196	.09665	24	.13257	.09730
25	.13512	.09846	26	-.07767	.09966
27	-.08087	.10005	28	.09537	.10048
29	.00231	.10106	30	-.02583	.10106
31	-.03312	.10111	32	-.02892	.10118



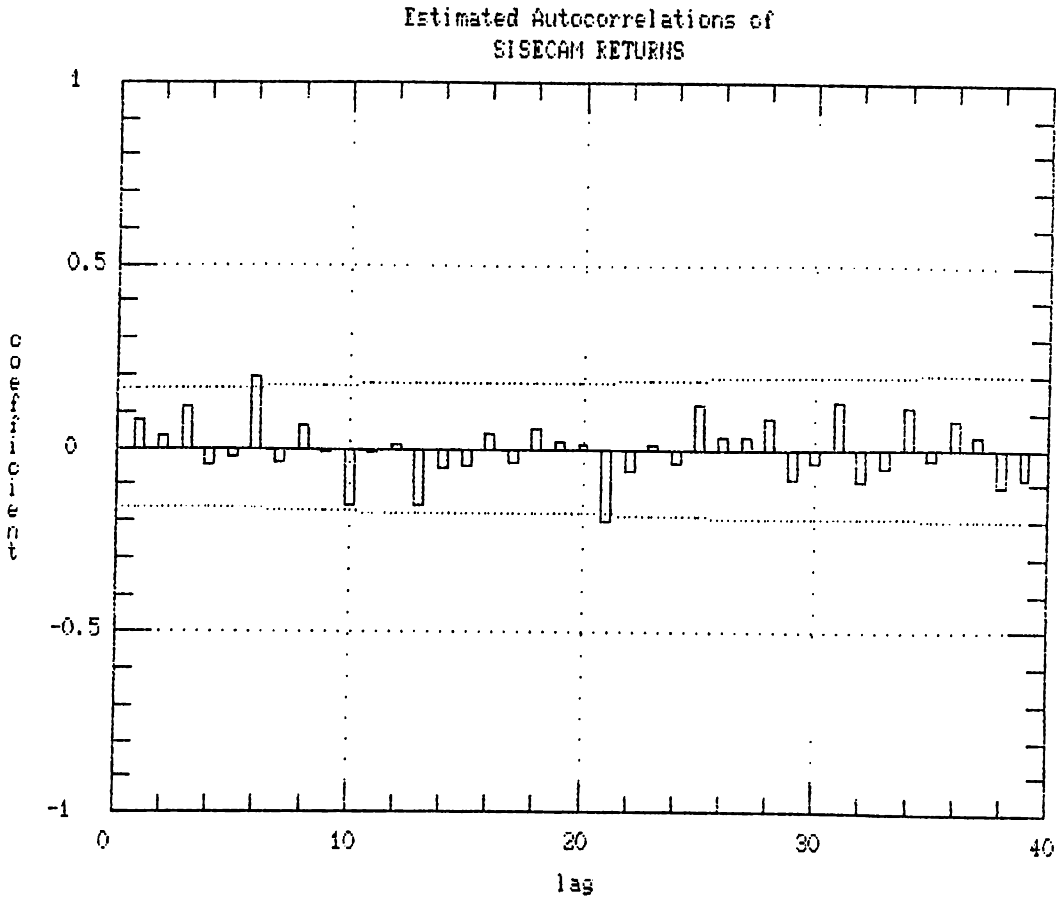
Estimated autocorrelations for D:RABAK.rate

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	-.09624	.08032	2	-.07129	.08106
3	-.01697	.08147	4	-.01645	.08149
5	-.01210	.08151	6	.27964	.08152
7	-.03179	.08749	8	-.08131	.08757
9	.02983	.08805	10	-.04679	.08812
11	-.02463	.08828	12	-.06816	.08832
13	-.06721	.08866	14	.01448	.08899
15	.02192	.08900	16	.02928	.08904
17	-.03463	.08910	18	-.16238	.08919
19	.02059	.09107	20	.06951	.09110
21	.06114	.09145	22	-.04200	.09171
23	.03614	.09183	24	-.02717	.09193
25	.09119	.09198	26	-.00463	.09256
27	.07681	.09256	28	.02635	.09297
29	.03972	.09302	30	-.04102	.09313
31	.10951	.09324	32	-.05263	.09407



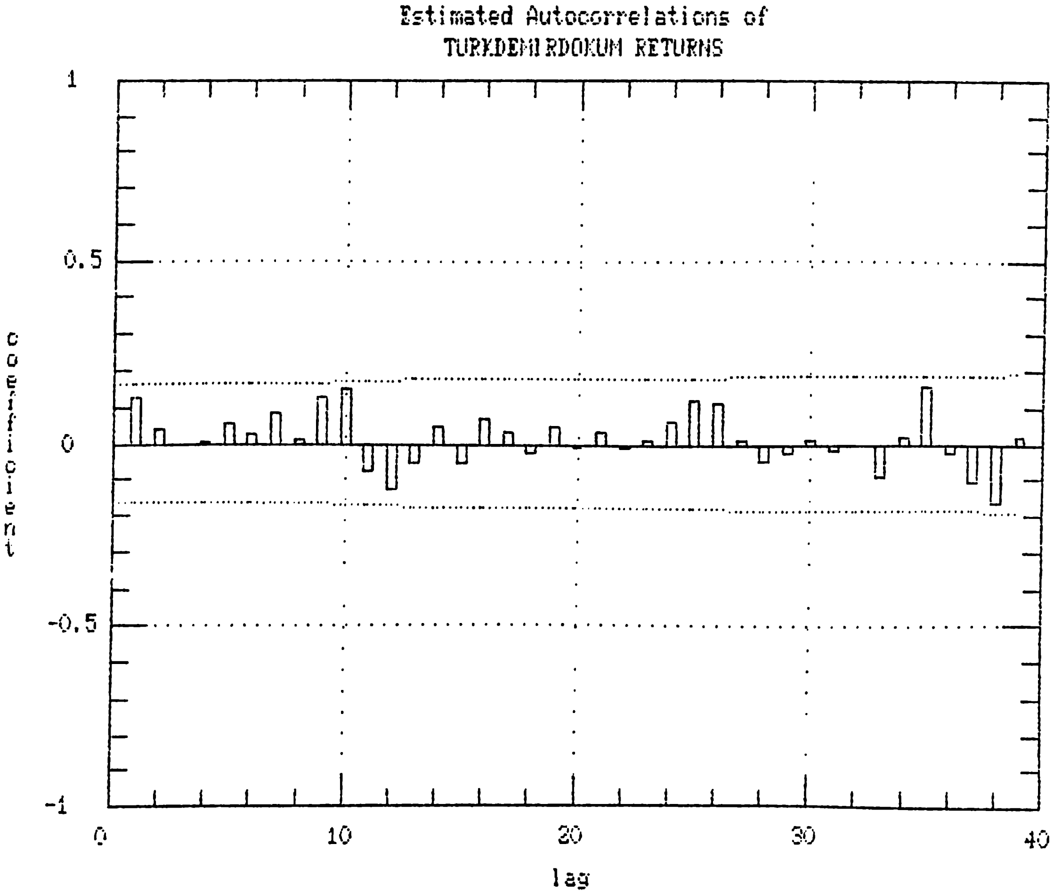
Estimated autocorrelations for D:SARKUY.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	-.11488	.08032	2	-.05482	.08138
3	-.01812	.08161	4	-.10536	.08164
5	.10402	.08251	6	.16035	.08335
7	-.03760	.08532	8	.10504	.08543
9	.01759	.08626	10	-.03990	.08628
11	-.00980	.08640	12	-.11345	.08641
13	-.04919	.08736	14	.15624	.08754
15	-.01105	.08932	16	-.01310	.08933
17	.02036	.08934	18	-.12945	.08937
19	.09797	.09057	20	-.02926	.09125
21	.06030	.09132	22	-.10969	.09157
23	.11067	.09242	24	-.13419	.09327
25	.17150	.09450	26	-.00196	.09649
27	-.03434	.09649	28	.03900	.09657
29	.03274	.09667	30	-.01482	.09674
31	.09204	.09676	32	-.06163	.09732



Estimated autocorrelations for D:SISECAM.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.07888	.08058	2	.03474	.08108
3	.11239	.08118	4	-.04560	.08218
5	-.02743	.08235	6	.19258	.08241
7	-.03847	.08528	8	.05971	.08539
9	-.01370	.08566	10	-.15877	.08568
11	-.01344	.08757	12	.00813	.08758
13	-.15714	.08758	14	-.05349	.08940
15	-.04885	.08960	16	.04045	.08978
17	-.04061	.08989	18	.05422	.09001
19	.02115	.09023	20	.01317	.09026
21	-.20138	.09027	22	-.06426	.09314
23	.01461	.09343	24	-.04215	.09344
25	.12000	.09357	26	.02942	.09456
27	.03273	.09462	28	.08318	.09469
29	-.08089	.09517	30	-.03807	.09561
31	.12365	.09571	32	-.08955	.09674



Estimated autocorrelations for D:TDEMIRDO.rate

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.13082	.08032	2	.04051	.08169
3	-.00266	.08181	4	.00073	.08182
5	.05630	.08182	6	.02520	.08206
7	.08418	.08211	8	.00910	.08267
9	.13077	.08268	10	.14690	.08400
11	-.07885	.08564	12	-.12754	.08611
13	-.05556	.08732	14	.05088	.08755
15	-.05312	.08774	16	.06973	.08794
17	.03203	.08830	18	-.02279	.08838
19	.04752	.08841	20	-.01105	.08858
21	.03628	.08859	22	-.00764	.08868
23	.00893	.08869	24	.06153	.08869
25	.11905	.08897	26	.11583	.08999
27	.00955	.09095	28	-.04591	.09095
29	-.02757	.09110	30	.01173	.09116
31	-.01907	.09117	32	-.00025	.09119

APPENDIX - D

Box-Jenkins ARIMA Models

If a process z can adequately be represented in the form

$$z_t = \phi_1 z_{t-1} + \dots + \phi_p z_{t-p} + a_t - \theta_1 a_{t-1} \dots - \theta_q a_{t-q}$$

where a is independent identically distributed white noise, then this representation is called an autoregressive moving average model of orders p and q (ARMA(p,q)). If p=0 then the process is called a moving average process of order q (MA(q)) and if q=0 the process is called an autoregressive process of order p (AR(p)). If both p and q are zero, then the process is white noise.

If a process x can adequately be represented as

$$x_t = x_{t-1} + z_t$$

where z is an ARMA(p,q) process then x is called an autoregressive integrative moving average process of orders p, 1 and q (ARIMA(p,1,q)). If p=0, an IMA(1,p) and if q=0, an ARI(p,1) process results. If this "integration" is performed k times, then the resulting series is ARIMA(p,k,q).

Seasonal Models

Defining the backshift operator B such that $B^k z_t = z_{t-k}$, an ARMA representation can also be written as

$$(1-\phi_1 B - \dots -\phi_p B^p) z_t = (1-\theta_1 B - \dots -\theta_q B^q) a_t$$

or

$$\phi(B) z_t = \theta(B) a_t$$

Now, a multiplicative seasonal model has the below form

$$(1-\Phi_1 B^s - \Phi_2 B^{2s} - \dots -\Phi_P B^{Ps}) \phi(B) z_t = (1 - \Theta_1 B^s - \Theta_2 B^{2s} - \dots -\Theta_Q B^{Qs}) \theta(B) a_t$$

It is a multiplicative seasonal ARIMA model of orders $(p,0,q)*(P,0,Q)_S$. Here, s is the length of seasonality. The seasonal model names used in the text have the below corresponding representations:

Name	Corresponding Model for Returns
SMA(6)	$(0,0,0)*(0,0,1)_6$
SAR(6)	$(0,0,0)*(1,0,0)_6$
SMA(7)	$(0,0,0)*(0,0,1)_7$
AR(1)SAR(7)	$(1,0,0)*(1,0,0)_7$
AR(7)SAR(13)	$(7,0,0)*(1,0,0)_{13}$
AR(1)SAR(13)	$(1,0,0)*(1,0,0)_{13}$

APPENDIX - E

Box - Jenkins Modelling Procedure for the Selected 5 Series:

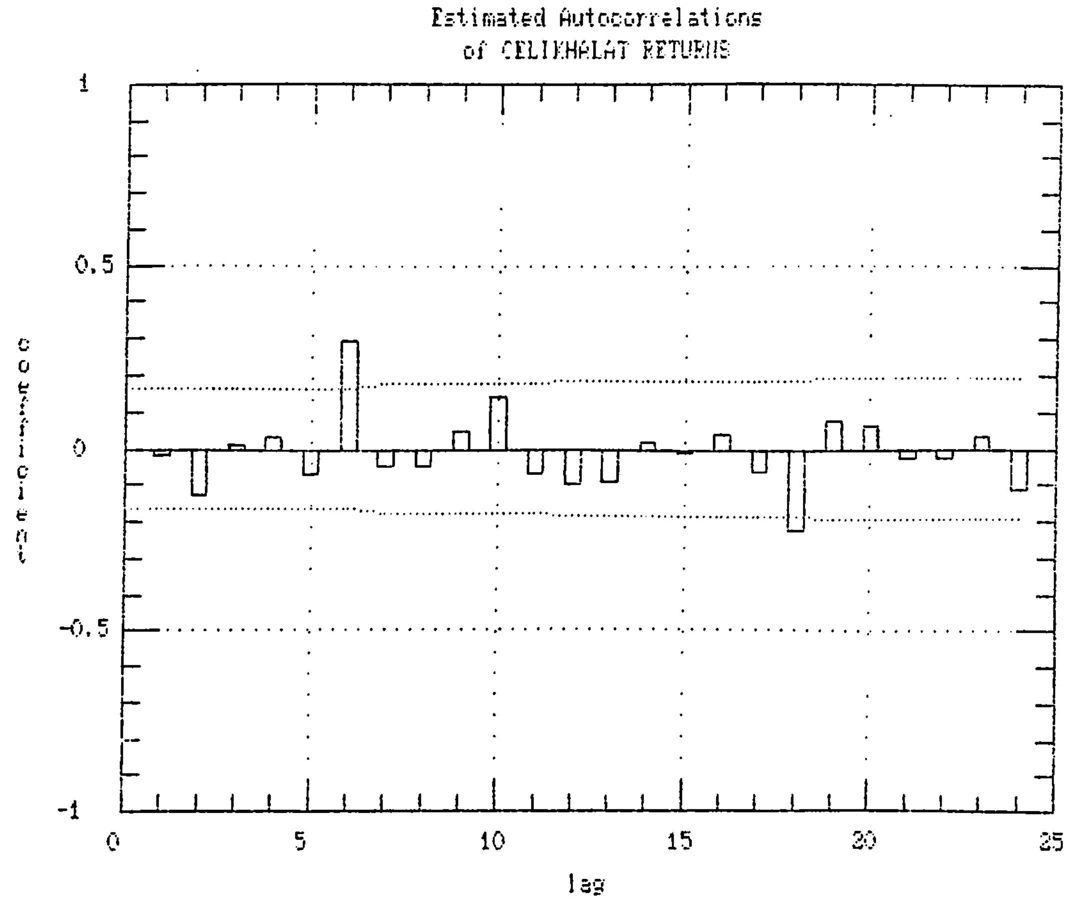
1) Celikhalat,
2) Kordsa,
3) Lassa,
4) Otosan,
5) Rabak.

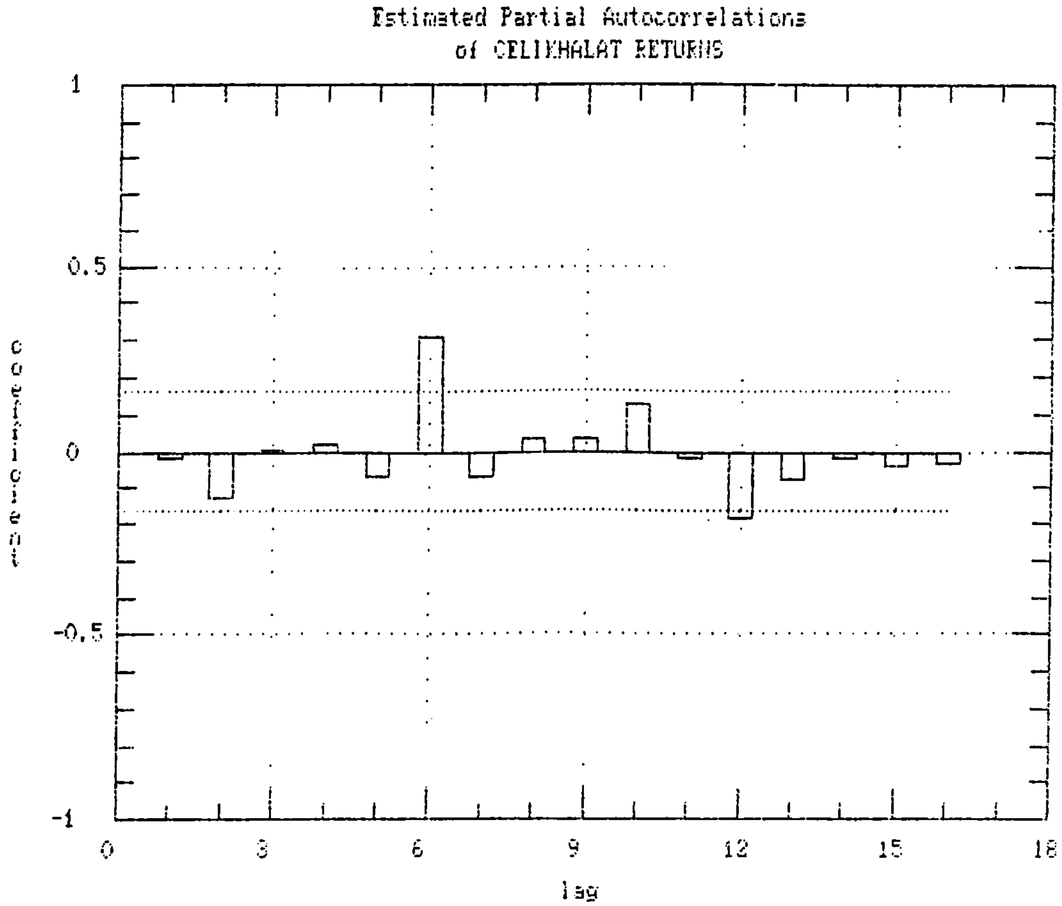
The procedure includes the steps

i. Model Identification using ACF and PACF plots,

ii. Model Estimation using an iterative least squares algorithm

iii. Model Diagnostic Checking using statistics and residual ACF plots


Estimated Autocorrelations
of CELIKHALAT RETURNS
1
0.5
0
-0.5
-1
coefficient
0
5
10
15
20
25
lag

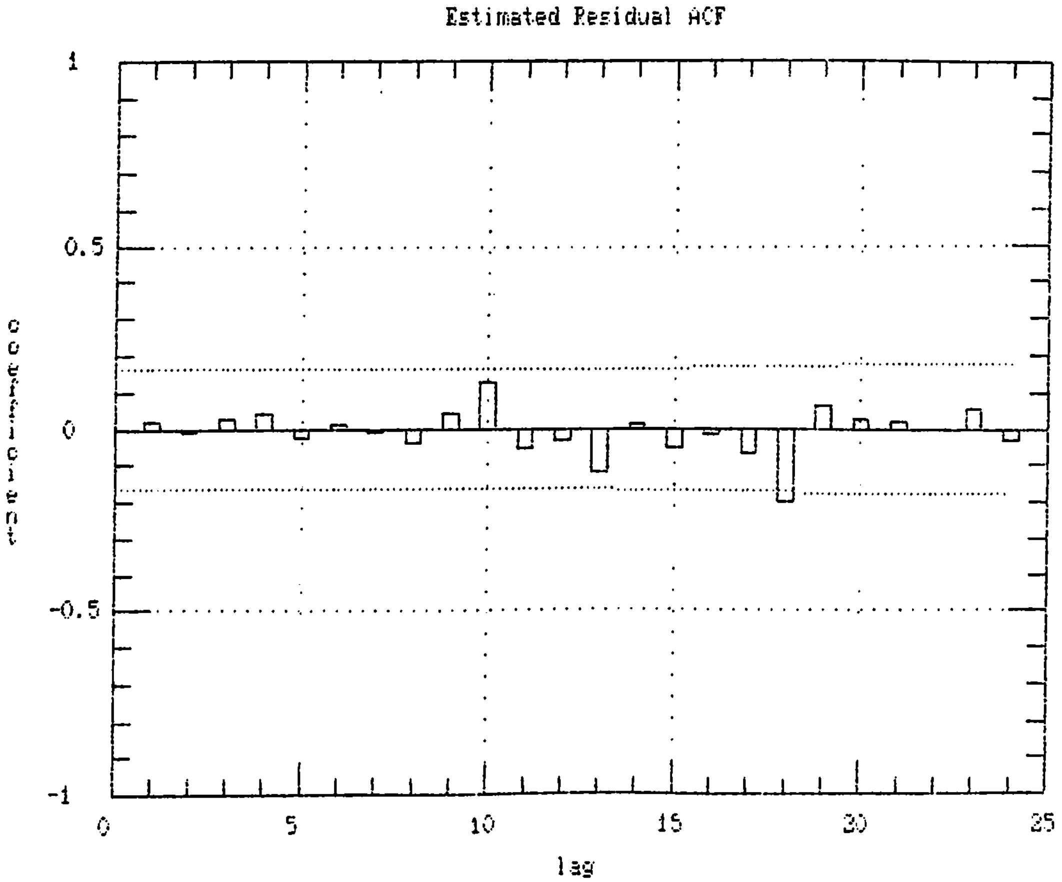

Estimated Partial Autocorrelations
of CELIKHALAT RETURNS
1
0.5
0
-0.5
-1
coefficient
0
3
6
9
12
15
18
lag

EI

Summary of Fitted Model for: D:CELIK.rate

Parameter	Estimate	Stnd.error	T-value	P-value
MA (1)	.01634	.07782	.20998	.83397
MA (2)	.13219	.07768	1.70167	.09092
MA (3)	.03153	.07856	.40133	.68876
MA (4)	.00073	.07883	.00927	.99261
MA (5)	.02631	.07783	.33808	.73579
MA (6)	-.34563	.07828	-4.41549	.00002
MEAN	.00814	.00867	.93873	.34940
CONSTANT	.00814			

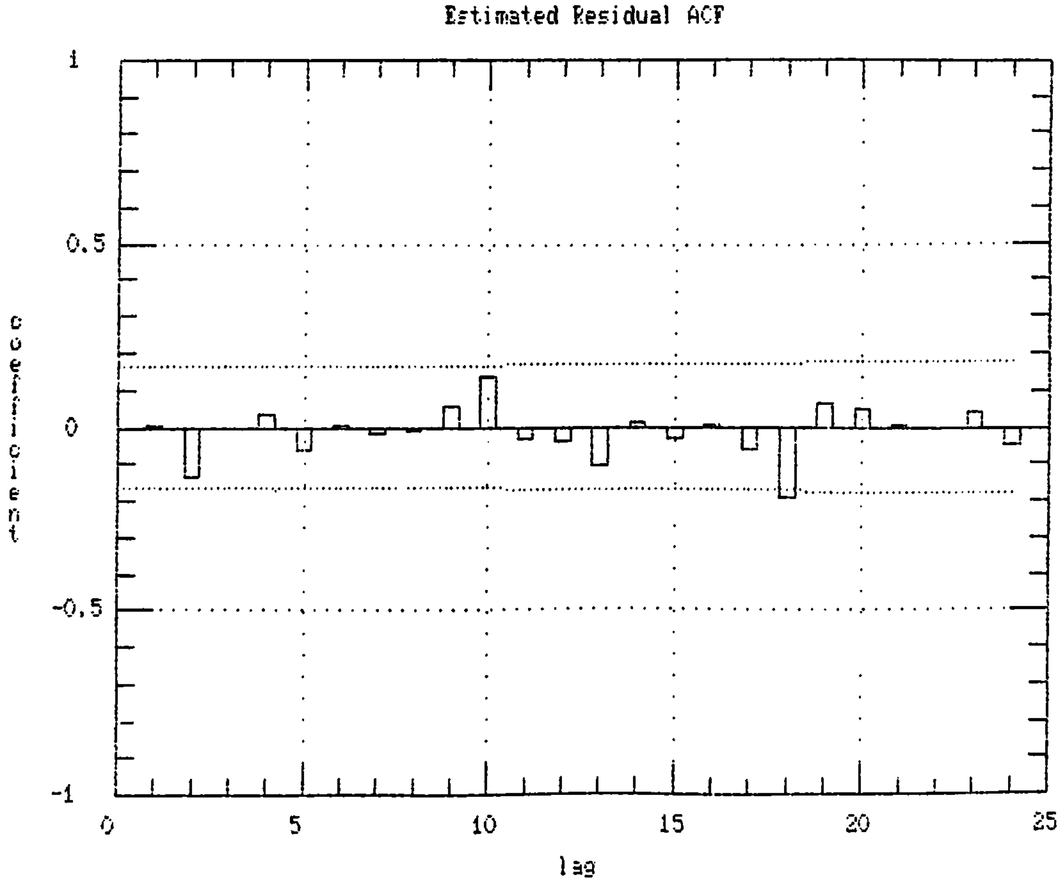
Estimated white noise variance = 9.15968E-3 with 148 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.0957062
Chi-square test statistic on first 20 residual autocorrelations = 14.4922
with probability of a larger value given white noise = 0.413722
Backforecasting: no Number of iterations performed: 3

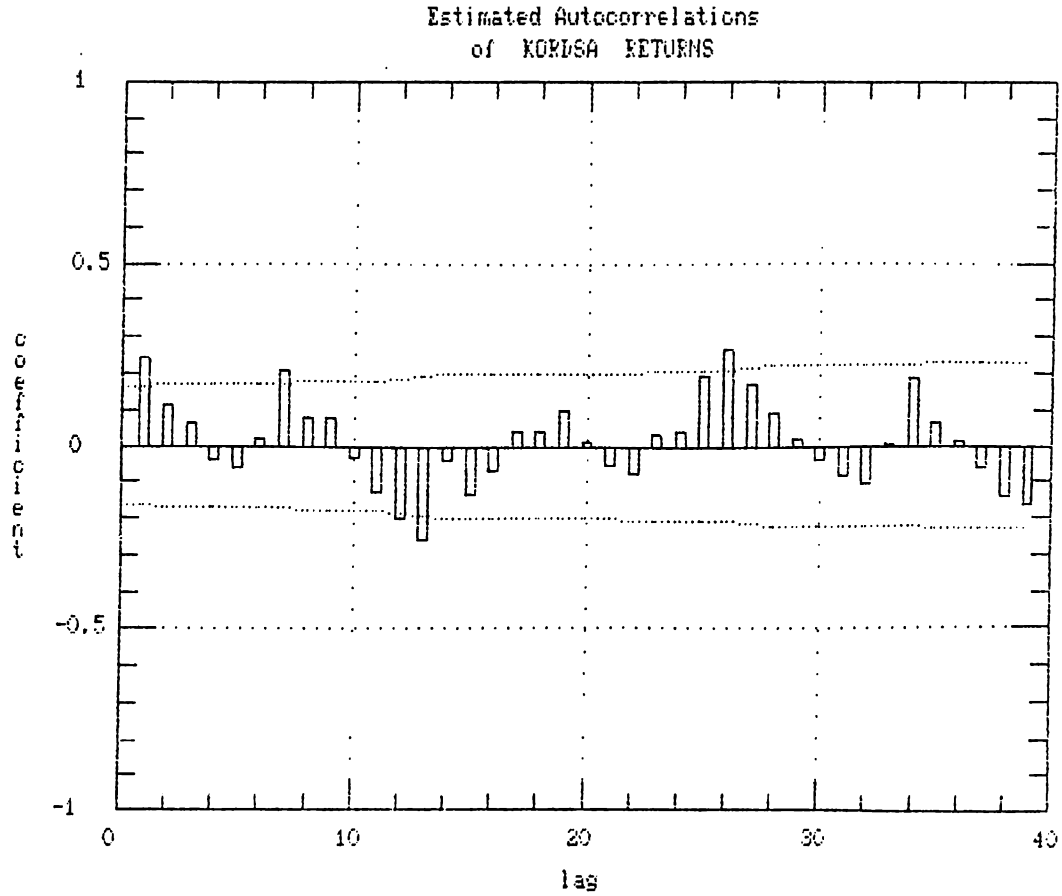


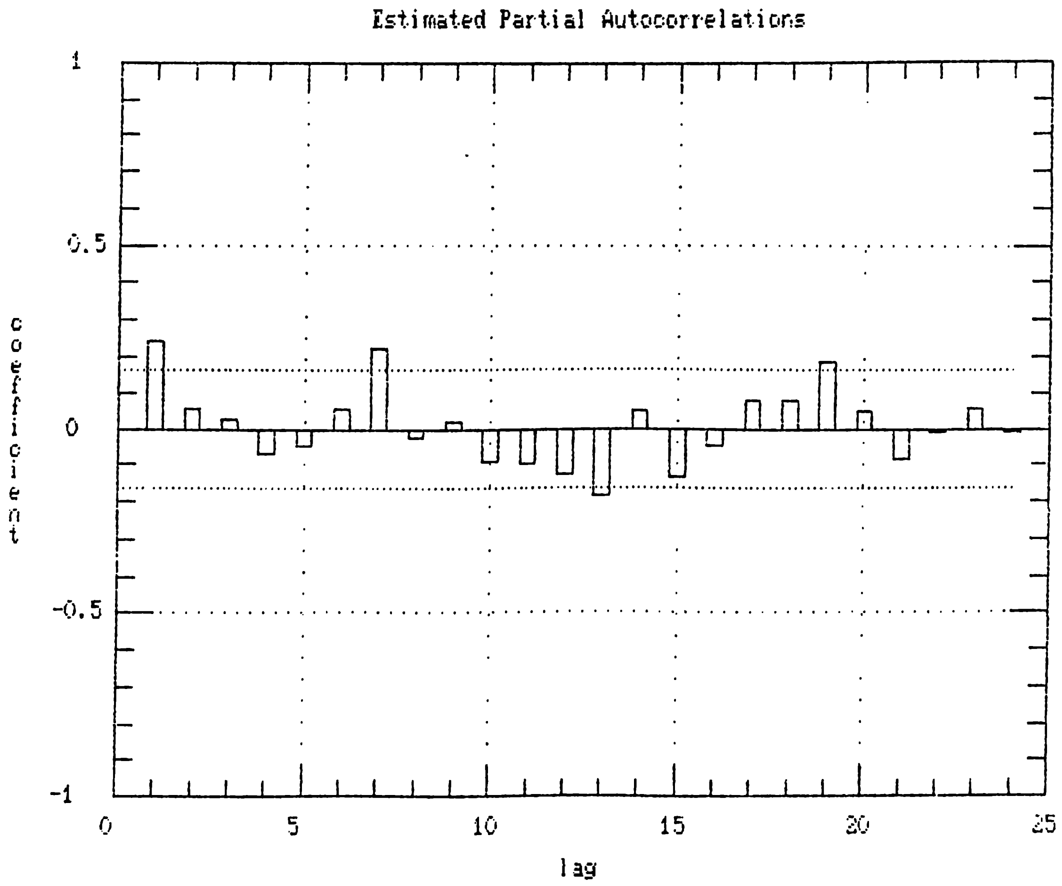
Summary of Fitted Model for: D:CELIK.rate

Parameter	Estimate	Stnd.error	T-value	P-value
SMA(6)	-.34210	.07648	-4.47324	.00001
MEAN	.00812	.01013	.80180	.42391
CONSTANT	.00812			

Estimated white noise variance = 9.05223E-3 with 153 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.0951432
Chi-square test statistic on first 20 residual autocorrelations = 16.5764
with probability of a larger value given white noise = 0.618544
Backforecasting: no Number of iterations performed: 4




Estimated Autocorrelations
of KORDSA RETURNS
coefficient
lag
1
0.5
0
-0.5
-1
0
10
20
30
40


Estimated Partial Autocorrelations
coefficient
lag
1
0.5
0
-0.5
-1
0
5
10
15
20
25

```
Estimation begins.....
Initial:     RSS = 1.68912  b = 0.247054 0.1 9.90431E-3
Iteration 1: RSS = 1.66983  b = 0.249869 0.174812 9.65314E-3
Iteration 2: RSS = 1.66752  b = 0.250468 0.204708 9.46418E-3
Final:       RSS = 1.66743   ...stopped on criterion 2
```

Summary of Fitted Model for: D:KORDSA.rate

Parameter	Estimate	Stnd.error	T-value	P-value
AR (1)	.25018	.07863	3.18182	.00177
SAR(7)	.21133	.07983	2.64719	.00897
MEAN	.00939	.01389	.67650	.49975
CONSTANT	.00556			

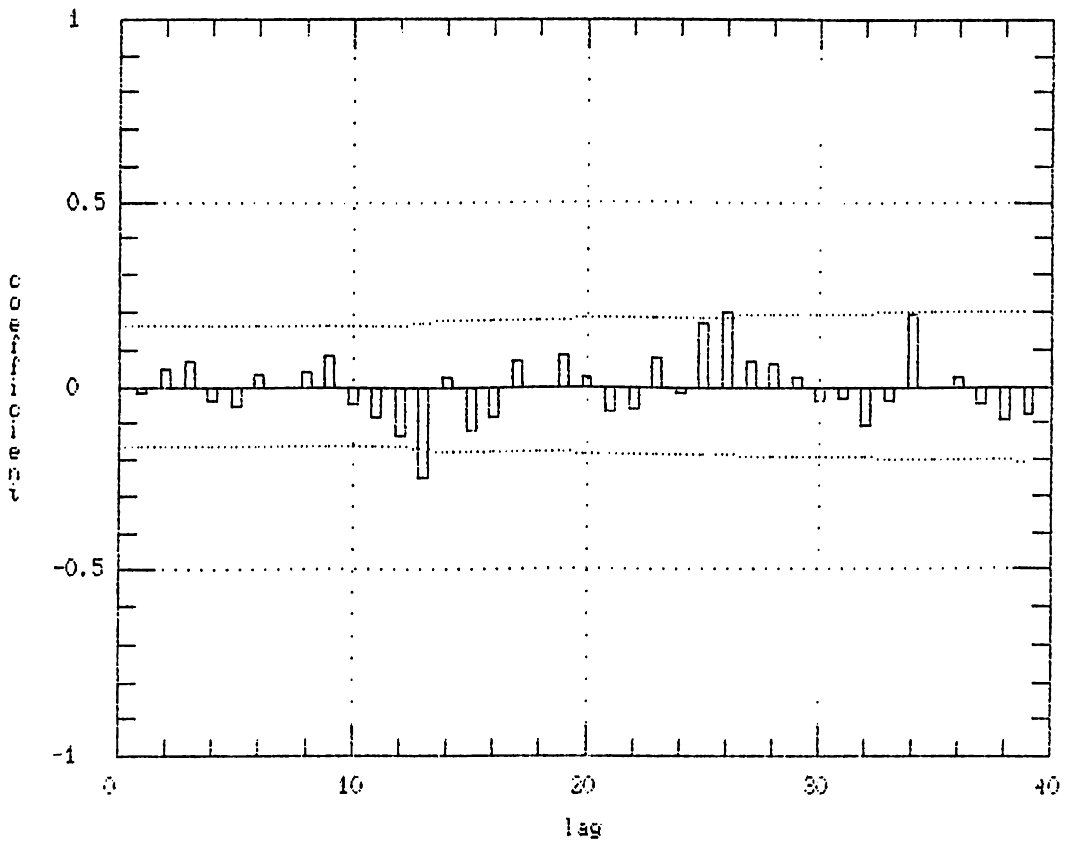
Estimated white noise variance = 0.0109699 with 152 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.104737
Chi-square test statistic on first 20 residual autocorrelations = 23.4131
with probability of a larger value given white noise = 0.214158
Backforecasting: no   Number of iterations performed: 3

Residual Summary

Number of observations = 155
Residual average = 1.3925E-5
Residual variance = 0.0109699
Residual standard error = 0.104737

Coeff. of skewness = 0.777818   standardized value = 3.95338
Coeff. of kurtosis = 3.43529   standardized value = 8.73019

Estimated Residual ACF

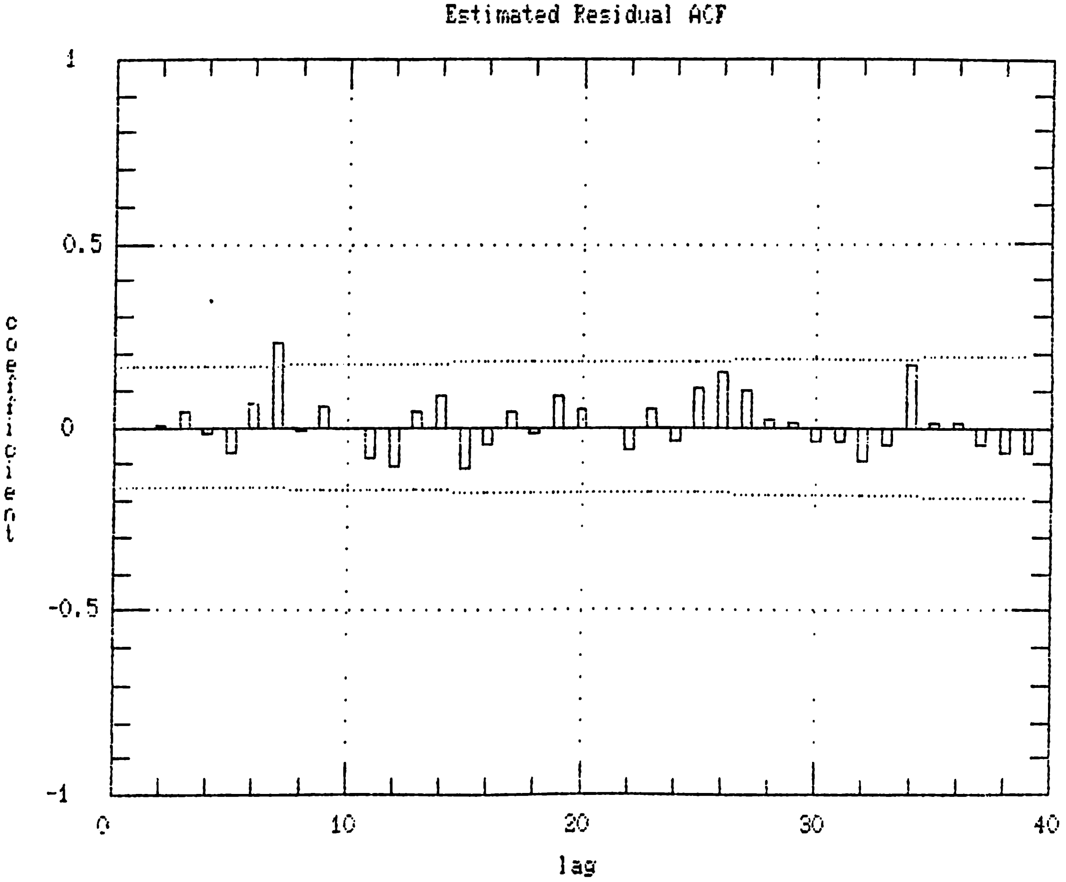


```
Estimation begins.....
Initial:      RSS = 1.84279  b = 0.247054 0.1 9.90431E-3
Iteration 1: RSS = 1.66987  b = 0.235367 -0.126025 0.0100239
Iteration 2: RSS = 1.64862  b = 0.222681 -0.217761 0.0104017
Final:        RSS = 1.64772   ...stopped on criterion 2
```

Summary of Fitted Model for: D:KORDSA.rate

Parameter	Estimate	Stnd.error	T-value	P-value
AR (1)	.21877	.07996	2.73587	.00696
SAR(13)	-.23843	.08065	-2.95623	.00361
MEAN	.01054	.00894	1.17896	.24026
CONSTANT	.01020			

```
Estimated white noise variance = 0.0108403 with 152 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.104117
Chi-square test statistic on first 20 residual autocorrelations = 18.3382
     with probability of a larger value given white noise = 0.433593
Backforecasting: no                              Number of iterations performed: 3
```

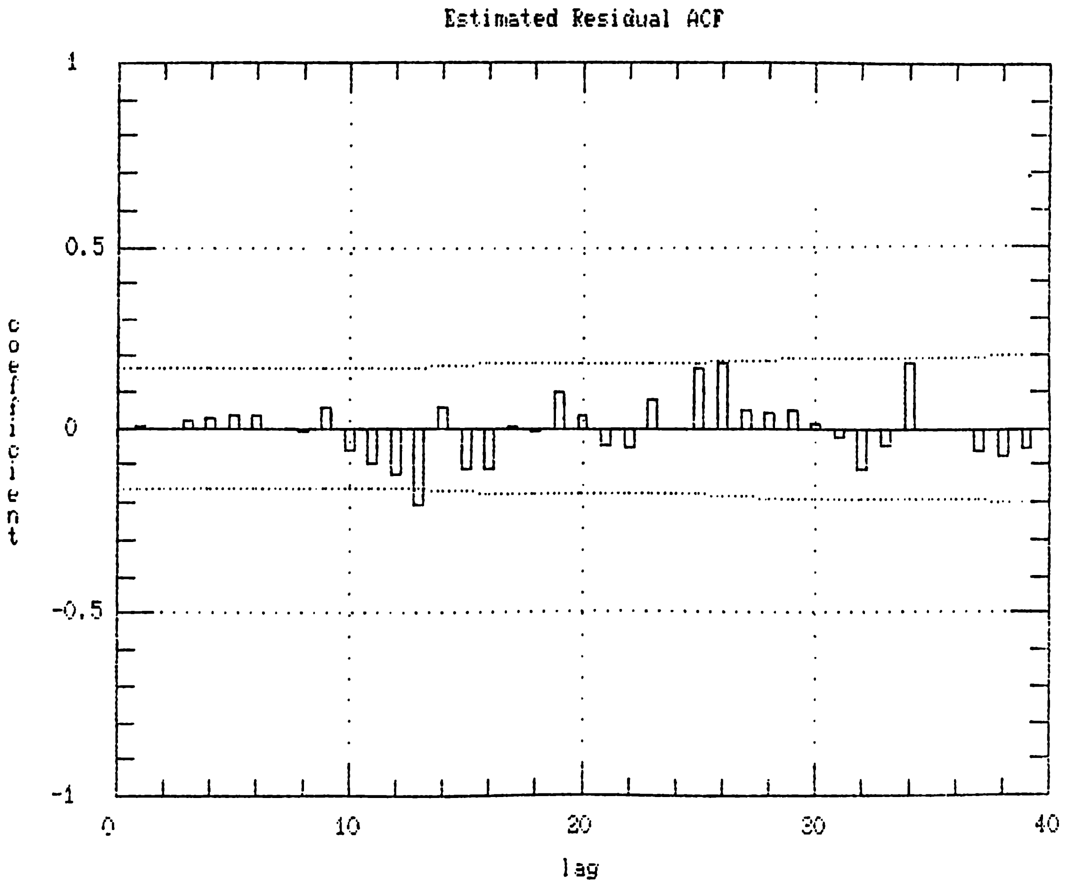


Final: RSS = 1.6358   ...stopped on criterion 2

Summary of Fitted Model for: D:KORDSA.rate

Parameter	Estimate	Stnd.error	T-value	P-value
AR (1)	.22155	.08043	2.75468	.00662
AR (2)	.07088	.08253	.85875	.39188
AR (3)	.05513	.08262	.66727	.50565
AR (4)	-.07066	.08272	-.85421	.39438
AR (5)	-.07288	.08282	-.88001	.38029
AR (6)	.00173	.08286	.02089	.98337
AR (7)	.22305	.08089	2.75762	.00656
MEAN	.00934	.01449	.64485	.52003
CONSTANT	.00534			

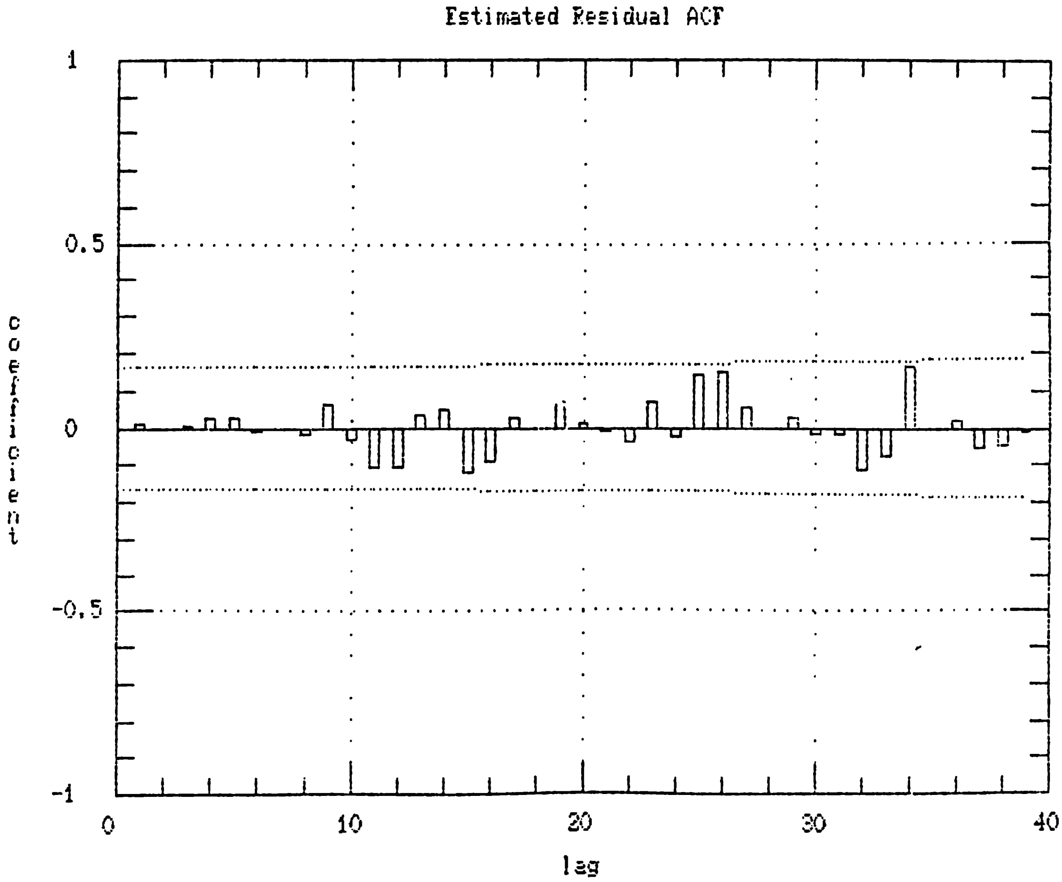
Estimated white noise variance = 0.0111279 with 147 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.105489
Chi-square test statistic on first 20 residual autocorrelations = 18.3924
with probability of a larger value given white noise = 0.14318
Backforecasting: no   Number of iterations performed: 1

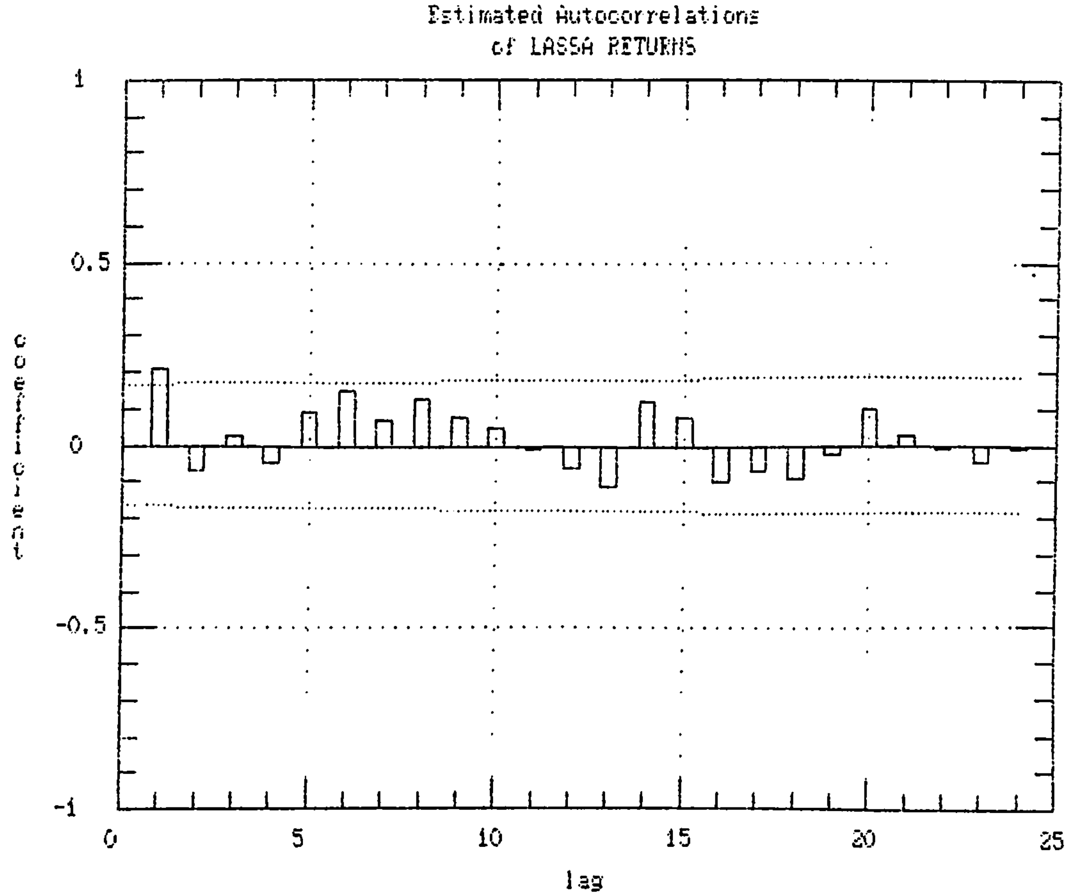


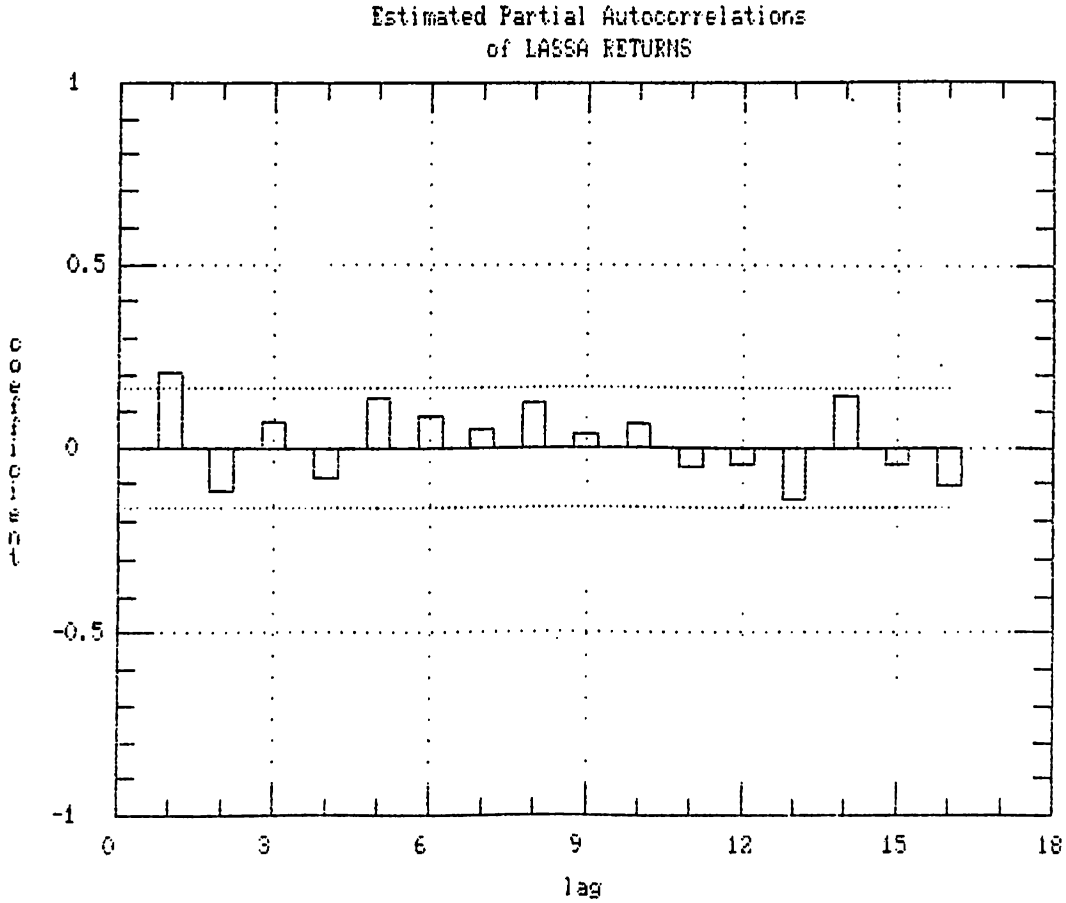
Summary of Fitted Model for: D:KORDSA.rate

Parameter	Estimate	Stnd.error	T-value	P-value
AR (1)	.19047	.08178	2.32921	.02122
AR (2)	.02126	.08244	.25789	.79685
AR (3)	.03835	.08218	.46662	.64147
AR (4)	-.02811	.08278	-.33963	.73463
AR (5)	-.06627	.08225	-.80567	.42175
AR (6)	.07941	.08394	.94597	.34573
AR (7)	.21501	.08136	2.64265	.00912
SAR(13)	-.26603	.08471	-3.14038	.00204
MEAN	.01048	.01187	.88317	.37860
CONSTANT	.00730			

Estimated white noise variance = 0.0105633 with 146 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.102778
Chi-square test statistic on first 20 residual autocorrelations = 9.50978
with probability of a larger value given white noise = 0.658881
Backforecasting: no Number of iterations performed: 4



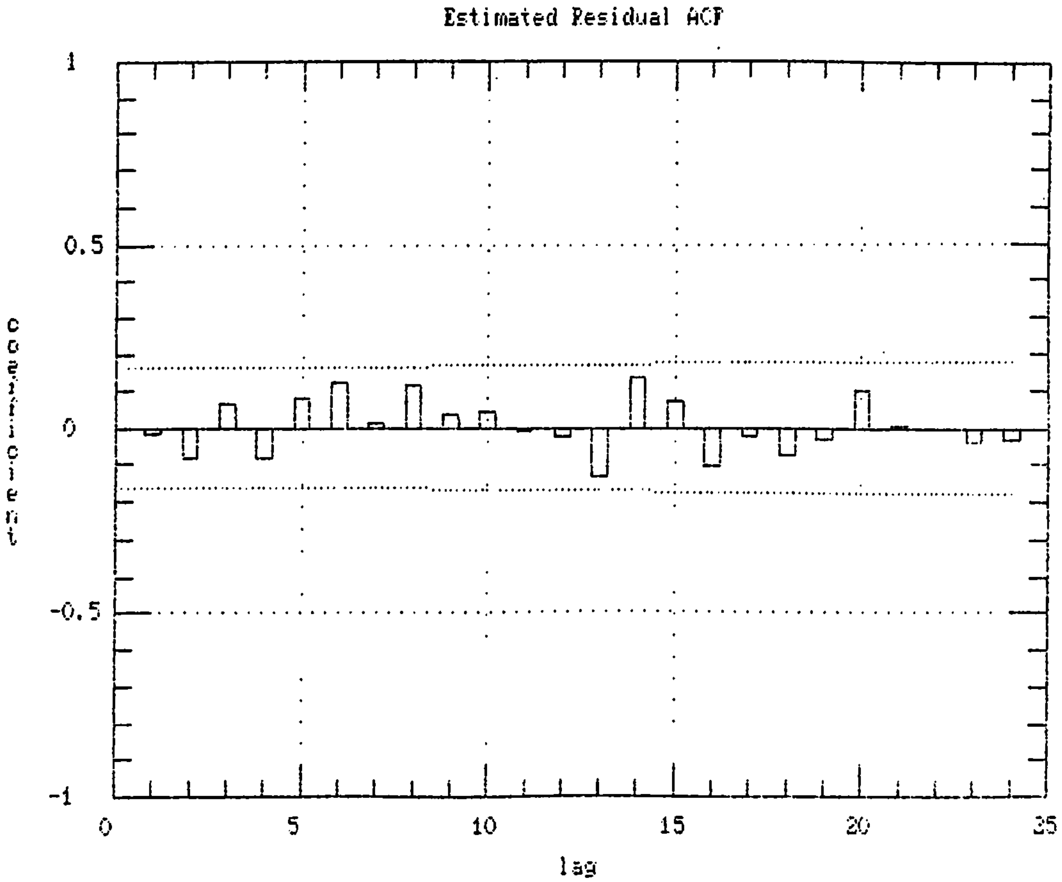

Estimated Autocorrelations
of LASSA RETURNS
coefficient
lag
1
0.5
0
-0.5
-1
0
5
10
15
20
25


Estimated Partial Autocorrelations
of LASSA RETURNS
coefficient
lag
1
0.5
0
-0.5
-1
0
3
6
9
12
15
18

Summary of Fitted Model for: D:LASSA.rate

Parameter	Estimate	Stnd. error	T-value	P-value
MA (1)	-.25682	.07914	-3.24491	.00144
MEAN	.01180	.01181	.99944	.31916
CONSTANT	.01180			

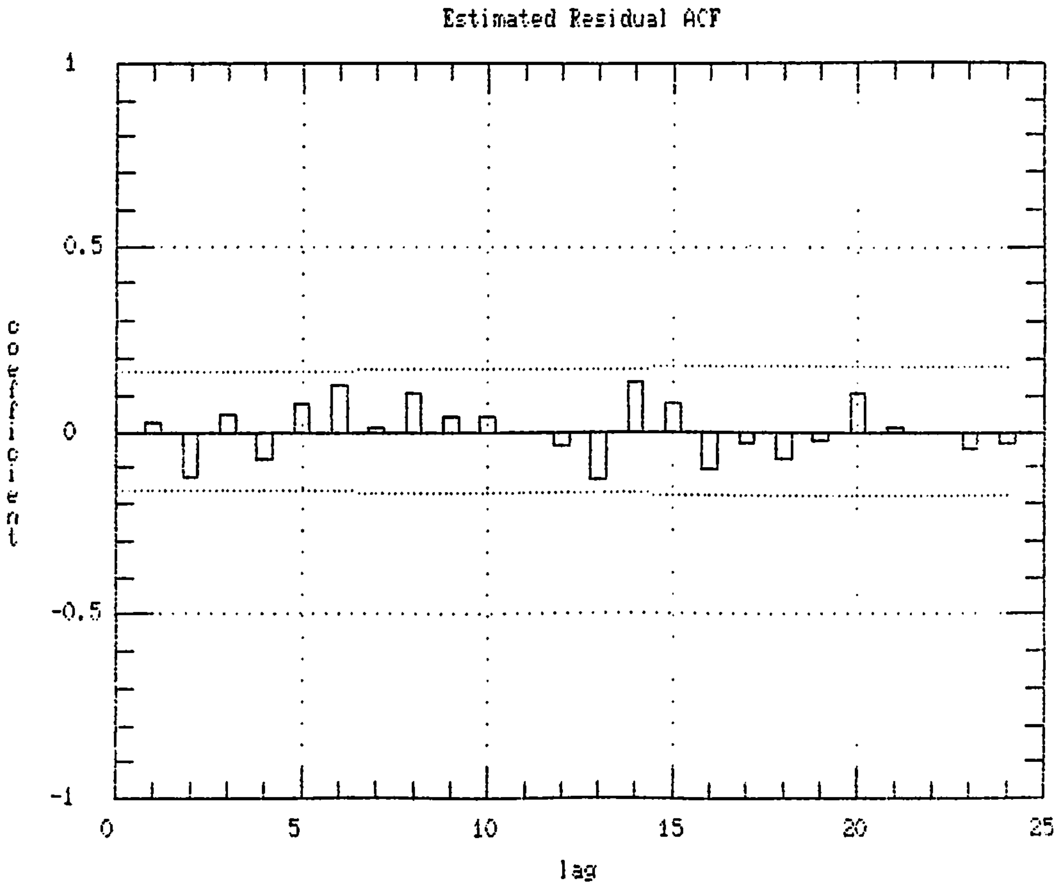
Estimated white noise variance = 0.0141269 with 153 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.118857
Chi-square test statistic on first 20 residual autocorrelations = 19.408
with probability of a larger value given white noise = 0.430959
Backforecasting: no   Number of iterations performed: 2

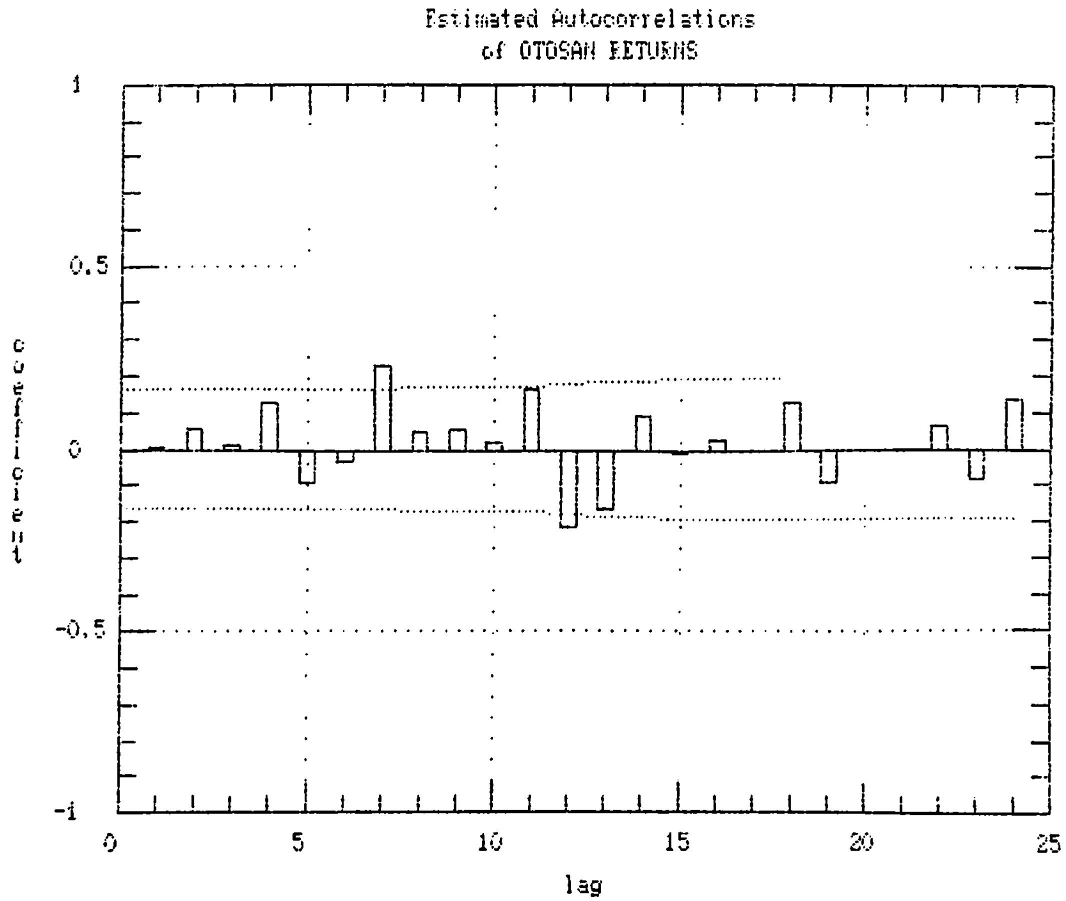


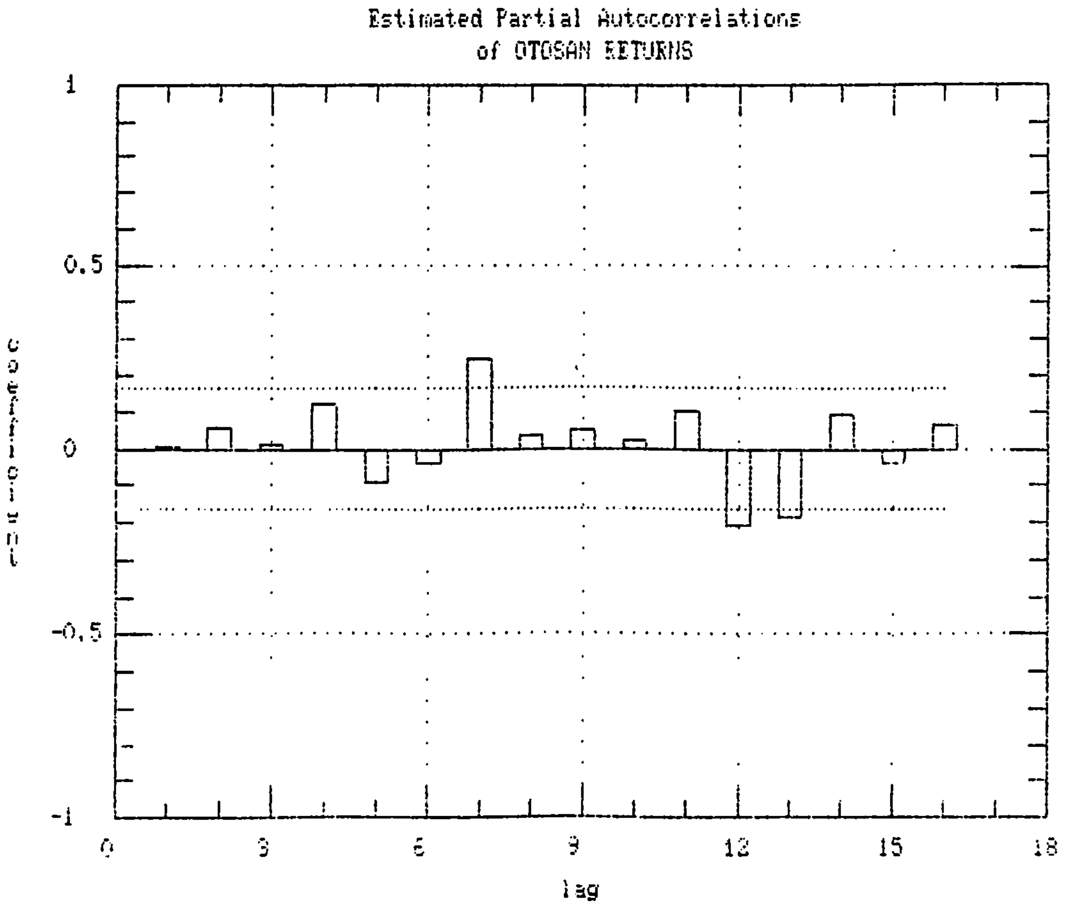
Summary of Fitted Model for: D:LASSA.rate

Parameter	Estimate	Stnd. error	T-value	P-value
AR (1)	.20641	.07911	2.60927	.00997
MEAN	.01178	.01208	.97473	.33123
CONSTANT	.00935			

Estimated white noise variance = 0.0143044 with 153 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.119601
Chi-square test statistic on first 20 residual autocorrelations = 20.9174
with probability of a larger value given white noise = 0.341381
Backforecasting: no Number of iterations performed: 1



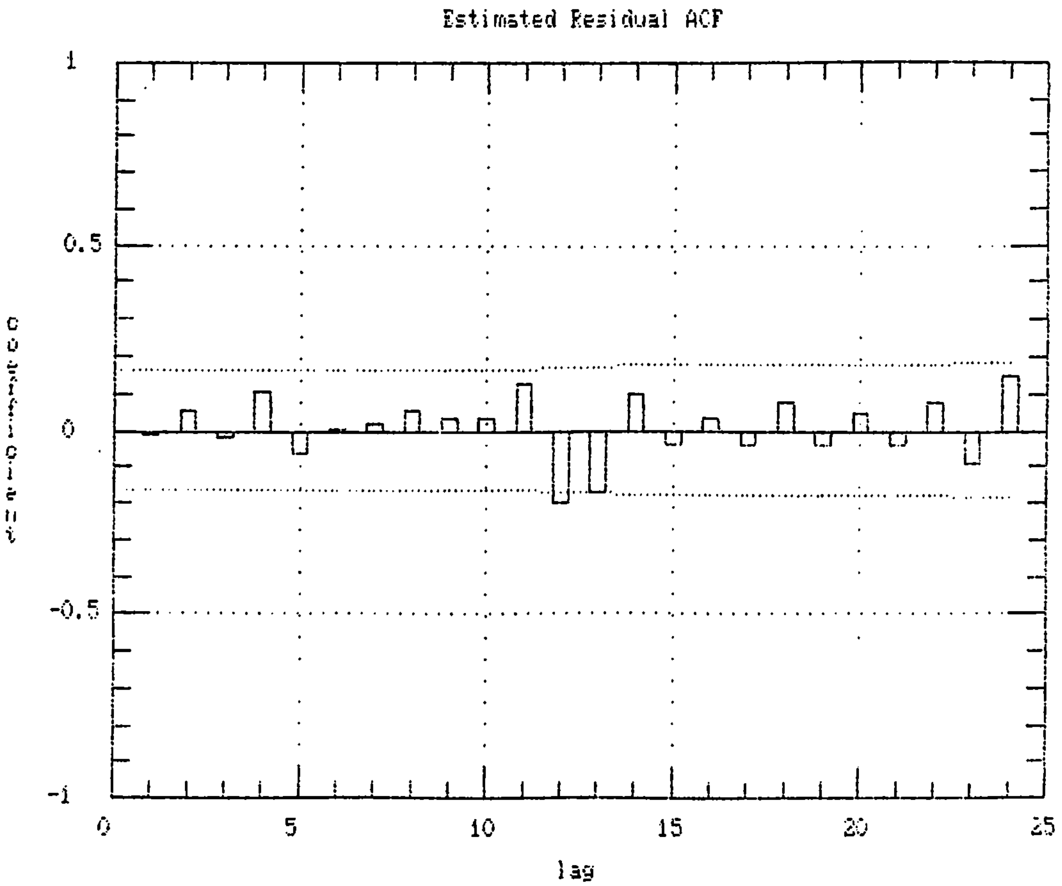

Estimated Autocorrelations
of OTOSAN RETURNS
1
0.5
0
-0.5
-1
coefficient
0
5
10
15
20
25
lag

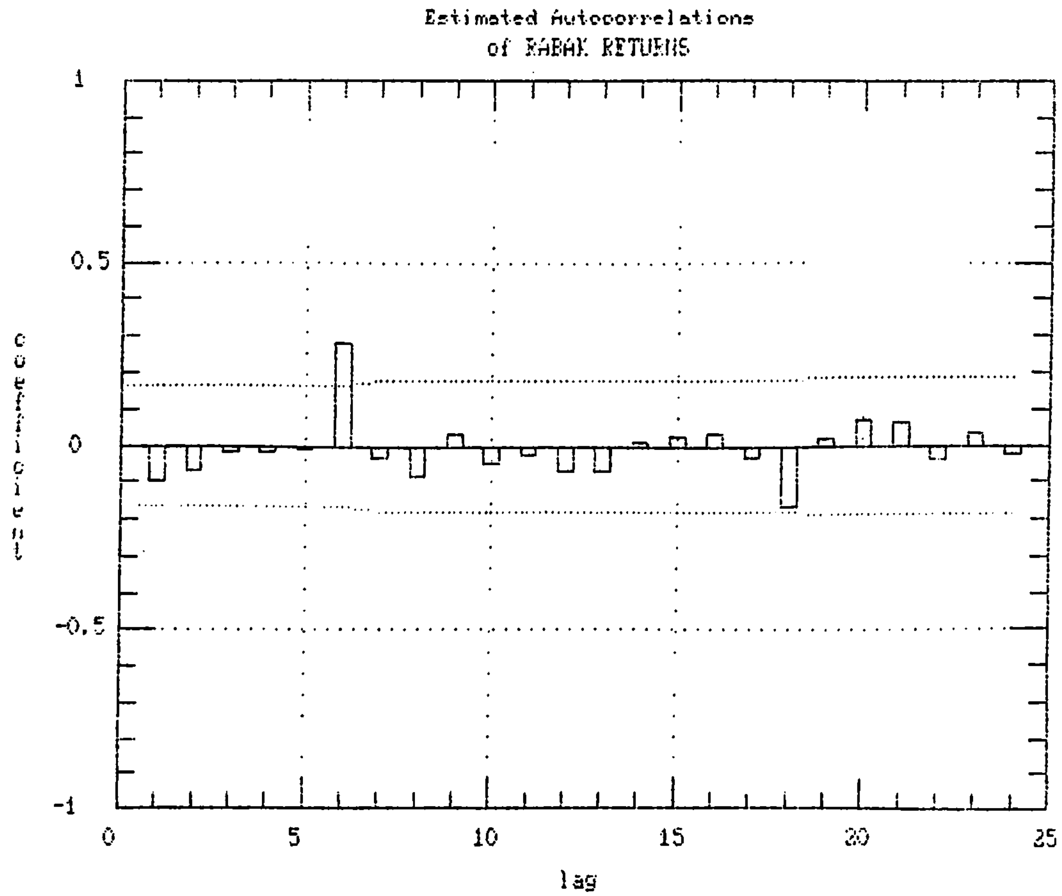

Estimated Partial Autocorrelations
of OTOSAN RETURNS
1
0.5
0
-0.5
-1
coefficient
0
3
6
9
12
15
18
lag

Summary of Fitted Model for: D:OTOSAN.rate

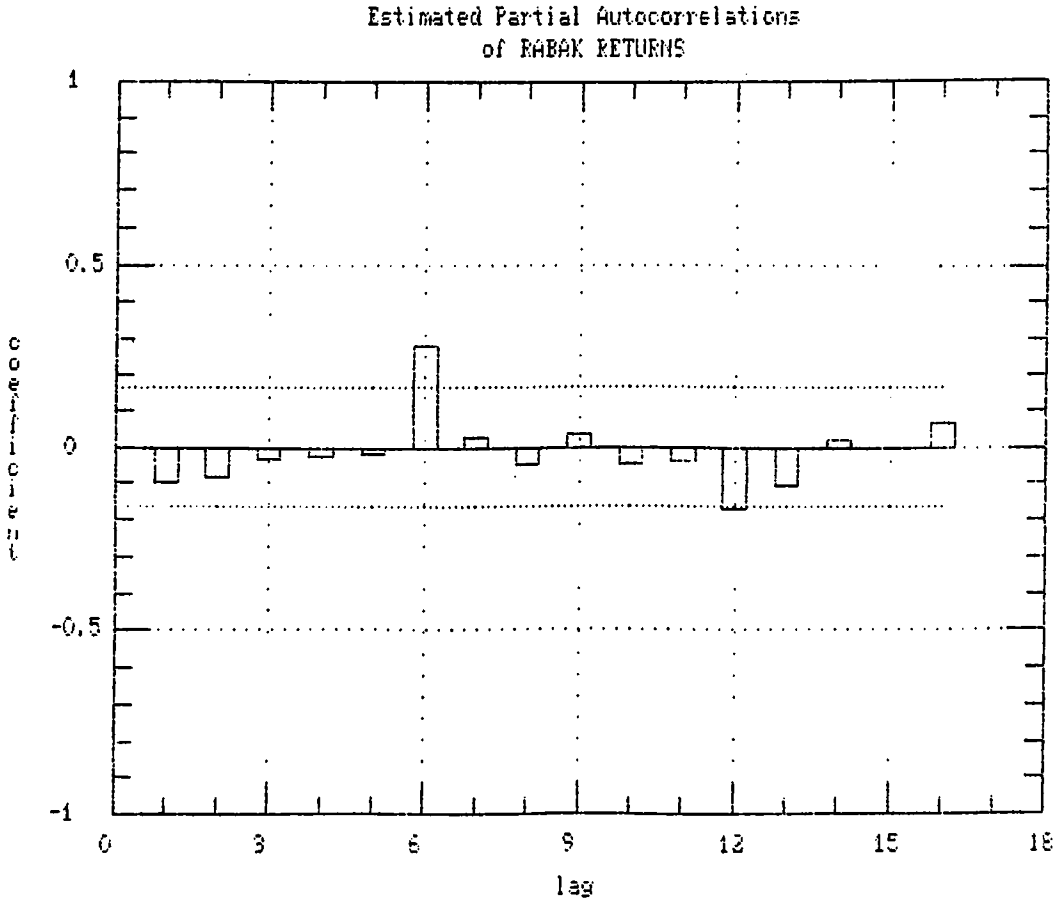
Parameter	Estimate	Stnd.error	T-value	P-value
SMA(7)	-.20160	.08041	-2.50707	.01323
MEAN	.01284	.01205	1.06576	.28822
CONSTANT	.01284			

Estimated white noise variance = 0.0157951 with 152 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.125679
Chi-square test statistic on first 20 residual autocorrelations = 20.3799
with probability of a larger value given white noise = 0.372053
Backforecasting: no Number of iterations performed: 3





Estimated Autocorrelations
of RABAK RETURNS
1
0.5
0
-0.5
-1
coefficient
0
5
10
15
20
25
lag



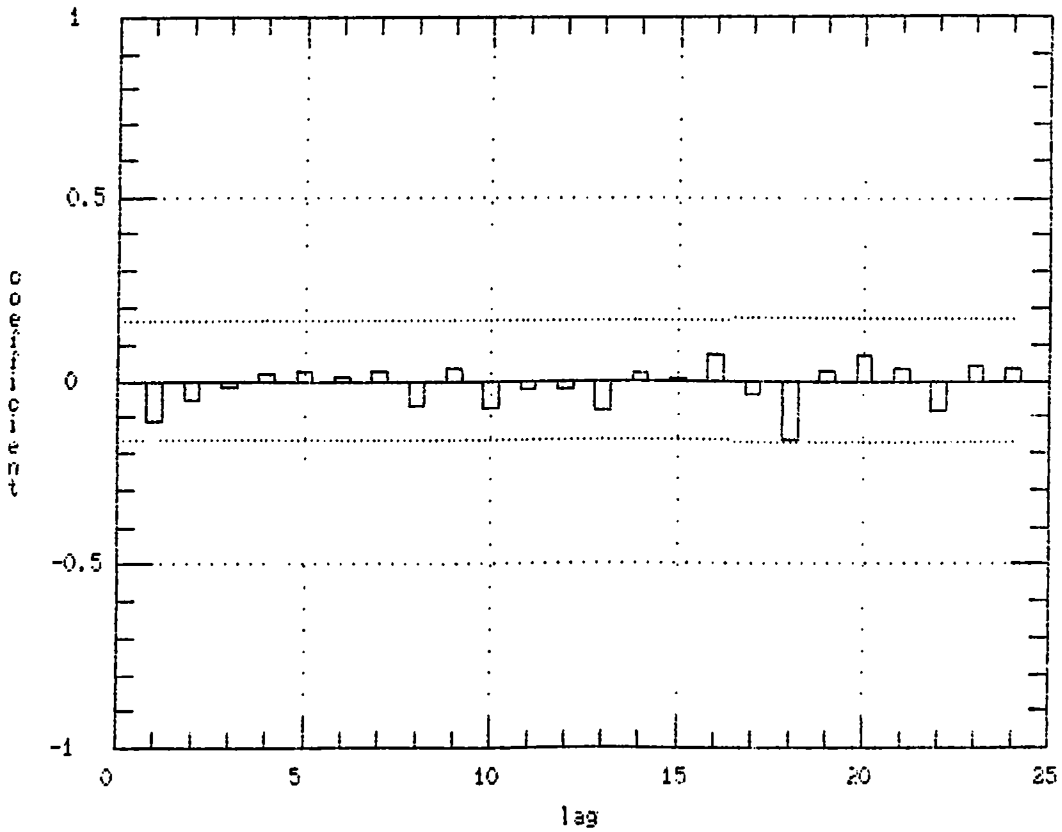
Estimated Partial Autocorrelations
of RABAK RETURNS
1
0.5
0
-0.5
-1
coefficient
0
3
6
9
12
15
18
lag

Summary of Fitted Model for: D:RABAK.rate

Parameter	Estimate	Stnd.error	T-value	P-value
SMA(6)	-.30924	.07765	-3.98250	.00011
MEAN	.01230	.01386	.88776	.37606
CONSTANT	.01230			

Estimated white noise variance = 0.0177232 with 153 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.133129
Chi-square test statistic on first 20 residual autocorrelations = 11.8237
with probability of a larger value given white noise = 0.893022
Backforecasting: no Number of iterations performed: 4

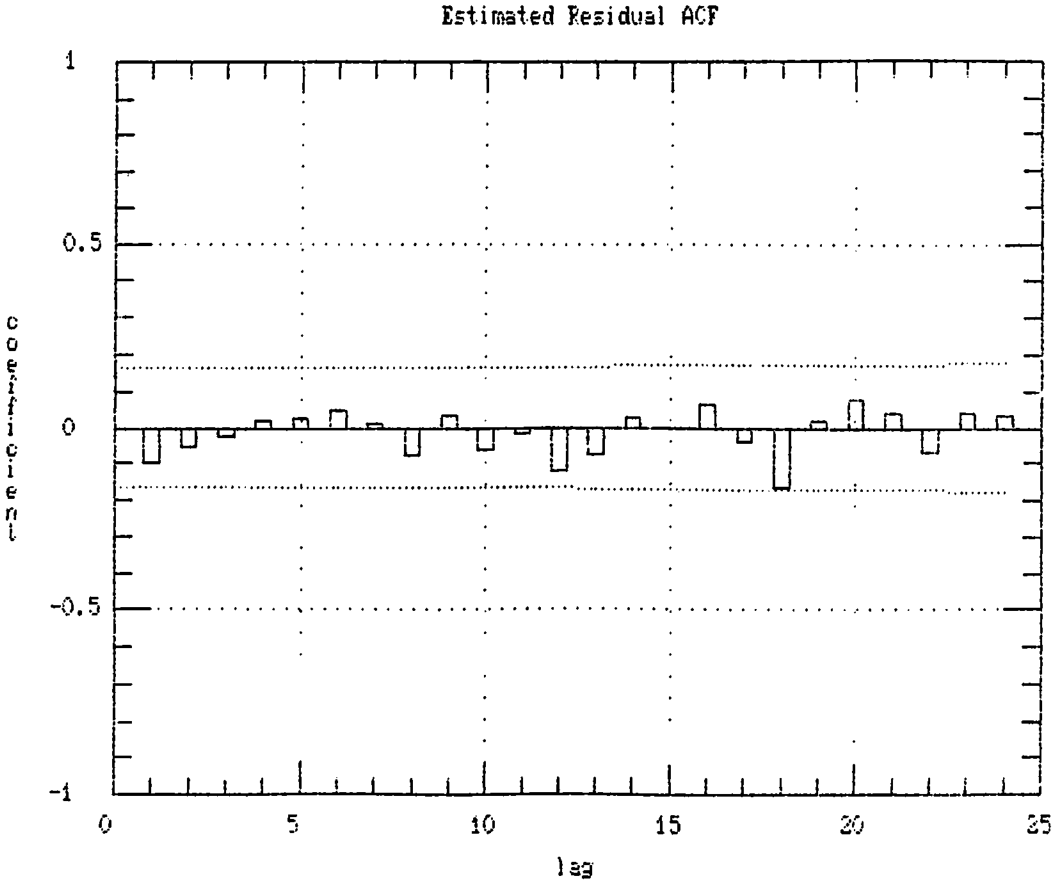
Estimated Residual ACF



Summary of Fitted Model for: D:RABAX.rate

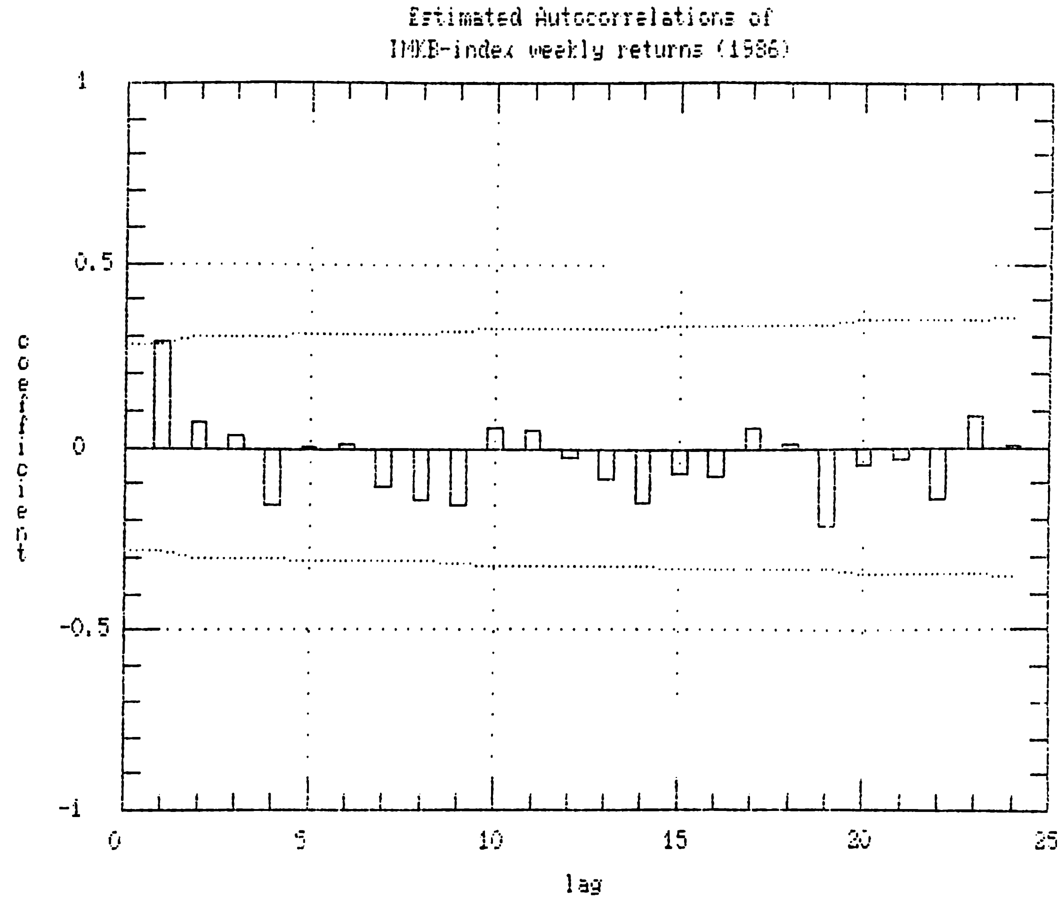
Parameter	Estimate	Stnd.error	T-value	P-value
SAR(6)	.29041	.07788	3.60073	.00043
MEAN	.01214	.01449	.83765	.40354
CONSTANT	.00874			

Estimated white noise variance = 0.0179552 with 153 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.133997
Chi-square test statistic on first 20 residual autocorrelations = 13.1918
with probability of a larger value given white noise = 0.828609
Backforecasting: no Number of iterations performed: 3



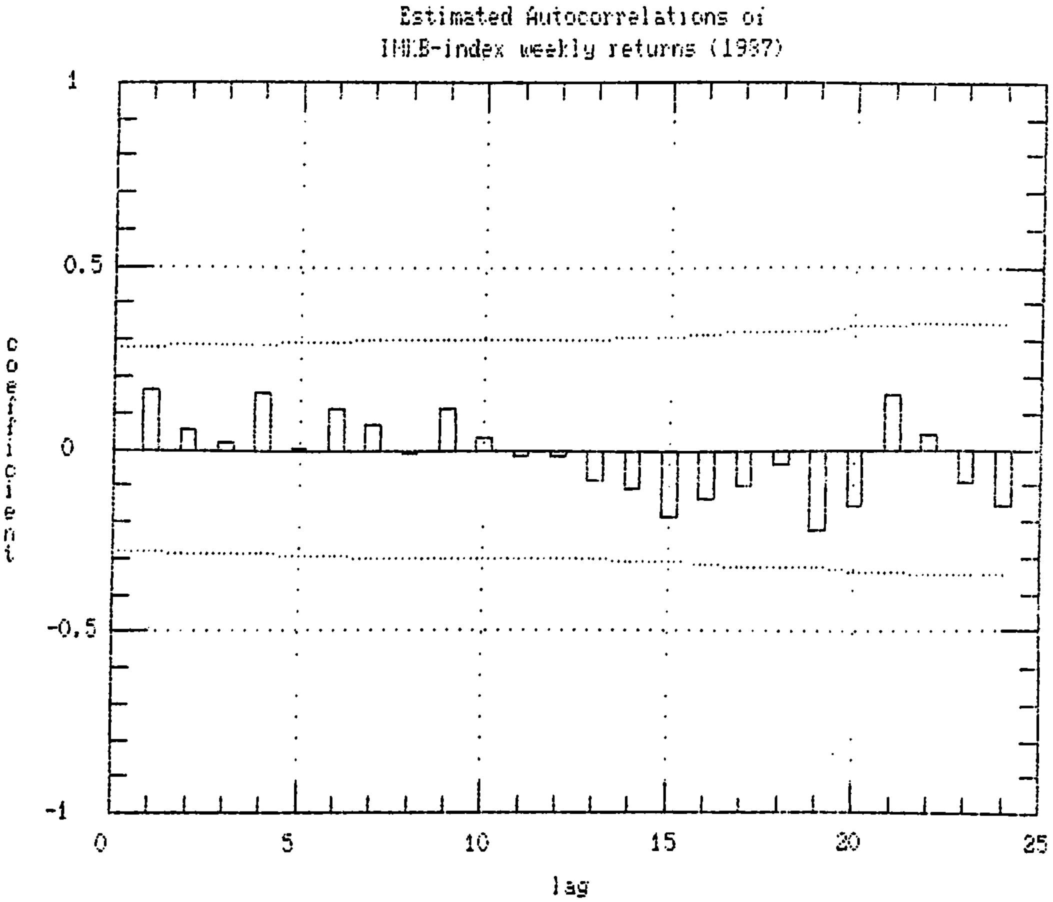
A P P E N D I X - F

Estimated Autocorrelation Functions for the three years 1986, 1987, 1988 Seperately for the 2 Series Kordsa and iMKB-index. The plots are used to show the nonstationarity of any spurious spike seen on ACF estimates.



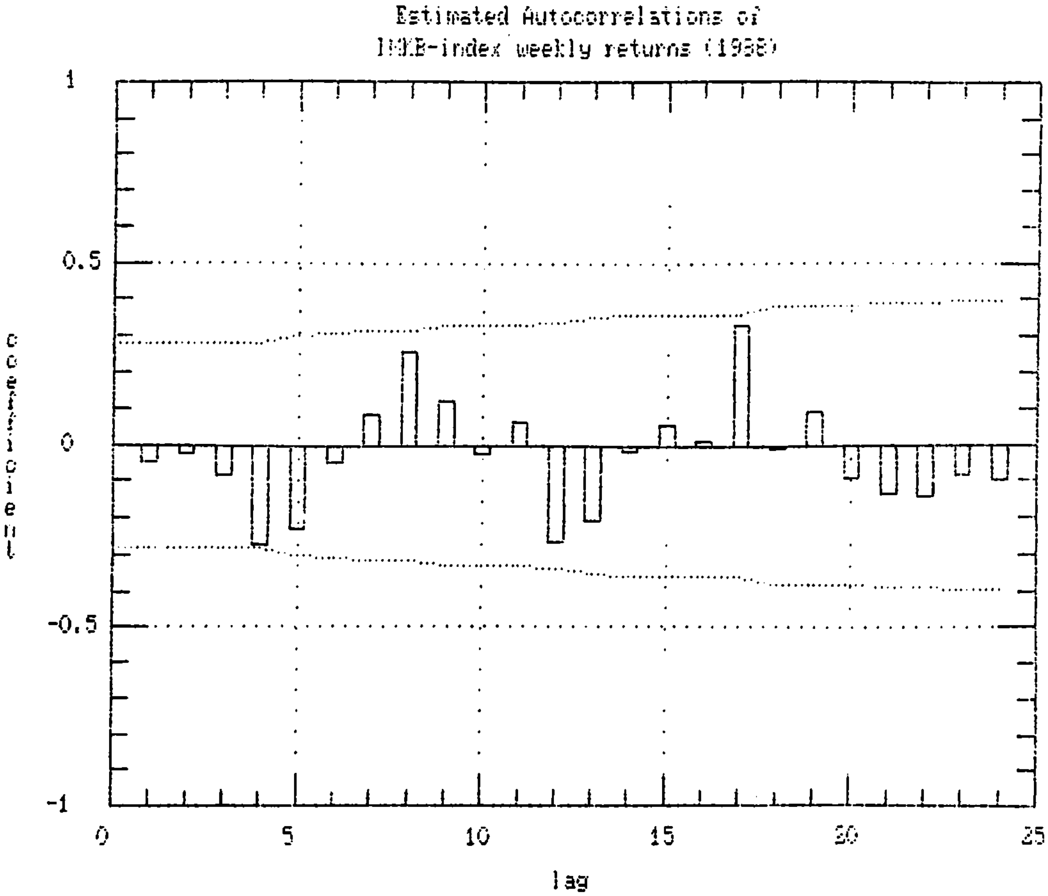
Estimated autocorrelations for D:IMKB.rate1 (1986)

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.28513	.13868	2	.06812	.14952
3	.03516	.15012	4	-.15778	.15028
5	.00330	.15343	6	.00886	.15343
7	-.10824	.15344	8	-.14483	.15490
9	-.15542	.15749	10	.05285	.16041
11	.04575	.16074	12	-.02619	.16099
13	-.08663	.16108	14	-.14626	.16197
15	-.07057	.16449	16	-.07912	.16507
17	.05386	.16580	18	.00852	.16613
19	-.21203	.16614	20	-.04644	.17127
21	-.03370	.17151	22	-.14451	.17164
23	.08650	.17396	24	.00595	.17479



Estimated autocorrelations for D:IMKB.rate2 (1987)

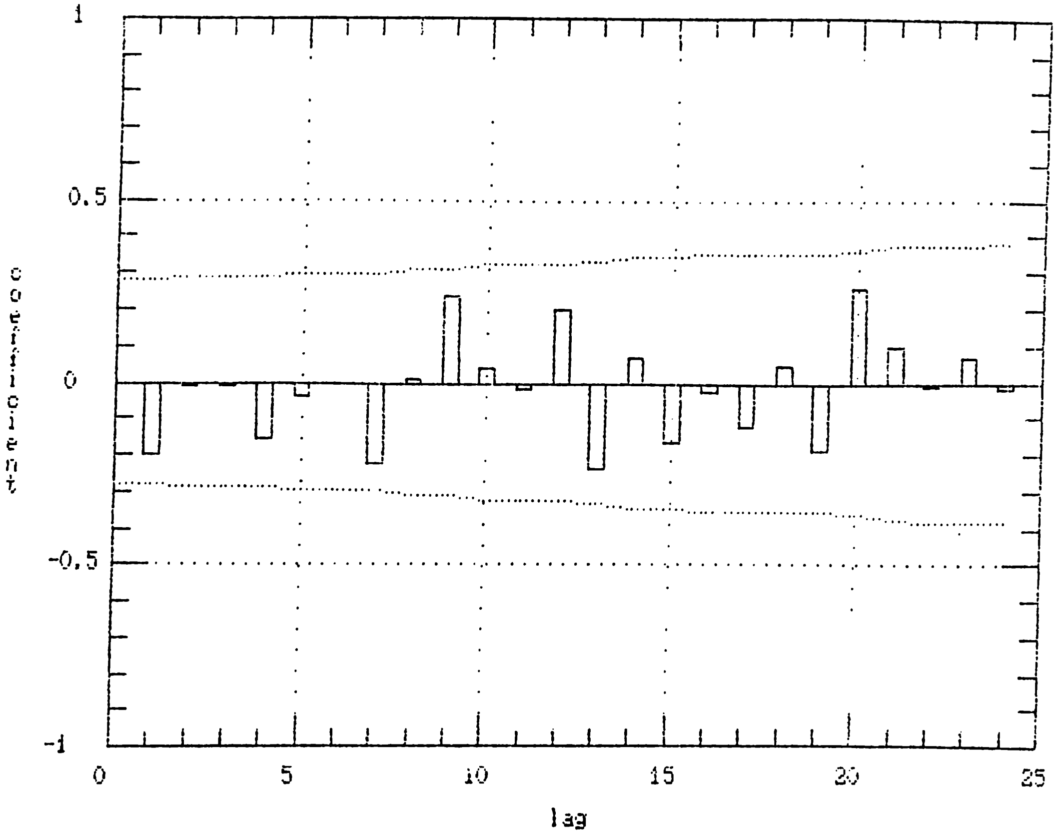
Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.16211	.14003	2	.05629	.14366
3	.01876	.14409	4	.15958	.14414
5	.00447	.14756	6	.11443	.14757
7	.06904	.14930	8	-.01387	.14990
9	.11095	.14993	10	.03554	.15153
11	-.01603	.15169	12	-.01943	.15173
13	-.08517	.15178	14	-.10372	.15271
15	-.18310	.15408	16	-.13776	.15829
17	-.09724	.16063	18	-.03764	.16178
19	-.21917	.16195	20	-.15393	.16766
21	.14979	.17041	22	.03975	.17297
23	-.08803	.17315	24	-.15786	.17413



Estimated autocorrelations for D:IMKB.rate3 (1988)

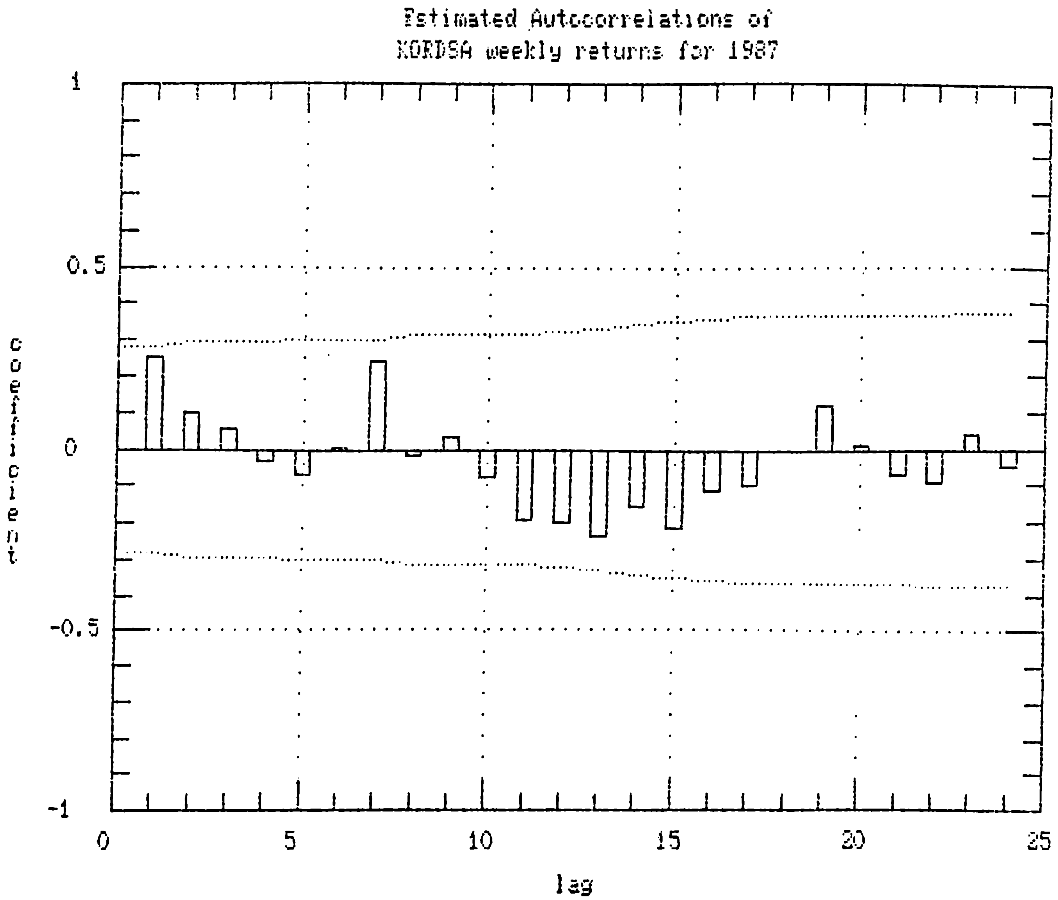
Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	-.04524	.13868	2	-.02433	.13896
3	-.08691	.13904	4	-.26922	.14008
5	-.22617	.14970	6	-.04854	.15613
7	.08500	.15642	8	.25618	.15731
9	.12092	.16514	10	-.02561	.16683
11	.06125	.16691	12	-.26300	.16734
13	-.20761	.17511	14	-.01822	.17978
15	.05331	.17981	16	.01119	.18012
17	.32863	.18013	18	-.00864	.19131
19	.08921	.19132	20	-.08869	.19212
21	-.13563	.19291	22	-.14436	.19473
23	-.08596	.19678	24	-.09757	.19750

Estimated Autocorrelations of KORDSA weekly returns for 1986



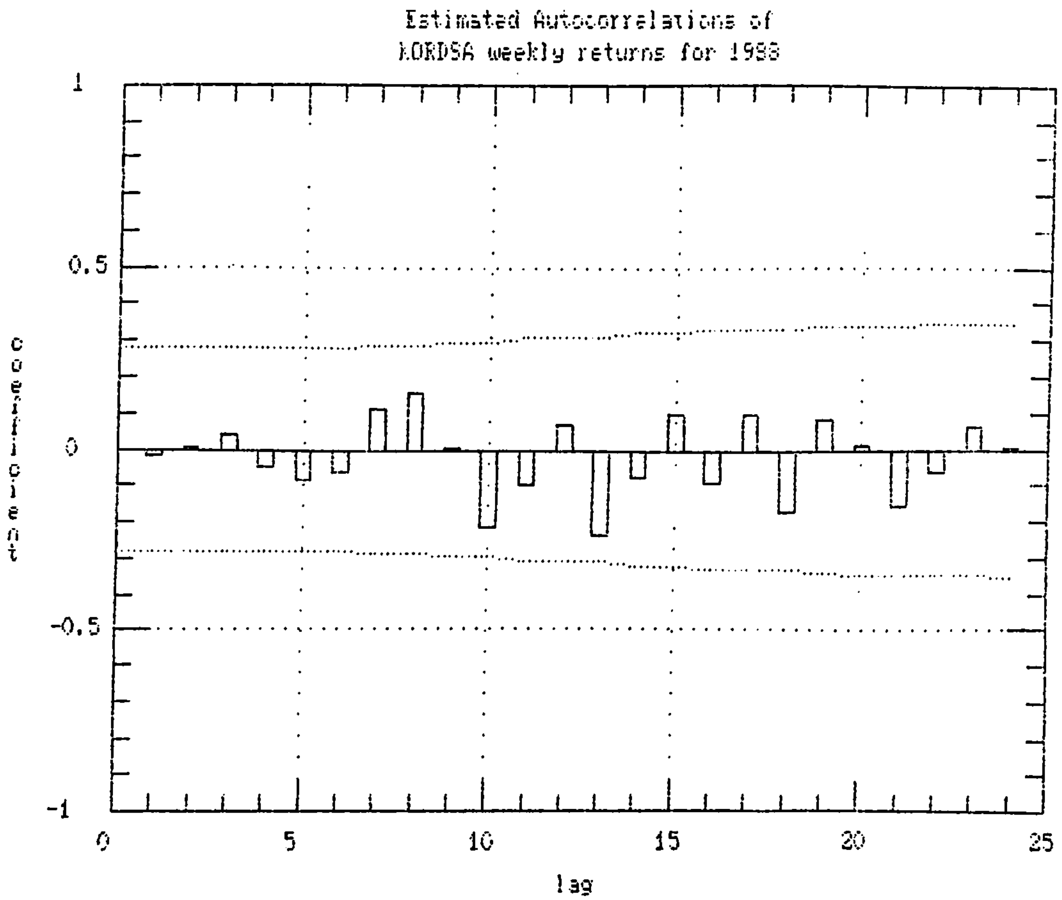
Estimated autocorrelations for D:KORDSA.rate1 (1986)

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	-.19751	.13868	2	-.01356	.14398
3	-.01085	.14401	4	-.15514	.14402
5	-.03762	.14720	6	-.00274	.14739
7	-.21919	.14739	8	.00755	.15353
9	.23778	.15354	10	.03726	.16046
11	-.01724	.16063	12	.20292	.16066
13	-.23800	.16552	14	.06963	.17197
15	-.16059	.17252	16	-.02202	.17537
17	-.12328	.17542	18	.04937	.17708
19	-.18366	.17734	20	.25776	.18096
21	.10118	.18789	22	-.00850	.18894
23	.06918	.18894	24	-.01802	.18943



Estimated autocorrelations for D:KORDSA.rate2 (1987)

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.25133	.13868	2	.10044	.14717
3	.05761	.14849	4	-.03523	.14892
5	-.07142	.14908	6	.00469	.14973
7	.24265	.14974	8	-.02107	.15712
9	.03389	.15717	10	-.07852	.15731
11	-.19410	.15806	12	-.19621	.16258
13	-.23449	.16707	14	-.15963	.17329
15	-.21485	.17609	16	-.11441	.18106
17	-.09606	.18245	18	-.00355	.18342
19	.11872	.18342	20	.01354	.18489
21	-.06591	.18491	22	-.09310	.18536
23	.04311	.18626	24	-.05053	.18645

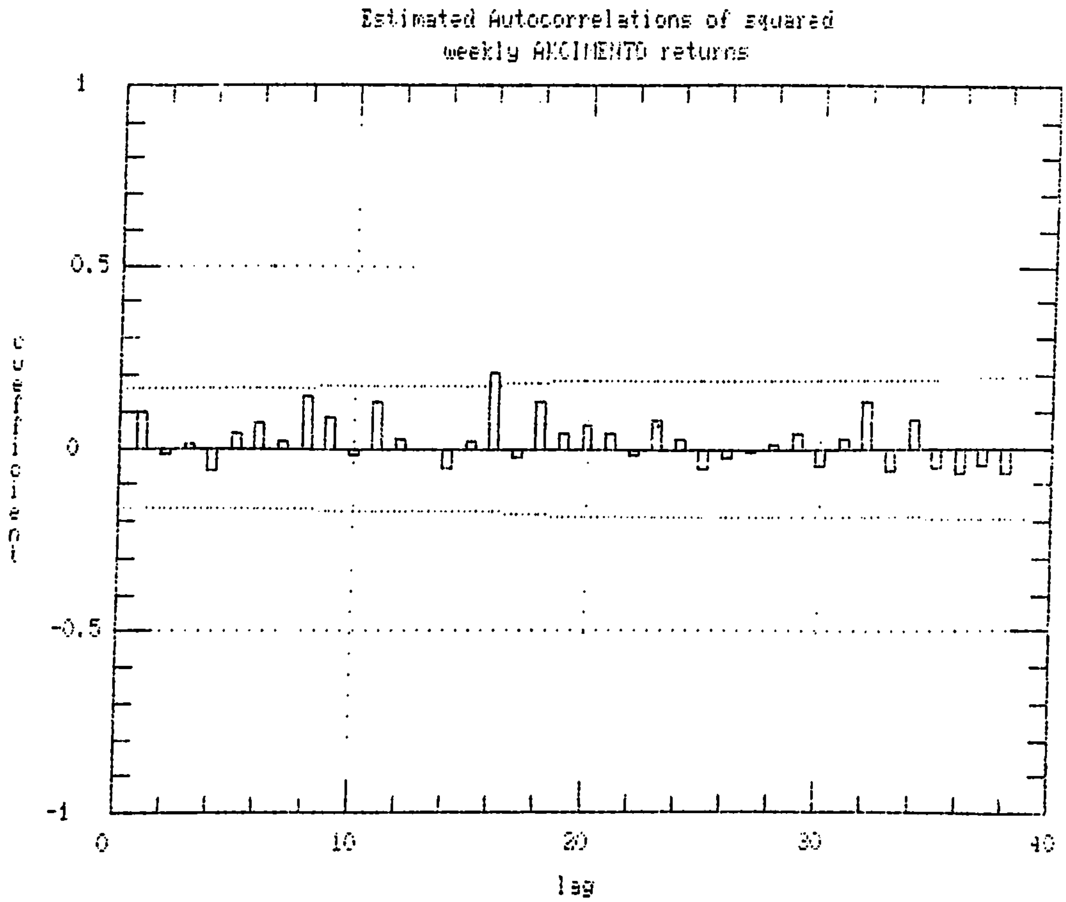


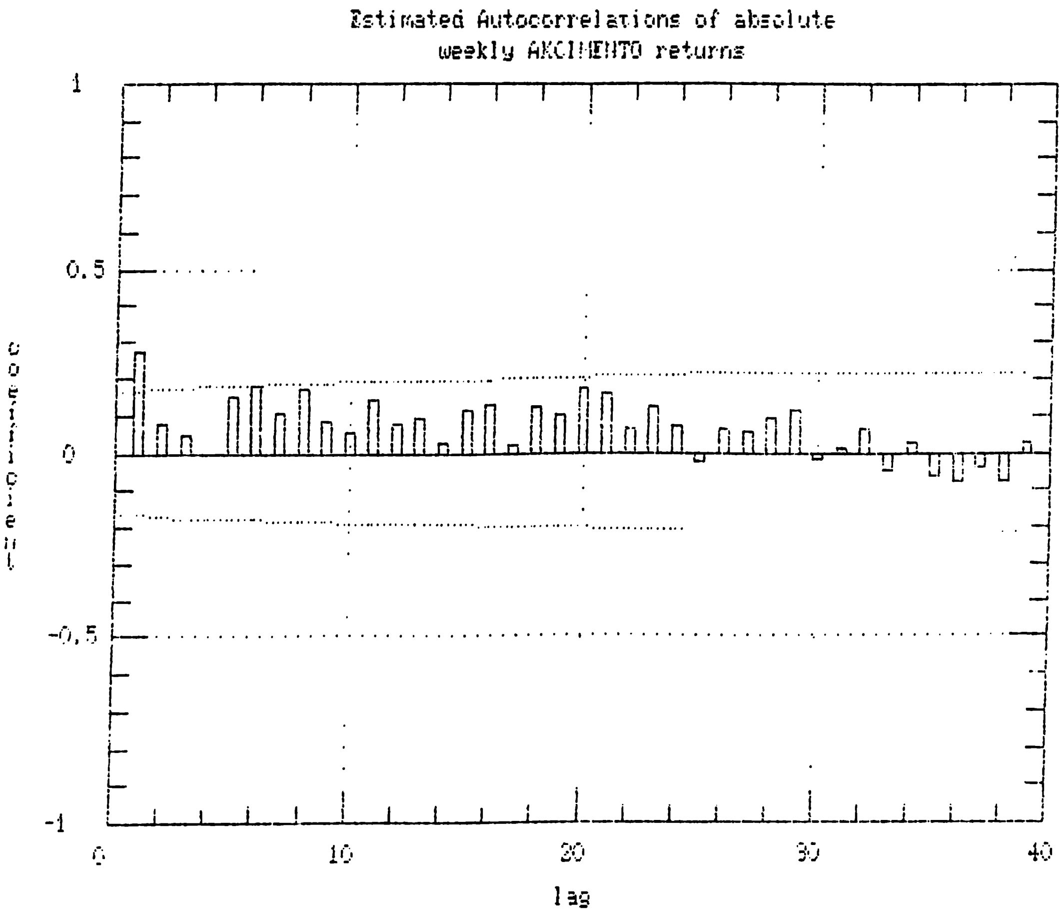
Estimated autocorrelations for D:KORDSA.rate3 (1988)

Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	-.01829	.14003	2	.00349	.14007
3	.04192	.14008	4	-.04801	.14032
5	-.08467	.14064	6	-.06515	.14164
7	.11626	.14223	8	.15871	.14408
9	.00157	.14747	10	-.21729	.14747
11	-.10032	.15362	12	.06732	.15490
13	-.23947	.15547	14	-.07719	.16254
15	.09607	.16326	16	-.09394	.16436
17	.09854	.16541	18	-.17252	.16656
19	.08057	.17003	20	.00967	.17077
21	-.15444	.17078	22	-.05809	.17350
23	.06516	.17388	24	.00013	.17436

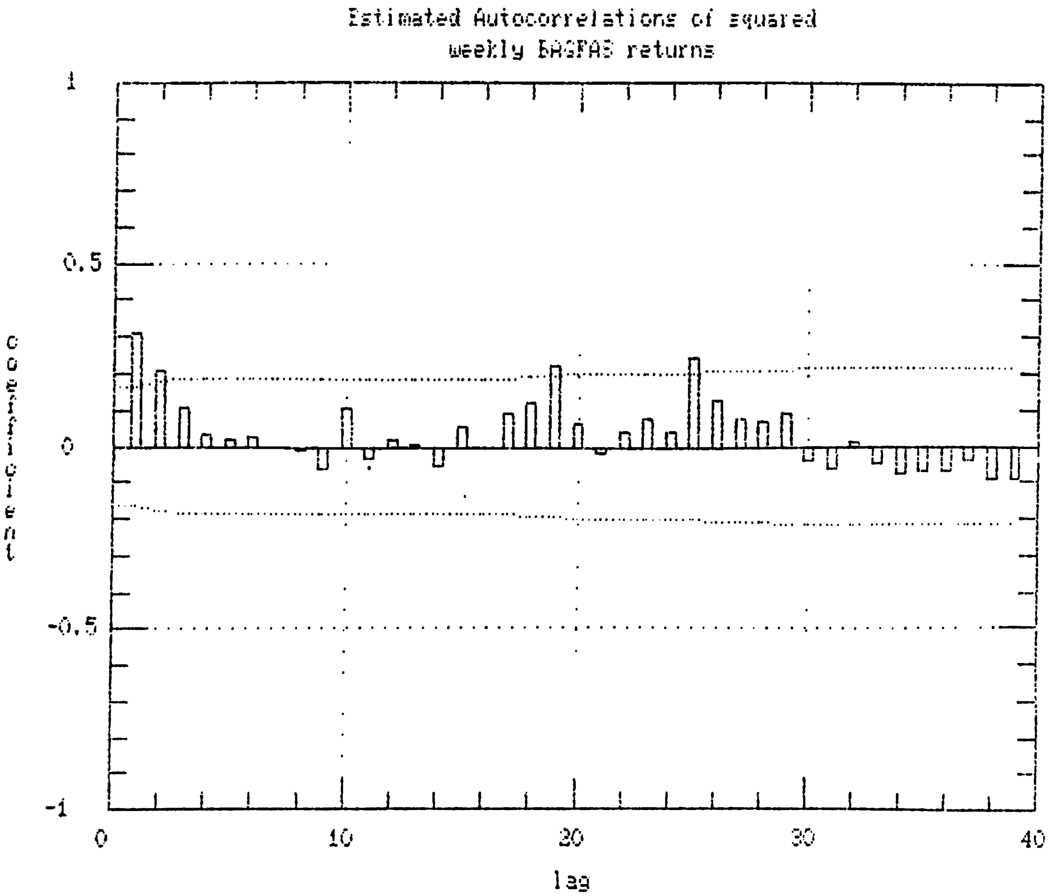
A P P E N D I X - G

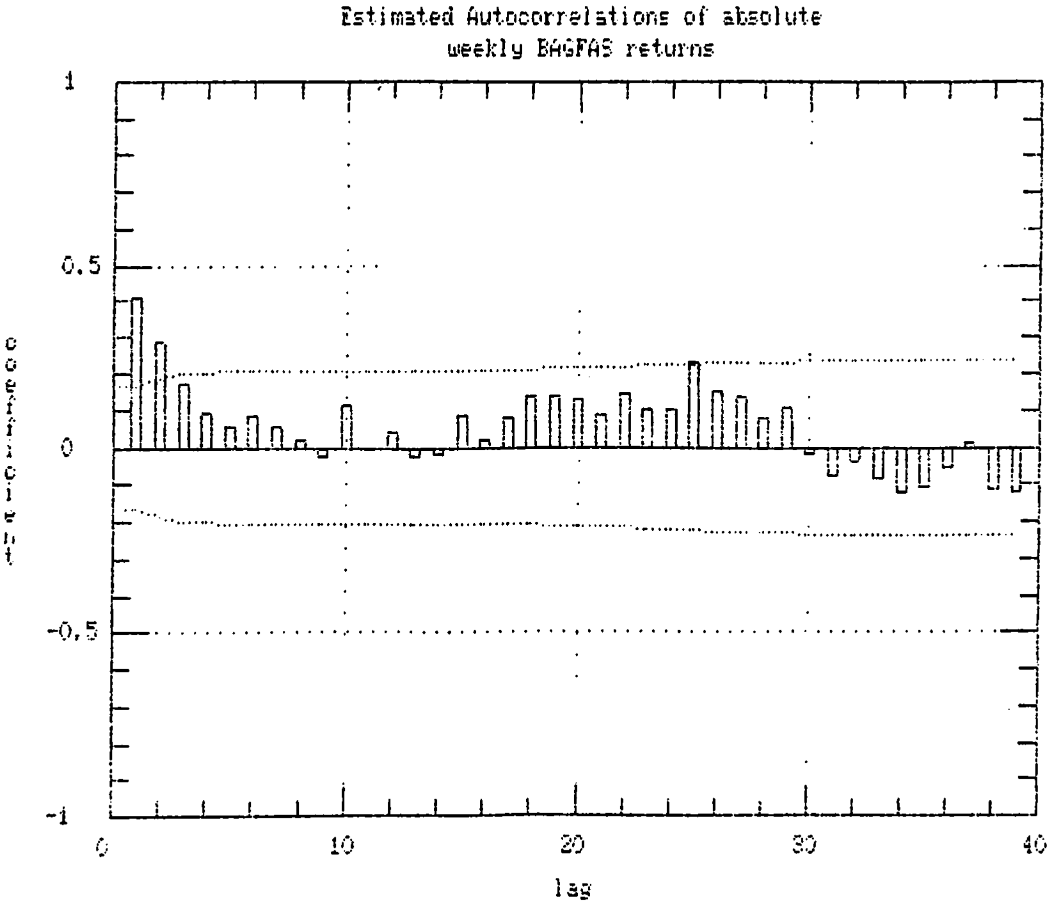
Autocorrelation Estimates for Absolute and Squared Returns of the 15 Common Stocks. The plots Indicate a Second Order Dependence on Weekly Returns.

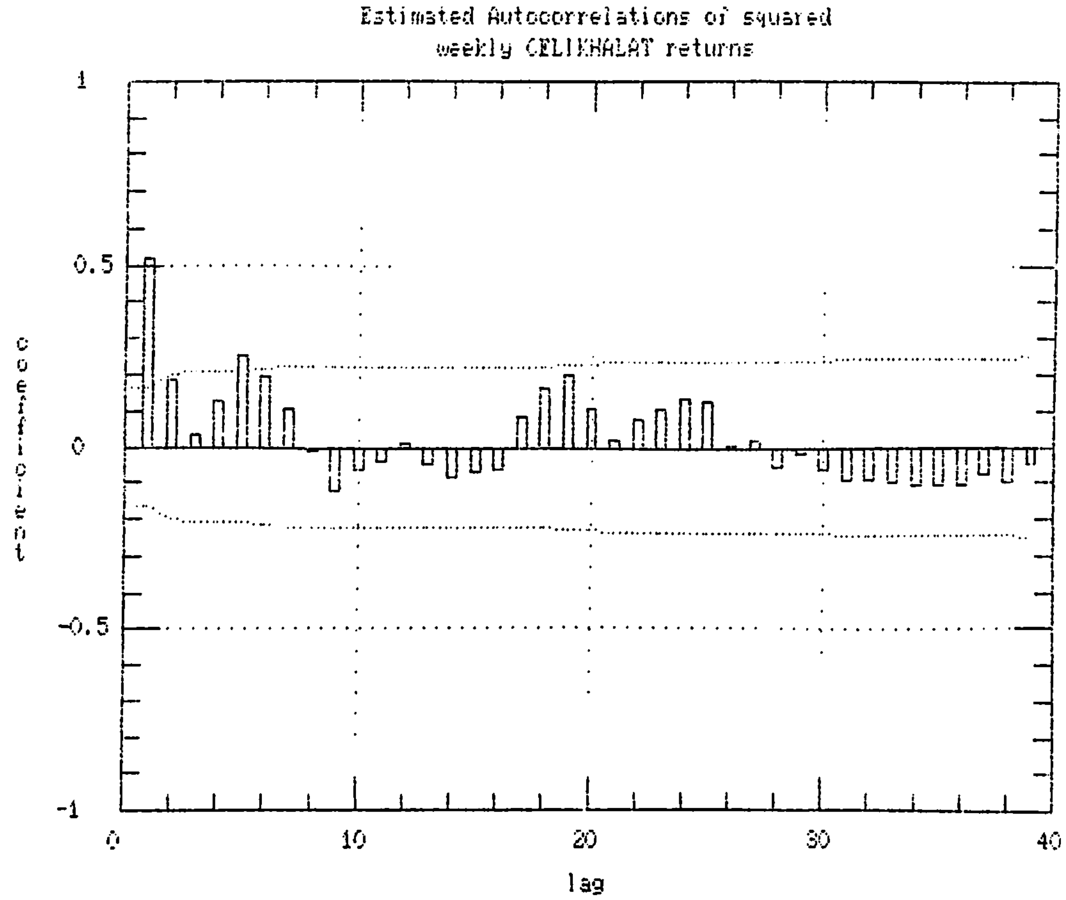

Estimated Autocorrelations of squared
weekly AKCIMENTO returns
1
0.5
0
-0.5
-1
0
10
20
30
40
lag
coefficient

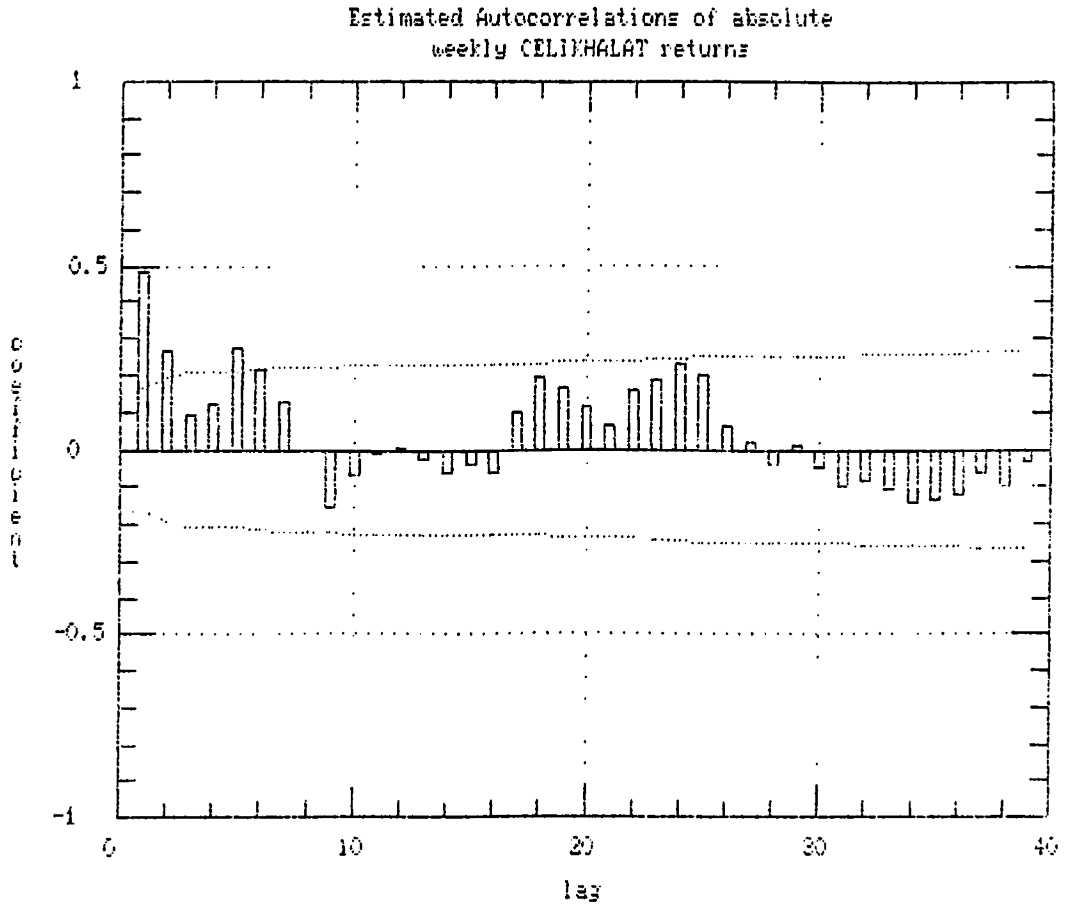

Estimated Autocorrelations of absolute
weekly AKCIMENTO returns
1
0.5
0
-0.5
-1
0
10
20
30
40
lag
coefficient

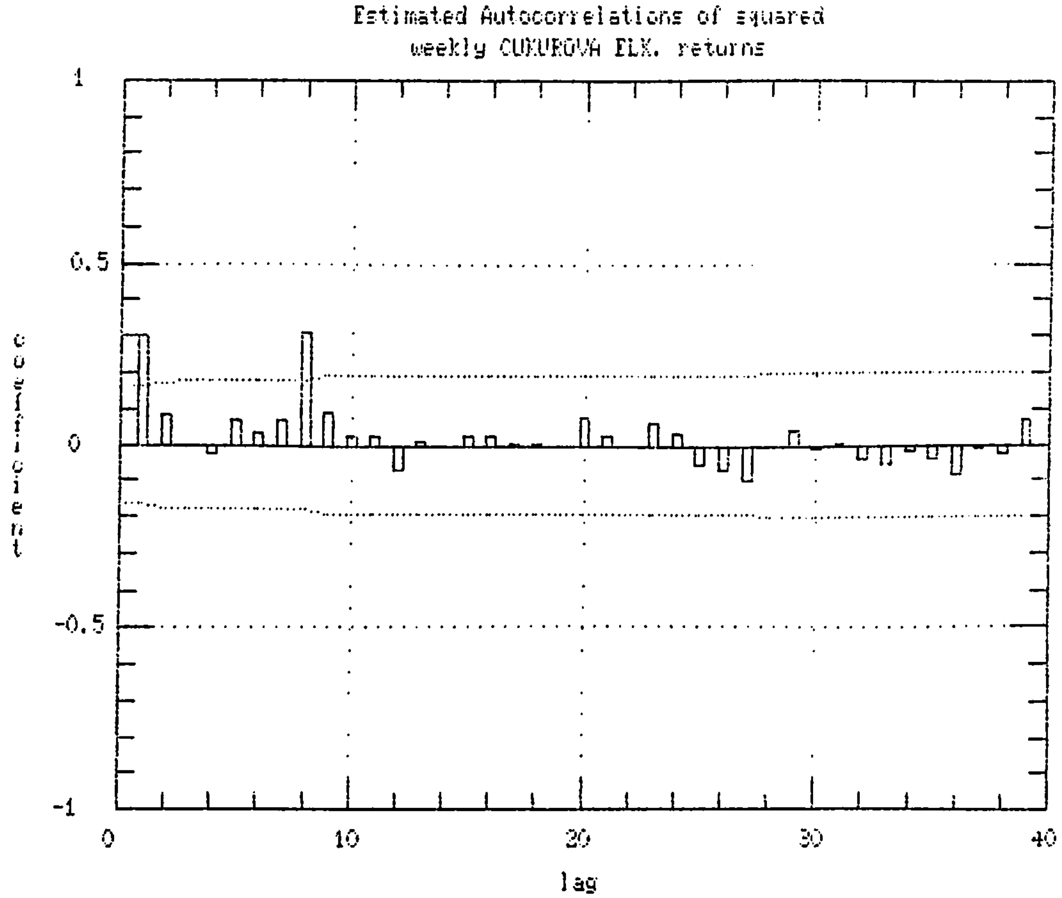
GI

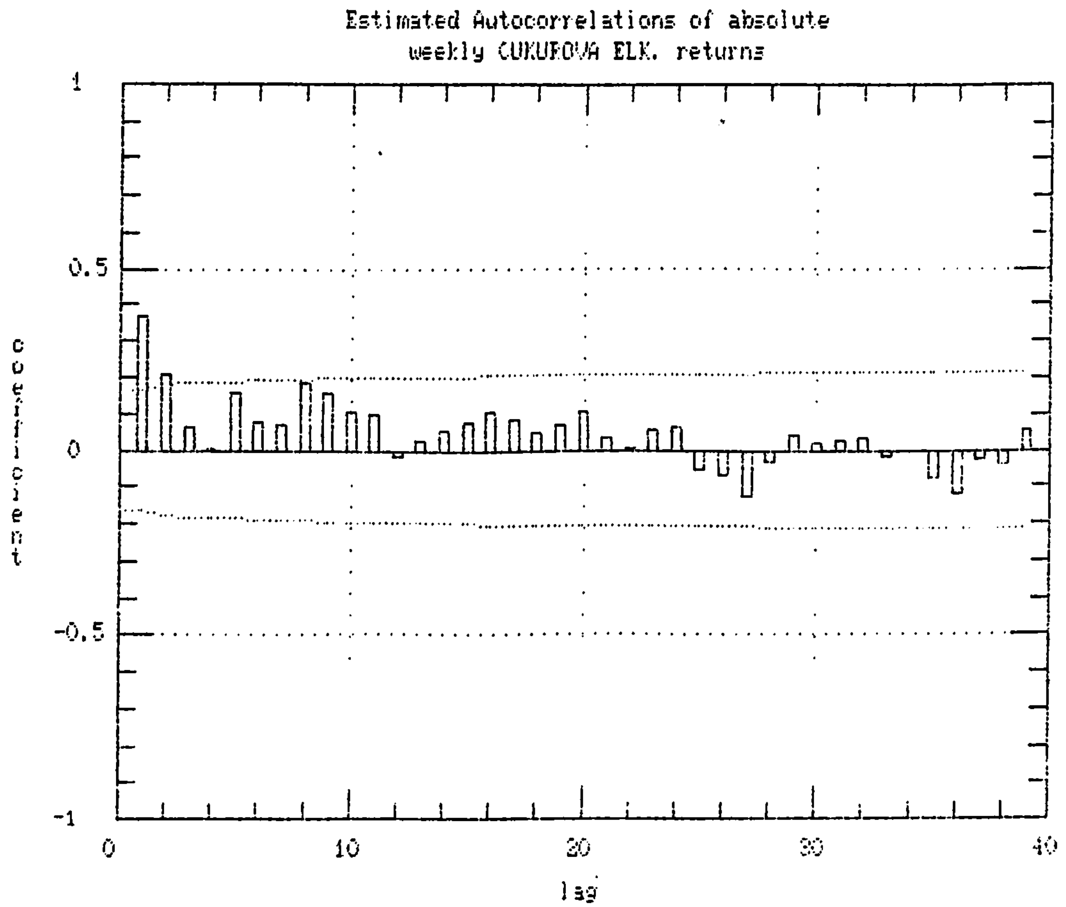

Estimated Autocorrelations of squared
weekly BAGFAS returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

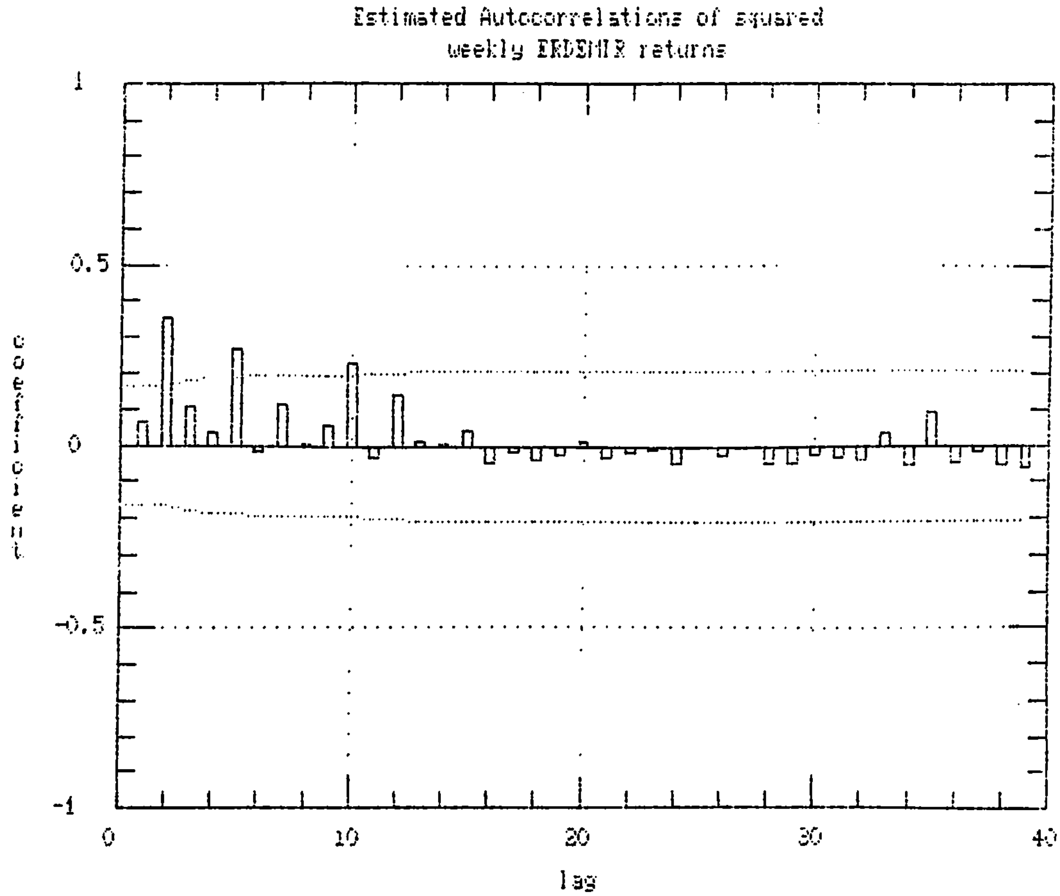

Estimated Autocorrelations of absolute
weekly BAGFAS returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag


Estimated Autocorrelations of squared
weekly CELIKHALAT returns
coefficient
lag
1
0.5
0
-0.5
-1
0
10
20
30
40

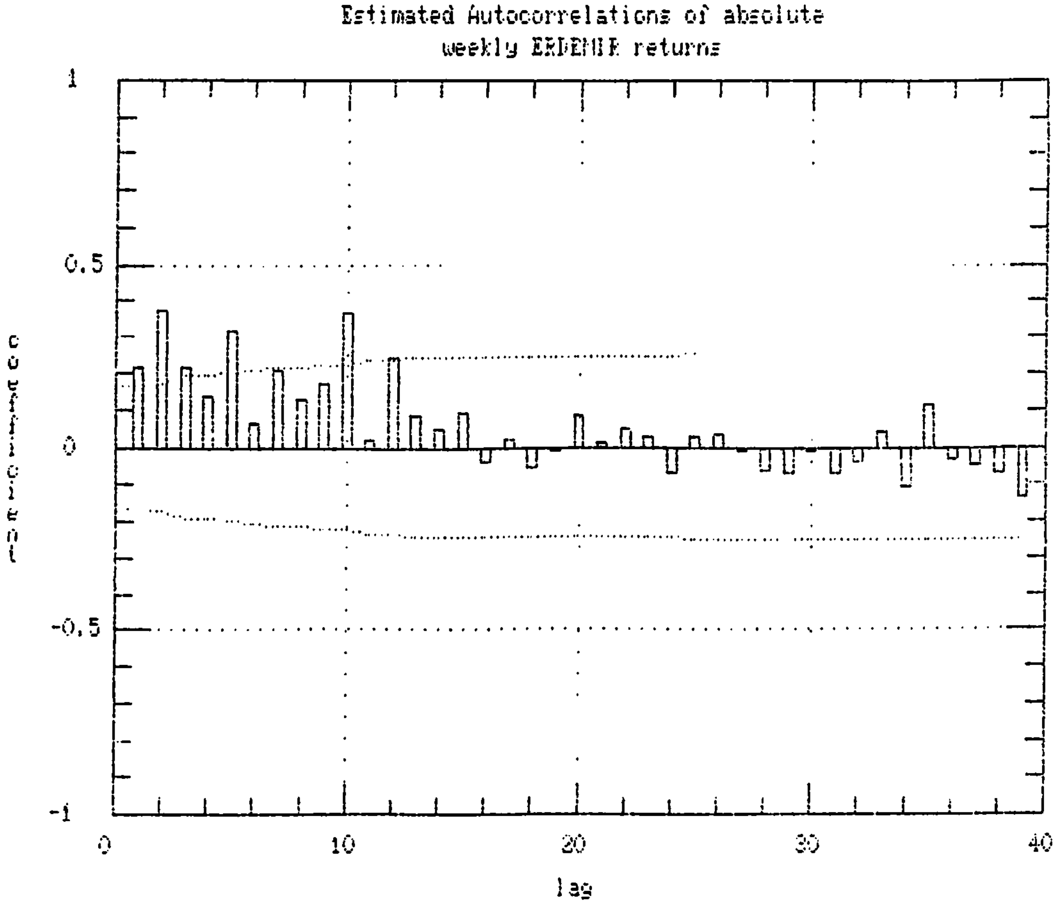

Estimated Autocorrelations of absolute
weekly CELIKHALAT returns
coefficient
lag
1
0.5
0
-0.5
-1
0
10
20
30
40


Estimated Autocorrelations of squared
weekly CUKUROVA ELK. returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

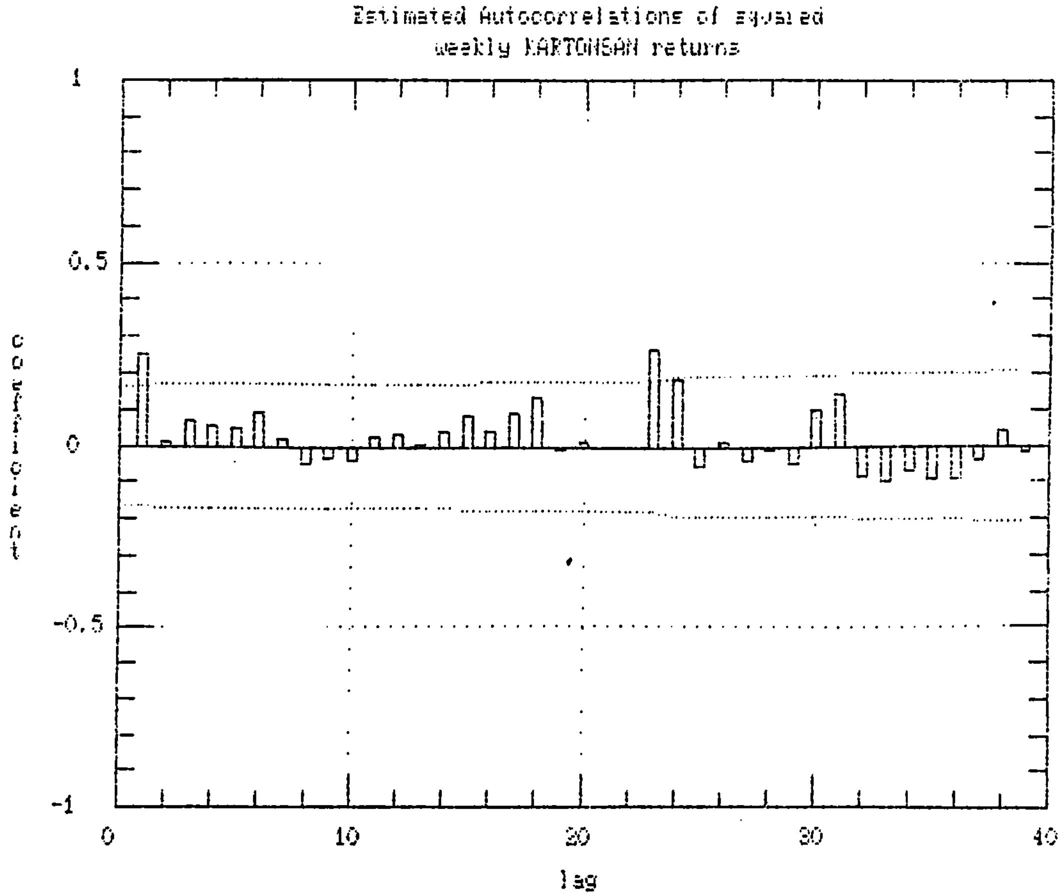

Estimated Autocorrelations of absolute
weekly CUKUROVA ELK. returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

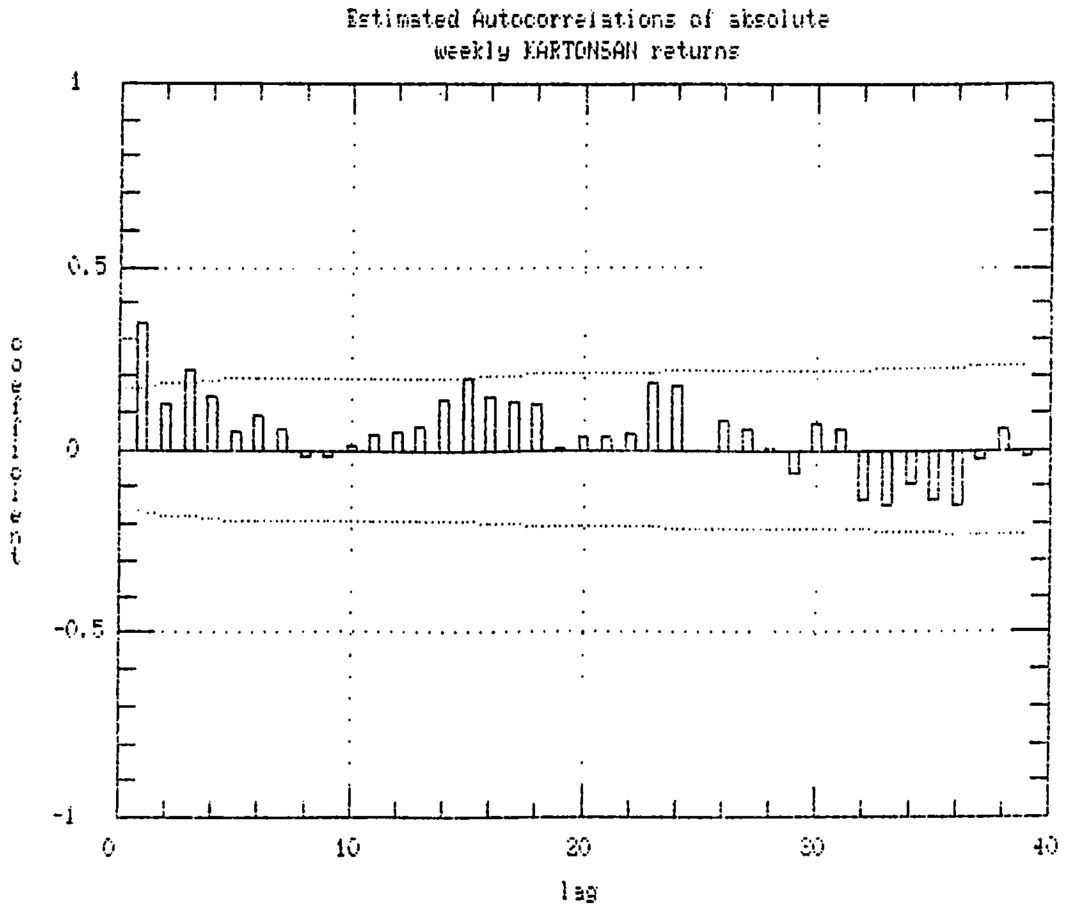


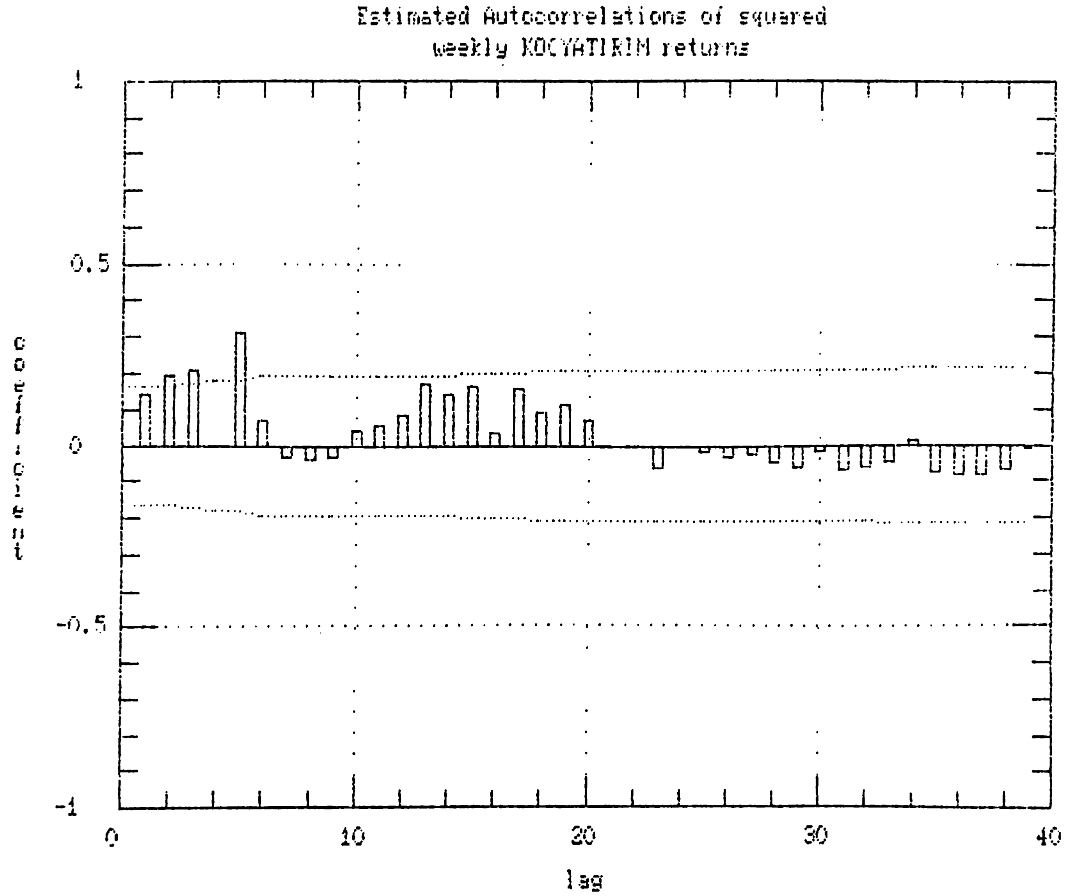
Estimated Autocorrelations of squared
weekly ERDEMIR returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag



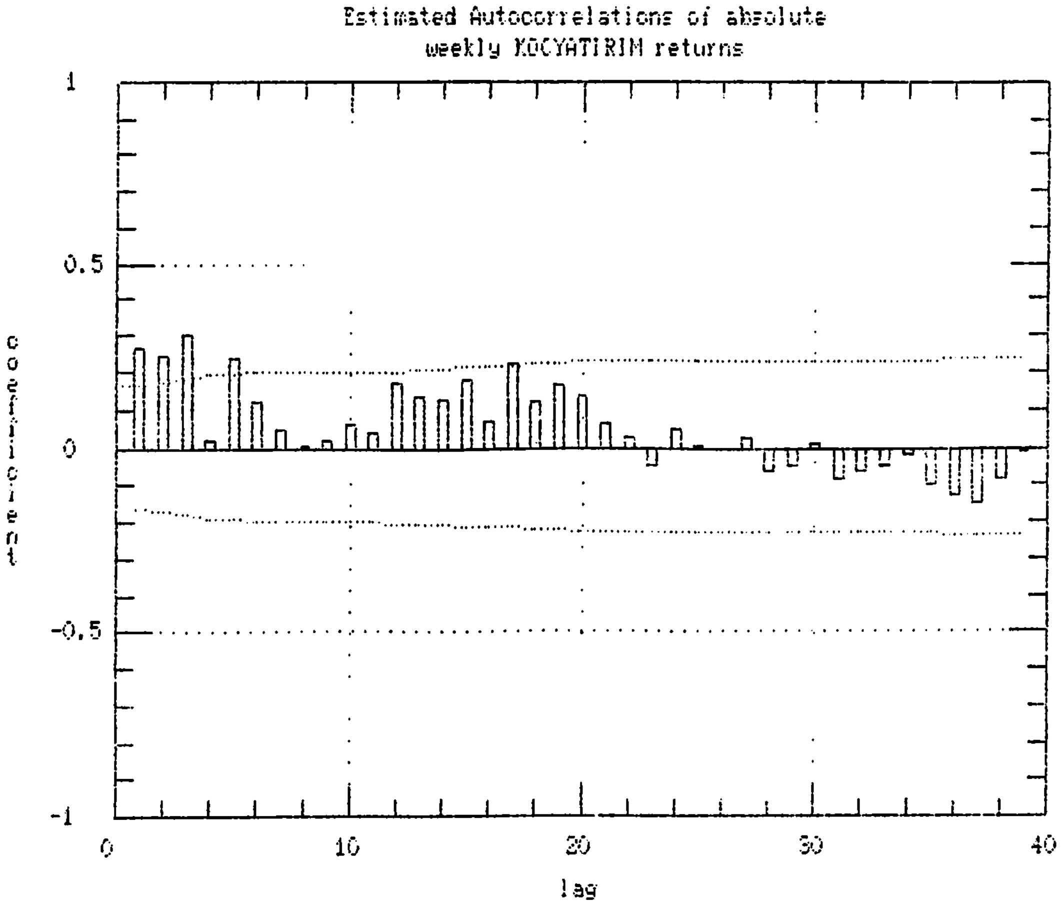
Estimated Autocorrelations of absolute
weekly ERDEMIR returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag


Estimated Autocorrelations of squared
weekly KARTONSAN returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag


Estimated Autocorrelations of absolute
weekly KARTONSAN returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

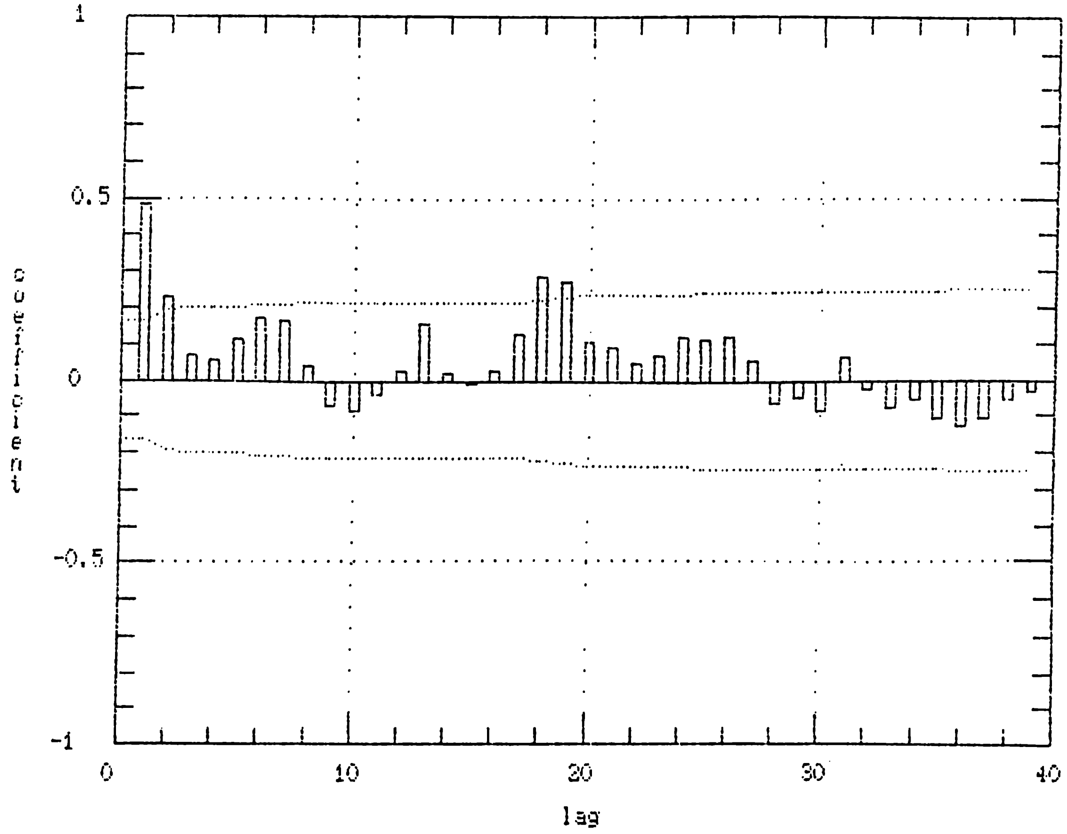


Estimated Autocorrelations of squared
weekly KOCYATIRIM returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

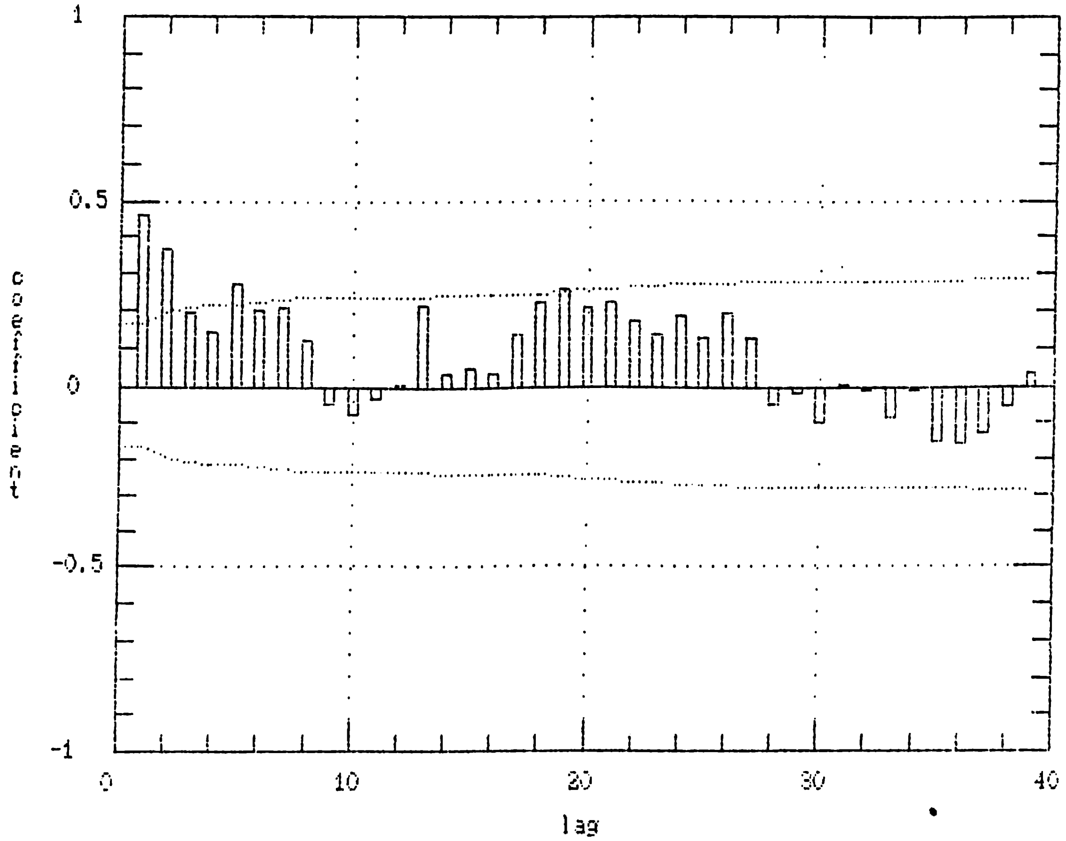


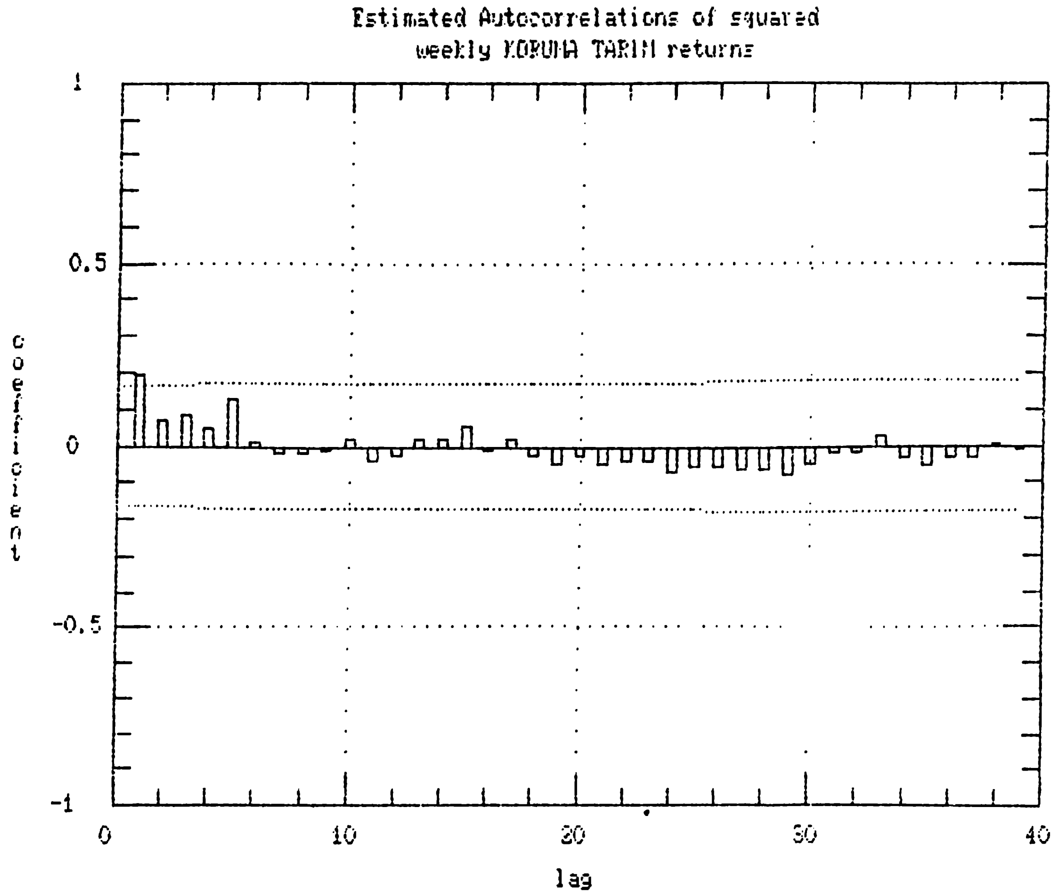
Estimated Autocorrelations of absolute
weekly KOCYATIRIM returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

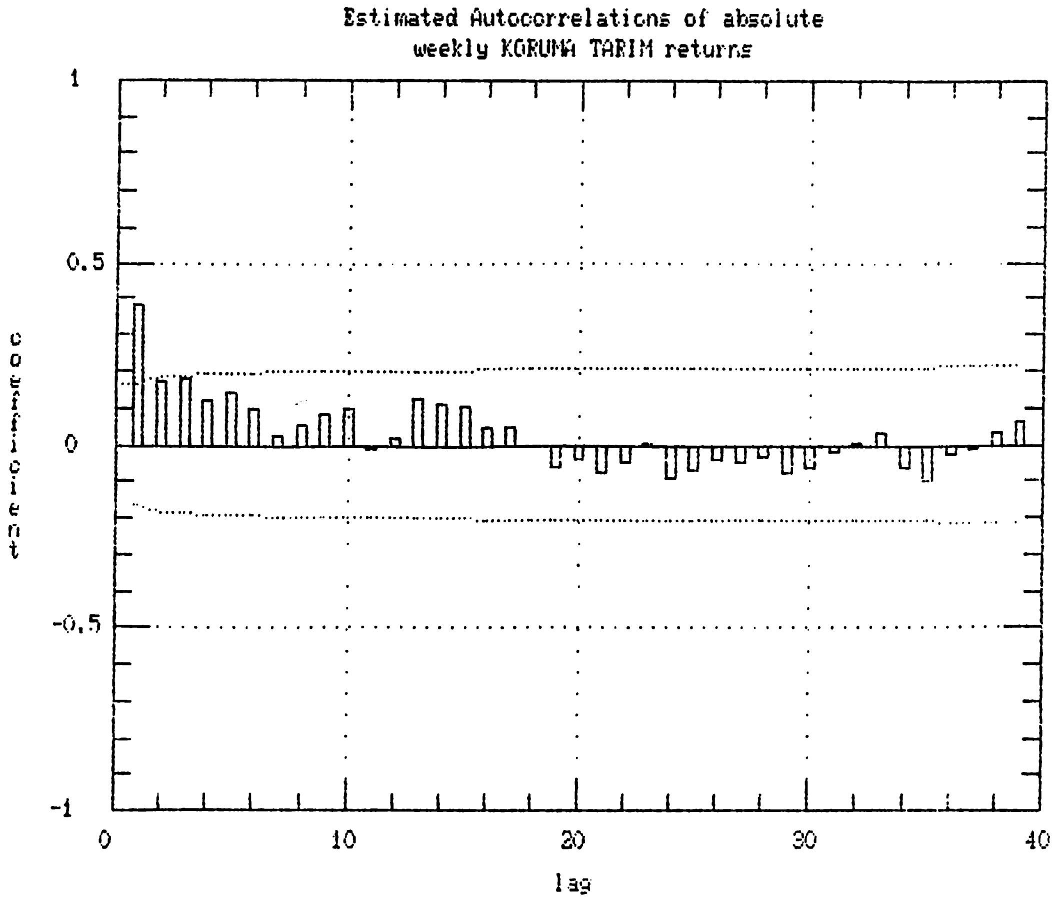
Estimated Autocorrelations of squared weekly KORDSA returns

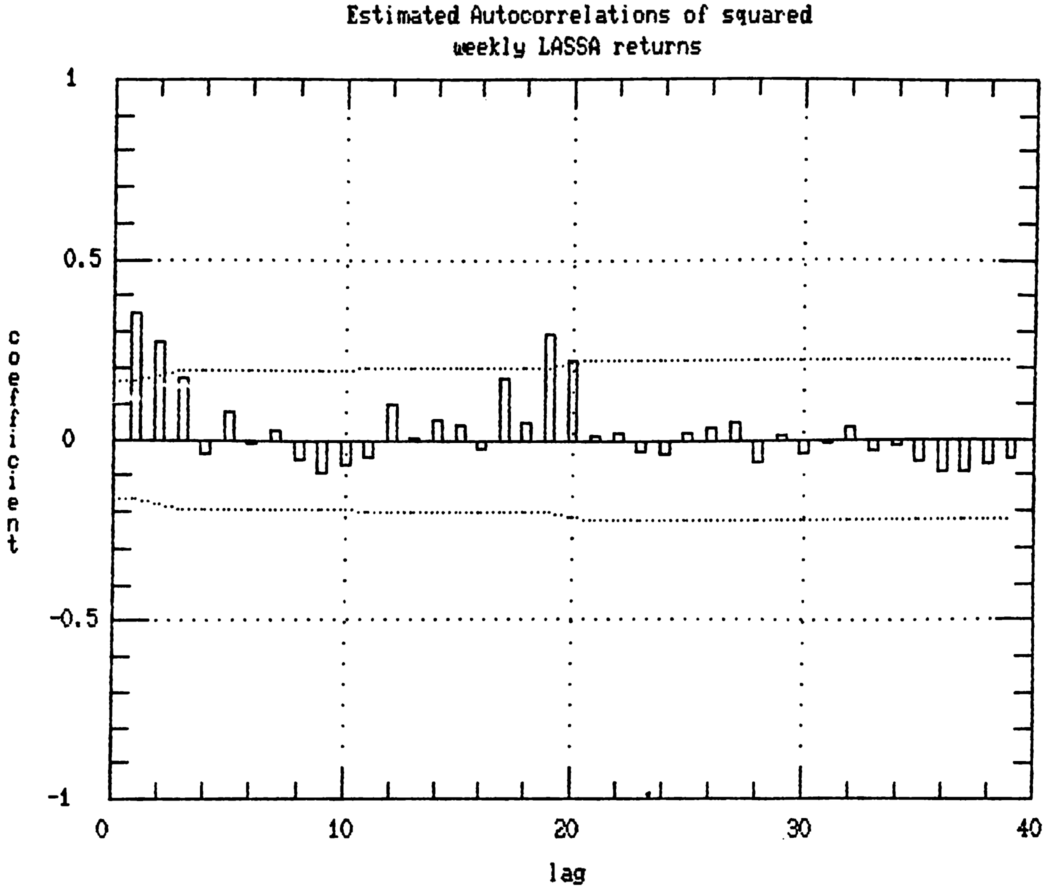


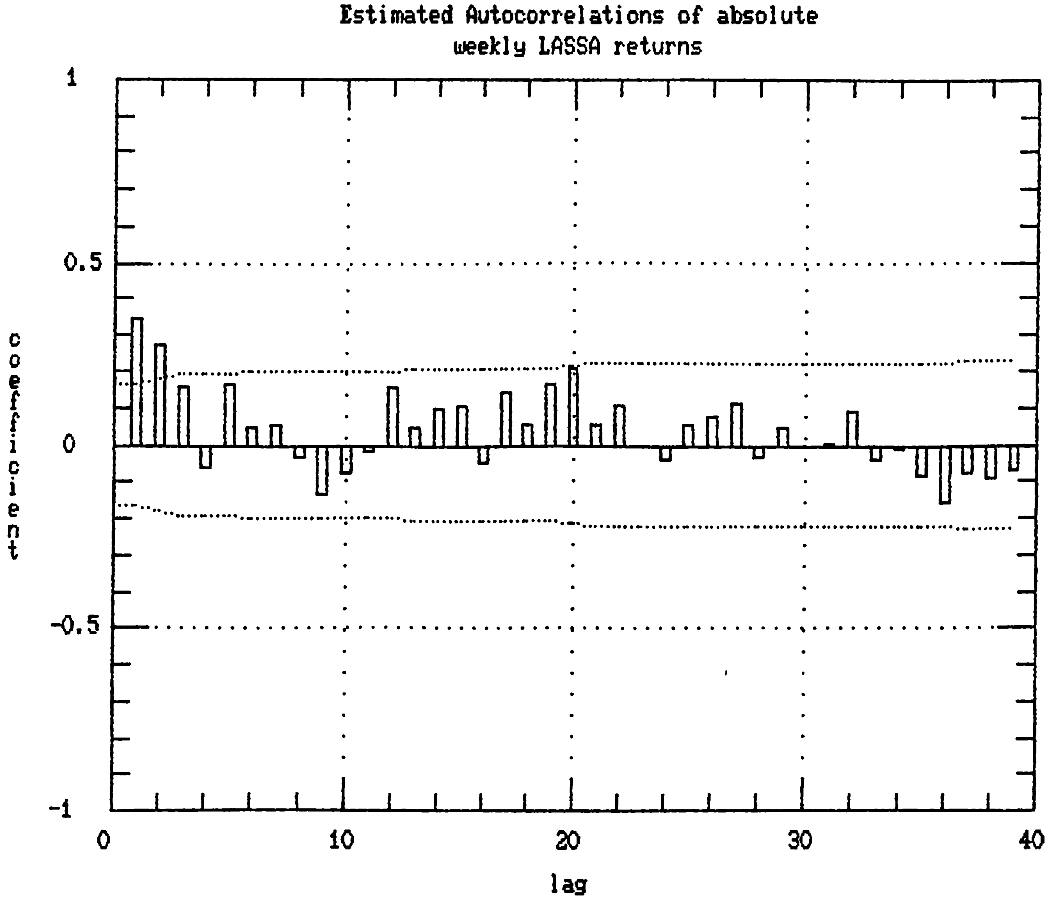
Estimated Autocorrelations of absolute weekly KORDSA returns




Estimated Autocorrelations of squared
weekly KORUMA TARIM returns
1
0.5
coefficient
0
-0.5
-1
0
10
20
30
40
lag

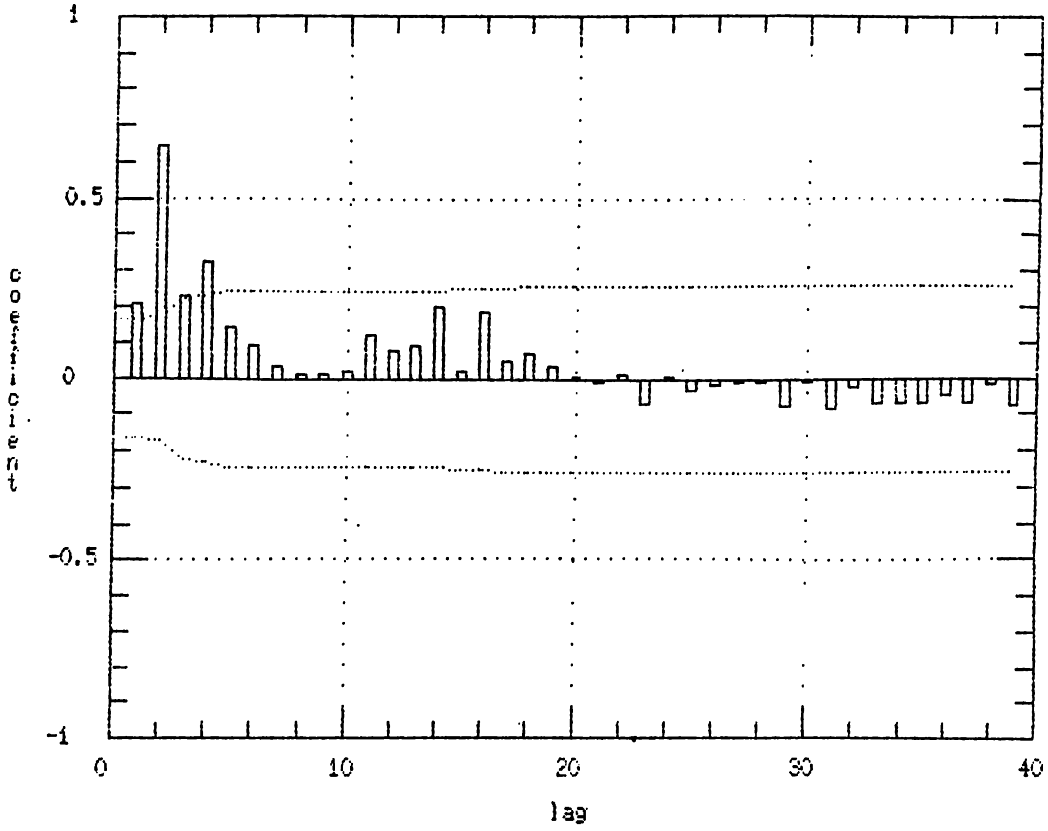

Estimated Autocorrelations of absolute
weekly KORUMA TARIM returns
1
0.5
coefficient
0
-0.5
-1
0
10
20
30
40
lag


Estimated Autocorrelations of squared
weekly LASSA returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

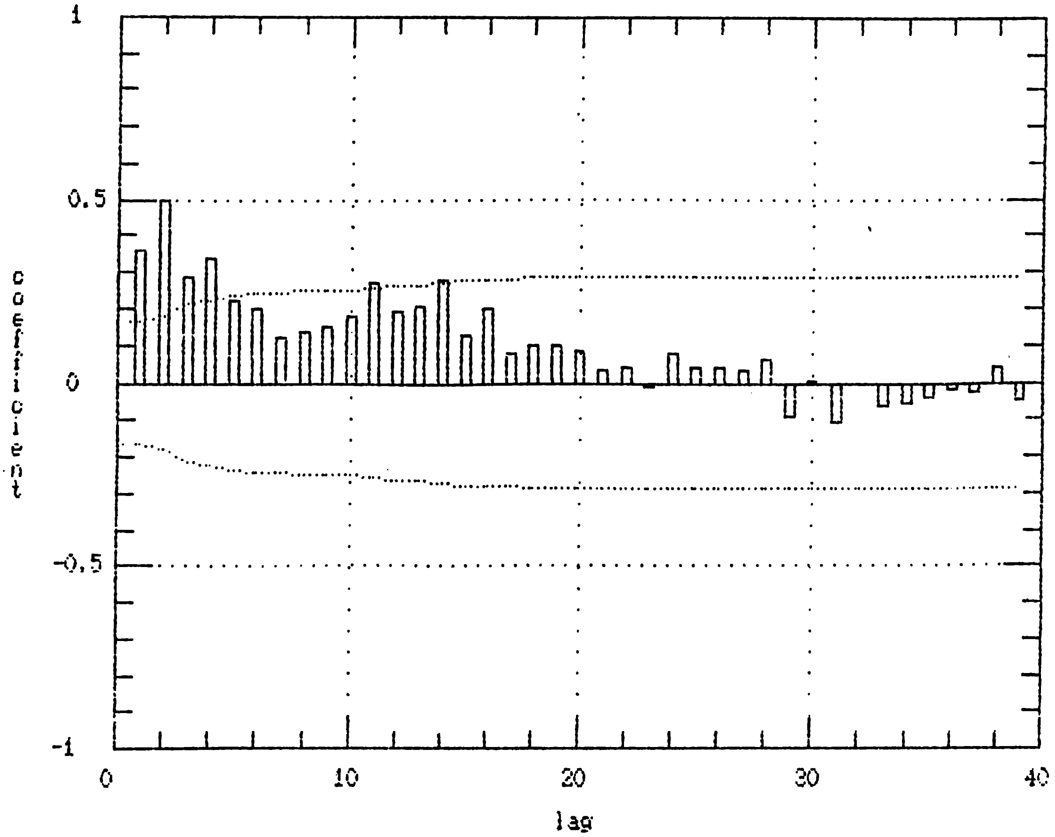

Estimated Autocorrelations of absolute
weekly LASSA returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

GIO

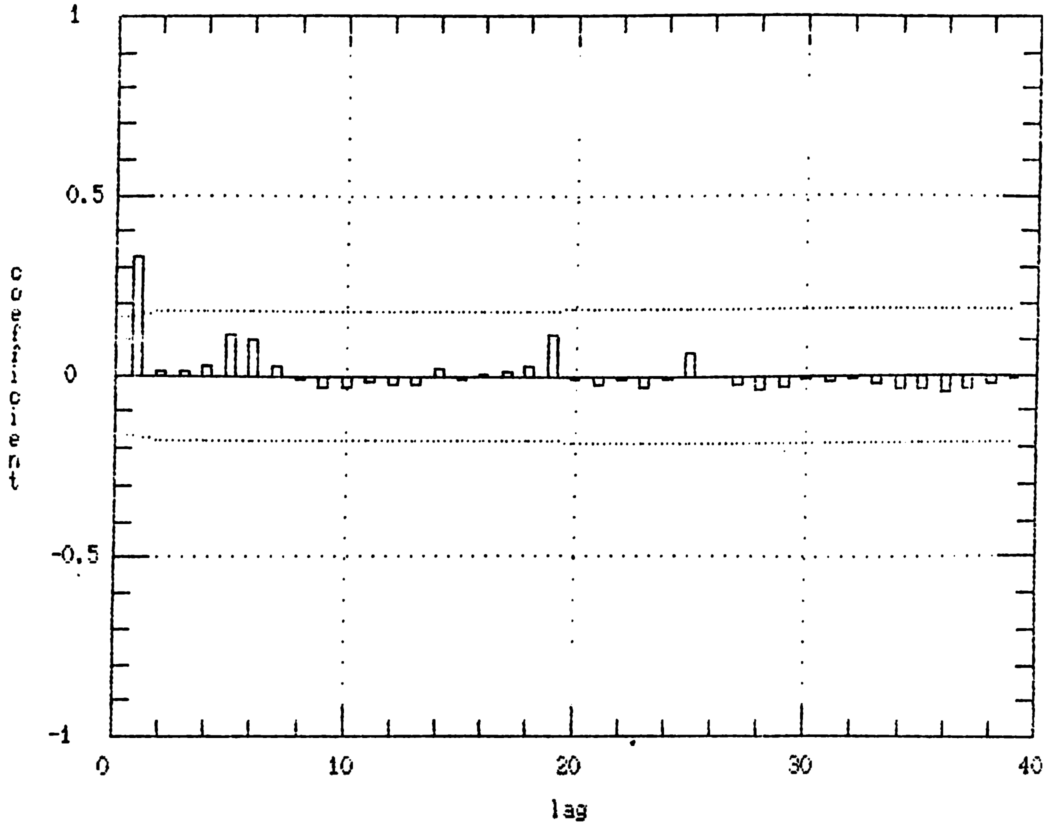
Estimated Autocorrelations of squared
weekly OTOSAN returns



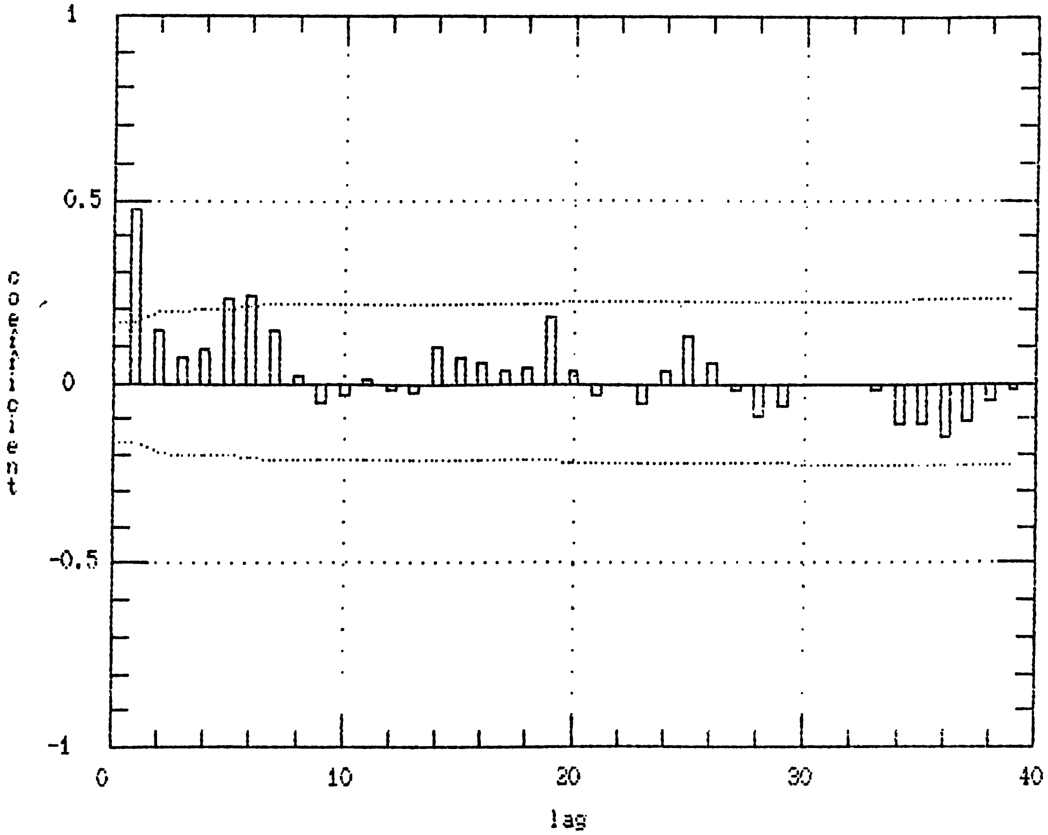
Estimated Autocorrelations of absolute
weekly OTOSAN returns



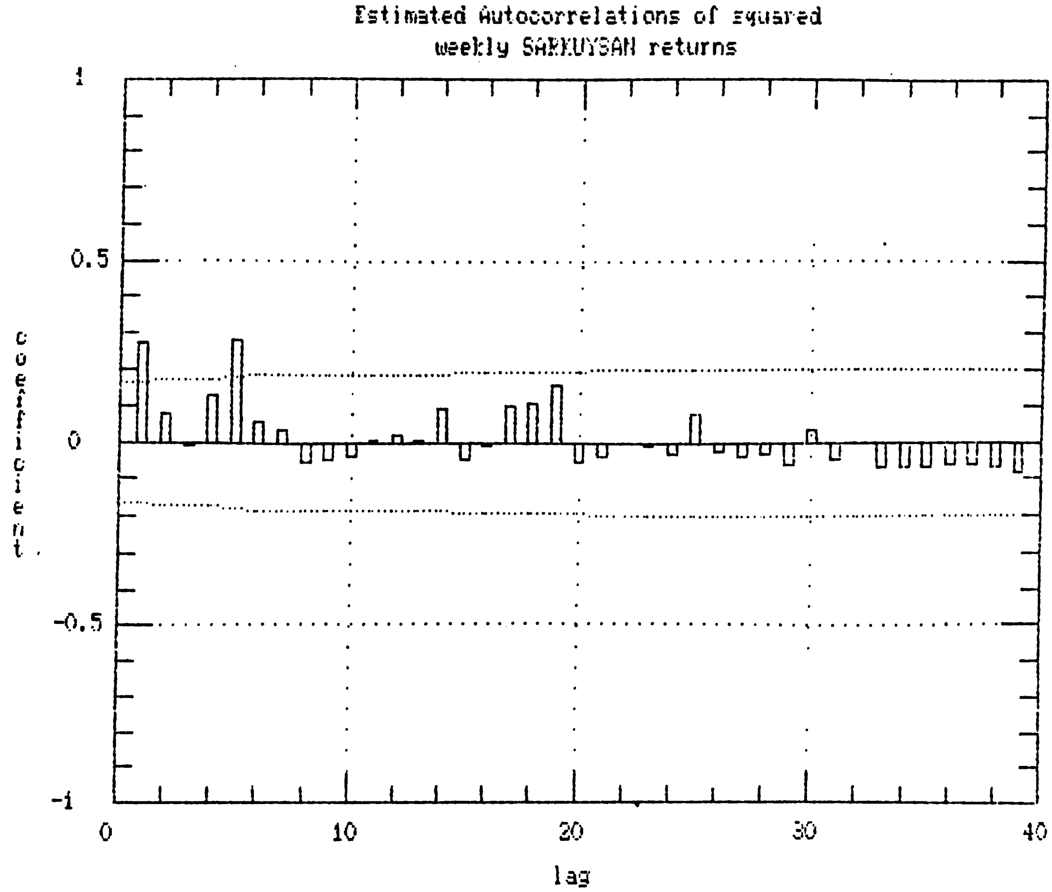
Estimated Autocorrelations of squared
weekly RABAK returns

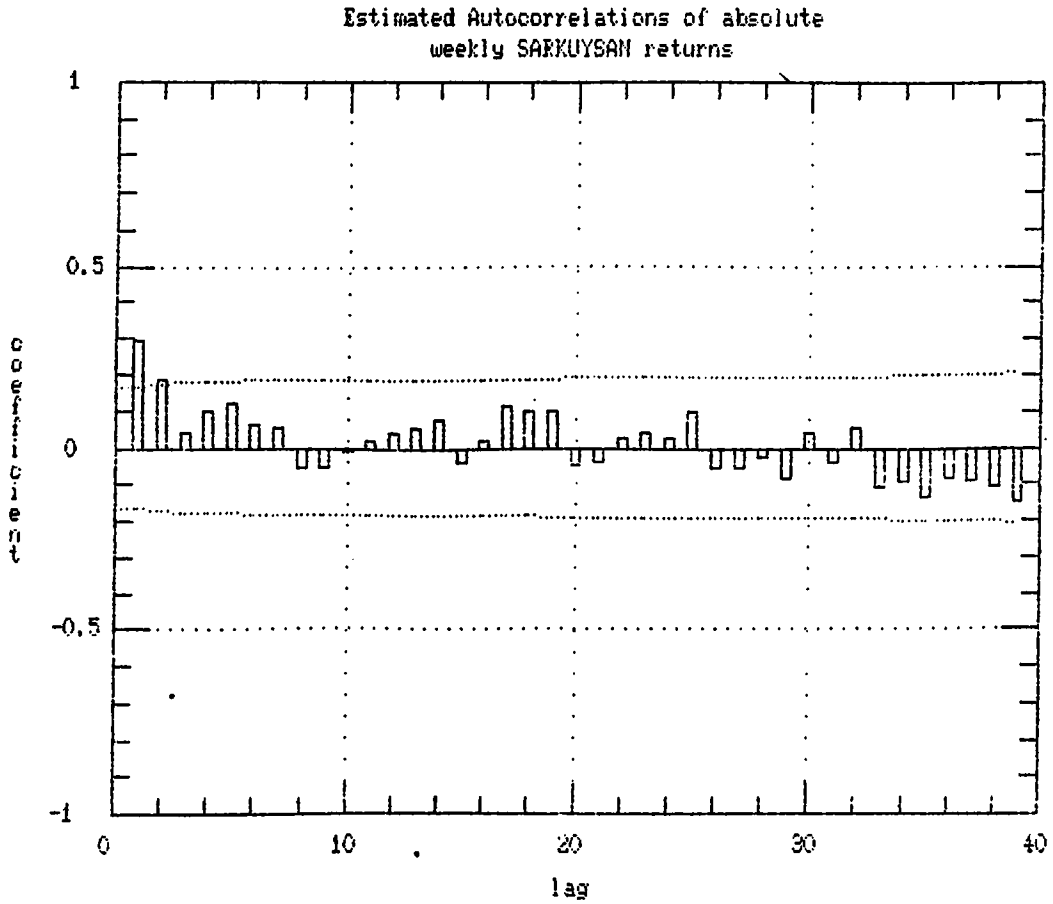


Estimated Autocorrelations of absolute
weekly RABAK returns

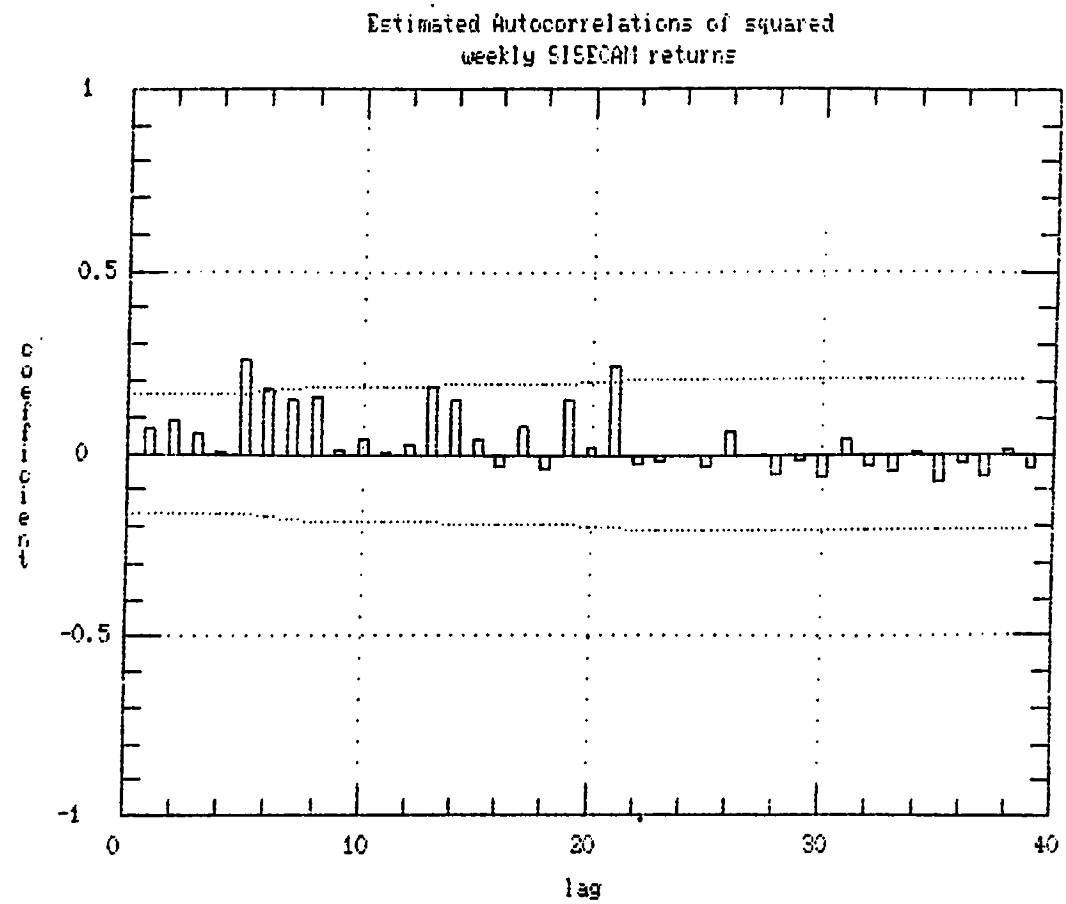


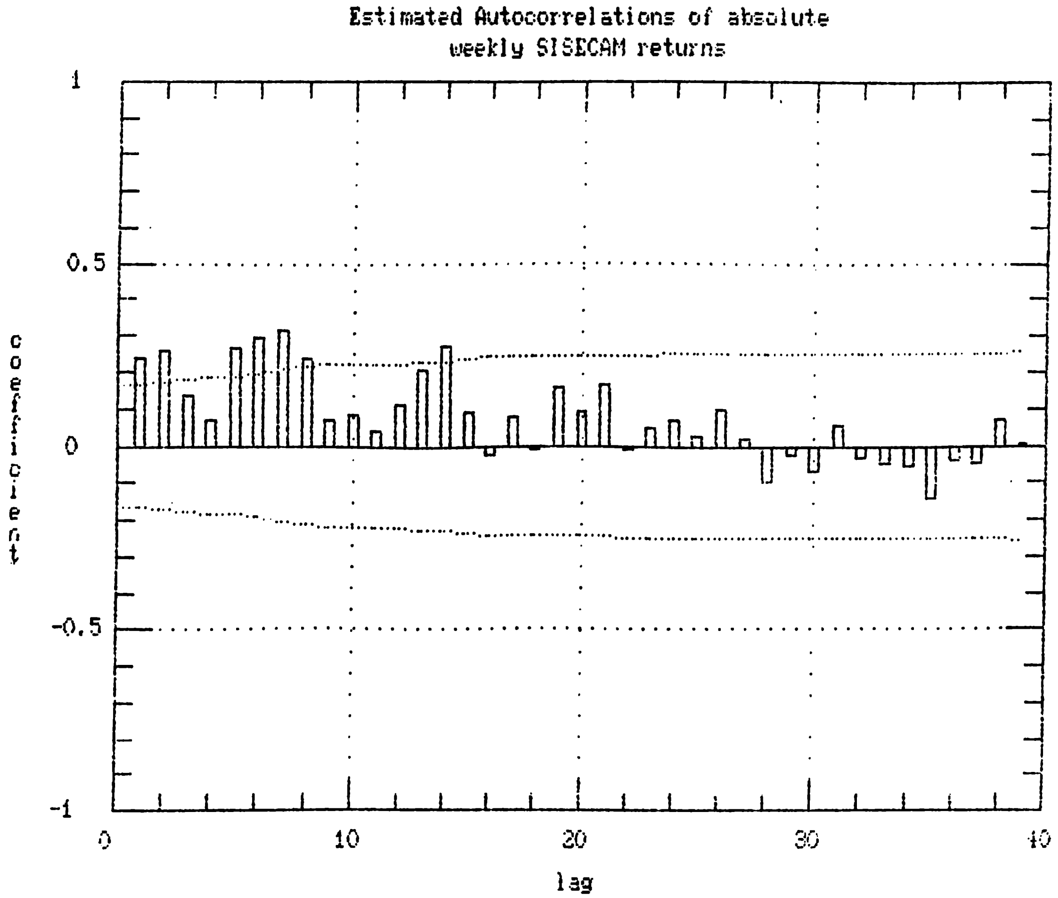
GI2


Estimated Autocorrelations of squared
weekly SARKUYSAN returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

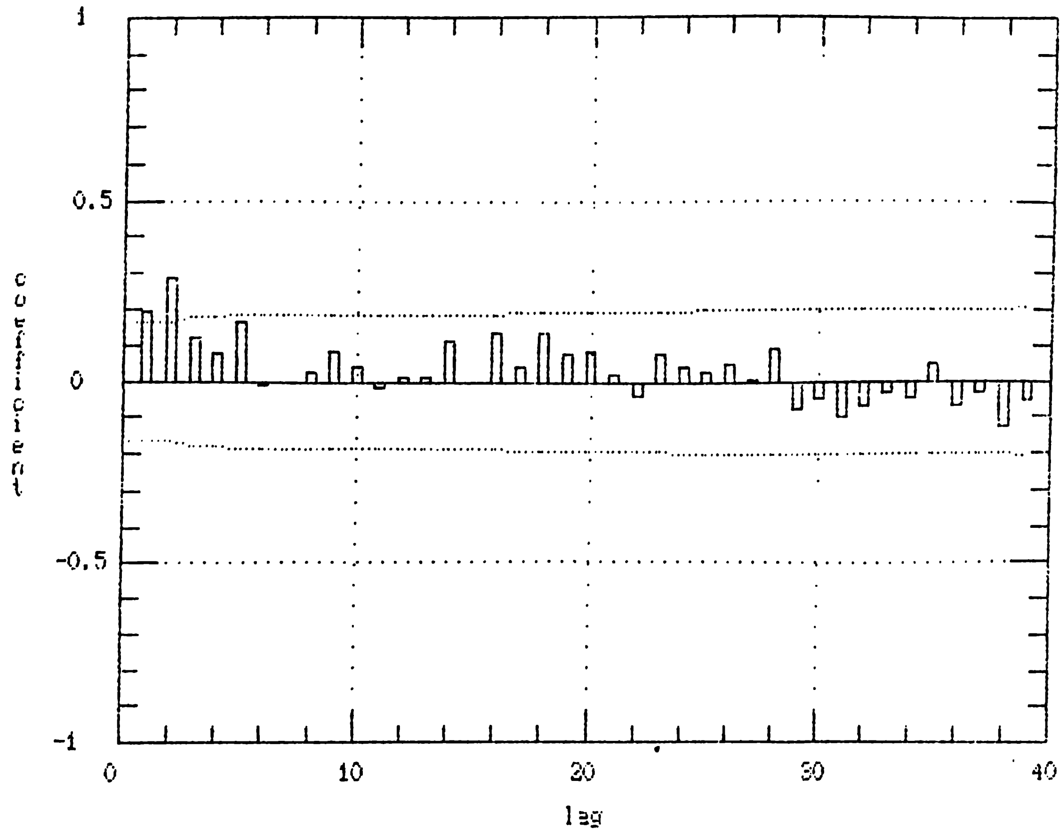

Estimated Autocorrelations of absolute
weekly SARKUYSAN returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

GI3

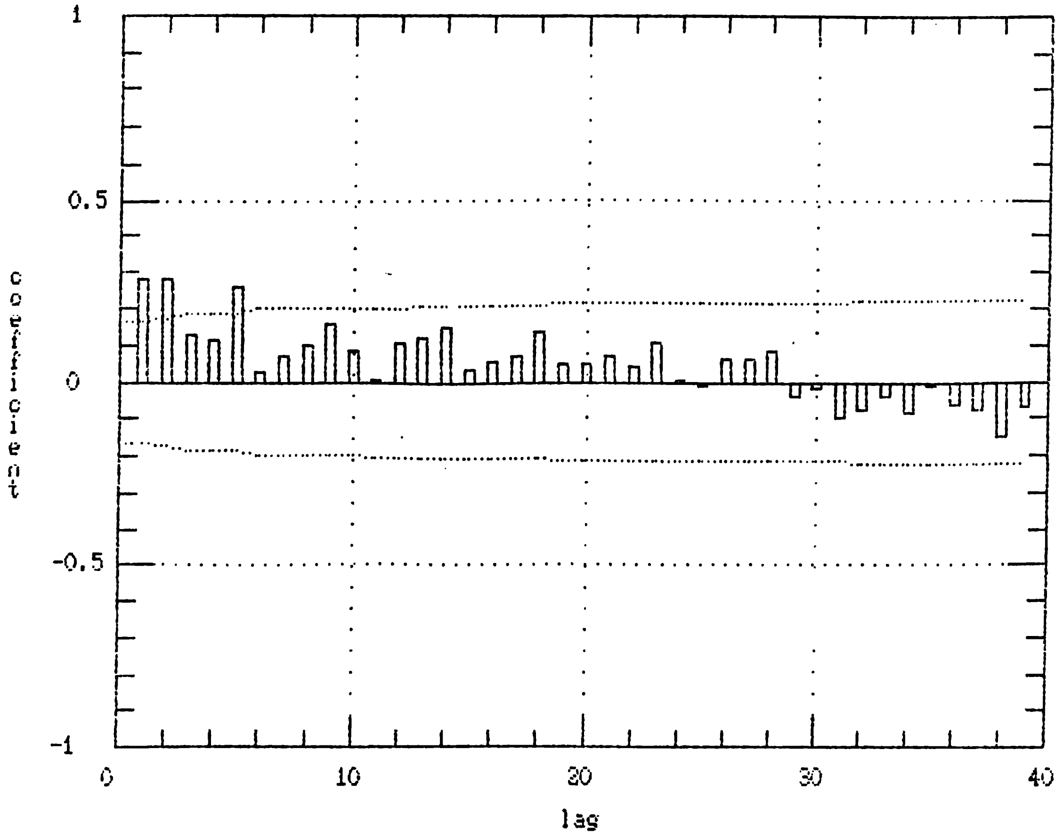

Estimated Autocorrelations of squared
weekly SISECAM returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag


Estimated Autocorrelations of absolute
weekly SISECAM returns
1
0.5
0
-0.5
-1
coefficient
0
10
20
30
40
lag

Estimated Autocorrelations of squared
weekly TURK DEMIRDOKUM returns



Estimated Autocorrelations of absolute
weekly TURK DEMIRDOKUM returns

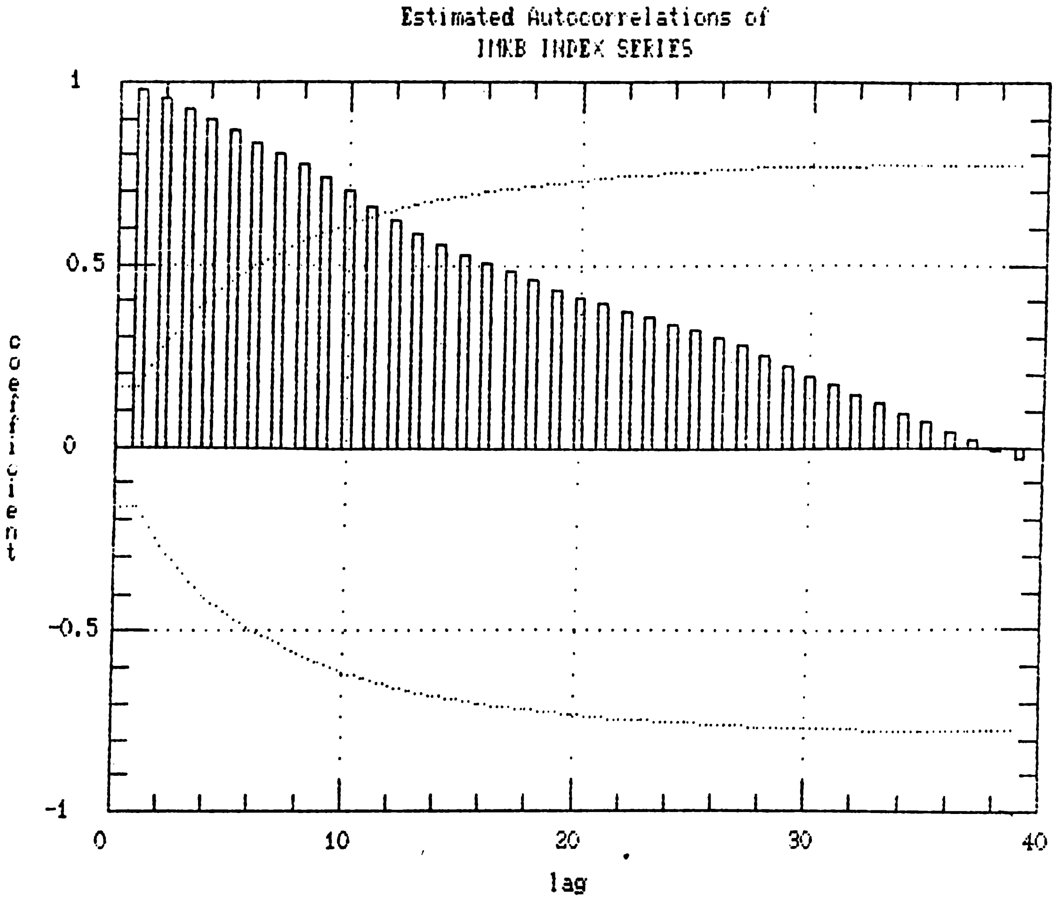


GI5

A P P E N D I X - H

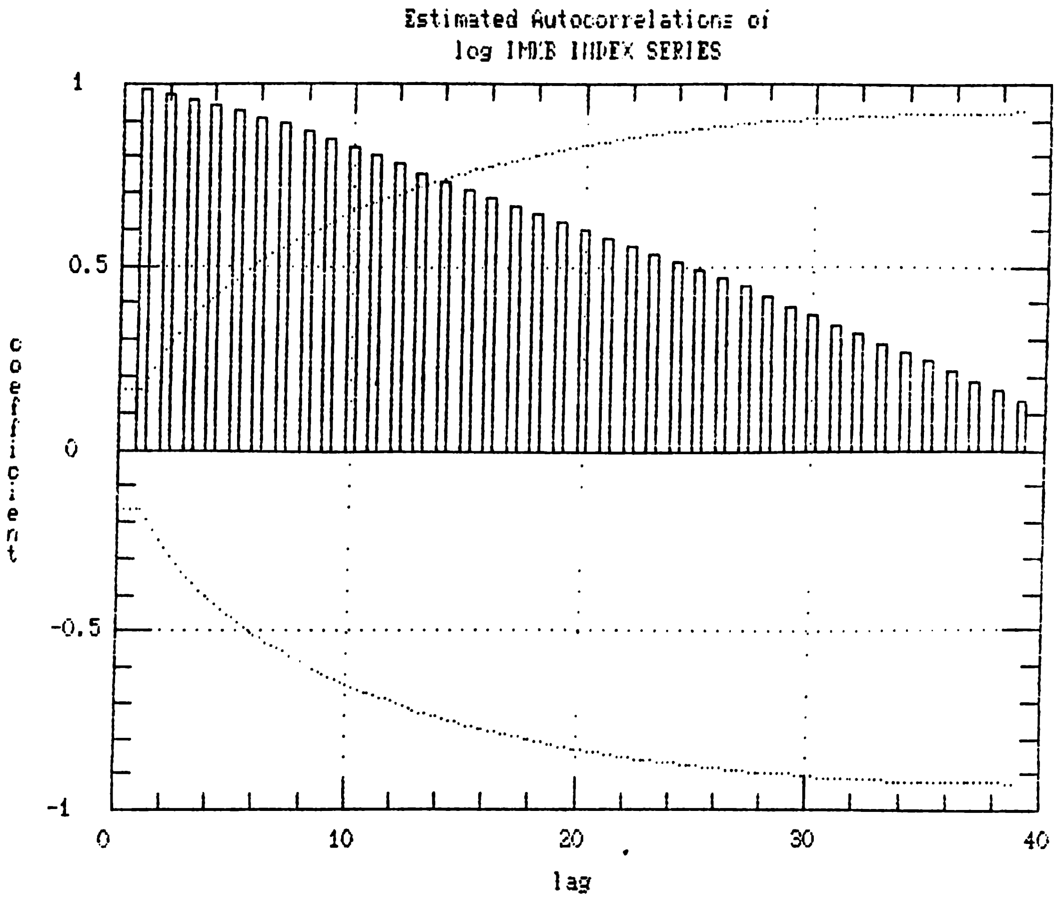
The Complete Analysis of iMKB-index including,

1) ACF of price index,
2) ACF of log price index,
3) ACF of differenced log price index (ie. returns)
4) ACF of squared returns
5) ACF of absolute returns.



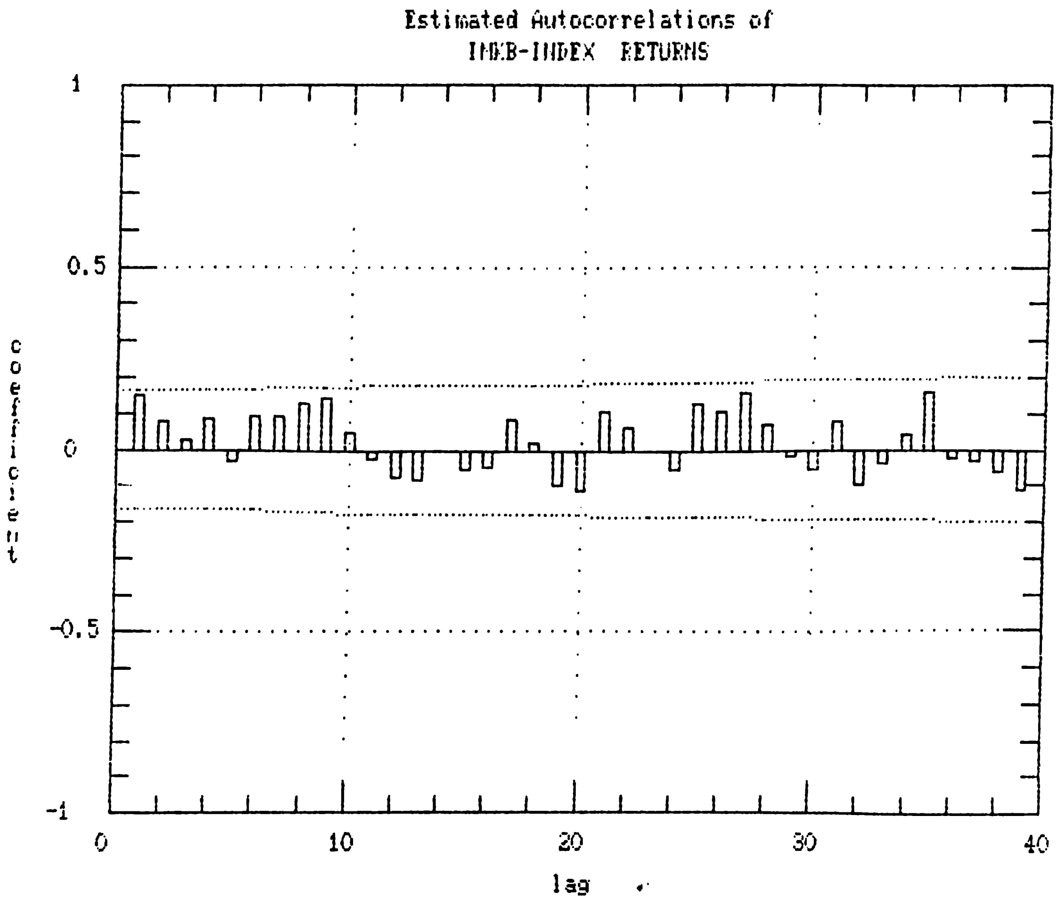
Estimated autocorrelations for D:IMKB.index

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.98023	.08006	2	.95359	.13685
3	.92584	.17432	4	.89782	.20341
5	.86627	.22740	6	.83566	.24765
7	.80550	.26511	8	.77368	.28036
9	.73845	.29373	10	.69829	.30540
11	.65762	.31547	12	.61969	.32414
13	.58558	.33164	14	.55523	.33821
15	.52712	.34400	16	.50391	.34914
17	.48434	.35377	18	.46142	.35800
19	.43575	.36179	20	.41370	.36514
21	.39620	.36813	22	.37652	.37085
23	.35659	.37330	24	.33852	.37547
25	.32190	.37742	26	.30124	.37918
27	.27724	.38071	28	.24941	.38200
29	.22051	.38304	30	.19345	.38386
31	.16815	.38448	32	.14123	.38495



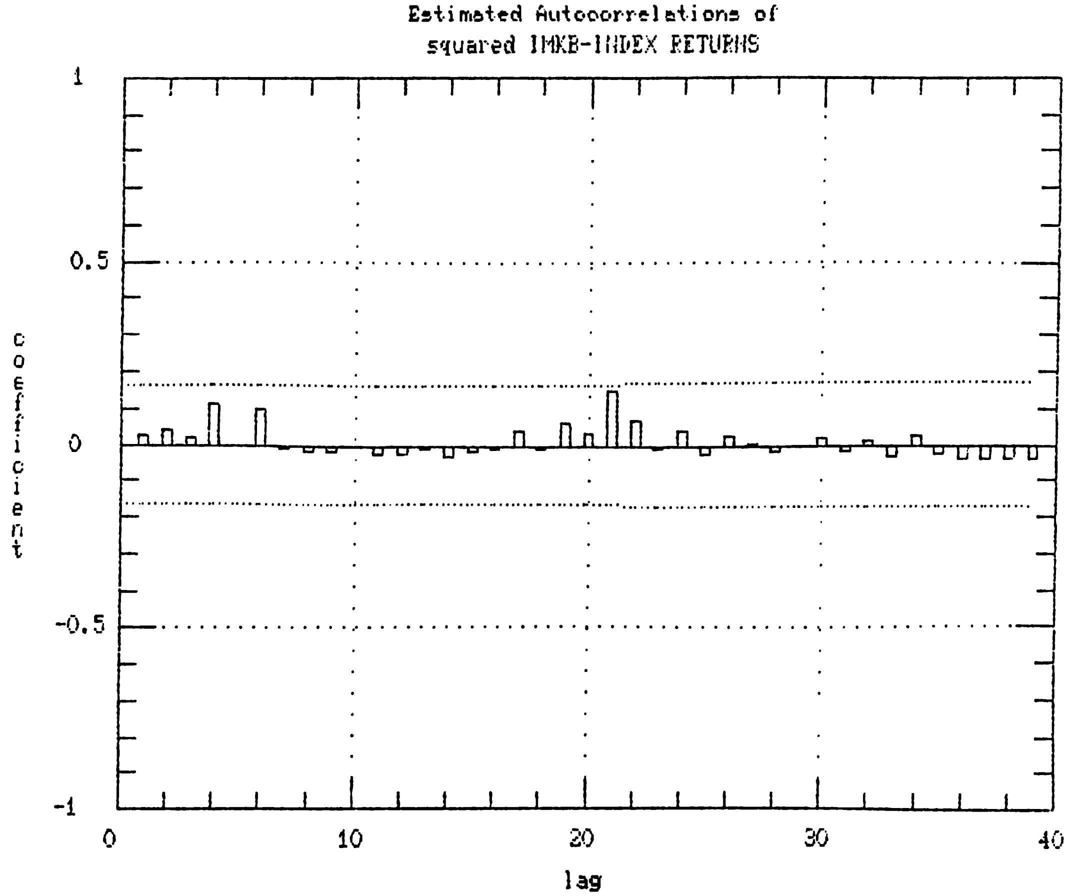
Estimated autocorrelations for D:IMKB.logp

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.98540	.08006	2	.97076	.13733
3	.95588	.17590	4	.94071	.20653
5	.92406	.23238	6	.90759	.25485
7	.88978	.27479	8	.87057	.29267
9	.84949	.30883	10	.82631	.32346
11	.80237	.33672	12	.77814	.34876
13	.75462	.35972	14	.73209	.36973
15	.70942	.37890	16	.68747	.38733
17	.66599	.39507	18	.64386	.40220
19	.62113	.40876	20	.59950	.41476
21	.57914	.42028	22	.55736	.42536
23	.53474	.43002	24	.51228	.43426
25	.49090	.43812	26	.46802	.44163
27	.44376	.44480	28	.41779	.44763
29	.39159	.45012	30	.36568	.45230
31	.34042	.45419	32	.31483	.45582



Estimated autocorrelations for D:IMKB.rate

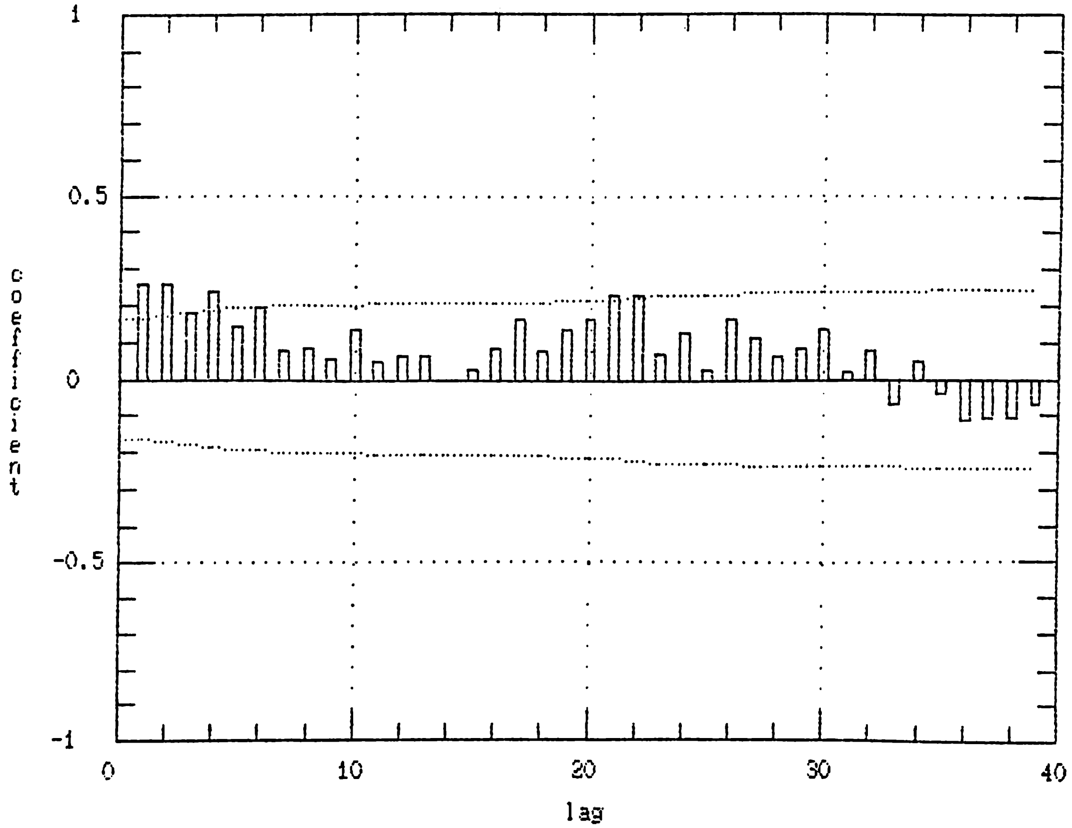
Lag	Estimate	Stnd. Error	Lag	Estimate	Stnd. Error
1	.14550	.08032	2	.07293	.08200
3	.02593	.08242	4	.08240	.08247
5	-.03584	.08300	6	.09231	.08310
7	.09035	.08376	8	.13046	.08439
9	.14410	.08568	10	.04925	.08723
11	-.02178	.08741	12	-.07869	.08744
13	-.08523	.08790	14	-.00009	.08843
15	-.05737	.08843	16	-.04862	.08867
17	.08508	.08884	18	.01843	.08937
19	-.09869	.08939	20	-.11524	.09009
21	.10353	.09104	22	.05947	.09179
23	-.00555	.09204	24	-.05598	.09204
25	.12614	.09226	26	.10224	.09337
27	.15935	.09409	28	.06619	.09582
29	-.01953	.09611	30	-.05120	.09614
31	.07772	.09631	32	-.09891	.09671



Estimated autocorrelations for D:IMKB.squared

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.02698	.08032	2	.03682	.08038
3	.02000	.08049	4	.11043	.08052
5	-.00562	.08149	6	.09662	.08149
7	-.01063	.08223	8	-.01536	.08224
9	-.01998	.08226	10	-.00398	.08229
11	-.02202	.08229	12	-.02235	.08233
13	-.01187	.08237	14	-.03203	.08238
15	-.01715	.08246	16	-.00973	.08248
17	.03777	.08249	18	-.01154	.08260
19	.05956	.08261	20	.03529	.08289
21	.14924	.08298	22	.07106	.08470
23	-.00789	.08508	24	.03763	.08509
25	-.02356	.08519	26	.02380	.08524
27	.00205	.08528	28	-.01870	.08528
29	-.00202	.08531	30	.01647	.08531
31	-.01730	.08533	32	.01155	.08535

Estimated Autocorrelations of
Absolute IMKB-INDEX RETURNS



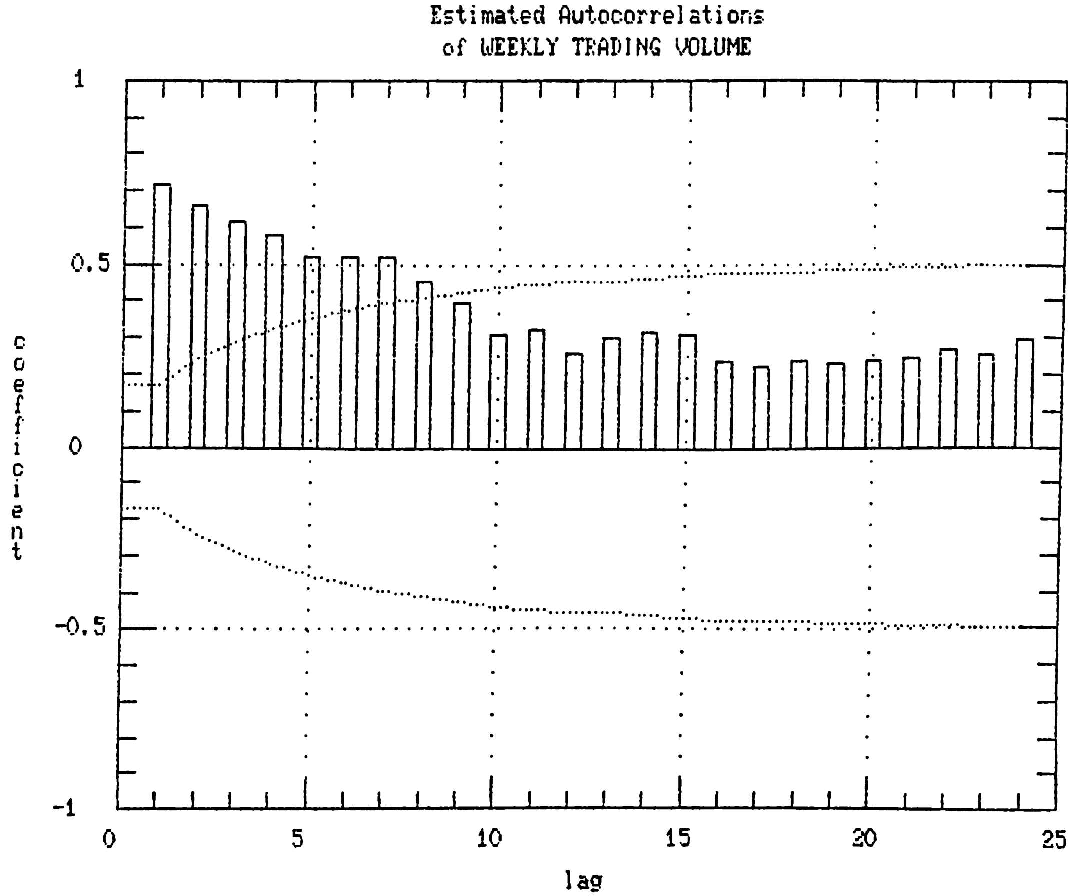
Estimated autocorrelations for D:IMKB.absolute

Lag	Estimate	Stnd.Error	Lag	Estimate	Stnd.Error
1	.26011	.08032	2	.25829	.08558
3	.17511	.09047	4	.23438	.09263
5	.14352	.09638	6	.19469	.09775
7	.07492	.10022	8	.08483	.10058
9	.05286	.10104	10	.13691	.10122
11	.04969	.10241	12	.05922	.10257
13	.06290	.10279	14	-.00611	.10303
15	.02817	.10304	16	.08127	.10309
17	.16687	.10350	18	.07406	.10522
19	.13313	.10556	20	.16425	.10663
21	.22673	.10825	22	.23176	.11128
23	.06980	.11435	24	.12854	.11462
25	.02500	.11555	26	.16215	.11558
27	.11206	.11704	28	.05902	.11773
29	.08136	.11792	30	.13654	.11828
31	.01708	.11930	32	.07929	.11931

A P P E N D I X - I

The Analysis of Weekly Total Trading Volume Including,

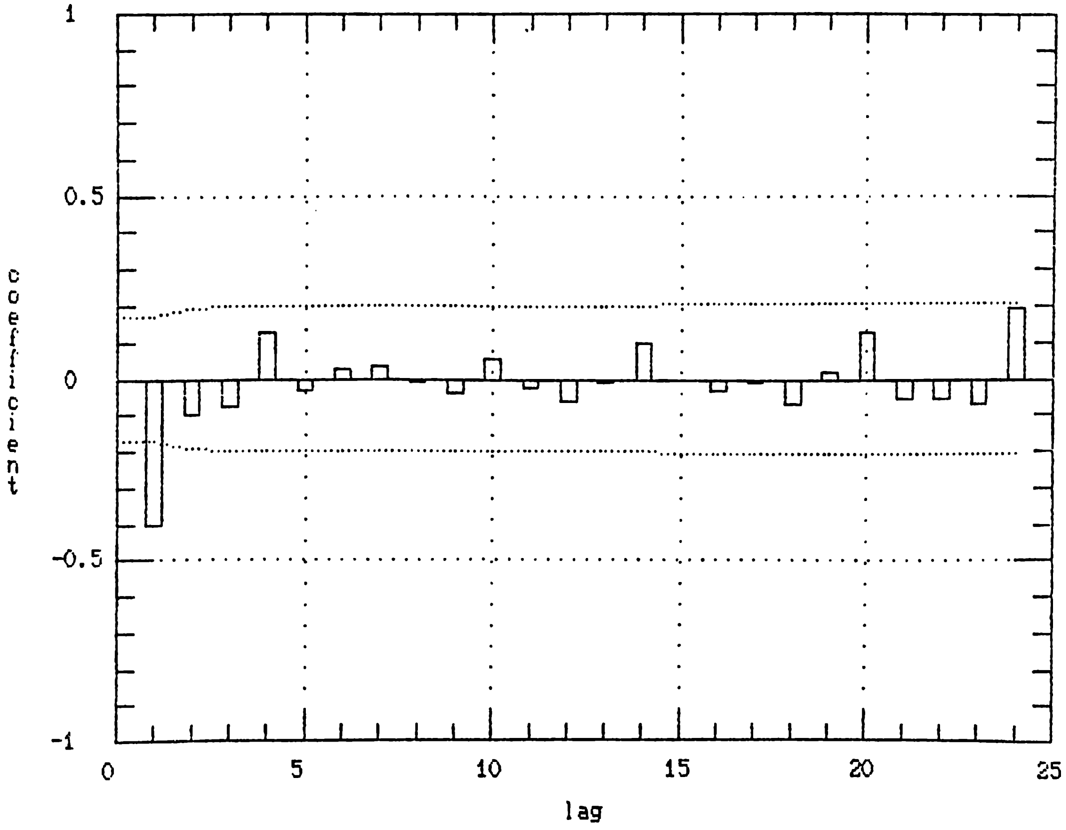
1) ACF of trading volume,
2) Summary statistics on rate of change in trading volume
3) ACF and PACF of rate of change in trading volume
4) Box-Jenkins ARMA model fitting and diagnostic checks for rate of change series.



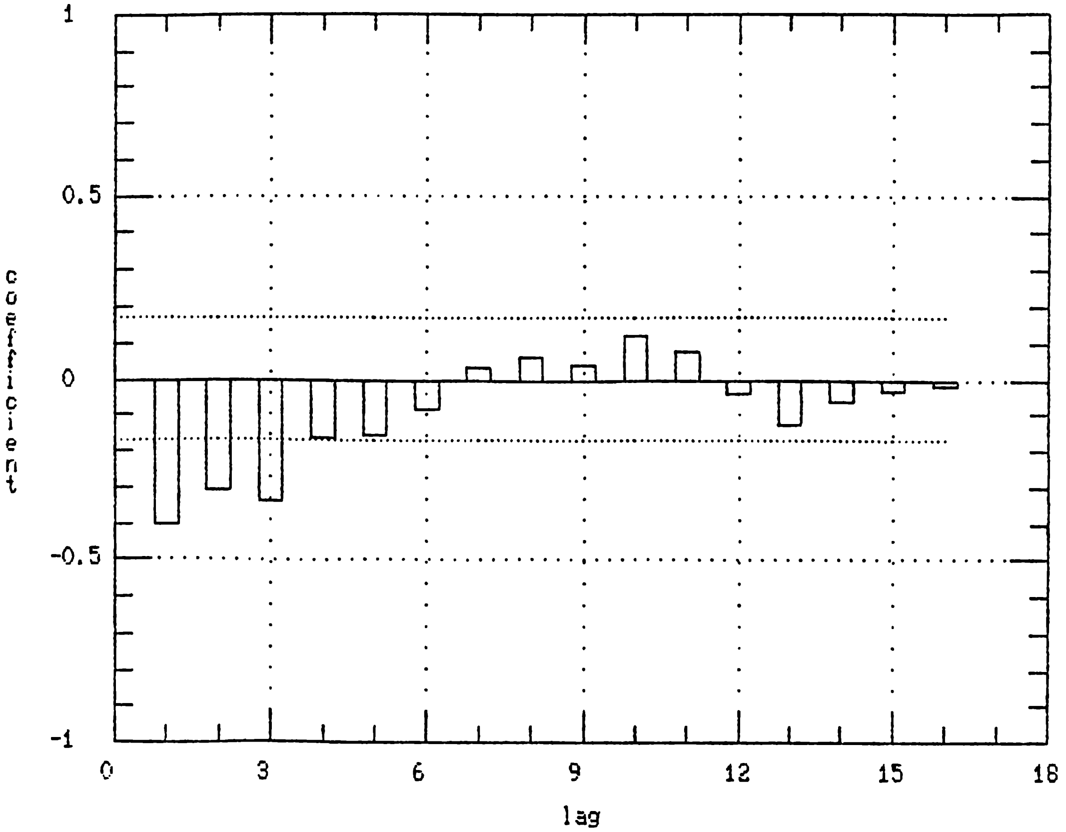
Summary Statistics on Rate of Change in Trading Volume

Sample size	138	
Average	0.017134	
Median	0.0143139	
Mode	3.41601E-3	
Variance	0.795802	(Note the high variance)
Standard deviation	0.892077	
Standard error	0.0759386	
Minimum	-4.21401	
Maximum	3.8385	
Range	8.05251	
Lower quartile	-0.394892	
Upper quartile	0.480048	
Interquartile range	0.87494	
Skewness	-0.376218	
Standardized skewness	-1.80428	
Kurtosis	5.94154	
Standardized kurtosis	14.2473	

Estimated Autocorrelations of
RATE OF CHANGE IN TRADE VOLUME



Estimated Partial Autocorrelations of
RATE OF CHANGE IN TRADE VOLUME

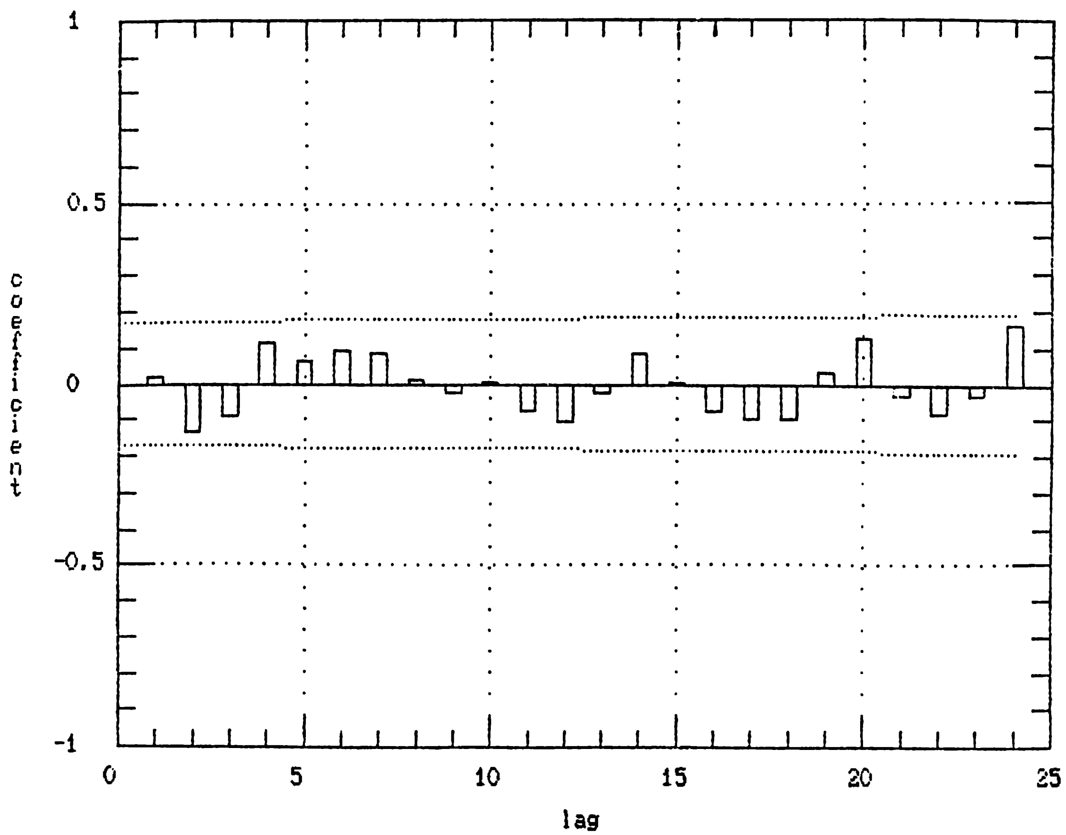


Summary of Fitted Model for : ratevol

Parameter	Estimate	Stnd.error	T-value	P-value
MA (1)	.72158	.05681	12.70068	.00000

Estimated white noise variance = 0.536768 with 137 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.732645
Chi-square test statistic on first 20 residual autocorrelations = 17.2258
with probability of a larger value given white noise = 0.574576
Backforecasting: no   Number of iterations performed: 3

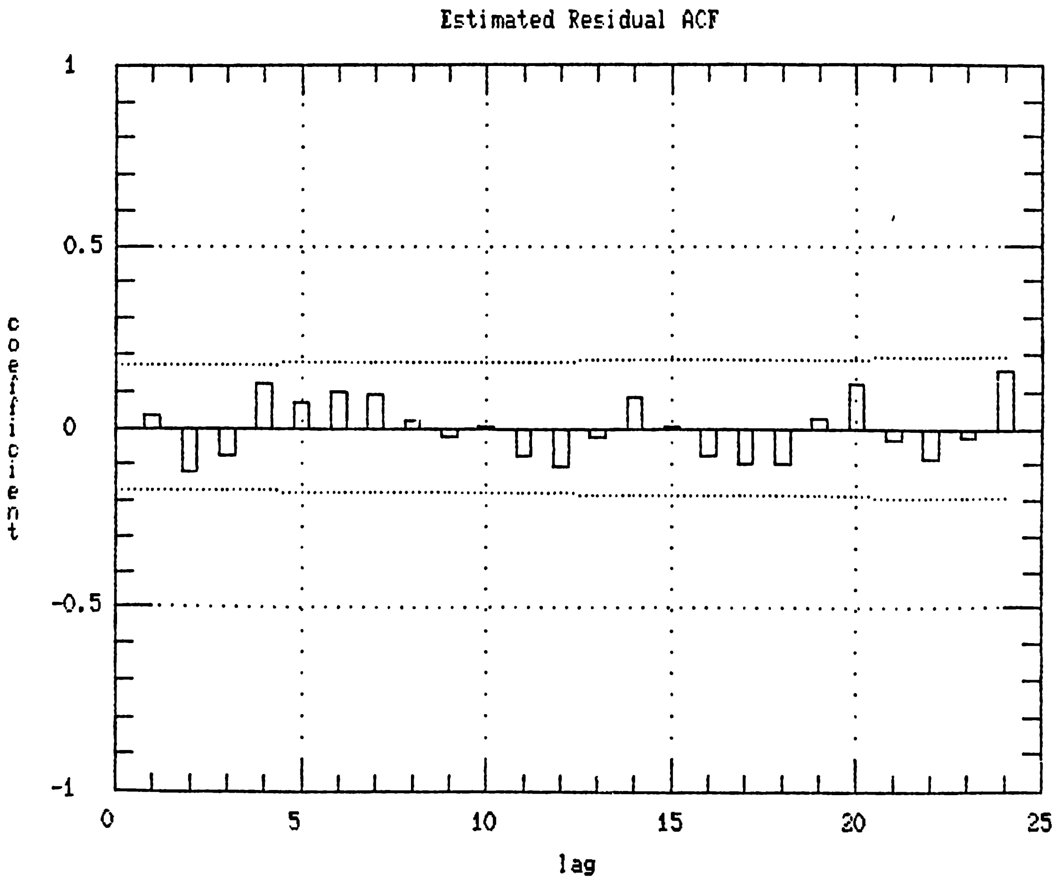
Estimated Residual ACF



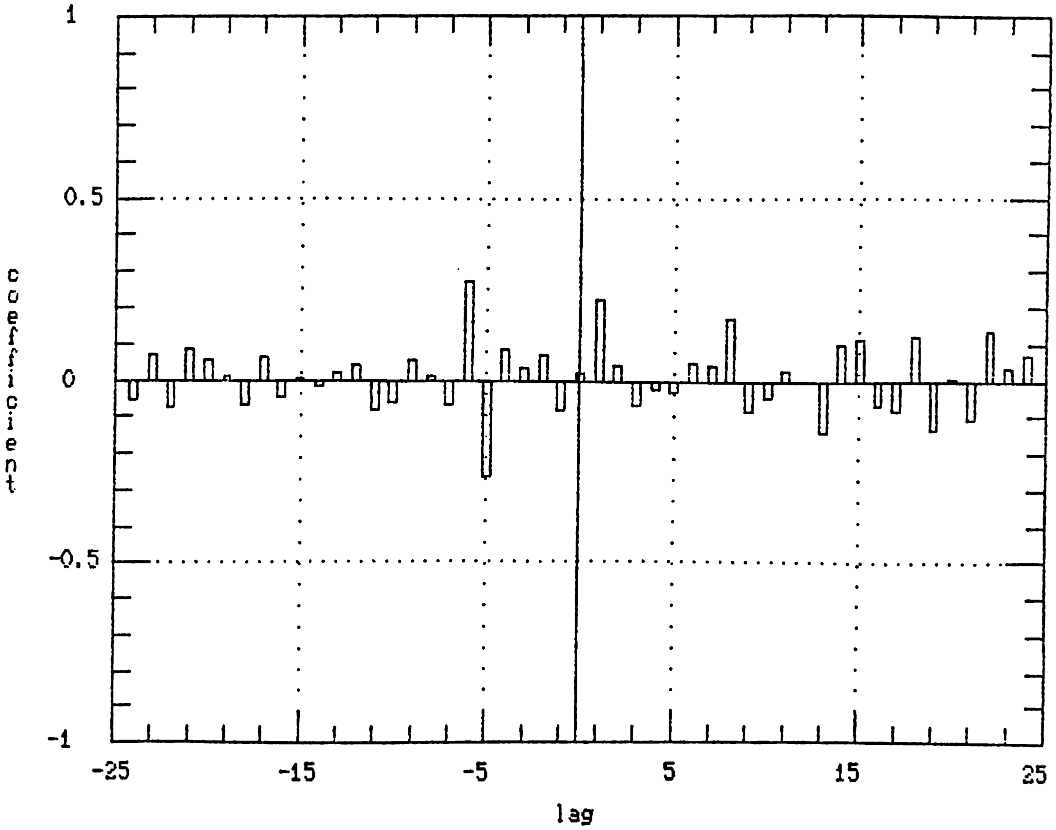
Summary of Fitted Model for: D:INDVOL.ratevol

Parameter	Estimate	Stnd.error	T-value	P-value
MA (1)	.74318	.05631	13.19855	.00000
MEAN	.02269	.01608	1.41096	.16054
CONSTANT	.02269			

Estimated white noise variance = 0.533596 with 136 degrees of freedom.
Estimated white noise standard deviation (std err) = 0.730477
Chi-square test statistic on first 20 residual autocorrelations = 17.176
with probability of a larger value given white noise = 0.577945
Backforecasting: no   Number of iterations performed: 3



A P P E N D I X - J



Estimated cross correlations between rate of change volume and index returns

Lag	Estimate	Lag	Estimate	Lag	Estimate	Lag	Estimate
-24	-.05552	-23	.07004	-22	-.07637	-21	.08440
-20	.05781	-19	.01419	-18	-.06737	-17	.06486
-16	-.04958	-15	.00053	-14	-.01980	-13	.02048
-12	.04039	-11	-.08180	-10	-.06274	-9	.05259
-8	.00799	-7	-.06848	-6	.27222	-5	-.26742
-4	.08398	-3	.02987	-2	.06669	-1	-.08106
0	.01617	1	.22282	2	.03772	3	-.06724
4	-.02734	5	-.03426	6	.04991	7	.04198
8	.16791	9	-.08222	10	-.05048	11	.02610
12	-.00599	13	-.14109	14	.09719	15	.11539
16	-.06697	17	-.08593	18	.11870	19	-.13167
20	.00228	21	-.10550	22	.13762	23	.03604
24	.06680						